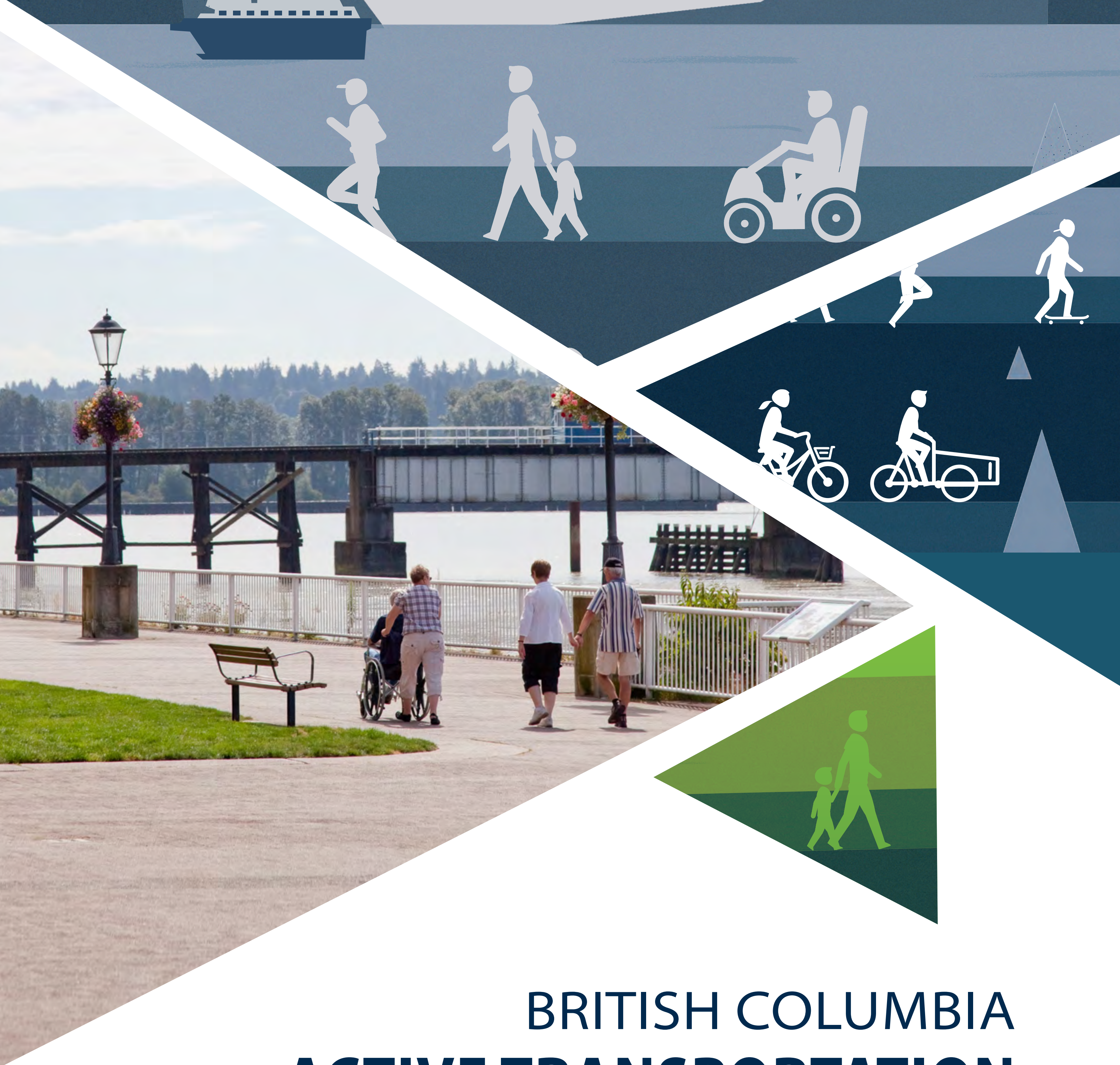

BRITISH COLUMBIA

ACTIVE TRANSPORTATION DESIGN GUIDE

2019 Edition

BRITISH COLUMBIA
Ministry of Transportation and Infrastructure

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ACKNOWLEDGMENTS

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BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

URBAN systems

ABOUT THE DESIGN GUIDE

The 2019 Edition of the Design Guide is a living document that will be updated to reflect evolving best practices and feedback from B.C. communities. MOTI encourages stakeholders across the province – including local and regional government staff, representatives of other government agencies, Indigenous communities, advocacy groups, professional associations, and academics – to review the Design Guide, apply it in real life, and provide feedback to help improve its contents. Please visit the MOTI website to provide feedback.

All photos courtesy of Urban Systems unless otherwise indicated.

Cover photo: New Westminster, B.C.

CLEANBC

The Design Guide is an initiative of ***CleanBC***, the provincial government's plan for achieving a prosperous, balanced, and sustainable future. *CleanBC* has a number of strategic focuses, including sustainable transportation; cleaner and more efficient technology; the introduction of new clean energy options; reducing and making better use of waste; significantly increasing industrial electrification; reducing emissions from forestry, land use and agriculture; and improving community design and services. More information can be found on-line at: www.cleanbc.gov.bc.ca.

cleanBC Active Transportation

FOREWORD

The Ministry of Transportation and Infrastructure is committed to improving our transportation networks that connect British Columbians from the places they live to the facilities they use daily.

As part of the Province's CleanBC plan to build a better future for all British Columbians, this new Design Guide helps transform how we get around in a way that reduces pollution and leads to better health outcomes for people, while making our communities cleaner and more liveable. Choosing to move under your own power can bring significant quality of life, health, and economic benefits.

The British Columbia Active Transportation Design Guide is a detailed planning and engineering reference that provides practical design guidance and application information for active transportation infrastructure for jurisdictions of all sizes throughout the province.

Building on international best practices, the Ministry of Transportation and Infrastructure initiated a broad review of active transportation infrastructure considerations in the development of this Design Guide. It incorporates theory, recent research, design concepts, best practices, new methodologies, and innovations to maximize the benefits of investing in active transportation infrastructure.

The Province thanks everyone who participated in the shaping of this Design Guide and we look forward to working with all stakeholders across B.C. to design and build infrastructure using this guidance. Working together we can build the best B.C. possible and enable everyone to choose active transportation.

Sincerely,

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Ministry of Transportation and Infrastructure

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District of Saanich, B.C.

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Multi-Use Pathway, Kidston Road, Coldstream B.C.

A.1

WHAT IS THE BRITISH COLUMBIA ACTIVE TRANSPORTATION DESIGN GUIDE?

This chapter introduces the document by providing an overview of the British Columbia Active Transportation Design Guide, including a summary of the purpose, scope, and goals of the Design Guide. This chapter also outlines the relationship to *CleanBC* and *Move. Commute. Connect: B.C.'s new strategy for cleaner, more active transportation*. Finally, this chapter summarizes the list of design guidelines that form the basis for this document, introduces the concept of design flexibility and need for professional judgement, and outlines legislative and other considerations.

PURPOSE

The British Columbia Active Transportation Design Guide is a comprehensive set of planning and engineering guidelines offering recommendations for the planning, selection, design, implementation, and maintenance of active transportation facilities across the province. The primary audience for the Design Guide is design professionals in the engineering, planning, landscape architecture, and architecture fields. It may also be a valuable resource for elected officials, community groups, and the general public.

The Design Guide brings together engineering principles and best practices from the municipal, provincial, national, and international levels. It was developed with input from a diverse range of stakeholders from across B.C. Stakeholders included staff from the provincial government as represented by the Ministry of Transportation and Infrastructure (MOTI), local and regional governments, Indigenous communities, advocacy groups, professional associations, and academics (see **Appendix A** for a full list of stakeholders who participated in the process).

The goals of the Design Guide are:

- To provide a reference that is **useful for communities of all types, sizes, and contexts**;
- To create **consistency in the design of active transportation facilities** throughout the province;
- To provide a **widely available resource** to increase the quality of the design of active transportation facilities throughout B.C. and beyond; and
- To **support provincial grant programs** with design guidance specific to B.C. to clarify the provincial government's expectations for the design of active transportation facilities.

SCOPE

The Design Guide addresses all human-powered modes of transportation, focusing primarily on walking, cycling, and rolling (see **Chapter B.1** for a full range and description of the various active transportation users). The Design Guide also discusses other emerging modes of transportation, including small, one-person electric vehicles (such as electric bicycles, e-scooters, segways, electric skateboards, and hoverboards). Furthermore, the Design Guide considers winter-based active modes (such as skiing, skating, kicksledding, and snowshoeing), water-based active modes (such as paddling, kayaking, and canoeing), and horseback riding, although these modes tend to be used more for recreation than daily transportation. Providing seamless connections to transit, ferries, and other forms of transportation is also a key focus of the Design Guide to enable an integrated, multi-modal transportation system serving the diverse needs of all British Columbians.

The Design Guide is intended to address daily active transportation needs and does not cover recreational trail development, such as dedicated hiking, cross-country skiing, or mountain biking trails. Furthermore, the Design Guide is not intended to provide detailed guidance for motor vehicle-related design elements such as medians, travel lane widths, or parking lane widths. Guidance for these elements can be found in other documents, including municipal, provincial, and national standards and guidelines.

RELATIONSHIP TO PROVINCIAL INITIATIVES

Active transportation is a key priority for the Government of British Columbia. The Design Guide is an initiative of *CleanBC*, the provincial government's plan for achieving a prosperous, balanced, and sustainable future. *CleanBC* has a number of strategic focuses, including:

- » **SUSTAINABLE TRANSPORTATION**
- » **CLEANER AND MORE EFFICIENT TECHNOLOGY**
- » **INTRODUCING NEW CLEAN ENERGY OPTIONS**
- » **REDUCING AND MAKING BETTER USE OF WASTE**
- » **SIGNIFICANTLY INCREASING INDUSTRIAL ELECTRIFICATION**
- » **REDUCING EMISSIONS FROM FORESTRY, LAND USE, AND AGRICULTURE**
- » **IMPROVING COMMUNITY DESIGN AND SERVICES**

The provincial government has also developed a B.C. Cycling Policy, which lays out a number of actions to improve cycling, including considering provisions for cycling on new and upgraded provincial highways, involving local and regional governments and interest groups as project stakeholders, considering all types of people who cycle when designing facilities, and providing consistent usage of signage and pavement markings. The B.C. Cycling Policy sets out the goal of integrating cycling on the province's highways wherever feasible by providing safe, accessible, and convenient bicycle facilities and by supporting and encouraging cycling.

To support this goal, the provincial government has been cost-sharing cycling infrastructure projects with local governments since 2008 through the BikeBC program.

The Design Guide was developed in parallel with *Move. Commute. Connect: B.C.'s new strategy for cleaner, more active transportation*, which engaged residents across the province to create a provincial framework to advance active transportation across B.C. This strategy provides the policy vision for B.C. and supports the provincial government's three key commitments to British Columbians: to make life more affordable, to deliver the services people count on, and to build a strong, sustainable economy.

APPLICATION OF THE DESIGN GUIDE

The Design Guide has been developed with two overarching applications in mind:

- To provide suggested guidance for local and regional governments for the planning, selection, design, implementation, and maintenance of active transportation facilities for projects under their jurisdiction, based on local, national, and international best practices.; and
- To provide suggested guidance for the planning, selection, design, implementation, and maintenance of active transportation facilities on roadways under provincial jurisdiction, recognizing the province's mandate and the current jurisdictional and legislative framework for active transportation within provincial rights-of-way (see **Chapter F.1**).

Providing design guidance for all B.C. communities requires a broad spectrum of design solutions, as B.C. is a vast province with a wide range of community types, geographies, and climate conditions. The planning and design of active transportation facilities can differ substantially between urban, suburban, and rural contexts. Furthermore, rural areas can be subdivided into different categories, each requiring unique considerations (see **Chapter B.2**). All designs should be applied with sound professional judgement that considers the unique context of each project – there is no one-size-fits-all solution to the design of active transportation facilities. See the Design Flexibility and Professional Judgement subsection on page A11 for further details.

The Design Guide offers best practice design solutions and encourages designing fully accessible facilities for people of all ages and abilities. However, it is recognized that active transportation facilities may not be appropriate or feasible on all roadways, and that context-specific constraints may make it challenging to create fully accessible facilities or facilities that are comfortable for people of all ages and abilities. Design professionals should strive to provide the best possible active transportation facility for the given context, even where the best practice design solution may not be feasible. See **Chapter B.2** for details regarding guiding principles, network planning, and facility selection.

The Design Guide is intended to be applied during the construction of new facilities and the rehabilitation of existing facilities. It is not intended as an assessment tool to measure existing facilities or to trigger rehabilitation projects.

Edgemont Boulevard, North Vancouver, B.C.

Provincial Context

At the provincial level, there are a number of regulations and pieces of legislation that shall be considered. The regulations made under the *B.C. Motor Vehicle Act (MVA)* outline the laws that govern the operation of all B.C. road users (including people driving motor vehicles, walking, cycling, and using other active modes), and define the rules of the road and related offenses and sanctions. Any facility under the provincial government's jurisdiction shall comply with the *B.C. MVA*. Pavement markings (such as cross-ride markings), regulations (such as cycling in a crosswalk), and traffic controls (such as bicycle signal heads) are not currently defined in the *B.C. MVA*.

Local and Regional Government Context

The *B.C. MVA* enables local and regional governments to regulate the operation of roads and road users through local bylaws. They may use these powers to allow new and emerging technologies or design elements on roads under their jurisdiction. Local governments (and road users) shall still abide by the *B.C. MVA* on roadways under MOTI jurisdiction within their communities.

An example of a local government using this power is the City of Vancouver, which amended its Road & Traffic Bylaw 2849 in 2017 to allow people cycling to ride in a crosswalk without dismounting, as long as the crosswalk is marked with elephant's feet cross-ride pavement markings – something that is not currently covered in the *B.C. MVA*. Local governments may also enact bylaws and regulations beyond the roadway, governing parks, pathways, and other areas that are not under the jurisdiction of the *B.C. MVA*.

RELATIONSHIP TO EXISTING STANDARDS AND GUIDELINES

The Design Guide does not outline mandatory standards or requirements. Rather, it provides recommended guidelines to assist the provincial government and local and regional governments in applying best practices to the planning, selection, design, implementation, and maintenance of active transportation facilities. The Design Guide is meant to supplement – not replace – any existing local, provincial, or national guidelines, standards, and regulations.

Furthermore, many local and regional governments rely on the provincial, national, and international reference documents listed on the next page. The Design Guide reflects a synopsis of the existing best practices and research that has been compiled with the applicability of the B.C. context in mind as of the time of publication in 2019. In general, the recommendations in the Design Guide align with the current national guidelines set out by the Transportation Association of Canada (TAC) and provincial guidelines. The Design Guide goes beyond the existing guidance in places, adding new material and covering some material in greater depth.

Reference Documents

The Design Guide incorporates relevant and recent research, guidance, best practices, and lessons learned regarding the planning, selection, design, implementation, and maintenance of active transportation facilities from local, provincial, national and international sources.

The reference documents reviewed for the Design Guide reflect current standards and best practices at the time of publication in 2019. However, it is recognized that best practices and research into the planning, selection, design, implementation, and maintenance of active transportation facilities is rapidly evolving. While the provincial government may update the Design Guide periodically to reflect emerging best practices, it is the responsibility of design professionals to ensure these guidelines are applied with an understanding of changing standards.

Definitions of key terminology used throughout the Design Guide are provided in the **Glossary** section at the end of the Design Guide. A complete list of reference documents is provided in the **References** section at the end of the Design Guide. The core reference documents that form the basis of the Design Guide are listed to the right.

Consider the Context

Because the Design Guide was developed based on national and international best practices, some active transportation facilities included in the Design Guide may not currently be allowed under existing federal, provincial, and/or local laws. All designs that are developed throughout the province that reference the Design Guide shall be carefully considered using sound professional judgement and shall consider legislative and site-specific constraints and risks based on local context, as well as the roles and responsibilities of the implementing jurisdiction.

Transportation Association of Canada (TAC) National Guidelines
Pedestrian Crossing Control Guide (2018)
Canadian Guide to Traffic Calming - Second Edition (2018)
Geometric Design Guide for Canadian Roads (2017)
Manual of Uniform Traffic Control Devices for Canada (MUTCDC) - Fifth Edition (2014)
Traffic Signal Guidelines for Bicycles (2014)
Bikeway Traffic Control Guidelines for Canada - Second Edition (2012)
Guide for the Design of Roadway Lighting (2006)
Illumination of Isolated Rural Intersections (2001)

Province of British Columbia Guidelines
B.C. Supplement to TAC Geometric Design Guide 2019 – 3rd Edition (2019)
B.C. Community Road Safety Toolkit (2018)
Design Exception Process (Technical Circular T-05/18) (2018)
Bridge Standards and Procedures Manual (2016)
2016 Standard Specifications for Highway Construction (2016)
Overview of B.C. Highway Functional Classification (2014)
Electrical and Traffic Engineering Manual (2013)
British Columbia's Bicycle Traffic Control Guidelines – Unpublished Draft (2012)
Manual of Standard Traffic Signs & Pavement Markings (2000)
Pedestrian Crossing Control Manual for British Columbia (1994)

Local, Regional, National, and International Guidelines

Alberta Transportation et al.: Alberta Bicycle Facilities Design Guide (2019)

Federal Highway Administration (FHWA): Bikeway Selection Guide (2019)

National Association of City Transportation Officials (NACTO): Don't Give Up At The Intersection - Designing All Ages and Abilities Bicycle Crossings (2019)

AC Transit: Multimodal Corridor Guidelines (2018)

BC Transit: BC Transit Infrastructure Design Summary (2018)

TransLink: Bus Infrastructure Design Guidelines (2018)

Canadian Standards Association (CSA): B651-18 – Accessible Design for the Built Environment (2018)

Capital Regional District: Capital Region Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Planning Guide (2018)

City of Vancouver: Engineering Design Manual (1st ed.) (2018)

Transport Canada: Safety Measures for Cyclists and Pedestrians around Heavy Vehicles (2018)

City of Vancouver: Transportation Design Guidelines: All Ages and Abilities Cycling Routes (2017)

FHWA: Accessible Shared Streets – Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities (2017)

NACTO: Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities (2017)

CROW (Netherlands): Design Manual for Bicycle Traffic (2016)

FHWA: Small Town and Rural Multimodal Networks (2016)

NACTO: Global Street Design Guide (2016)

Transport Canada: Grade Crossing Standards and Regulations (2016)

Association of Pedestrian and Bicycle Professionals (APBP): Essentials of Bike Parking (2015)

FHWA: Separated Bike Lane Planning and Design Guide (2015)

Massachusetts Department of Transportation (MassDOT): Separated Bike Lane Planning & Design Guide (2015)

Portland Bureau of Transportation: Neighbourhood Greenway Assessment Report (2015)

Alberta Transportation: Trails in Alberta Highway Rights-of-Way Policies, Guidelines, and Standards (2015)

CSA: S6-14 – Canadian Highway Bridge Design Code (2014)

NACTO: Urban Bikeway Design Guide (2014)

Ontario Traffic Council: Ontario Traffic Manual (OTM) Book 18: Cycling Facilities (2014)

Transport for London: London Cycling Design Standards (2014)

City of Boston: Boston Complete Streets – Design Guidelines (2013)

City of Cambridge: Bicycle Parking Guide (2013)

City of Copenhagen: Focus on Cycling: Copenhagen Guidelines for the Design of Road Projects (2013)

Cycling Embassy of Denmark: Collection of Cycle Concepts 2012 (2012)

American Association of State Highway and Transportation Officials (AASHTO): Guide for the Development of Bicycle Facilities (2012)

Capital Regional District: Capital Regional District Pedestrian and Cycling Master Plan Design Guidelines (2011)

APBP: Bicycle Parking Guidelines 2nd Edition (2010)

BC Transit: Infrastructure Design Guidelines (2010)

Vélo Québec: Planning and Design for Pedestrians and Cyclists (2010)

Portland State University: Fundamentals of Bicycle Boulevard Planning & Design (2009)

City of Vancouver: Accessible Street Design (n.d.)

DESIGN FLEXIBILITY AND PROFESSIONAL JUDGEMENT

The guidance provided in the Design Guide is based on the premise that the design of transportation infrastructure is contextual; design flexibility is needed to reflect site-specific conditions and to enhance safety and comfort for all travel modes, particularly vulnerable users such as people walking and cycling. No single document can address the range of situations encountered during a design process. It is therefore critical that the guidelines contained in this document are applied by a design professional exercising sound professional judgement. As noted above, some facilities recommended in the Design Guide may not currently be allowed under existing federal, provincial, and/or local laws. All designs that reference the Design Guide shall be carefully considered using sound professional judgement and shall consider legislative and site-specific constraints.

In an effort to provide design flexibility, the Design Guide includes specific, targeted language to describe where, and the extent to which, desirable design parameters may be varied to reflect site-specific challenges.

Design Choice

The Design Guide leaves ample room for design choice and flexibility. Design professionals should adhere to other established guidelines and standards and apply sound judgement, with the safety and comfort of all users of paramount importance.

The following are referenced throughout the document:

- **Desirable:** Desirable dimensions represent the recommended upper limit for most applications to achieve the highest quality facility design and maximize user safety, accessibility, and comfort.
- **Constrained Limit:** Constrained limit dimensions represent the recommended lower limit for most applications to achieve acceptable facility design and maintain user safety, accessibility, and comfort. The constrained limit may not be desirable, but could possibly be required due to site-specific constraints.
- **Minimum:** Minimum dimensions are generally below the constrained limit and should only be considered in exceptional circumstances.

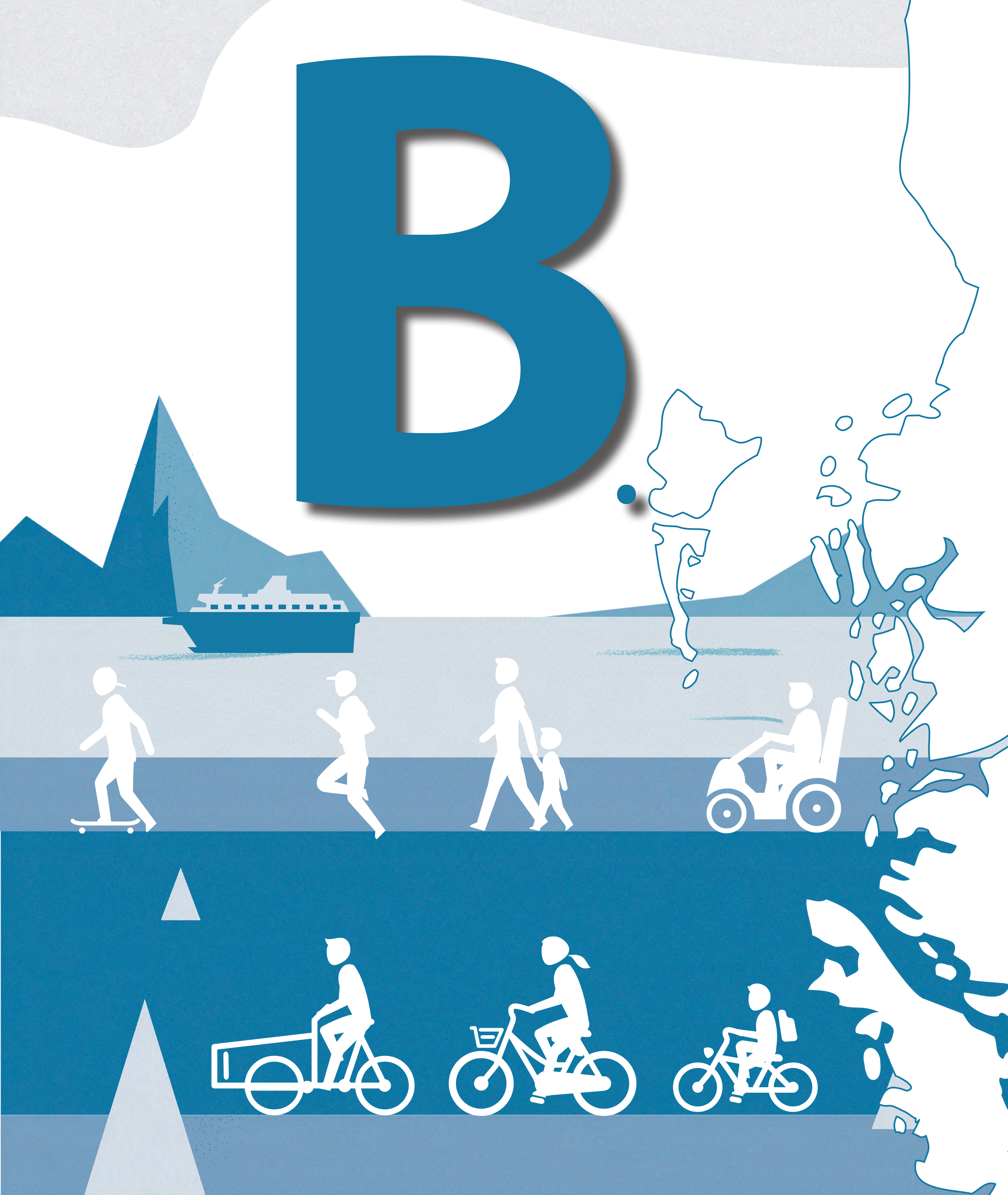
Where it is determined that certain guidelines cannot be achieved due to site-specific circumstances, professional judgement should be applied to satisfy safety, operational, and other facility design considerations. It should be noted that choosing a design that follows minimum or constrained limit width dimensions may require retrofitting at additional cost in the future, especially as user volumes increase. Design professionals should identify situations where relevant guidelines have not been adhered to, document the rationale for doing so, and monitor the safety of any such facility to make changes as needed. TAC provides direction for documenting design exceptions in the TAC *Geometric Design Guide for Canadian Roads*, Chapter 1, Section 1.5.

DESIGN GUIDE ORGANIZATION

The Design Guide is organized into nine overarching sections, each containing a number of chapters covering more detailed topics. Throughout the Design Guide, a number of **Case Studies** have also been included to highlight examples of active transportation facilities and programs, and **Reference Notes** have been provided to summarize recent relevant research. Key pieces of information have been highlighted with colour throughout the guide. The Design Guide sections are introduced below:

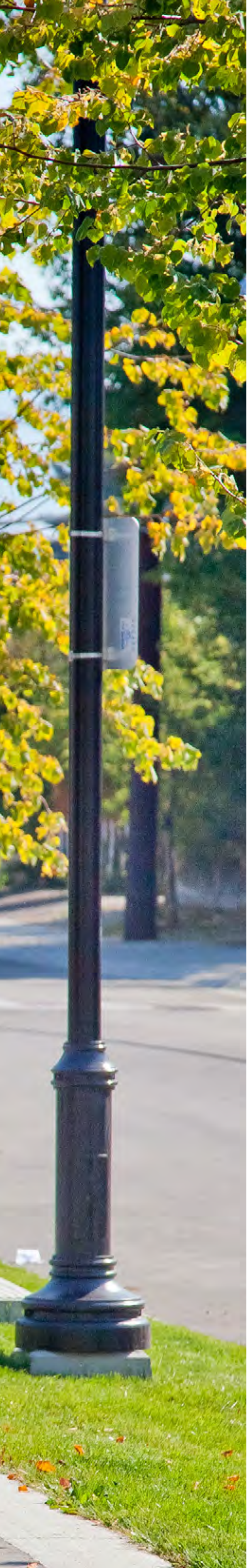
1. **Sections A and B** introduce the Design Guide and set out the planning and design framework, including basic design parameters, universal design considerations, and behavioural and operating characteristics.
2. **Sections C, D, and E** provide mode-specific guidance covering pedestrian, bicycle, and multi-use facilities.
3. **Section F** provides an overview of active transportation facilities on roadways under provincial jurisdiction, outlining the province's mandate and describing which facilities are appropriate.
4. **Section G** provides guidance for intersections and crossings, which are some of the most complex and important parts of an active transportation facility.
5. **Section H** describes amenities including multi-modal integration, end-point facilities, wayfinding, lighting, , and new modes of transportation.
6. **Section I** describes important post-implementation considerations, including celebrating and launching new facilities, monitoring and reporting, and maintenance.
7. A **Glossary** is provided to outline key terminology used throughout the Design Guide.
8. **References** used throughout the Design Guide are outlined in a reference list.
9. **Appendix A** contains a full list of stakeholders who participated in the process by attending webinars, completing an on-line survey, and/or providing direct input to the process. Stakeholders included staff from the provincial government, local and regional governments, representatives of other government agencies, Indigenous communities, advocacy groups, professional associations, and academics.
10. **Appendix B** outlines the signage and pavement markings that are relevant to active transportation facilities.
11. **Appendix C** provides specific design guidance for various traffic calming and traffic diversion measures.

B.



SETTING THE CONTEXT

Multi-Use Pathway, Cawston Avenue, Kelowna, B.C.



B.1

WHAT IS ACTIVE TRANSPORTATION?

Active transportation includes any form of human-powered transportation, including walking, cycling, or rolling using a skateboard, in-line skates, wheelchair, or other wheel-based forms of human-powered transportation. It also includes winter-based active modes, water-based active modes, and horseback riding, although these modes are typically more recreational in nature.

This chapter describes these various modes of active transportation, outlines the benefits of active transportation, and provides key considerations to ensure that active transportation facilities are accessible for everyone, regardless of age, ability, location, background, or season.

TYPES OF ACTIVE TRANSPORTATION

Active transportation can take many forms and is continually evolving as new technologies emerge. Active transportation most commonly refers to people walking or cycling, but can also include people rolling, using winter-based modes, or using water-based modes. In addition, active transportation increasingly includes emerging forms of technology such as electric bicycles and small, one-person electric vehicles. Multi-modal integration is also a critical component of any active transportation network. Active transportation users often utilize many different transportation modes throughout their journey, so it is important to ensure that all modes are safe, appealing, and convenient for all users. Refer to **Chapter H.1** for further detail on multi-modal integration. A detailed list of active modes of transportation is provided below.

TYPES OF ACTIVE TRANSPORTATION

Walking includes people walking dogs, people jogging, and people using mobility devices such as wheelchairs, walkers, and strollers.

Cycling includes all people travelling by bicycle using a full range of types of bicycles such as bicycles with trailers, children's bicycles, recumbent bicycles, cargo bicycles, electric bicycles, adult tricycles, fat tire bicycles, and bicycles built for people with mobility challenges. Refer to **Chapter B.4** for further detail on different types of bicycles.

Rolling includes people skateboarding, longboarding, scootering, in-line skating, and roller skiing.

TYPES OF ACTIVE TRANSPORTATION

Winter-based modes include modes that require conditions only available during colder winter months such as cross-country skiing, snowshoeing, kicksledding, and ice skating.

Water-based modes include connections to active forms of marine transportation, such as canoeing, kayaking, and stand-up paddle boarding. Although these are more frequently considered recreational-based activities that are less viable as forms of transportation, there are opportunities for communities to provide easier access points to these activities and identify potential locations for docks and lock up stations to safely secure canoes, stand-up paddle boards, kayaks, and other devices.

Small, one-person electric vehicles include e-scooters, electric skateboards, hoverboards, segways, self-balancing electric unicycles, and other emerging modes. Refer to **Chapter H.5** for further detail on new forms of mobility.

BENEFITS OF ACTIVE TRANSPORTATION

Communities across B.C. and throughout the world are increasingly recognizing the value of investing in active transportation. Investments in active transportation can result in a more balanced transportation system that is accessible, cost-effective, and more equitable in terms of a community's infrastructure investments. There are also significant quality of life, health, safety, and economic benefits associated with investing in active transportation.

Environmental benefits. Transportation is one of the largest contributors to greenhouse gas (GHG) emissions in B.C. Active transportation can help to reduce motor vehicle trips, congestion, air pollution, and GHG emissions. Promoting active transportation also helps with efforts towards climate change mitigation while supporting the protection and improvement of the natural environment.

Economic benefits. Active transportation, as part of a balanced, efficient, and accessible transportation system, is one of the drivers of success for economic diversity and prosperity. Neighbourhoods and destinations that are accessible and attractive for people using active transportation can attract more visitors, who can in turn be patrons of local services and amenities. Active transportation also provides more choices for people travelling to work, school, services, and other daily destinations, which is essential for British Columbians who would prefer to spend less on transportation or who do not have access to motor vehicles or transit.

Health benefits. A significant body of research has found links between investments in active transportation and increased rates of physical activity and healthier communities. Regular physical activity reduces the risk of early death and numerous chronic diseases. Physical activity has been proven to improve psychological well-being and prevents weight gain and obesity. While the benefits of physical activity have been well documented, low levels of physical activity in children and adults is still prevalent and continues to increase. Active transportation is one of the most affordable and accessible ways for British Columbians to add exercise to a daily routine.

Societal benefits. Active transportation facilities provide affordable and accessible transportation choices for people of all ages and abilities. High levels of active transportation in a community is a strong indicator of sustainability and livability. Active transportation encourages social interaction, creating opportunities for face-to-face interactions with members of the community and building trust, respect, understanding, and a sense of co-operation among members of the community. Studies have shown that social interactions diminish when motor vehicle volumes increase and walking infrastructure decreases. These social connections are found to be particularly important for youth, as they can develop sustainable travel patterns at an early age that can continue later in life. Social connections are also important for older adults, enabling them to stay active for longer and maintain physical and mental health.

Safety benefits. Making B.C. roads safer is paramount. Properly designed active transportation facilities that provide dedicated spaces for active transportation users and enhance their visibility within the roadway have the potential to reduce the risk of collisions and create a safer transportation system for all road users. Roads designed for slower motor vehicle speeds feel safer for active transportation users. Furthermore, studies have shown that slower motor vehicle speeds decrease the probability of serious injury and death for active transportation users (see **Chapter B.4**).

District of Saanich, B.C.
Source: District of Saanich

District of North Vancouver, B.C.

Vision Zero

The Design Guide, along with other resources such as the B.C. Community Road Safety Toolkit, provides guidance that helps to support the provincial Vision Zero initiative. Vision Zero is an approach that is intended to bring together all of B.C.'s road safety partners towards the ultimate goal of zero traffic fatalities and zero serious injuries.

MOBILITY FOR ALL

Design professionals should aspire to create active transportation facilities that are comfortable, convenient, safe, and attractive for everyone, regardless of age or ability. This is often referred to as 'All Ages and Abilities', 'AAA', or 'Triple A' facilities in active transportation design. Planning and designing for people of all ages and abilities is a national and international best practice that should be aspired to for all active transportation facility design and network implementation. In addition, active transportation facilities should be accessible at all times of day, in all seasons, and in all weather conditions, with maintenance and operations considered at the outset of the planning and design process and on an ongoing basis.

The following considerations for inclusive mobility have shaped the recommendations in the Design Guide:

- **Equitable.** Equity as it relates to transportation refers to the distribution of impacts (benefits and costs) and whether the distribution of impacts is considered fair and appropriate. Equity impacts can include the quality of available transportation choices, indirect and external costs, transportation expenditures, and public resource allocation, among others. Well designed and maintained facilities make access to transportation more equitable by allowing active modes to travel safely and comfortably.

- **Inclusive.** The transportation system should be designed to be inclusive to everyone, regardless of their socio-economic or demographic background. The Design Guide has been developed following gender based analysis plus (GBA+) principles. GBA+ is an analytical process used to assess how diverse groups of people may experience policies, programs, and initiatives. The 'plus' in GBA+ acknowledges that GBA goes beyond biological (sex) and socio-cultural (gender) differences. This also includes ensuring that people of all incomes, cultures, and socio-economic backgrounds have access to active transportation facilities, including Indigenous communities, new immigrants, and low-income groups.
- **Age-Friendly.** In order to design a transportation system that is welcoming for people of all ages, it is critical to focus on those with unique travel needs, such as older adults and seniors, as well as children and youth. Older adults and seniors may experience slowing reflexes, vision loss, slower walking speeds, difficulty hearing vehicles, decreasing cognitive ability, and reduced endurance requiring periodic rest breaks. In addition, older adults and seniors may be less likely to drive a motor vehicle, resulting in increased reliance on active transportation, carpooling, or transit. Age-friendly active transportation facilities can help to provide older adults and seniors with the option to age in place while continuing to access community destinations.

  Similarly, children and youth typically do not have access to motor vehicles and are reliant on active transportation, carpooling, or transit to travel in their community. Children and youth have less experience at identifying hazards, have less developed depth perception, and may not be able to assess the speed of motor vehicle traffic. Due to their smaller size, children and youth are also less visible to motorists. Refer to **Chapter B.4** for more detail regarding the operational and behavioural characteristics of various active transportation users.
- **Accessible.** Accommodating people of all abilities should be a primary objective when designing active transportation facilities. Designing using universal design principles ensures that the built environment is accessible to people of all ages and abilities, regardless of any type of physical or cognitive impairment. It is important to fit the accessibility level to the context and location. Refer to **Chapter B.3** for more detail on universal design.
- **Safe.** More people will use active forms of transportation if they have safe places to walk, roll, and cycle. Increased numbers of active transportation users can also lead to 'safety in numbers,' which can raise awareness of active users and result in even safer roads. Better active transportation facilities are also directly correlated with increased safety for all road users. Poor or inadequate infrastructure forces people walking or cycling to choose between feeling safe and following the rules of the road. Not following the rules of the road can include wrong-way cycling, riding on sidewalks, or jaywalking, which are all often illegal unless noted otherwise through municipal bylaws or signage.

By applying these considerations, both the provincial government and local and regional governments can work towards creating active transportation networks and facilities that are safe and comfortable for people of all ages and abilities, all-year round.

Not every consideration may be achievable in all contexts. Design professionals should use these ideals to guide the planning and design processes, seeking to create the best possible facility within the unique constraints of each context.

Riding to the beach in Tofino, B.C.

B.2

PLANNING FOR ACTIVE TRANSPORTATION

This chapter provides an overview of the considerations and guiding principles for planning and designing active transportation facilities, covering a variety of key topics that should be considered by planning and design professionals. The planning and design of active transportation facilities can differ substantially depending on whether it is located in an urban, suburban, or rural context. This chapter introduces some of the nuances and terminology for addressing these contextual differences. Design considerations for preserving and protecting wildlife when designing active transportation facilities are also discussed.

The chapter then describes the key elements of streets, providing an overview of road classifications and the various road zones that will be referred to throughout the Design Guide. Active transportation users are also described, with notes on typical trip purpose and user characteristics. Cycling typologies are also introduced, helping to break down the potential market for bicycle facilities.

Network planning considerations are also examined, including land use and neighbourhood design, connectivity, multi-modal integration, and topography. An overview of a typical planning process is provided, along with some basic facility selection considerations. A number of retrofit strategies are provided for dealing with constrained rights-of-way.

Planning and designing for people of all ages and abilities within the transportation system is becoming a widely supported priority across the province. Reasons for prioritizing active transportation include: increasing constraints in urban areas, distance between communities, environmental factors, cost effectiveness concerns, and growing community demands for active transportation. All levels of government are now starting to think differently and adaptively about the development of active transportation networks and the application of active transportation design best practices. The planning considerations outlined in this chapter are intended to help design professionals address the considerations outlined on page B10 by understanding the existing conditions in their communities and by outlining key aspects to consider throughout the planning process.

GUIDING PRINCIPLES

The following guiding principles were developed based on national and international best practices and should be considered when planning and designing active transportation facilities. Active transportation facilities and networks should be:

- **Safe and Stress-Free**. Mitigating both real and perceived safety concerns is a crucial step in attracting active transportation users. In general, as the speed and mass differential between modes increases, so should separation between modes. Personal safety should be addressed by applying Crime Prevention Through Environmental Design principles (see **Chapter B.4**). Other health-related considerations include minimizing physiological stress (e.g. avoiding steep slopes and bumpy surfaces) and mitigating pollution from emissions and road noise.
- **Inclusive**. Active transportation facilities should consider the needs of users of all ages and abilities, including universal access for people with any form of physical or cognitive impairment (see **Chapter B.3**). Facility design should consider human behaviour and be forgiving of user error, accommodating mistakes in a way that mitigates negative outcomes.
- **Context Sensitive**. Climate, topography, land use, and other context-specific issues – both current and future – should be considered when planning and designing active transportation facilities. Active transportation facilities should support community goals and should seamlessly integrate with the public realm and other transportation facilities.
- **Cohesive and Direct**. Active transportation facilities should fit within a cohesive network that provides direct access to destinations such as commercial areas, employment areas, residential areas, and community amenities. Access to these destinations should be direct and achievable in short travel times to ensure active transportation is an attractive alternative to motor vehicles. Multi-modal cohesion is also important, with convenient connections to transit facilities, parking, and road networks.
- **Attractive and Intuitive**. Facilities should be comfortable and pleasant for people of all ages and abilities. They should be well maintained and may incorporate landscaping, public art, and amenities, making them attractive and welcoming for users. Active transportation facilities should also be predictable, recognizable, and consistent, making them intuitive for users of all modes.

URBAN, SUBURBAN, AND RURAL CONSIDERATIONS

The planning and design of active transportation facilities can differ substantially depending on whether they are located in an urban, suburban, or rural context. This context impacts land use, neighbourhood design, distance between destinations, road classification, and community expectations. In all contexts, safety for active transportation users is a key consideration that should be prioritized in all planning and design work.

In addition, the planning and design of active transportation facilities should consider the jurisdictional context. Most of the roadways under provincial jurisdiction throughout the province are high-speed numbered limited access highways. These highways focus on providing inter-regional and provincial transportation connections between communities. As such, many of these facilities are best suited for motor vehicle travel and goods movement. However, where facilities on roadways under provincial jurisdiction pass through urban, suburban, or rural contexts, and in unincorporated communities where the provincial government has jurisdiction over the road network, the considerations below may apply.

Urban Context

An urban context is typically understood to be a developed area within a city, district, town, or village. Urban environments typically provide a denser mix of land uses, which can be beneficial for active transportation. Researchers have found convincing evidence that people who live in communities characterized by mixed land use, well-connected road networks, and high residential density are more active than those who live in less dense communities.

Similar built form and mixed land uses can also appear in suburban neighbourhood centres and smaller rural communities including unincorporated communities that have relatively compact cores. In these contexts, design professionals should apply urban considerations when planning and designing active transportation facilities.

Suburban Context

A suburban context is an area of a city or a separately incorporated city or town with predominantly low-density, residential land uses. Suburbs may also contain clusters of commercial, retail, and employment areas, but land uses are typically more spread out and segregated compared to urban areas. Suburban road networks are often characterized by 'loops and lollipops' – a non-grid structure that can decrease the connectivity of the road network. Unlike most urban roads, some suburban roads may be designed without a curb, gutter, or sidewalk, similar to rural roads.

Rural Context

A rural context covers a range of community types. Rural contexts are an especially important consideration for the Design Guide. In many cases throughout the province, roadways under provincial jurisdiction pass through rural contexts, including both incorporated communities and unincorporated communities where the province has jurisdiction over all roadways.

Rural contexts can generally be divided into three categories: basic rural, outer developed rural, and developed rural cores (see **Figure B-1**). These categories do not necessarily align with municipal or regional boundaries, but rather are based on development patterns. This rural classification is conceptual and should not be considered firm classes – design professionals should consider the local context whenever planning and designing active transportation facilities.

1 **Basic Rural**. Communities with limited social or economic links to developed rural areas, with large distances between communities and destinations. In this context, many roadways may be under provincial jurisdiction, particularly for unincorporated rural communities. There may be limited demand for active transportation facilities, particularly for people of all ages and abilities.

2 **Outer Developed Rural**. Small communities from which people travel to developed rural cores for employment, services, shopping, school, or recreation. In this context, there is a greater need for active transportation facilities than basic rural areas to ensure connections to developed rural cores.

3 **Developed Rural Core**. Regional centres consisting of rural towns with concentrations of residents, services, businesses, and community destinations. In this context, design professionals should apply the urban context design considerations noted above when planning and designing active transportation facilities, and should consider the needs of people of all ages and abilities.

Population density and demand supportive of active transportation is often lower in rural areas. Nonetheless, many active transportation design features can be implemented in rural contexts. Developed rural cores can be ideal for active transportation. As networks develop, they may be comprised of varying facilities that appeal to a range of ages and abilities, such as off-street pathways, sidewalks, and bicycle lanes.

Many communities characterized as basic rural and outer developed rural are located along highways and roadways that were built to serve high-speed motor vehicle traffic, making them less desirable or comfortable for active transportation. Additionally, these communities are typically located long distances from services that are not offered within their communities. Demand for active transportation is typically lower in these areas. Over time, it is possible to redesign and retrofit these roadways to accommodate a transportation network that better accommodates active modes of transportation.

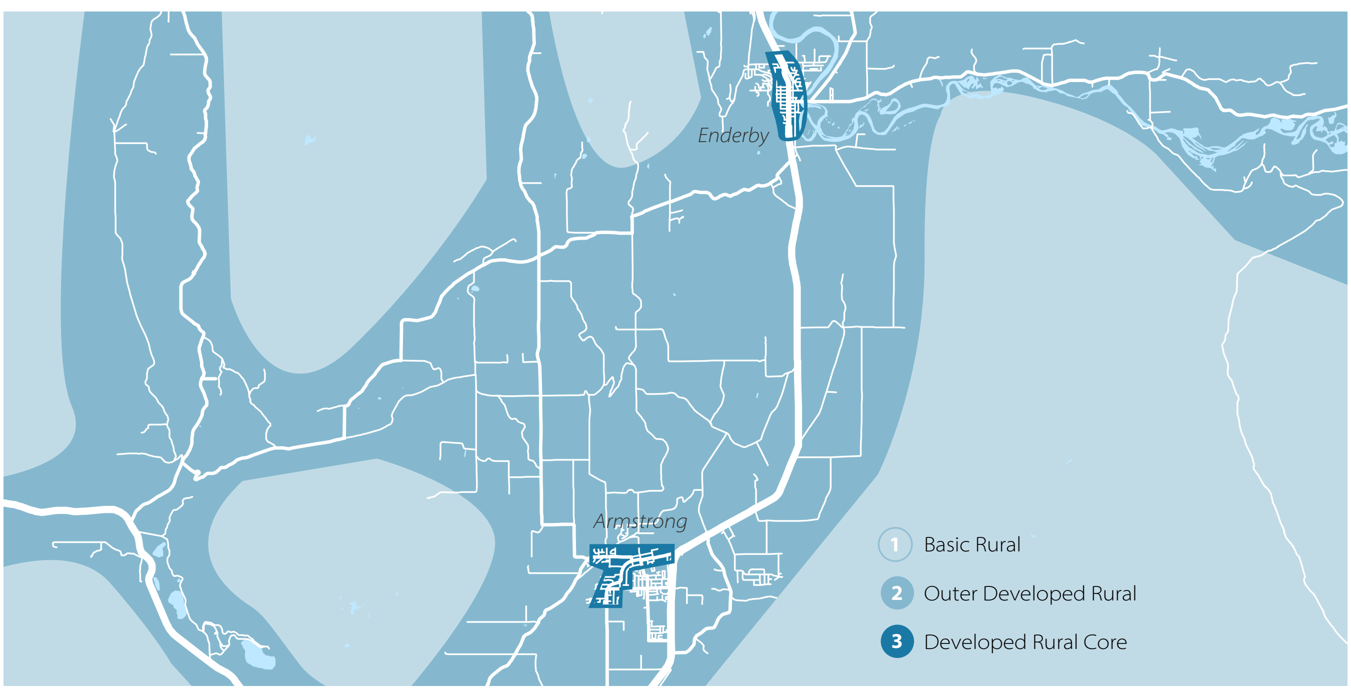


Figure B-1 // Conceptual Rural Classifications – Enderby, Armstrong, and Spallumcheen Area

Recommendations for facilities in rural contexts are provided throughout the Design Guide. Specific design guidance for rural contexts in the Design Guide is provided in the following chapters:

- **Chapter C.4**: Rural Pedestrian Design Considerations
- **Chapter D.6**: Rural Cycling Design Considerations
- **Chapter E.2**: Multi-Use Pathways
- **Chapter F.1**: Context Specific Applications
- **Section G**: Intersections + Crossings (relevant information throughout)

User comfort is an important aspect of a multi-modal network, regardless of the setting. Rural communities have great potential for creating viable networks that serve residents and visitors. Rural communities can offer access to retail businesses, schools, and other amenities within a relatively small community core. However, active transportation connections to neighbouring communities may be more challenging to accommodate, especially with facilities that are comfortable for people of all ages and abilities.

Other challenges that face rural communities may include the following:

- **Constrained Terrain**. Highways often have physical constraints that make the provision of cost effective facilities for those travelling by active means difficult.
- **Highway as a Main Street**. In some rural communities, a provincial highway is also the primary downtown main street. The highway mandate of safely and efficiently moving people and goods may conflict with the local community's desire for facilitating active transportation, commerce, and community activity. See **Chapter F.1** for more details regarding active transportation on roadways under provincial jurisdiction.
- **Safety**. High motor vehicle speeds, limited crossing opportunities, and a lack of dedicated space for active transportation may create safety concerns for active transportation users.
- **Climate and Maintenance**. Maintaining roads and active transportation networks in all weather conditions is a challenge across the province. Many local and regional governments do not have adequate resources to provide necessary snow removal or sweeping equipment.

ENVIRONMENTAL CONSIDERATIONS

In addition to considering the human context, the planning, design, and implementation of active transportation facilities should also consider and seek to mitigate impacts to the local environment. This could include:

- Impacts on wildlife habitat;
- Loss of riparian area;
- Introduction of invasive plants; and
- Erosion and sediment control.

Users of the Design Guide should investigate regulatory requirements for environmental consideration prior to initiating any infrastructure project.

DEFINING ROADS AND STREETS

Roads are designed to move people and goods from one place to another. They exist on a spectrum from high-speed, long distance links to low-speed, local connections, with a range of intended uses and roles within the transportation network. Roads are also a critical component of a community's public realm and can offer spaces for people to socialize, recreate, shop, and work. They have the potential to serve as vibrant, lively public spaces that enhance the quality of life for residents and encourage healthy, active living. Roads can also provide critical links to other types of public facilities and dedicated areas such as plazas, squares, transportation hubs, trail systems, greenways, and parks.

Complete Streets

The term 'complete streets' has been widely used to refer to roads that balance safety, access, and comfort for users of all modes, as opposed to the historic North American road design that typically prioritized motor vehicles. Complete streets are intended to be safe, comfortable, and universally accessible. They offer a wide range of benefits, including increased safety, sustainability, and cost effectiveness.

However, not every road can fulfill every function; road design is complex and must respond to varied land uses, local conditions, and constraints. Each road has a different role with unique design priorities – some are part of a public transit or goods movement network, for example, while others might be focused on prioritizing active transportation. Where priorities compete, such as where a numbered highway serves as a community's main street, there are many design challenges and trade-offs that must be negotiated.

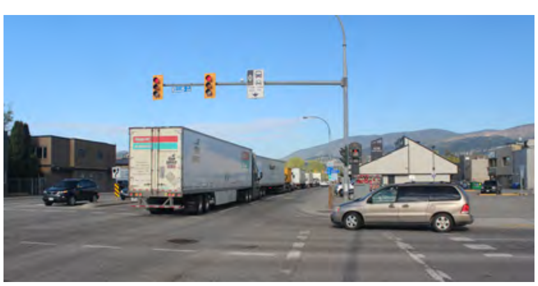
The surrounding built form plays a large role in road function, with some roads containing street-oriented buildings and others containing non-street oriented built form as seen below. A road's function may also differ depending on the time of day, day of the week, or season.

Street Classification and Terminology

The *B.C. MVA* uses the term 'highway' to describe 'every road, lane or right of way designed or intended for or used by the general public for the passage of vehicles.' To provide greater detail, the Design Guide uses the terms 'road' and 'street' While these terms may be

RELATIONSHIP OF BUILDING TO THE STREET

Street Oriented: Typically, adjacent land hosts road-facing buildings with minimum setbacks and entrances directly connected to the road, which supports the prioritization of active transportation.



Non-Street Oriented: Building setbacks are greater and building entrances may face away from the adjacent road. Often primary access is from neighbouring surface parking.

used interchangeably, 'street' is often used to describe lower speed corridors that emphasize multi-modal transportation, as opposed to 'roads' that are often in more rural contexts and prioritize motor vehicle travel, such as highways. The term 'street' also tends to have a more urban connotation implying a curb and gutter cross-section, whereas 'roads' may have either curb and gutter or an open shoulder cross- section.

Streets and roads are generally classified based on their typical functional and operational characteristics. Road classifications can be used to recommend values for design elements such as lane widths, speeds, geometry, and intersection design. Roads can be divided into functional, service, and design classes. Further details regarding street classification can be found in Section 100.11.1.3 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* and Section 2.6 of the TAC *Geometric Design Guide for Canadian Roads*.

Service Classes

Service classes describe physical design and access features. Common service classes include:

- Alley;
- Local;
- Collector;
- Arterial;
- Expressway; and
- Freeway.

Note that most freeways in B.C. are numbered highways under provincial jurisdiction. Other types of roads that may require consideration include shared streets, service or frontage roads, and cul-de-sacs.

Design Classes

Design classes are more detailed descriptions of service classes that consider the predominant characteristics of the adjacent land (e.g. urban or rural), whether the road is divided or undivided, and the design speed. Design classes are coded using alphanumeric abbreviations: Urban (U), Rural (R), Collector (C), Arterial (A), Expressway (E), Freeway (F), Divided (D), and Undivided (U). For example:

- RAU80 = rural arterial undivided street with an 80 km/h posted speed limit
- UAD70 = urban arterial divided street with a 70 km/h posted speed limit

Functional Classes

Functional classification groups streets according to the character of the service they are intended to provide. Higher function highways place more emphasis on mobility for through traffic, and lower function highways and roads place more emphasis on land access. B.C. highways are functionally classified into five groups:

- **Primary Highways** (typically freeways, expressways, or arterials);
- **Secondary Highways** (typically arterials but may include expressways or freeways);
- **Major Roads** (typically arterials but may include collectors);
- **Minor Roads** (typically collectors but may include arterials); and
- **Local Roads.**

The upper three functional classes – primary highways, secondary highways, and major roads – apply to the numbered highway system.

Street Zones

Streets can be divided into a series of zones that each serve a dedicated purpose, such as providing space for through traffic, accommodating people walking or cycling, or the installation of street furniture. **Figure B-2** shows the range of zones in an urban street setting, while **Figure B-3** shows the range of zones in a rural road setting. These are examples only – not all streets will contain each zone, and there are many street designs in both urban and rural settings. The placement and the geometry of the zones is flexible and dependent on available right-of-way, road class, and land use. The various street zones are described below.

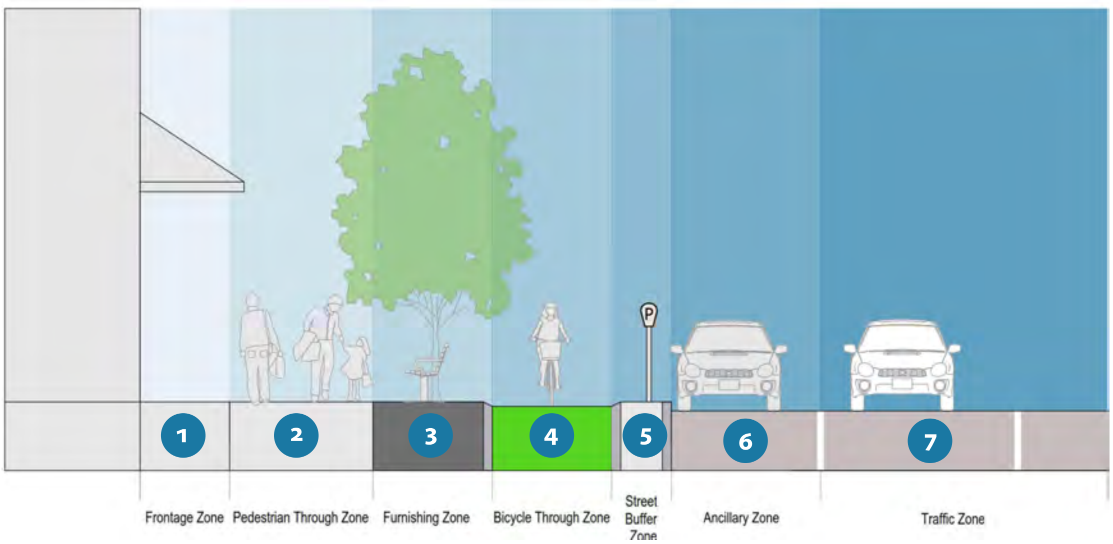


Figure B-2 // Urban Street Zones

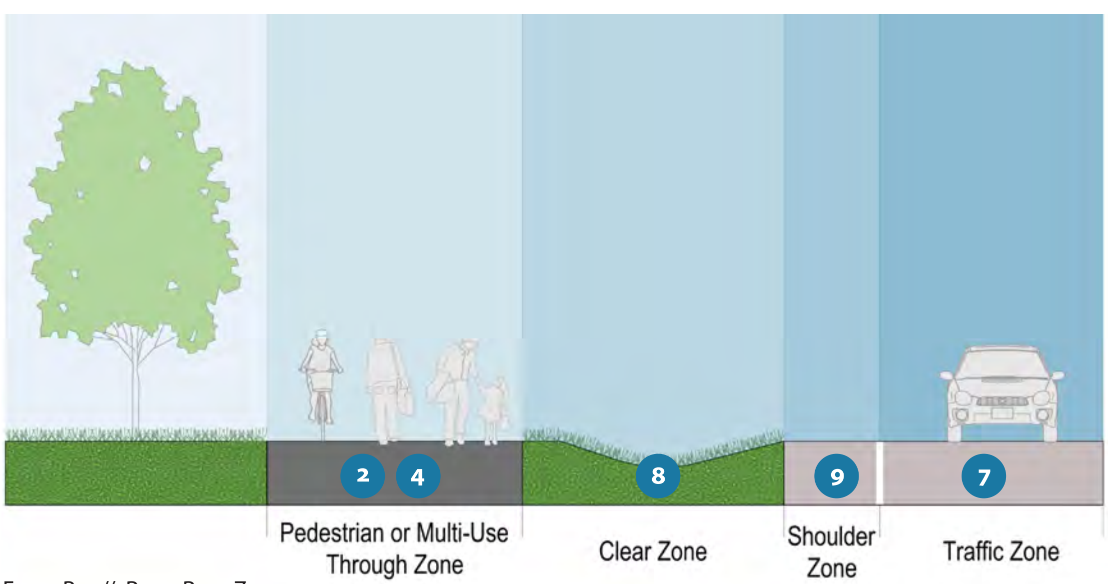


Figure B-3 // Rural Road Zones

1 Frontage Zone

The Frontage Zone is the area adjacent to properties, such as building entrances, front yards, vending, café seating, and building-related utilities. This area may be part of the public right-of way, or private, if a building setback is present. The Frontage Zone predominantly applies to an urban street context as the Frontage Zone is typically private front yard space in a local or suburban context. See **Chapter C.3** for design guidance.

2 Pedestrian Through Zone

The Pedestrian Through Zone is the most important area of the road for safe, accessible, and efficient movement of people walking. The width of this zone depends on the road context and the volume of pedestrian activity anticipated for the corridor or block. This area should be entirely free of permanent and temporary objects. See **Chapter C.2** for design guidance.

3 Furnishing Zone

The Furnishing Zone is a space between the Pedestrian Through Zone and the road that buffers pedestrians from the Traffic or Ancillary Zone and provides space for street furniture and utilities. See **Chapter C.3** for design guidance.

4 Bicycle Through Zone

The Bicycle Through Zone exists on roads with bicycle facilities. On some roads, the Bicycle Through Zone takes the place of the Ancillary Zone, but not always. However, an Ancillary Zone with on-street parking may still be provided adjacent to a Bicycle Through Zone. See **Section D** for design guidance.

5 Street Buffer Zone

The Street Buffer Zone only occurs on streets with protected bicycle lanes. Where present, it provides a buffer between moving or parked motor vehicles and the protected bicycle lane. Uses can include landscaping, as well as street furniture, utilities, and parking metres. See **Chapter D.3** for design guidance.

6 Ancillary Zone

The Ancillary Zone is a flexible space located on-street within the roadway that is not designated for motor vehicle through traffic, but that supports the primary functions of either the roadway or the sidewalk. Uses can include on-street motor vehicle or bicycle parking, bicycle facilities, docked bike share stands, loading zones, transit stops, taxi or ride hailing zones, curb extensions, parklets, or patios. This space also includes the concrete gutter and, depending on the road design, may be used for snow storage. See **Chapter C.3** for design guidance.

7 Traffic Zone

The Traffic Zone accommodates users travelling through a road or accessing destinations along the road. Traffic Zone uses can include motor vehicle through traffic, transit, goods movement, and bicycle travel. The Traffic Zone can be divided into multiple lanes that are shared by multiple users or dedicated to certain vehicles (such as exclusive transit lanes). Medians and refuge areas can also be included within this zone.

8 Clear Zone

In highway design, design professionals shall consider roadside safety, which encompasses the area outside the travelled portion of the roadway (e.g. the Traffic Zone). This includes the shoulder, the side slopes, ditches, and any fixed objects and water bodies that could present a serious hazard to the occupants of a motor vehicle leaving the roadway. The Clear Zone is the most important element of roadside safety design.

The Clear Zone consists of the Shoulder Zone, a recoverable slope, a non-recoverable slope, and/or a clear runout area. The desired width is dependent upon the design traffic volume and speed and on the roadside geometry. The Clear Zone can also facilitate roadside drainage. Section 620 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* and Chapter 7.3 of the TAC *Geometric Design Guide for Canadian Roads* provide further design guidance for the Clear Zone. See **Chapter D.6** for design guidance.

9 Shoulder Zone

In rural, suburban, or highway contexts where there are no curbs, paved and/or unpaved shoulders may be present. The Shoulder Zone is the part of a roadway contiguous with the Traffic Zone intended for emergency stopping, and/or lateral support of the roadway structure. The Shoulder Zone is primarily intended to support motor vehicle needs but can be designed to allow walking and cycling in some contexts. In rural areas, gutters are located within the shoulder zone. See **Chapter C.4** and **Chapter D.6** for design guidance.

Additional Road Elements

Curbs separate the road zones from the sidewalk zones in urban conditions. They have practical applications as they prevent water from road run-off from entering the pedestrian space, discourage vehicles from encroaching on pedestrian space, and can facilitate road sweeping and snow clearing. Curbs can also help define the pedestrian environment within the road zone. The gutter facilitates drainage.

DEFINING THE USERS

Everyone moving about a community is an active transportation user at some point in their trip. Whether running an errand on foot, cycling to work, walking to the parking lot, or connecting to transit, each and every trip begins and ends with some form of active movement. There are characteristics about active transportation users that can be useful to design professionals when planning and designing active transportation facilities.

Trip Purpose and Characteristics

Active transportation users cannot be categorized into one homogeneous group. The users of each active mode, including people walking, cycling, and using other active modes, have different characteristics and require unique design considerations. **Table B-1** provides a high-level look at some of these user characteristics. Design professionals should consider these when designing active transportation facilities, but should note that each user group may contain a broad range of users that do not necessarily meet these descriptions.

Types of Users

General characteristics and preferences of both existing and potential active transportation users are important to understand before selecting and designing an active transportation facility. A variety of factors influence an individual's decision to travel by active transportation, such as neighbourhood characteristics, motor vehicle volumes and speeds, the quality of existing facilities, distance between destinations, and personal preferences. There are a range of existing and potential users who each may have different motivations, barriers, preferences, and needs. People who travel by active transportation can be categorized in a number of ways, including by demographics, trip purpose, or by level of experience.

Categorizing active transportation trips as 'recreation' vs. 'transportation' is discouraged, as mobility needs are similar for both groups and such categorization may be misleading. The generally accepted way to categorize people who cycle is based on people's willingness to use a bicycle for transportation. The City of Portland was the first to classify the general population into a 'bicycle rider spectrum' made up of the following four groups of bicycle users, ordered by their level of stress and risk tolerance from high to low (see **Figure B-4**):

- **Strong and Fearless** (approximately 2-6% of the population): People who are generally comfortable riding on major roads, regardless of motor vehicle volumes or speeds, weather conditions, or the presence of existing bicycle facilities. These people often prefer to use the most direct routes to their destination, regardless of whether bicycle facilities are provided.
- **Enthused and Confident** (approximately 9-28% of the population): People who are generally comfortable on most roads with bicycle facilities. These people may select a route with lower motor vehicle volumes or speeds, or separated facilities where provided, over a more direct route.
- **Interested but Concerned** (approximately 37-60% of the population): These people often own a bicycle but do not ride frequently due to concerns about the safety of cycling. They are interested in cycling more, but usually restrict their riding to roads with physically protected facilities or lower motor vehicle volumes and speeds. The 'interested but concerned' segment of the population is typically found to be the largest segment of the population in communities of all sizes and contexts. There is a significant opportunity to focus on the needs of this large market segment to achieve a substantial increase in regular bicycle ridership. To do so, many communities throughout B.C. are now focusing on developing bicycle networks with an emphasis on all ages and abilities facilities.
- **No Way, No How** (approximately 25-38% of the population): This group may be uninterested or unable to ride a bicycle, or they may perceive severe safety issues with cycling in motor vehicle traffic. A significant portion of this group will likely never choose to ride a bicycle under any circumstances, although some may eventually choose to ride given enough time and education.

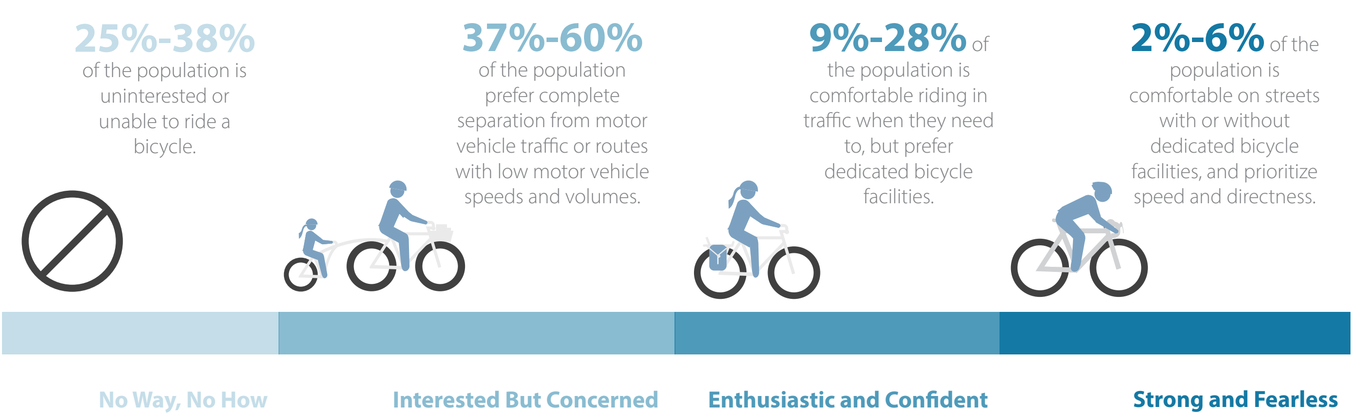


Figure B-4 // Bicycle Rider Spectrum

TABLE B-1 // TYPICAL ACTIVE TRANSPORTATION USER CHARACTERISTICS

USER GROUP	TYPICAL TRIP LENGTH	UNIQUE CONSIDERATIONS
Walking	0-2 km	▪ Includes all trip types, including errands, commuting, social, and recreation. ▪ Used for trip chaining to combine with other modes, as all trips begin or end on foot. ▪ Users include people of all ages and abilities. ▪ Special consideration needs to be given to accommodating people with visual and mobility impairments.
Cycling	2-10 km	▪ Tends to include a greater proportion of commuting trips than other modes. ▪ Also includes other trip types including recreation, errands, and social trips. ▪ Can be used for trip chaining by combining with other modes such as transit. ▪ A variety of bicycle types exist, each with unique design considerations. ▪ Electric bicycles can increase the typical trip length and expose cycling to new user types, including those with mobility impairments.
Skateboarding, in-line skating, and small, one-person electric vehicles.	0-4k m	▪ Commonly used to commute to work and school, as well as for recreation and other trip purposes. ▪ Large range of devices with diverse operating characteristics, including unique considerations such as wider operating requirements (such as in-line skating and roller skiing) or different stopping requirements. ▪ Not all of these modes are currently approved for operation on local or provincial roadways. Refer to **Chapter H.5** for further detail on micro-mobility.
Water-based active modes	0-5k m	▪ Less commonly used for transportation - most trips are recreational in nature. ▪ Devices tend to be much larger than other active mode devices, requiring parking/storage considerations. ▪ Users typically have more gear that needs storage and may require change room or locker facilities due to wet clothing.
Winter active modes	0-4k m	▪ Less commonly used for transportation – most trips are recreational in nature. ▪ Large range of winter active mode operating considerations and trip lengths. Snowshoeing, for example, is similar to walking, whereas cross-country skiing and skating have very different characteristics. ▪ Users typically have more gear that needs storage and may require change room or locker facilities due to wet clothing.

PLANNING PROCESS

Before designing individual active transportation facilities, it is important to first ensure that a long-term plan for developing the active transportation network along with support programs and policies is in place. This plan can take the form of an active transportation plan, separate bicycle and pedestrian plans, and/or be part of an integrated multi-modal transportation master plan, which includes considerations for walking, cycling, driving, transit, and goods movement. A list of high-level planning steps is provided below in order to assist planning and design professionals in beginning the process of developing a plan to promote active transportation.

- **Assess existing conditions:**
  - *Collect data (e.g. bicycle and pedestrian counts) and conduct technical analysis to understand existing baseline conditions for active transportation*
  - *Work with community officials and stakeholders to identify issues and opportunities*
  - *Identify connections that are missing or requiring improvement*
- **Establish a vision and goals:**
  - *Work with stakeholders to identify needs, priorities, and desires*
  - *Consider local and regional connections*
  - *Develop a vision statement with supporting goals and measurable targets*
- **Develop a long-term plan:**
  - *Identify significant destinations and desire lines, considering existing conditions and future land development*
  - *Explore all relevant local and regional plans and policies*
  - *Consider the transportation network as a whole, including multi-modal and regional connections*
  - *Assess local needs and draft recommendations*
  - *Work iteratively with stakeholders to achieve community validation and establish a preferred network*
- **Develop an implementation plan:**
  - *Analyze network scenarios*
  - *Assess the cost and timelines of each individual improvement*
  - *Create a project schedule, prioritizing short-, medium-, and long-term priorities, including identifying immediate needs that could be addressed through quick-build solutions*
  - *Identify key stakeholders and departments who are responsible for implementing specific parts of the plan*
- **Develop a monitoring and evaluation plan:**
  - *Establish a plan for gathering data and feedback once construction begins*
  - *Utilize the data and feedback in an iterative process to update the plan and improve the active transportation network*

NETWORK PLANNING CONSIDERATIONS

Establishing a complete, connected, and convenient network of active transportation facilities is critical to encouraging more trips by active transportation. This section describes four key factors that influence the planning, design, and ultimately, the success of an active transportation network: land use and neighbourhood design, connectivity, multi-modal integration, and topography.

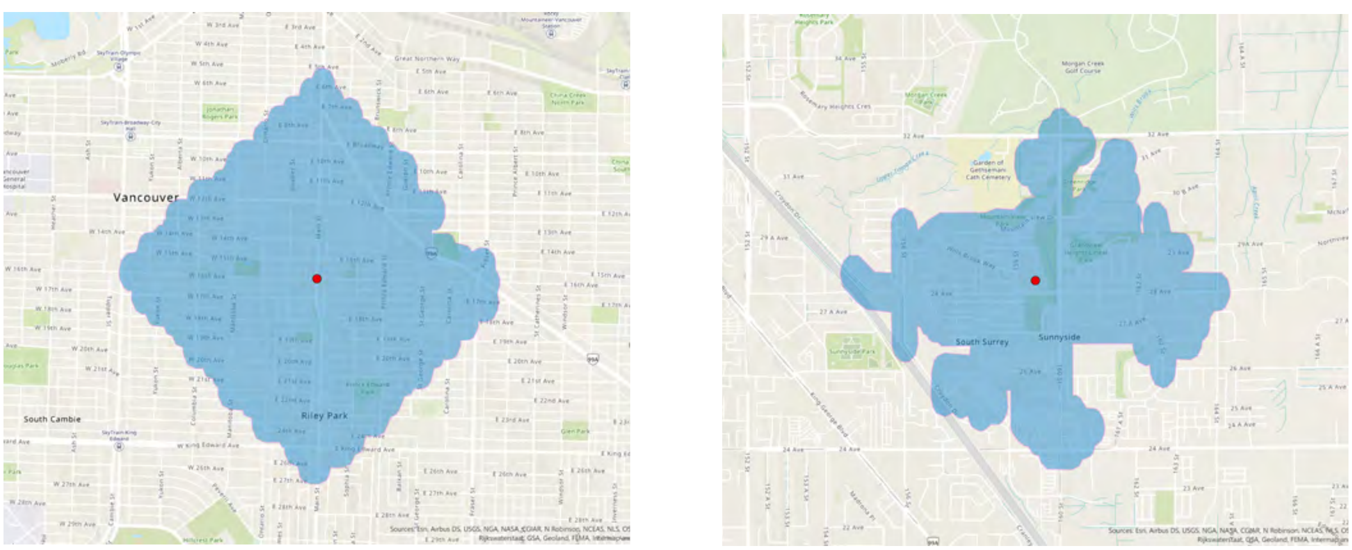
Land Use and Neighbourhood Design

Land use is a key consideration for active transportation planning as it directly influences distances to destinations, environmental quality, and user convenience and experience. Road design and active transportation network planning should consider the type and concentration of adjacent land uses, as these factors influence how the road will be used. Key active transportation generators include: commercial areas, healthcare facilities, post-secondary institutions, and other institutions, particularly those generating employment. Schools, parks, and other community amenities are also key active transportation generators, serving as community gathering places.

Neighbourhood design is another key consideration. Active transportation use is positively associated with dense land use, especially residential and commercial density. Mixed use development also facilitates active transportation by locating destinations in closer proximity to each other, enabling people to meet their daily needs using active transportation. A compact, grid-like road network, common in larger urban centres and some smaller communities, provides greater connectivity over non-grid road networks (see **Figure B-5**). Connectivity may be improved in non-grid road layouts by providing cut-throughs (active transportation-only pathways that cut through developments, creating a short-cut between two roads).

Connectivity

A well-connected active transportation network enables users to safely and easily travel to their destinations. Block length, street and pathway network density, number of intersections, connections to off-street pathways, and the presence of well-maintained and high-quality facilities are typical measurements of transportation network connectivity. These can impact how often an individual chooses to travel by active modes. Connectivity can be broken down into four components, each of which contributes to a fully connected network:



A one-kilometre walkshed in Vancouver's grid-like Mount Pleasant neighbourhood (left) compared to a one-kilometre walkshed in Surrey's North Grandview Heights neighbourhood, which is characterized by more curvilinear, dead-end roads (right).

Figure B-5 // Neighbourhood Design and Connectivity

- **Completeness.** The active transportation network should be well-connected to let users travel virtually anywhere they need to go by active means. They should have access to all or most of the full transportation network. Any gaps identified in the active transportation network should be prioritized, especially when connecting to key destinations. A traveller encountering an unexpected gap in the network is forced to either detour to a safer route, which often requires local knowledge, or to continue through substandard or potentially hazardous conditions. Where active modes are not supported, such as along highways or freeways, alternative routes should be provided.
- **Directness.** Users should not be required to go out of their way in order to safely access their destination. Providing direct routes that connect to key destinations will ensure that active transportation – particularly cycling – is competitive with motor vehicles in terms of convenience. Communities are encouraged to develop a network comprised of primary routes and supplemented with secondary routes providing connections between dedicated bicycle facilities.
- **Density and Diversity.** Users should have a range of route options. Small blocks with frequent intersections contribute to more convenient networks. Where large blocks exist, cut-throughs can increase permeability. Research conducted by the Cycling in Cities Program at the University of British Columbia found that while comfortable cycling facilities are important, people cycling need to be able to access these routes quickly and easily. The study found that people cycling are unlikely to detour more than approximately 400 metres to find a route with a bicycle facility[1]. As a result, the study concluded that a bicycle network with designated facilities spaced a minimum of every 500 metres apart should be the goal for areas where there is a desire to increase the modal share of cycling. It has also been recommended that a dense bicycle network should be located within urban centres and areas of high cycling potential. Smaller communities should ensure routes that connect neighbourhoods or neighbouring communities include cycling facilities.
- **Comfort.** A comfortable and complete active transportation network includes a variety of facility types that appeal to a wide range of users, providing equitable and convenient access for all residents, commuters, and visitors. Ideally, active transportation users should be provided with a dedicated facility that is separated from motor vehicle traffic or that is located on a quiet street with low motor vehicle volumes and speeds (see **Research Note** on following page). Further details regarding cycling safety and route preferences is provided in **Chapter D.1**. It should also be well maintained and provide adequate lighting and sightlines, helping to alleviate personal safety concerns. The network should be universally accessible and should contribute to a pleasant travel experience.

1Meghan Winters et al., How Far Out of the Way Will We Travel?: Built Environment Influences on Route Selection for Bicycle and Car Travel (Transportation Research Board, 2010).

Research Note

Research conducted by the Cycling in Cities Program at the University of British Columbia found that most people who cycle prefer those facilities that are protected from motor vehicles or are located on quiet streets with low motor vehicle speeds and volumes[1]. These are also generally the safest type of bicycle facilities[2].

The studies from the Cycling in Cities Program found that these preferences were similar among various demographics and cycling experience levels. For example, it found that all users, including men, women, more experienced bicycle users, and less experienced bicycle users, preferred facilities that are physically separated from motor vehicle traffic or on quiet streets.

1 Chris Monsere et al., Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S. Final Report (Portland State University, 2014).

2 Anne Lusk et al., Risk of injury for bicycling on cycle tracks versus in the street (Injury Prevention, 2011).

Multi-Modal Integration

Not all trips are possible or desirable using active transportation. However, providing seamless integration between active transportation and other modes – especially transit – can ensure that active transportation makes up a component of the trip and encourages sustainable transportation. Refer to **Chapter H.3** for more details on multi-modal integration.

Topography

Topography is a significant factor in many B.C. communities. The coastal and mountainous geography can create appealing vistas, but it also presents significant challenges to the adoption of active transportation. Steep grades can make walking , cycling, and other forms of active transportation difficult or uncomfortable for many users. Furthermore, wet or snowy weather conditions can exacerbate the negative impacts of topography. Design professionals should strive to place active transportation facilities along less steep routes, creating routes with accessible grades wherever possible. Design guidance for mitigating the impact of topography in the pedestrian network is provided in **Chapter C.2**.

FACILITY SELECTION CONSIDERATIONS

There are a number of important context-specific considerations that go into active transportation facility selection. The selection considerations listed below apply to any type of active transportation facility and should inform the choice of facility. The final facility selection decision will also depend in part on the experience and judgement exercised by design professionals.

Refer to **Chapter C.1** for further details on pedestrian facility selection and **Chapter D.1** for further details on bicycle facility selection, including decision support tools that lay out when each type of facility is appropriate. The decision support tools in these chapters are based on the following selection considerations.

Motor Vehicle Speed and Volume

One of the biggest factors influencing the use of active modes of transportation is motor vehicle speed and volume. **Chapter B.4** outlines key safety concerns associated with motor vehicle collisions. For people walking, separation from motor vehicles is always preferred. For people cycling, different types of facilities are appropriate in different road environments. For example, on roads with low motor vehicle speeds and volumes, facilities such as neighbourhood bikeways are most appropriate. As motor vehicle speeds and volumes increase, there is an increasing preference for separation from motor vehicle traffic. Alternatively, traffic calming elements may be used to reduce motor vehicle speeds and volumes where appropriate (see **Chapter D.2**).

Road Width

Available right-of-way and road width can influence the type and design of an active transportation facility. The most cost-effective facilities in retrofit situations are implementable within the available road width and do not require any road widening. However, in new construction or reconstruction situations, it may be possible to widen the road, allowing for a more comfortable facility to be built that accommodates all users. Retrofit strategies for dealing with constrained rights-of-way are discussed later in this chapter.

Users

Wherever feasible, active transportation facilities should be universally accessible, accommodating the full spectrum of potential users with all levels of experience. Facility design should also consider the full range of active transportation devices that must be accommodated on that facility (see **Chapter B.4**). Consideration should be given to the skills, needs, and preferences of the types of users who are anticipated to use the facility. For example, facilities near parks, schools, and residential neighbourhoods are likely to attract a higher percentage of recreational users and children, who prefer a greater degree of separation from high motor vehicle speeds and volumes. The majority of the population falls into the 'interested but concerned' category of bicycle users. As such, this group is the preferred design user group, especially in urban and suburban contexts as well as developed rural cores.

On-Street Motor Vehicle Parking

The presence of on-street motor vehicle parking can provide a buffer between the Traffic Zone and the Pedestrian Through Zone, which can be beneficial to people walking. However, the turnover and density of on-street parking can negatively impact cycling safety due to the potential for motor vehicle doors opening into the Bicycle Through Zone or the potential for motor vehicles to pull in or out of a parking space. Safety concerns can be mitigated by considering the removal or consolidation of on-street parking where possible, or by ensuring there is sufficient buffer space to avoid the risk of motor vehicle doors opening into the path of people cycling. Moving people who cycle off-road, or positioning them between the parking lane and the sidewalk, can also decrease risk and increase user comfort.

Truck and Bus Traffic

The presence of trucks, buses, and other large, heavy vehicles can cause unique challenges for active transportation users, especially people cycling. Where heavy vehicles make up more than 5% of motor vehicle traffic, consideration should be given to providing increased separation between people cycling and motor vehicles or providing alternative routes for active transportation. Potential conflicts at loading zones and transit stops, in addition to pavement deterioration, should also be considered.

Conflict Points

Intersections, crossings, and transition points present potential conflict points between users. A high percentage of collisions involving active transportation users occur at these conflict points; therefore, it is vital to give careful design consideration to mitigating these conflicts. Facility selection should consider strategies to minimize exposure to conflicts wherever possible. Some facility types, such as bi-directional protected bicycle lanes and off-road facilities, are less appropriate where there are a high number of crossing points. See **Section G** for a variety of strategies for minimizing conflicts at intersections.

Aesthetics

Providing attractive facilities can help attract users and promote active transportation. Certain facility types provide greater opportunity for aesthetic improvements – for example, planters can be used along the Street Buffer Zone, and pedestrian facilities can include creative pavement decorations. Street trees provide aesthetic appeal while also providing a windbreak and shade. Aesthetic elements must not restrict sightlines or become a distraction to other road users.

Costs/Funding

Facility selection will normally involve a cost analysis of alternatives, and the availability of funding may limit the types of facility that can be considered. The decision to implement an active transportation facility should be made with a commitment to properly design and construct the facility, in addition to a conscious, long-term commitment to proper maintenance. When funding is limited, lower-cost improvements such as signage, pavement markings, and low-cost traffic calming measures may be more feasible and should be considered instead of not providing facilities.

Maintenance

All-season maintenance is a key component of a safe and comfortable active transportation facility. At the outset of the design process, maintenance requirements should be considered, including noting local conditions and maintenance practices. Active transportation facilities that facilitate and simplify maintenance will help ensure effective use of the facility throughout the year. Refer to **Chapter I.3** for more detail on maintenance.

Land Use Context

Land use is a key consideration for both network planning and facility selection. The predominant land use (commercial, residential, industrial, etc.) as well as the greater context (urban, suburban, or rural) should be considered.

RETROFIT STRATEGIES

Retrofitting existing roads to add or improve active transportation facilities can be a challenge that often involves working within constrained conditions. Design professionals should evaluate trade-offs to come up with a feasible solution that best accommodates all modes of transportation that are using the road. Note that there are minimum design criteria (such as travel lane widths for each road class) that need to be met in order for each transportation mode to function safely and efficiently. When considering facility retrofits, design professionals should apply sound professional judgement and should reference the TAC *Geometric Design Guide for Canadian Roads*, the MOTI *B.C. Supplement to TAC Geometric Design Guide* and any other applicable local, provincial, or national design standards to ensure that retrofits continue to meet minimum standards. Different considerations may be required on local and provincial rights-of-way.

When faced with limited right-of-way, one or more of the following strategies can be used to make room for active transportation facilities:

Reduce Lane Widths

Where appropriate, lane widths within the Traffic Zone may be reduced. In addition to providing additional space for active transportation facilities, narrower lane widths result in reduced crossing distances, increased visibility of active transportation users, and slower motor vehicle travel speeds. Wider travel lanes are correlated with faster motor vehicle speeds, with each additional 0.1 metre of lane width resulting in faster travel speeds of approximately 1.5 km/h[2]. Therefore, narrowed travel lanes can reduce motor vehicle travel speeds and are an asset for increasing safety for other modes.

While narrower lanes can be beneficial for active transportation, careful consideration is required before reducing lane widths. Design professionals should consider the road class, motor vehicle speeds and volumes, and required design vehicle. When reducing lane widths, special consideration should be given to larger, heavy vehicles such as buses, trucks, and emergency vehicles.

Travel lane widths for motor vehicle traffic are context specific and can vary from community to community and setting to setting. Motor vehicles can operate within lanes as narrow as 3.0 metres. However, trucks and transit vehicles typically require a lane width of at least 3.3 metres. In many cases, a hybrid approach is feasible whereby inner lanes are reduced to approximately 3.0 metres and wider curbside lanes are maintained for large vehicle access. If a design is located on a transit route, design professionals should consult with the local transit agency to confirm minimum lane width requirements and that the design will not adversely impact transit operations.

Reduce the Number of Lanes

Reducing the number of travel lanes can free up space to create active transportation facilities, but may impact motor vehicle traffic operations and transit operations. Design professionals should analyze current and projected motor vehicle volumes along the corridor prior to reducing the number of lanes and should consider the potential of motor vehicle traffic shifting to adjacent roads. If a design is located on a transit route, design professionals should consult with the local transit agency to confirm that the design will not adversely impact transit operations.

Remove On-Street Parking

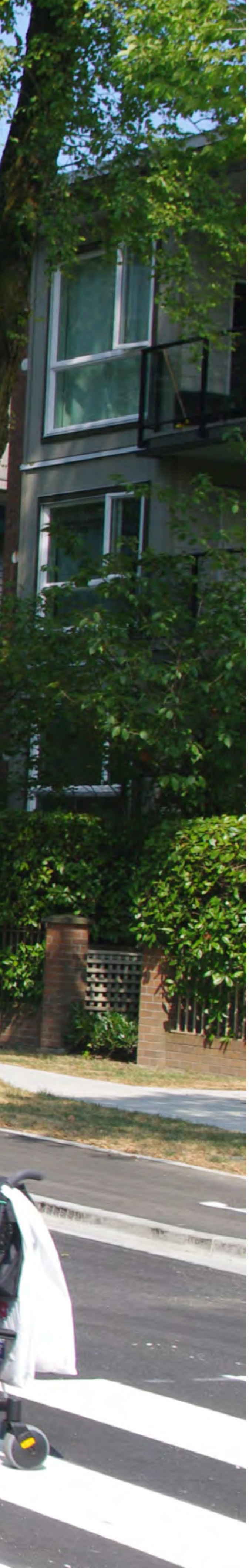
On-street parking may be repurposed as active transportation facilities. A parking assessment should be completed prior to removal. The parking assessment should analyze current parking usage and existing or potential on- and off-road parking capacity in the surrounding area. The removal of on-street parking can be controversial, especially in residential and commercial areas. However, by assessing parking demand and identifying alternatives, design professionals can mitigate negative impacts and community push back.

Widen the Roadway

Before widening the roadway, it is recommended that the above three strategies are considered first, especially where wide travel lanes exist. The most cost-effective facilities in retrofit situations are implemented within the existing roadway. However, in new construction or reconstruction situations, it may be possible to widen the roadway, allowing for a more comfortable active transportation facility to be built that accommodates all users. Widening the roadway may not be possible due to a number of constraints, including topography and right-of-way constraints.

2 K. Fitzpatrick et al., Design Factors That Affect Driver Speed on Suburban Streets (Transportation Research Record: Journal of the Transportation Research Board, 2000).

West 10th Avenue, Vancouver, B.C.



B.3

UNIVERSAL DESIGN

Universal design ensures that the built environment is accessible to people of all ages and abilities, regardless of any type of physical or cognitive impairment. Universal design is a fundamental design principle that should be applied in all contexts but is especially important for designing active transportation facilities and accommodating people walking.

This chapter describes the importance of providing universal accessibility and introduces key universal design principles and strategies. It also provides an overview of the various accessibility challenges that should be considered in the design of active transportation facilities, including impairments to mobility, vision, hearing, comprehension, and strength and dexterity.

UNIVERSAL DESIGN: INCLUSION FOR ALL

The goal of universal design, which is also referred to as barrier-free or inclusive design, is quite simply 'inclusion for all.' Universal design principles should be applied in all types of planning and design, including the design of active transportation facilities. Article 2 of the *United Nations Convention on the Rights of Persons with Disabilities* (ratified by the Government of Canada in 2010) defines universal design.

What is Universal Design?

'Universal design' means the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. 'Universal design' shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.

Universal design can be applied to any design activity, program, service, or business practice where people interact with the physical, virtual, or social environment. The underlying concept of universal design is that when the environment is designed to be universally accessible, everyone benefits. It is important to note that universal design should not be treated as a special requirement for only a small group of people. According to the Rick Hansen Foundation, one in seven Canadians currently lives with a disability that impacts their mobility, vision, or hearing.[1] As the population ages, this number is predicted to rise to one in five within the next 20 years. Therefore, creating universally accessible active transportation networks is crucial for enabling Canadians to live active lives.

Universal Design Principles

There are seven guiding principles for universal design (see **Table B-2**), which were conceived by a working group of designers, architects, and researchers led by architect and accessibility advocate Ronald Mace.[2] These principles apply to indoor and outdoor environments as well as product design and communications.

Universal Design In Active Transportation

In the design of active transportation facilities, the most relevant universal design principles are those related to outdoor circulation, spaces, and amenities pertaining to the transportation network, with a focus on the pedestrian realm. There are numerous examples of universal design in the design of active transportation facilities. For example, curb ramps are intended primarily to provide road access for wheelchair users. However, they also benefit parents with strollers, people pulling luggage or delivery carts, small children cycling, seniors using walkers, and many others who may not have been the original impetus for the design. There are a variety of other examples of universally designed products and environments, including automatic doors, lever door handles, and smooth walking surfaces.

Currently, there are no national or provincial universal design standards for the design of accessible active transportation facilities. However, there are a number of resources that provide excellent guidance, including guidelines developed by standards associations, agencies, non-profit associations, and municipalities. The TAC *Geometric Design Guide for Canadian Roads* and *Pedestrian Crossing Control Guide* consider accessibility in their design recommendations.

Another key guiding document is the *Standard B651-18: Accessible Design for the Built Environment*. These standards were authored by the CSA, an independent

1 'Become Accessible,' Rick Hansen Foundation, accessed May 21, 2019, *https://www.rickhansen.com/become-accessible*

2 'About UDI,' RL Mace Universal Design Institute, accessed May 21, 2019, *https://www.udinstitute.org/about*

Table B-2 // Universal Design Principles

PRINCIPLE	GUIDELINES
1: Equitable Use The design is useful and marketable to people with diverse abilities.	▪ Provide the same means of use for all users: identical whenever possible; equivalent when not. ▪ Avoid segregating or stigmatizing any users. ▪ Provisions for privacy, security, and safety equally available to all users. ▪ Make the design appealing to all users.
2: Flexibility in Use The design accommodates a wide range of individual preferences and abilities.	▪ Provide choice in methods of use. ▪ Accommodate right- or left-handed access and use. ▪ Facilitate the user's accuracy and precision. ▪ Provide adaptability to the user's pace.
3: Simple and Intuitive Use Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	▪ Eliminate unnecessary complexity. ▪ Be consistent with user expectations and intuition. ▪ Accommodate a wide range of literacy and language skills. ▪ Arrange information consistent with its importance. ▪ Provide effective prompting and feedback during and after task completion.
4: Perceptible Information The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	▪ Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. ▪ Provide adequate contrast between essential information and its surroundings. ▪ Maximize 'legibility' of essential information. ▪ Differentiate elements in ways that can be described (e.g. make it easy to give instructions or directions). ▪ Provide compatibility with a variety of techniques or devices used by people with sensory limitations.
5: Tolerance for Error The design minimizes hazards and the adverse consequences of accidental or unintended actions.	▪ Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. ▪ Provide warnings of hazards and errors. ▪ Provide fail safe features. ▪ Discourage unconscious action in tasks that require vigilance.
6: Low Physical Effort The design can be used efficiently and comfortably and with a minimum of fatigue.	▪ Allow user to maintain a neutral body position. ▪ Use reasonable operating forces. ▪ Minimize repetitive actions. ▪ Minimize sustained physical effort.
7: Size and Space for Approach and Use Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	▪ Provide a clear line of sight to important elements for seated or standing users. ▪ Make reach to all components comfortable for any seated or standing user. ▪ Accommodate variations in hand and grip size. ▪ Provide adequate space for the use of assistive devices or personal assistance.

organization that publishes building, equipment, and construction standards that may be used as the basis for building bylaws and provincial building codes. Universal design principles, including recommendations from TAC and CSA, have been woven into the design recommendations provided throughout the Design Guide.

Context-specific trade-offs and considerations are necessary when designing facilities in order to achieve the highest possible level of accessibility for active transportation facilities. Design professionals are encouraged to aim for the highest level of universal accessibility. However, it may not always be feasible to meet every universal design principle. There are three levels of accessibility that may be considered:

- **Basic Access Requirements**: Design considers safety and liability issues, seeks to comply with the current geometric design and/or building code access requirements, and aims to provide meaningful basic access.
- **Inclusive Access Requirements**: Design is intended to address important issues that are not covered by current building code access requirements, plus additional, cost-effective measures to improve access across the full range of disability groups.
- **Full Access Strategy**: Identifies a best practice approach specific to the project needs and goals through a combination of national and international guidelines and standards, community preferences, and the practical application of universal design.

While universal design strategies have been imbedded throughout the Design Guide, it should be noted that the strategies listed do not cover every possible access feature that could be deployed. Design professionals should consider all best practice accessibility resources when designing a facility and should work with stakeholders in the disability community to test out designs.

ACCESSIBILITY CHALLENGES

Universal design covers people of all ages and abilities, with a focus on those people facing accessibility challenges in the transportation network. Universal design is not simply about mobility (such as wheelchair access) – there are other physical, sensory, and cognitive challenges that should be considered. It is important to understand the capabilities and traits of a facility's expected users in order to determine how to best to meet their needs. Design professionals should strive to ensure that when a barrier is removed for one group, a new barrier is not being introduced to a different group. Accommodating people with disabilities is a core component of universal design. 'Disabilities' is an umbrella term covering impairments, activity limitations, and participation restrictions:

- An **impairment** is a problem in body function or structure;
- An **activity limitation** is a difficulty encountered by an individual in executing a task or action; and
- A **participation restriction** is a problem experienced by an individual during involvement in day to day situations.

Disability is thus not just a health problem – it is a complex phenomenon reflecting the interaction between features of a person's body and features of the society in which that person lives. Overcoming the difficulties faced by people with disabilities requires interventions to remove environmental and social barriers. Universal design also considers people who may not conventionally be considered disabled but who still encounter barriers to movement. For example, children may have difficulty navigating the active transportation network due to their smaller size, slower walking speed, and developing depth perception and decision-making capabilities.

The following section describes some of the key aspects that can limit ease of movement through the public realm.

Mobility

Locomotion difficulties are a common impairment, especially among older demographics. This group includes:

- People who use mobility devices such as wheelchairs and mobility scooters;
- People who can walk but require an aid such as a cane or walker; and
- People who may walk without an aid but require frequent rests.

Table B-3 summarizes the recommended distance between resting spots for different groups[3]. Weather conditions, gradients, and the presence of supports such as hand rails can also influence walking distances. The provision of resting spots with accessible seating is crucial. Standing for prolonged periods may also be difficult for many people, so consideration should be given to providing seating along pedestrian routes and anywhere that people have to wait, such as at transit stops.

Table B-3 // Typical Walking Distances Between Resting Spots

GROUP	RECOMMENDED DISTANCE BETWEEN RESTING SPOTS (METRES)
Mobility impaired people using a cane	50
Mobility impaired people without walking aid	100
Wheelchair users	150
Visually impaired people	150

Walking speed is another important mobility consideration for universal design, especially at road crossings. **Chapter B.4** outlines typical travel speeds for adults, children, and people using mobility devices. Crossing times should consider the slowest user, providing ample time to safely cross the road (see **Chapter G.2**). Design elements such as curb extensions and median refuge islands may be used to shorten crossing distances and allow people walking to cross the road in stages (see **Chapter G.3**).

Vision

Vision impairments exist on a spectrum from completely blind to partially-sighted, with variations including: limited field of vision, loss of central vision, loss of peripheral vision, night blindness, and loss of overall acuity (blurriness). Approximately 85% of people who are classified as legally blind possess some remaining vision[4].

Vision impairments reduce a person's ability to see or identify objects that are necessary for navigating the road, including traffic signs and signals, crosswalks, obstructions, and other road users. Vision impairments may impact depth perception, the ability to judge the speed of bicycles and motor vehicles, and the ability to see colour or visual contrast. This can make it challenging to identify tripping hazards and different pavement materials. Vision impairments can also affect a person's ability to negotiate movement with other road users, as interactions between users are often communicated through eye contact, hand gestures, and other visual forms of communication.

3 City of Vancouver, Engineering Design Manual, 1st ed. (2018), accessed May 21, 2019, *https://bids.vancouver.ca/bidopp/RFA/Documents/PS20181461-CityofVancouver-EngineeringDesignManualFirstEdition2018.PDF*

4 Federal Highway Administration, Accessible Shared Streets – Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities (U.S. Department of Transportation, 2017).

People with vision impairments rely on a variety of non-visual strategies to navigate roads and public spaces, including:

- **Touch**: 'shorelining' by following detectable edges. Detectable edges include building faces, curbs, score lines, or tactile walking surface indicators. Touch can also include identifying curb ramps, driveway slopes, and different pavement materials under foot or cane.
- **Audible information**: navigating by sounds produced by motor vehicles and active transportation users, echolocation, and accessible pedestrian signals.
- Noting the **direction of sun or wind** to maintain orientation.
- **Visual contrast** based on tone or colour.

Visually impaired people may also use navigational aids, including:

- Long white canes;
- Guide dogs;
- Human guides;
- Telescopes and low vision aids (for reading signs); and
- Emerging techniques (digital wayfinding applications and hand-held ultrasonic echo-location devices).

Shared streets and open plazas may present navigational challenges due to the atypical road layout and the lack of curb or other detectable edge (see **Chapter E.4**). Skewed or non-standard intersections may also be problematic for people with visual impairments, as motor vehicle traffic may not be travelling perpendicular to pedestrian crossings. Additionally, the inconsistent application of detectable edges such as tactile walking surface indicators (see page B4139) makes it challenging to rely on these for navigation.

Hearing

According to the World Health Organization, 'normal hearing' is defined as hearing thresholds of 25 dB or better in both ears.[5] Anyone who is not able to hear as well as someone with normal hearing is said to have hearing loss. Hearing impairments may be mild, moderate, severe, or profound. People who are 'deaf' typically have profound hearing loss, which implies little or no ability to hear. Hearing impairments make it more difficult for people to communicate with each other as they travel and to detect other road users, such as fast-moving bicycles and motor vehicles.

Strength and Dexterity

Many people experience challenges related to reaching, stretching, dexterity, and strength, frequently as a result of arthritis, muscular dystrophy, or nervous system complaints. Strength and dexterity challenges can influence the design of pedestrian amenities and accessibility treatments. Examples of designs to avoid include pedestrian signals with pressure resistance on call buttons and non-graspable hand rails.

Comprehension

People with cognitive impairments or learning disabilities may encounter difficulties interpreting signage, wayfinding, and other complicated information or using machines such as transit ticket machines. The same may be true for people with language barriers. Active transportation facilities should be designed to be intuitive and easy to navigate, with layers of information provided to aid navigation without too much complexity in colour patterns.

5 World Health Organization, *Deafness and hearing loss* (World Health Organization, 2019).

UNIVERSAL ACCESSIBILITY DESIGN TOOLBOX

A number of design elements may be used to make active transportation facilities universally accessible, including mobility, tactile, audible, and visual aids. These elements are introduced here and have been embedded in design recommendations throughout the Design Guide.

Mobility

Universally accessible facilities need to accommodate people using mobility devices such as wheelchairs, walkers, canes, and mobility scooters. This requires:

- Providing **accessible slopes and grades**, with appropriate landing areas and resting spots;
- Providing **accessible ramps** where applicable;
- Ensuring that **surfaces** are smooth, firm, slip-resistant, and free of tripping hazards;
- Providing **curb ramps** for road access;
- Maintaining a **Pedestrian Through Zone** that is clear of vertical and horizontal obstructions; and
- Providing **year-round monitoring and maintenance**.

Section C provides detailed guidance on pedestrian facilities, covering most of these elements. **Chapter I.3** provides guidance on with maintenance, while **Chapter G.6** provides guidance on ramps and staircases.

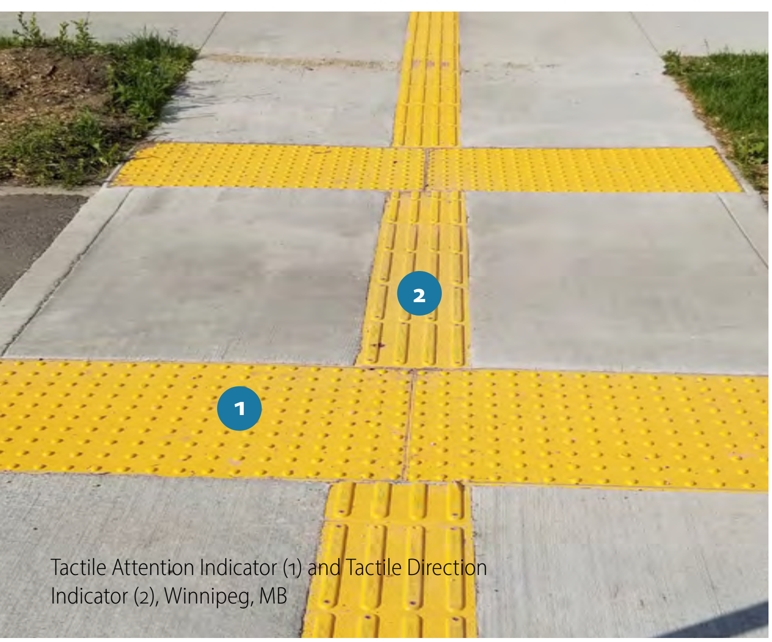
Langley City, B.C.

Tactile

Detectable Warning Surfaces

Detectable warning surfaces are detectable underfoot or by a cane and alert and/or guide people with blindness or low vision. Tactile walking surface indicators (TWSIs) are recommended by the CSA as the standardized detectable warning surface treatment. CSA Standard *B651-18: Accessible Design for the Built Environment* provides detailed guidance on TWSI construction and placement. TWSIs should have a visual contrast of 75% from the pavement (yellow is typically used). They are most effective when placed adjacent to smooth pavement so that the difference is easily detected. There are two types of TWSIs, each with distinct functions, as described below. They should not be used interchangeably.

1. **Tactile Attention Indicator**: A TWSI comprising truncated domes that alert people of an impending change in elevation, conflicts with other transportation modes, and/or other potential hazards. Locations where tactile attention indicators may be appropriate include:
   - *The base of curb ramps;*
   - *The edge of depressed corners;*
   - *The border of medians;*
   - *The border of raised crosswalks and intersections;*
   - *The edge of transit platforms; and*
   - *Rail crossings.*
2. **Tactile Direction Indicator**: A TWSI that uses elongated, flat-topped bars to facilitate wayfinding in open areas. The elongated bars indicate the travel direction. Locations where tactile direction indicators may be appropriate include:
   - *Inside transit stations;*
   - *At the boarding area at transit stops;*
   - *Comprehensively on sidewalks, especially in high traffic areas; and*
   - *In open spaces such as shared streets and plazas, where there is no curb or other standard navigational elements.*



Tactile Attention Indicator (1) and Tactile Direction Indicator (2), Winnipeg, MB


Tactile walking surface indicators at floating transit stop, McDermot Avenue, Winnipeg, MB

Score Lines

Score lines, also known as parallel grooves, are a series of parallel lines that are embedded or troweled into concrete pavement. These are detectable under foot or cane and are used on curb ramps, driveway ramps, and alleyway crossings. Score lines provide directional wayfinding for people who are visually impaired. The score lines should be aligned with the crosswalk and the receiving curb ramp, ensuring that visually impaired people are guided in the correct direction. They may be used in conjunction with other tactile guidance, such as TWSIs.

Tactile Wayfinding Information

Static tactile information consisting of braille or raised map elements may be used on signage and wayfinding to allow use by visually impaired people. Static tactile information may be used in conjunction with large font and high colour contrast.

Visual

Signage, pavement markings, and wayfinding are important tools for visual navigation and are described in **Chapter H.3**. Contrasting pavement materials may also be used to differentiate between different road zones (see **Chapters C.2** and **C.3**). Countdown timers may be installed at crosswalks to show pedestrians how long they have to cross the road (see **Chapter G.2**). Finally, wherever feasible, adequate lighting is recommended along all active transportation facilities (see **Chapter H.4**). Road lighting may be augmented with LED surface or guidance indicators in areas such as crosswalks.

Audible

Audible pedestrian signals that make sounds to indicate when to cross a road are designed to help visually impaired people to safely navigate intersections. Audible pedestrian signals are a universal design element that benefits all users. See **Chapter G.2** for guidance on signals. Emerging technologies such as digital navigation aids are increasingly being used to help visually impaired people navigate by giving audible GIS-based wayfinding updates. Communities can help to improve the accuracy of these devices by ensuring that on-line GIS databases are accurate and up to date.

Score lines on curb ramp, Vancouver, B.C.

Audible pedestrian signal and countdown timer, Vancouver, B.C.

Traffic circle on a neighbourhood bikeway in Vancouver, B.C.
Source: Modacity

B.4

OPERATIONAL AND BEHAVIOURAL CHARACTERISTICS

This chapter introduces the safety considerations surrounding active transportation planning and design, including traffic safety and personal safety. It then describes the operational and behavioural characteristics for people walking, cycling, and using other forms of active transportation. This includes details on the design user concept, operating space requirements, clearance from obstructions, performance characteristics, and operating speed for a variety of active modes. Finally, this chapter explains how measurements are calculated throughout the Design Guide.

SAFETY CONSIDERATIONS

Safety concerns can be a significant barrier to active transportation. Mitigating safety concerns, both substantive and perceived, should be a priority when planning and designing active transportation facilities. **Substantive safety** refers to collision, injury, fatality, and crime rates; whereas **perceived safety** refers to individual risk tolerance and stress levels, which can vary from person to person. Design professionals should consider substantive and perceived concerns related to both traffic safety (such as the risk of motor vehicle collisions) and personal safety (such as crime-related concerns). Safety should be emphasized for people of all ages and abilities, at all times of the day, and in all weather conditions.

Traffic Safety

The largest safety risk associated with active transportation is the potential for collisions between motor vehicles and people walking, cycling, or using other forms of active transportation. In a collision, the risk of serious injury and death is directly correlated to the speed, weight, and size of the parties involved. When speeds are greater and there is a larger speed or weight differential, the likelihood of serious injury or death increases.

Research has shown that the severity of collisions involving vulnerable road users and motor vehicles increases greatly with motor vehicle speed.[6] This is outlined in **Figure B-6**, which shows the likelihood of pedestrian fatality when hit by a motor vehicle travelling at various speeds. Collisions at 30 km/h or less correlate with a lower probability of death (10%), whereas at motor vehicle speeds above 40 km/h, the probability of death increases significantly. Furthermore, collisions between pedestrians and light trucks have an additional severity equivalent to being hit by a passenger car travelling approximately 10% faster.[7] Larger motor vehicles such as buses and full-sized trucks present even greater risks for active transportation users.

Developing designs that are simple and intuitive tends to facilitate predictable movements among all road users. Other strategies for reducing both substantive and perceived safety concerns along active transportation facilities include:

- **Managing motor vehicle speeds and volumes**;
- Providing **physical separation between users** – generally, as speed differentials increase, separation between users should increase and conflicting movements should be more strongly controlled and clearly delineated;
- Improving **intersections and crossings**, and reducing conflict zones (see **Section G**);
- Providing **adequate lighting** for all modes for guidance and wayfinding;
- **Maintaining transportation facilities** in all seasons to avoid build up of snow, ice, wet plant matter, gravel, and debris; and
- Providing **accessible slopes and clear travel paths** that are free of obstructions and tripping hazards.

Collisions between people walking and faster-moving active transportation users such as people cycling should also be considered. While the risk of severe injury and death is lower than when motor vehicles are involved, the speed and mass differential between people cycling and people walking can still be significant. Separating slower and faster active transportation users can help prevent or reduce severity of collisions. Refer to **Section E** for design guidance on when and how to separate active transportation users on multi-use facilities.

6 Dewan Karim, Narrower Lanes, Safer Roads (Regina: Canadian Institute of Transportation Engineers, 2015).

7 American Automobile Association, Impact Speed and a Pedestrian's Risk of Severe Injury or Death (Heathrow FL: American Automobile Association, 2011).

Personal Safety

Concerns over personal safety can be a barrier to active transportation, especially walking. Crime prevention through environmental design (CPTED) is a suite of design strategies that can reduce the threat of crime to those travelling by active means. CPTED reduces the opportunity for crime to occur and increases both substantive and perceived safety, which in turn promotes active transportation as a safe and attractive mobility option. Special considerations for lighting, sightlines, fencing, and maintenance are important in designing active transportation facilities.

Neighbourhood and building design can also have a significant impact on personal safety. One of the most important components of personal safety is providing passive surveillance. This involves ensuring that there are 'eyes on the street' and enough people around to dissuade criminal activity. Placing active transportation facilities in active, lively areas can create safer facilities. Furthermore, urban planning that promotes mixed-use development and road-facing buildings, with windows looking out onto the road and activity at all times of day, can ensure that passive surveillance occurs even when people are indoors.

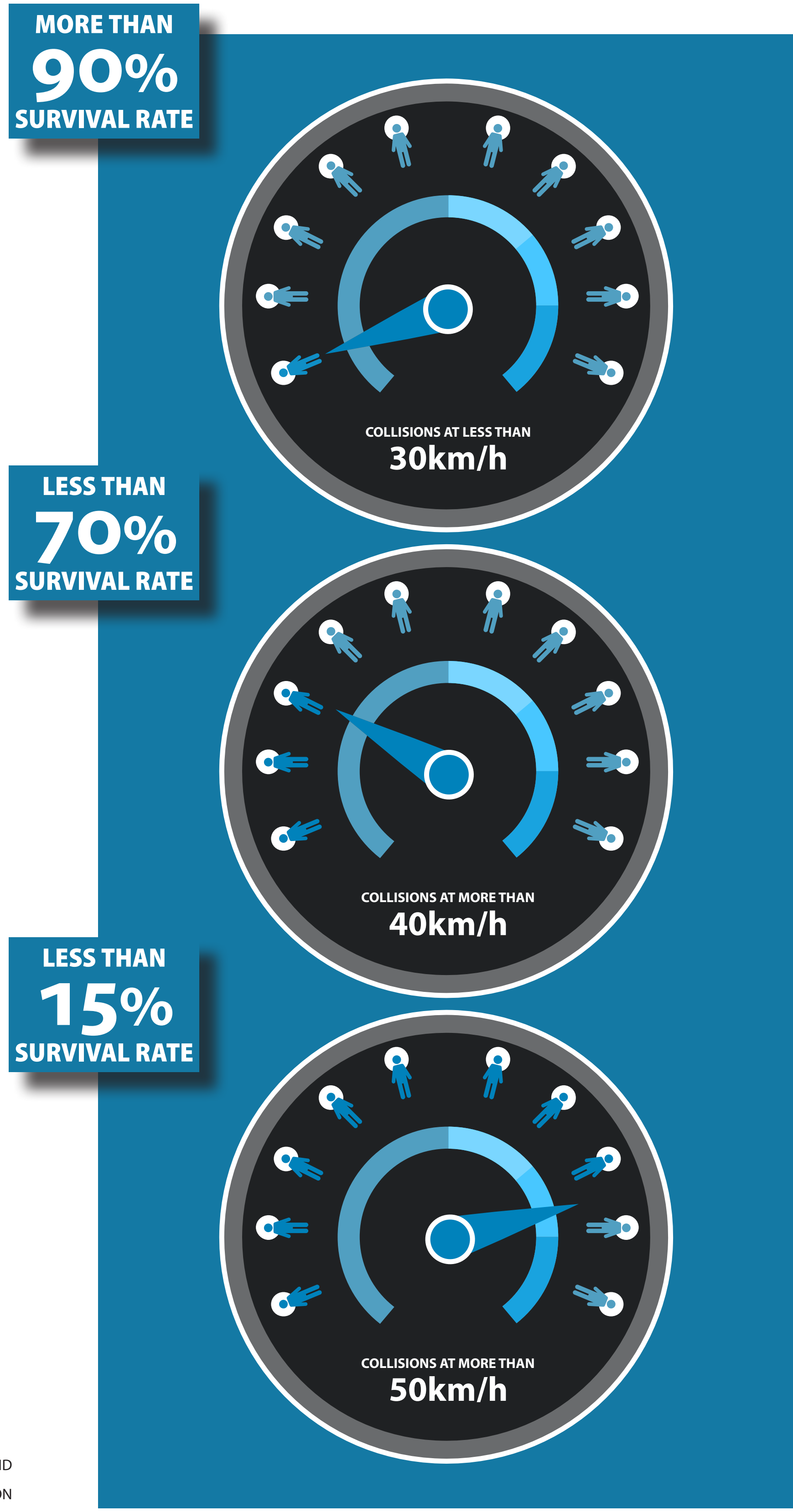


Figure B-6 // Relationship Between Motor Vehicle Speed and Pedestrian Fatality Risk in a Collision

OPERATIONAL AND BEHAVIOURAL CHARACTERISTICS

This section introduces the concept of design domain and summarizes active transportation user operating space, behavioural characteristics, and design considerations.

Design Domain

The design domain is a concept used in the TAC *Geometric Design Guide for Canadian Roads* that provides a range of values describing the fitness-for-purpose of the design element. The value chosen for construction will have unique benefits and constraints in terms of operational performance, user experience, and construction and maintenance costs. While all values within the range of design domain are acceptable, some may be better than others for a given situation. The TAC *Geometric Design Guide for Canadian Roads* includes four levels within the design domain: practical lower limit, recommended lower limit, recommended upper limit, and practical upper limit.

For the purposes of the Design Guide, the primary focus is on those levels that TAC identifies to be part of the recommended lower limit (referred to as **constrained limit** in the Design Guide) or recommended higher limit (referred to as **desirable** in the Design Guide). Although the preference is to remain within this range of values, the Design Guide also outlines **minimum** values that should only be considered in exceptional circumstances. Refer to **Chapter A.1** for more discussion surrounding these three levels and the use of professional judgement in facility design.

For cases where one or more design elements fall outside the recommended design domain values, a design exception may be required, depending on the community's approving authority. Further details regarding the design domain concept as well as the criteria and process for identifying design exceptions are provided in Chapter 1 of the TAC *Geometric Design Guide for Canadian Roads*. The design exception process for roadways under provincial jurisdiction is outlined in the MOTI *Design Exception Process Technical Circular T-05/18*.

Design User and Operating Space

A 'design vehicle' is the vehicle whose dimensions and speed potential are used to dictate the minimum design requirements for a given road or facility. A 'design user' is the person operating the vehicle, or in the case of people walking without a vehicle or mobility device, simply refers to the person. When designing an active transportation facility, the design vehicle – or design user – should be determined based on the expected user of the facility.

People Walking

In the case of pedestrian facilities, people walking and using mobility devices are the design users. This covers a large range of people of all sizes, ages, and abilities. **Figure B-7** shows the typical physical space taken up by an adult walking.

People using manual wheelchairs, electric wheelchairs, and mobility scooters may require special consideration in order to create universally accessible facilities. A person using a mobility device will have a

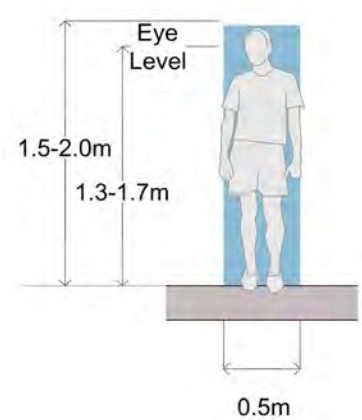


FIGURE B-7 // TYPICAL DIMENSIONS OF AN ADULT PEDESTRIAN lower eye level and a limited forward and side reach, which should be considered when placing objects such as a pedestrian activated signal.

The design width of a person using a manual wheelchair is 0.75 metres, although a minimum floor area of 0.8 metres is required to accommodate the hand motion that propels the wheelchair. Electric wheelchairs and mobility scooters are typically 0.8 metres wide and are often longer than manual wheelchairs. Mobility scooters have a typical length of 1.35 metres. However, the CSA recommends using a footprint that is 1.5 metres long to accommodate all mobility scooters, as these devices are increasingly getting larger.

In addition to the physical height and the width of the user and their device (if applicable), the required horizontal and vertical operating envelopes should be considered. Furthermore, turning area is a key consideration for wheelchair and mobility scooter users.

Figure B-8 illustrates the typical horizontal and vertical operating envelopes for people walking. The vertical operating envelope for a pedestrian is 2.1 metres. The horizontal operating envelope for an adult is 0.75 metres, which accounts for lateral sway when walking.

People with shopping bags, pushing a stroller, or using a guide cane have horizontal operating envelopes between 0.9 and 1.0 metres. An adult walking with a child, a service animal, or large luggage can take up to 1.2 metres of horizontal space.

Pedestrian facilities should be wide enough to allow people to walk side-by-side or pass one another. Two adults walking side-by-side have an operating envelope of 1.5 to 1.8 metres. The lower end of this range is the minimum physical operating space, while the upper end of the range accounts for providing personal space. Personal space preferences are highly variable, but proxemics (personal space) research indicates that designing for 0.8 metres of personal space between people walking is typically appropriate.[8] Three people walking side-by-side have a horizontal envelope of 2.25 to 3.0 metres.

8 Edward Hall, The Hidden Dimension (Garden City NY: Random House Inc., 1966); Anna Frohnwieser, Richard Hopf, and Elisabeth Oberzaucher, Human Walking Behaviour: the Effect of Pedestrian Flow and Personal Space Invasions on Walking Speed and Direction (Human Ethology Bulletin, 2013), 20-287

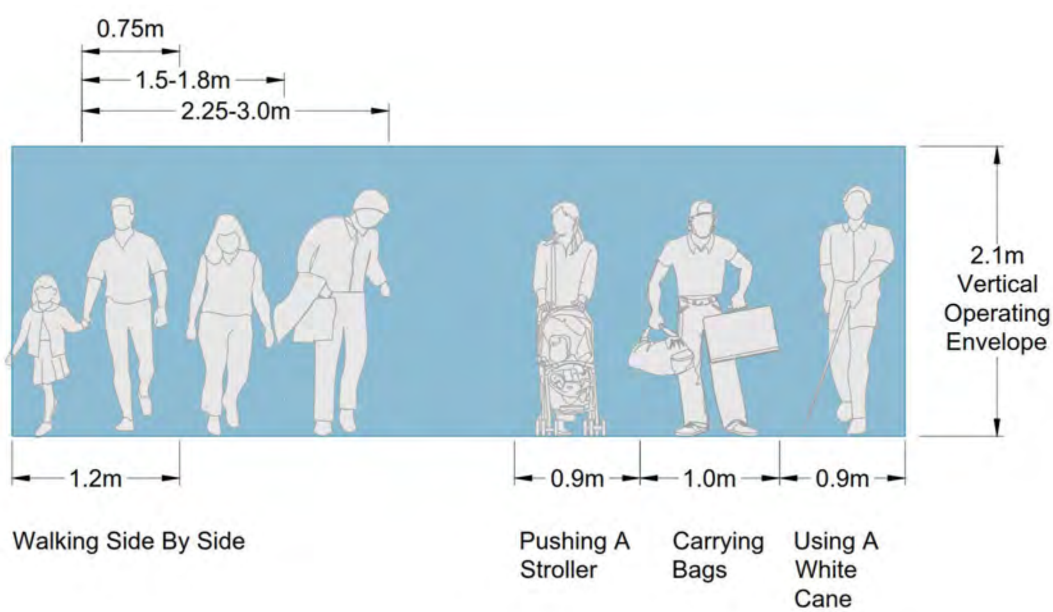


Figure B-8 // Typical Pedestrian Operating Space Requirement

The horizontal operating envelope of a wheelchair is 0.9 metres. Two wheelchairs require 1.8 metres to pass each other or travel side by side, as shown in **Figure B-9**. This measurement establishes the constrained limit width of the Pedestrian Through Zone (see **Chapter C.2**).

Figure B-10 shows the turning space required for various wheelchairs. The lateral width required for a manual wheelchair to make a 180° turn is 1.7 metres. Electric wheelchairs typically require 2.25 metres, while larger mobility scooters may require up to 3.15 metres.

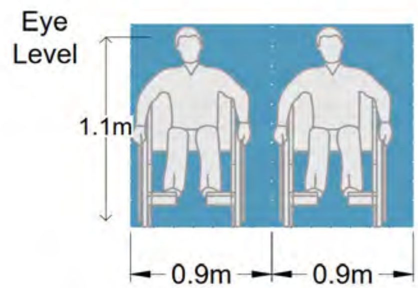


FIGURE B-9 // SPACE REQUIRED FOR TWO WHEELCHAIRS SIDE-BY-SIDE

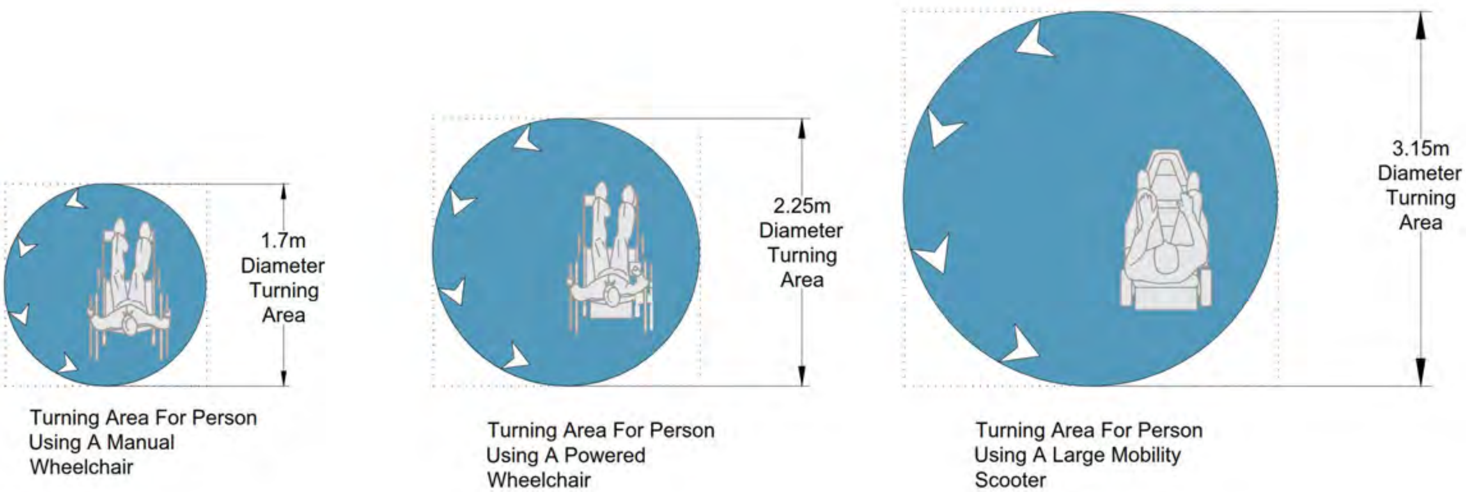


FIGURE B-10 // TYPICAL WHEELCHAIR TURNING DIAMETRES

People Cycling

For multi-use facilities and dedicated bicycle facilities, the bicycle is used as the design vehicle. It is important to note that bicycles are not uniform in size or operating style. **Figure B-11** shows a sample of the different types of bicycles. This is not to be considered an exhaustive list; bicycles come in many different configurations, with 'non-standard' designs becoming increasingly popular in B.C. Multi-use facilities and dedicated bicycle facilities should accommodate the full range of bicycles, including standard bicycles such as road, touring, mountain, and hybrid styles, children's bicycles, tricycles, bicycles with trailers, cargo bicycles, recumbent bicycles, handcycles, bicycles built for people with mobility restrictions, and electric bicycles (e-bikes), among others.

Bicycle facilities are typically designed for a standard adult bicycle that is 1.8 metres long. Where a higher number of non-standard bicycles is expected, it may be appropriate to design facilities – especially intersections, crossings, and refuge areas – for a design vehicle of 3.0 metres in length. Bicycle parking and other end-of-trip facilities should also be designed with the full range of bicycle types in mind (see **Chapter H.2**).

Where bicycles and other devices are concerned, there is a wide range of user preferences, physical abilities, and levels of training or experience, all of which contribute to the operation of the device. For example, family members may wish to bicycle side-by-side, either for social purposes or when a parent is helping to guide or teach a young child.

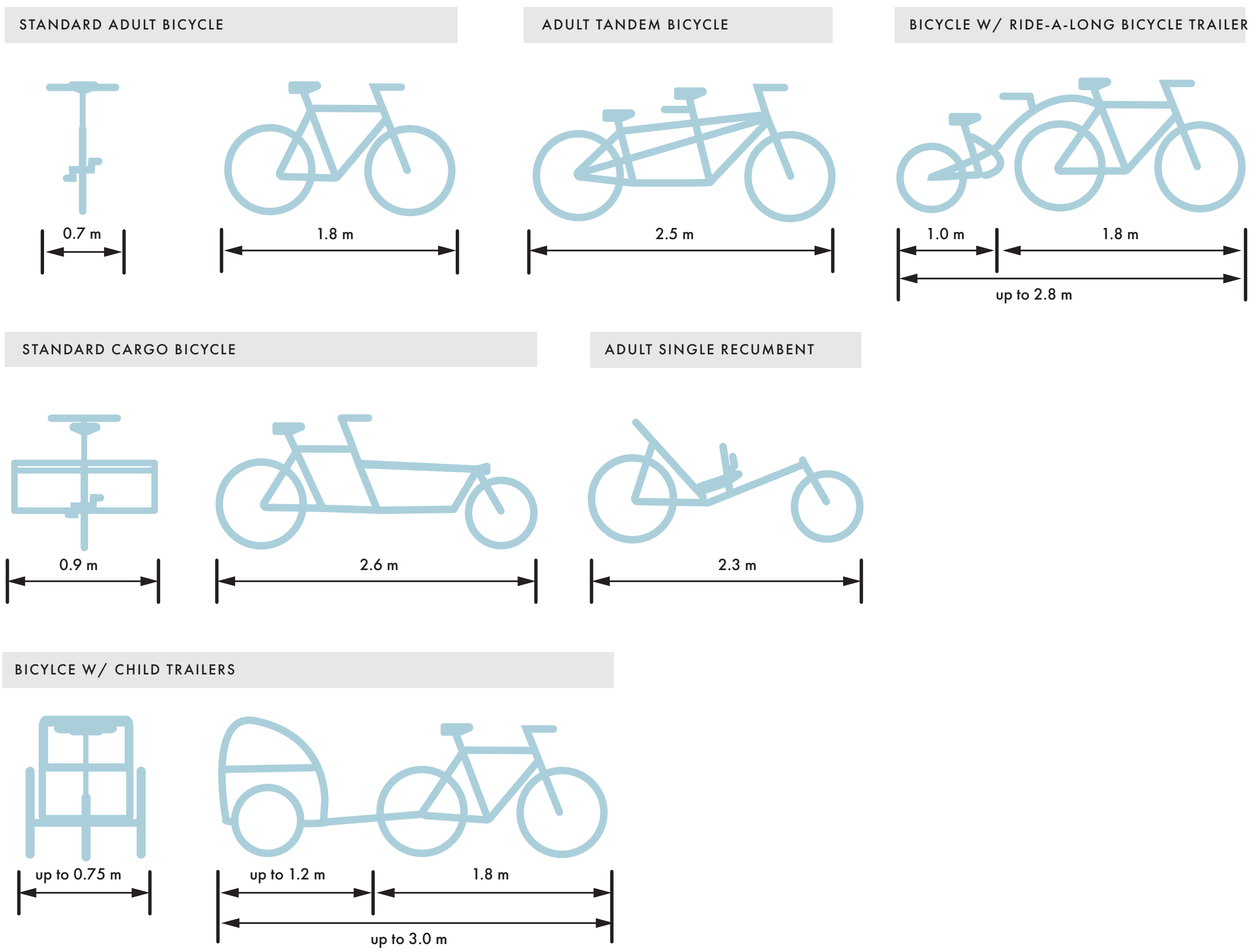


FIGURE B-11 // TYPICAL BICYCLE DESIGNS AND DIMENSIONS

Figure B-12 illustrates the horizontal and vertical operating envelopes for people cycling. These dimensions form the basis of the design parameters for bicycle facilities. People cycling have a typical vertical operating envelope of 2.5 metres. Eye level (typically 1.5 metres) and handlebar height (0.9 to 1.1 metres) are also important considerations.

A single person cycling requires a horizontal operating envelope of 1.2 to 1.5 metres, which allows for variations in lateral movement, which is common when riding uphill and when moving at full speed. However, active transportation facilities should be wide enough to accommodate occasional side-by-side riding and passing. A comfortable horizontal operating envelope for people riding side-by-side or passing is 2.5 metres. For this reason, a horizontal envelope on the higher end of the design domain should be used on bicycle facilities with steep grades.

For optimal usability and comfort, physically separated facilities such as off-street pathways and protected bicycle lanes should be designed to be wide enough for comfortable passing and side-by-side cycling. A desired operating width of 2.5 metres is recommended on uni-directional facilities, while a desired operating width of 3.0 metres is recommended on bi-directional facilities.

Facilities designed with this range of users in mind will accommodate the majority of existing and potential bicycle users and should also accommodate most other active transportation devices. These other active modes, such as skateboarding, in-line skating, and others, have unique operational and behavioural characteristics that should be considered. For example, in-line skating and roller skiing have wider operating envelopes due to their style of movement. Where a larger proportion of facility users are expected to be devices other than bicycles, consideration should be given to adjusting the facility geometry accordingly.

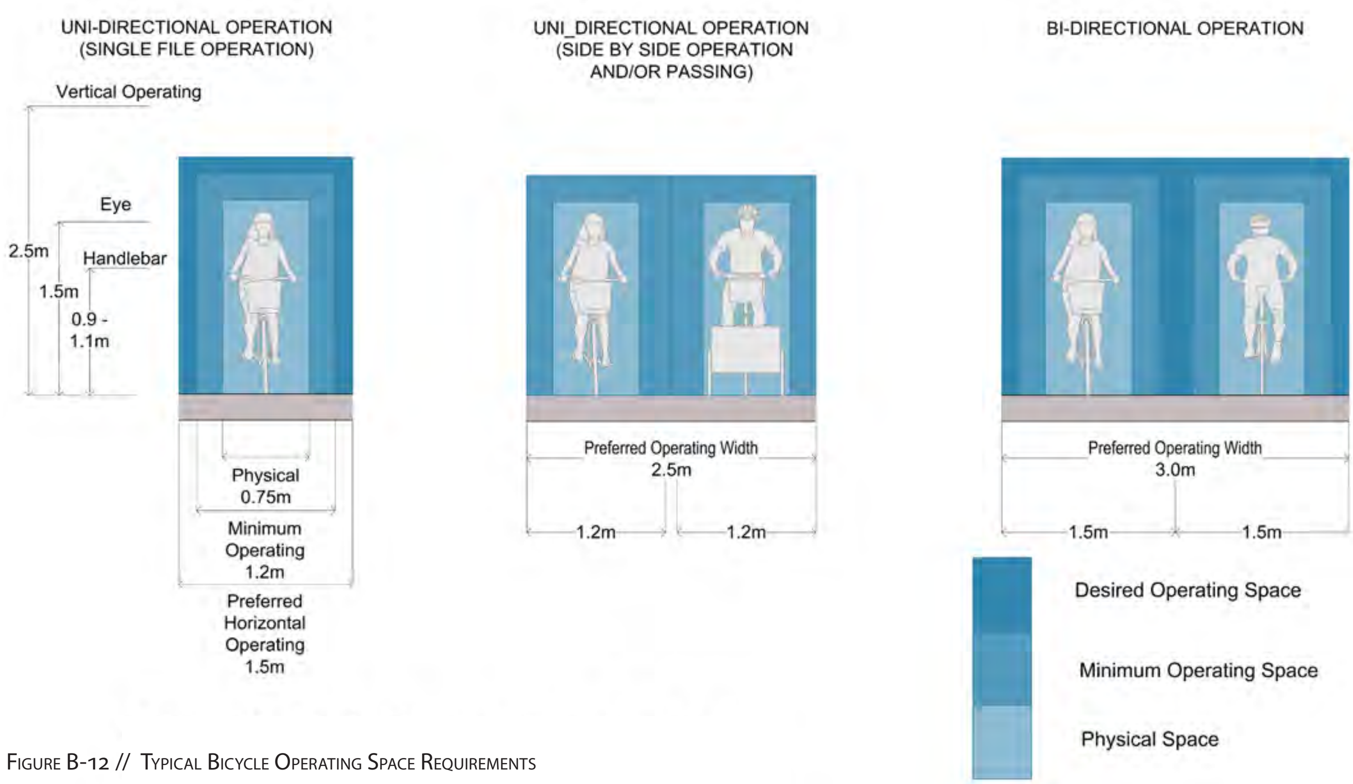


Figure B-12 // Typical Bicycle Operating Space Requirements

CLEARANCE FROM OBSTRUCTIONS

In addition to considering operating space, it is necessary to provide adequate vertical and horizontal clearance from obstructions above and alongside active transportation facilities.

People Walking

With the exception of doorways, the vertical clearance in pedestrian areas should be a minimum of 2.05 metres. In order to accommodate people with vision impairments, obstructions should be cane detectable. According to the CSA, any object protruding more than 100 millimetres from walls, columns, or free-standing supports should be cane-detectable at or below 685 millimetres from the floor or should have their underside at a height of at least 2.05 metres (see **Figure B-13**).

People Cycling and Other Active Transportation Users

Figure B-14 shows the desired vertical clearance for people cycling. The recommended vertical clearance should range from a constrained limit height of 3.0 metres to a desirable height of 3.6 metres (**Table B-4**). A vertical clearance of 3.6 metres also accommodates most small service vehicles and provides a comfortable buffer beyond the 2.5 metres required for people cycling. In exceptional circumstances, a minimum vertical clearance of between 2.7 and 3.0 metres can be considered. However, this minimum clearance is less comfortable for people cycling and should only be used for short distances (under 100 metres).

Figure B-14 also shows the required horizontal clearance from lateral obstructions of varying height. Minimum horizontal clearances from lateral

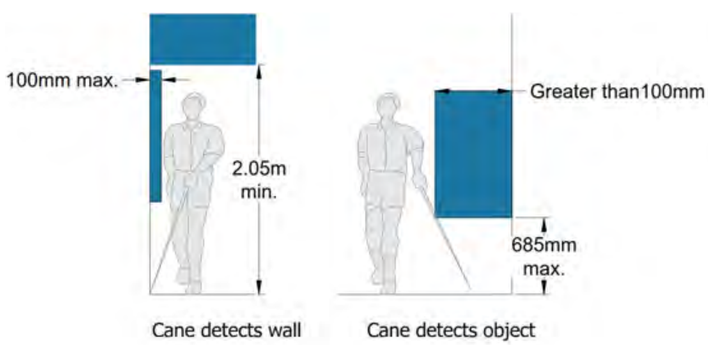


Figure B-13 // Clearance from Obstructions for People Walking

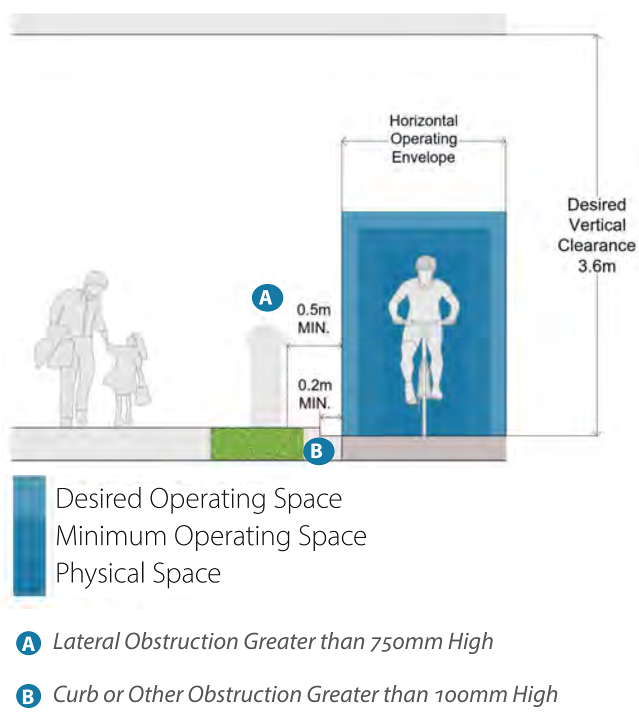


Figure B-14 // Clearance from Obstructions for People Cycling obstructions are determined by the typical height of bicycle pedals and handle bars. Lateral obstructions can include lane delineators, street trees, railings, fences, and curbs. Horizontal clearances vary by object height as follows:

- **Objects less than 100 millimetres in height:** These objects should be shorter than a bicycle pedal; no additional horizontal clearance is required.
- **Lateral obstructions between 100 and 750 millimetres in height:** A minimum 0.2 metre horizontal clearance is desirable.
- **Lateral obstructions greater than 750 millimetres in height:** A minimum 0.5 metre horizontal clearance is desirable.

Table B-4 // Bicycle Operating Vertical Clearance

PARAMETER	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Vertical clearance (bicycle facility surface to overhead structures/ foliage)	3.6	3.0

PERFORMANCE CHARACTERISTICS

Performance characteristics are particularly relevant for bicycles and other active transportation devices. In addition to factoring in the operating dimensions of bicycles and their users, the attributes that enable the safe and comfortable operation of a bicycle should be considered when designing bicycle facilities. These attributes include the surface type, connectivity of the bicycle network, and ability to maintain consistent cycling speeds. These requirements are applicable to all types of active transportation facilities, including on-street and off-street facilities. Maintenance is another key factor in assuring safe bicycle operation and is discussed in **Chapter I.3**.

Maintaining momentum is important for all modes of transportation, including cycling, as it takes a disproportionately large amount of energy to return to the desired operating speed after stopping or slowing. As a result, active transportation routes should be designed to reduce the need to frequently slow down or stop wherever possible. This can be accomplished by minimizing rough surfaces, tight corners, steep gradients, intersections, and the need to yield to others.

OPERATING AND DESIGN SPEED

Design speed is a fundamental design control used to determine geometric features of active transportation facilities as well as signal timing and road crossing parameters. The speed of an active transportation user is dependent on several factors, including:

- Age and physical condition of the user;
- Type and condition of the user's equipment;
- Purpose and length of the trip;
- Condition, surface material, location, and grade of the facility;
- Prevailing wind and direction; and
- Number and types of other users on the facility.

Figure B-15 shows the typical operating speed range for a variety of active transportation users.

People Walking

Walking speeds are a key consideration for signal timing (**Chapter G.2**) and Pedestrian Through Zone width (**Chapter C.2**). Pedestrians have a range of typical walking speeds, with children, older pedestrians, and people using mobility aids moving more slowly and requiring more time to cross the road at intersections. The TAC *Pedestrian Crossing Control Guide* recommends using the following pedestrian walking speeds when considering the design and operation of pedestrian crossings.[9]

- Use 0.8 m/s walking speed where at least 20% of pedestrians crossing the signalized intersection use assistive devices for mobility (e.g. near hospitals or nursing homes);
- Use 0.9 m/s walking speed where at least 20% of pedestrians crossing the signalized intersection are older pedestrians (age 65 and older); or
- Use 1.0 m/s walking speed to accommodate the general population.

People Cycling and Other Active Transportation Users

Typical adult cycling speeds are used to establish design speeds and basic geometric design requirements for stopping sight distance, horizontal and vertical alignment, and cross slopes. This is because higher speeds require more conservative geometric design components. Facilities designed in this fashion will accommodate slower bicycle users, including children, seniors, and less confident users. The typical adult travels at average speeds of 15 km/h to 30 km/h on flat level terrain. Electric bicycles can provide power assist up to a maximum of 32 km/h (see **Chapter H.5**). Using a design speed of 30 km/h is an appropriate speed in most contexts.

Adjustments to design speed should consider grade and facility surface, as follows:

- For every 1% increase in downhill grade, cycling speed increases by approximately 0.9 km/h; however, design speed should not exceed 50 km/h.
- For every 1% increase in uphill grade, cycling speed decreases by approximately 1.4 km/h.
- When designing unpaved paths, a slower design speed (20 km/h) should be used.

Design speeds slower than the typical adult bicycle user should be considered for some elements of design, as follows:

- Using 3.3-4.2 m/s (12-15 km/h) as the design speed for intersection crossings will account for slower bicycle users who need more time to cross intersections, such as children and seniors, and should be used for signal timing.
- For urban bicycle facilities with a variety of users and frequent conflicts or constraints, a lower design speed should be used (15 km/h). Geometric design and traffic control devices should be included in the design to reduce the speeds of bicycle users and motor vehicles at conflict points.

9 Jeannette Montufar, Garreth Rempel, and Sarah Klassen, Pedestrian Walking Speed for Traffic Operations in Canada (Ottawa: Transportation Association of Canada, 2013).

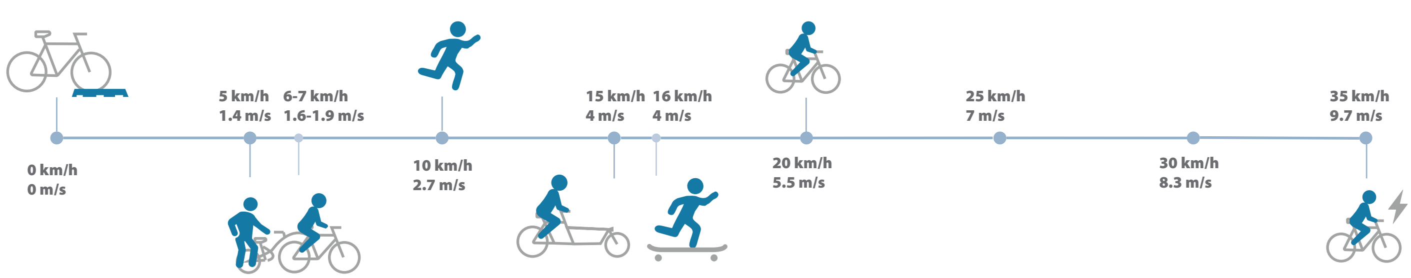


Figure B-15 // Typical Active Transportation User Speeds

Calculating Measurements

Where there is a curb and/or gutter, all measurements in the Design Guide are measured from the lip of gutter (as opposed to the face of curb) and exclude the gutter pan (see **Figure B-16**). Where there is no curb and/or gutter, all measurements in the Design Guide are measured to the edge of pavement. In addition, measurements to longitudinal pavement markings are calculated to the centre of the painted line.

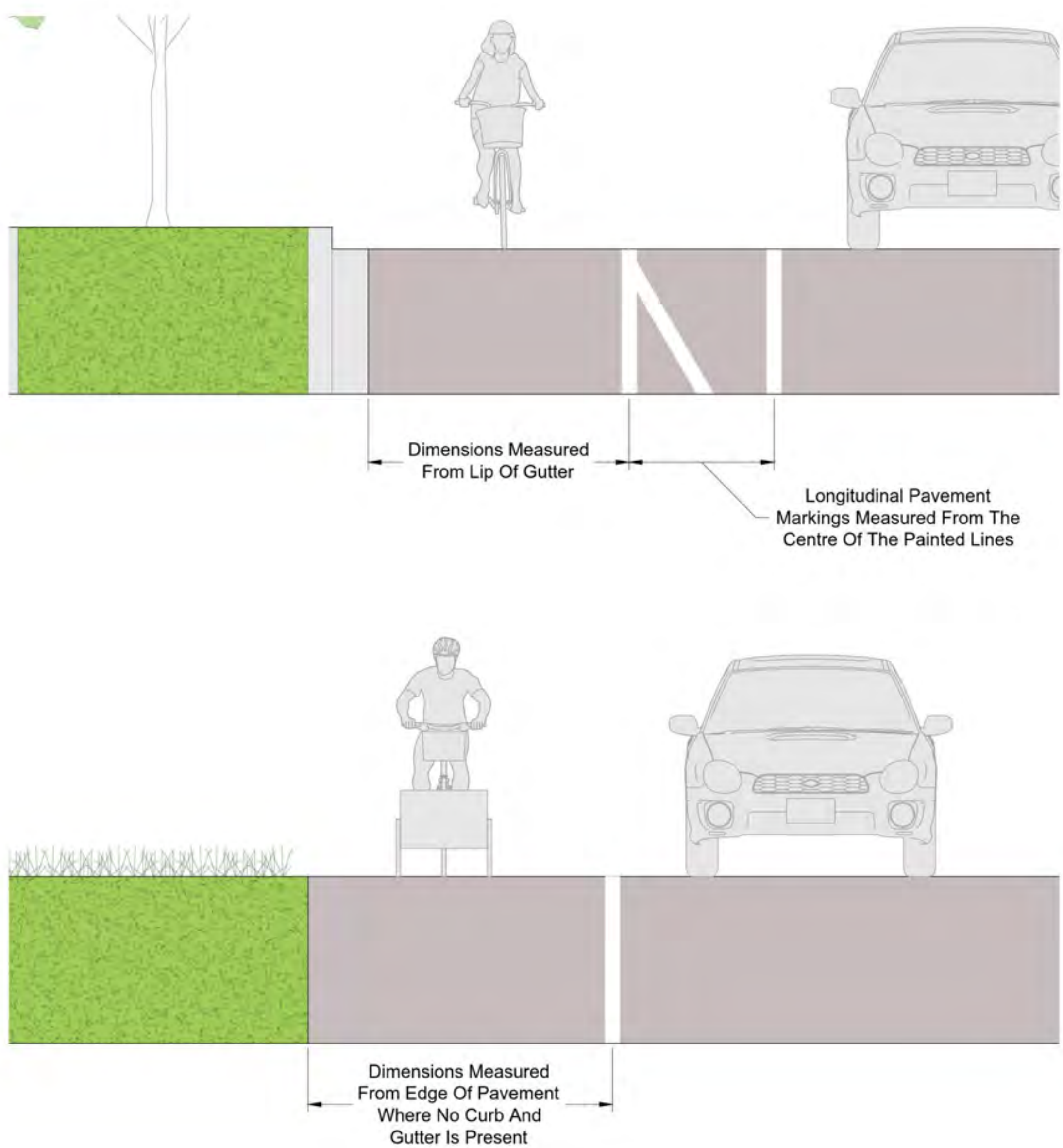


Figure B-16 // Calculating Measurements

10th Avenue Bikeway in Vancouver, B.C.
Source: Victor Wang

C.

PEDESTRIAN FACILITIES

Campbell Street, Tofino, B.C.

C.1

GENERAL DESIGN GUIDANCE

This chapter provides general design guidance for pedestrian facilities to create walkable environments in both urban and rural contexts. This chapter introduces the various pedestrian zones, outlines a number of pedestrian facility types, and provides guidance for facility selection based on the local context and adjacent road conditions.

CREATING WALKABLE ENVIRONMENTS

Walking is the most universal mode of transportation. Every trip, regardless of the primary mode used, begins and ends with walking or using a mobility device. Communities of all sizes should strive to provide pedestrian facilities and amenities that make walking or using a mobility device safe, convenient, pleasant, and universally accessible. Pedestrian facilities should not only accommodate, but also welcome people of all ages and abilities. There are a number of characteristics that can help to create comfortable and desirable walking environments, including:

- **Physical separation** from other road users;
- Adequate **clear width** to allow more than one person walking or using a mobility device to pass each other;
- **Firm, smooth, and even surfaces**;
- Sufficient **pedestrian crossing** opportunities;
- **Short distances** between destinations;
- **Continuous and direct routes** between destinations that reflect pedestrian desire lines;
- **Buildings** that are oriented towards the road, creating an engaging environment;
- **Diverse land uses** that create a varied and interesting walking experience;
- **Wayfinding** that makes it easy to navigate between destinations;
- **Street trees** and other vegetation;
- **Weather protection** elements to provide refuge from rain or snow;
- Adequate **lighting** for safety, security, and visibility;
- Sufficient **benches and rest areas;**
- Pedestrian **amenities** including landscaping, water fountains, washrooms, garbage and recycling receptacles, public art, and street furniture; and
- **Well-maintained** pedestrian facilities in all seasons.

Design professionals should aim to achieve as many of these characteristics as possible when designing pedestrian facilities. It should be noted, however, that pedestrian design considerations can differ significantly based on community size and layout, land use, topography, climate, and many other elements. For example, busy urban commercial districts, suburban residential roads, rural roadways, and everything in between each have unique characteristics, constraints, and design requirements.

PEDESTRIAN ZONES

When located within a road right-of-way in an urban context, the pedestrian environment can be divided into three functional zones (see **Figure C-17**):

1. **Frontage Zone**
2. **Pedestrian Through Zone**
3. **Furnishing Zone**

In addition, the adjacent 4 **Ancillary Zone** is a flexible on-street space that can sometimes include pedestrian amenities. The Pedestrian Through Zone should always be prioritized, as it enables pedestrian movement and accessibility. Design guidance for the Pedestrian Through Zone is provided in **Chapter C.2**. Design guidance for the Frontage Zone, Furnishing Zone, and Ancillary Zone is provided in **Chapter C.3**.

Providing all three pedestrians zones is especially important in areas of high pedestrian activity, such as in urban areas and developed rural cores, as this can enhance the safety, convenience, and enjoyment of the pedestrian environment**.**

When located within a road right-of-way in outer developed rural and basic rural contexts, the pedestrian environment can have very different cross-sections and may only require a **Pedestrian Through Zone** (**Figure C-18**). Depending on the context, there may also be a Clear Zone and/or a Shoulder Zone between the Pedestrian Through Zone and the Traffic Zone.

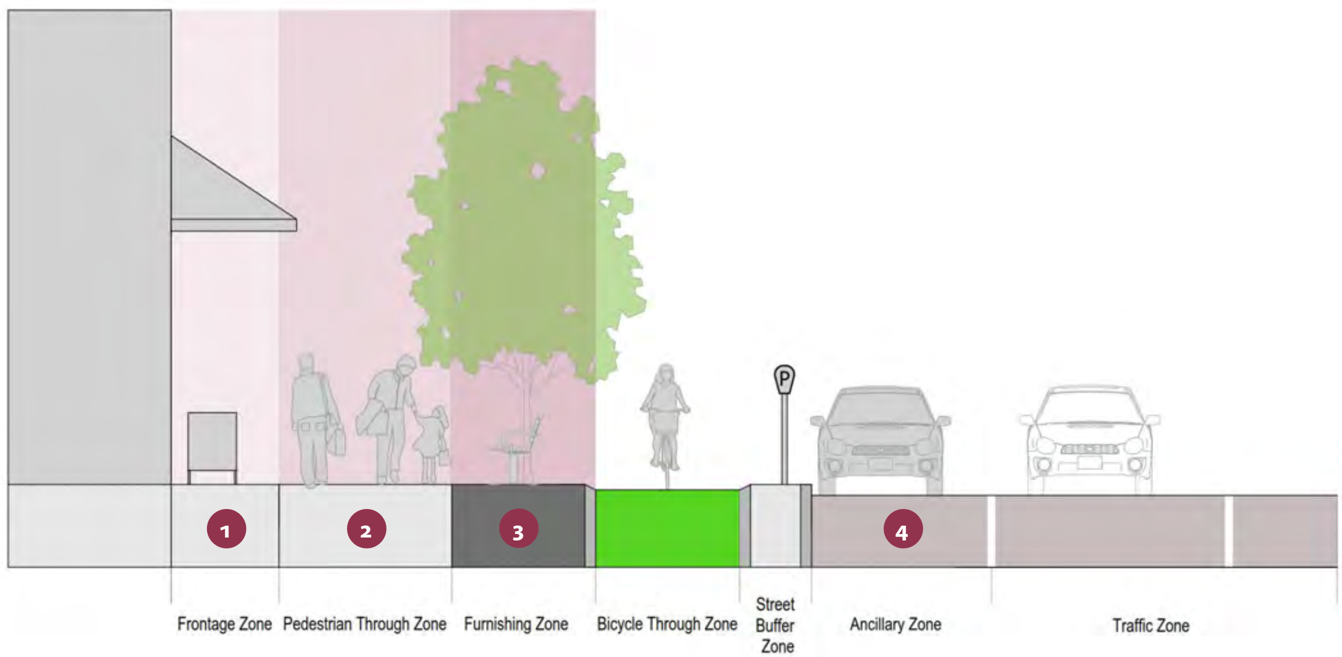


FIGURE C-17 // PEDESTRIAN ZONES IN URBAN CONTEXT

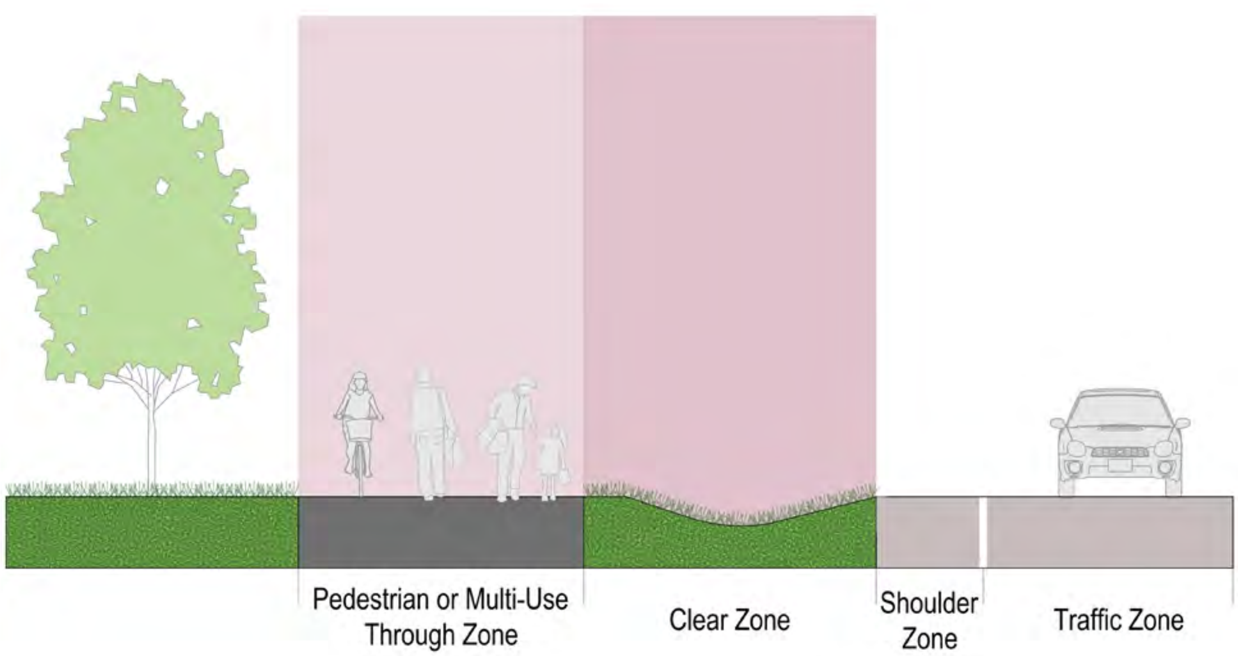


FIGURE C-18 // PEDESTRIAN ZONES IN RURAL CONTEXT

PEDESTRIAN FACILITY TYPES

Figure C-19 shows a spectrum of pedestrian facilities, which have been divided into supporting facilities and all ages and abilities facilities. Each type of facility may be appropriate in a different context, as described below:

- **Off-Street Pathway**: Pathways that are physically separated from the road, including multi-use pathways and separated bicycle and pedestrian pathways (see **Chapter E.2** and **Chapter E.3**).
- **Enhanced Separated Sidewalk**: Consists of a wide separated sidewalk with ample space for pedestrian movement, sidewalk utilities, and placemaking opportunities.
- **Separated Sidewalk**: A Furnishing Zone separates the Pedestrian Through Zone from the roadway. This buffer enhances pedestrian safety and comfort while providing space for sidewalk amenities and utilities (see **Chapter C.3**).
- **Non-Separated Sidewalk**: The Pedestrian Through Zone is located directly next to the roadway, but is physically separated from the roadway by a curb. Gutters are provided for drainage.
- **Walkable Shoulder**: If no formal sidewalk is provided, a shoulder may be provided. People walking may utilize the shoulder, with the Pedestrian Through Zone directly adjacent to the Traffic Zone. This type of facility is not considered appropriate for people of all ages and abilities. **Chapter C.4** outlines additional ways to accommodate people walking where sidewalks are not feasible or appropriate.

Figure C-19 // Pedestrian Facility Type Spectrum

APPLICABILITY AND CONTEXT

Urban Context

Sidewalks are the foundation of the pedestrian network in urban contexts and where there is high walking activity in suburban and developed rural core contexts. Sidewalks provide a dedicated space within the right-of-way that facilitates movement, access, and connectivity while providing physical separation from motor vehicles. Sidewalks also serve as public spaces, playing a key role in activating communities both socially and economically. A well-designed sidewalk network that considers local context and universal accessibility can make walking and using mobility devices safer and more attractive, ultimately contributing to increased public health and helping to maximize social capital.

Sidewalks are recommended on all types of urban roads. Ideally, sidewalks should be provided on both sides of the road in order to enhance pedestrian network connectivity, provide full accessibility, and limit unnecessary road crossings. However, this may not be necessary if there are not pedestrian destinations present on one side of the road or if traffic volumes and speeds are sufficiently low. Where appropriate, an off-street pathway can take the place of a sidewalk (see **Chapter E.2** and **E.3**).

In general, separated sidewalks are preferred over non-separated sidewalks, as they provide the following benefits:

- Increase the safety and comfort for people walking due to the larger buffer from motor vehicles;
- Provide space in the Furnishing Zone for utilities and sidewalk amenities such as benches, bicycle racks, street trees, and landscaping, while maintaining an unobstructed Pedestrian Through Zone;
- Provide an adequate slope area for driveway ramps between the curb and sidewalk (see **Chapter C.2**);
- Provide space for snow storage; and
- Decrease the likelihood of people walking being splashed by motor vehicles during wet weather (due to the increased buffer space).

Separated sidewalks should be considered along all arterial roads and in areas with high pedestrian activity. They may also be used along local and collector roads, including near health care facilities and school zones. While they have a number of important benefits, separated sidewalks take up more right-of-way and can also be more expensive to construct and maintain due to the addition of a Furnishing Zone. While separated sidewalks are preferred, non-separated sidewalks may be acceptable where motor vehicle speeds and volumes are sufficiently low, where there are no key pedestrian destinations, or where the right-of-way is constrained.

Deep Cove, District of North Vancouver, B.C.

Enhanced separated sidewalks are recommended in downtown commercial centres, along main streets, near major transit hubs, and in other areas of high pedestrian activity. Greater sidewalk width is highly beneficial in these contexts to allow for increased pedestrian volumes, pedestrian passing movements, and enhanced pedestrian amenities. Where wider sidewalks are not possible due to right-of-way constraints, pedestrian flow can be aided by reducing the size of the Frontage and Furnishing Zones and ensuring that objects such as sandwich boards and planters are not obstructing the Pedestrian Through Zone.

Rural Context

In rural contexts, sidewalks are recommended in developed rural cores such as towns and villages with population densities of at least 400 people per square kilometre. In order to increase pedestrian safety, sidewalks are recommended along roads with more than 2,000 motor vehicles per day or motor vehicle speeds over 30 km/h. Sidewalks are also appropriate along short distances between built-up areas that connect pedestrian destinations such as neighbourhoods, schools, health-care facilities, and commercial areas.

In outer developed and basic rural areas, sidewalks may not always be feasible or necessary. Sidewalk construction in these environments can be cost-prohibitive, and the curb and gutter construction of sidewalks may not support the existing rural character. Separated pedestrian walkways or off-street pathways separated from motor vehicle traffic by a landscaped ditch in the Clear Zone, may be more appropriate.

Special attention should be given to pedestrian facilities in school zones or near health-care facilities where a higher proportion of people may be children, people with mobility aids, and people with visual and/or mobility impairments. In these cases, as much separation as possible should be provided between motor vehicles and people walking. Traffic calming measures that reduce motor vehicle speeds and volumes may be appropriate near schools.

Flexible Strategies

Flexible and inexpensive strategies for accommodating people walking in rural contexts can be found in **Chapter C.4**.

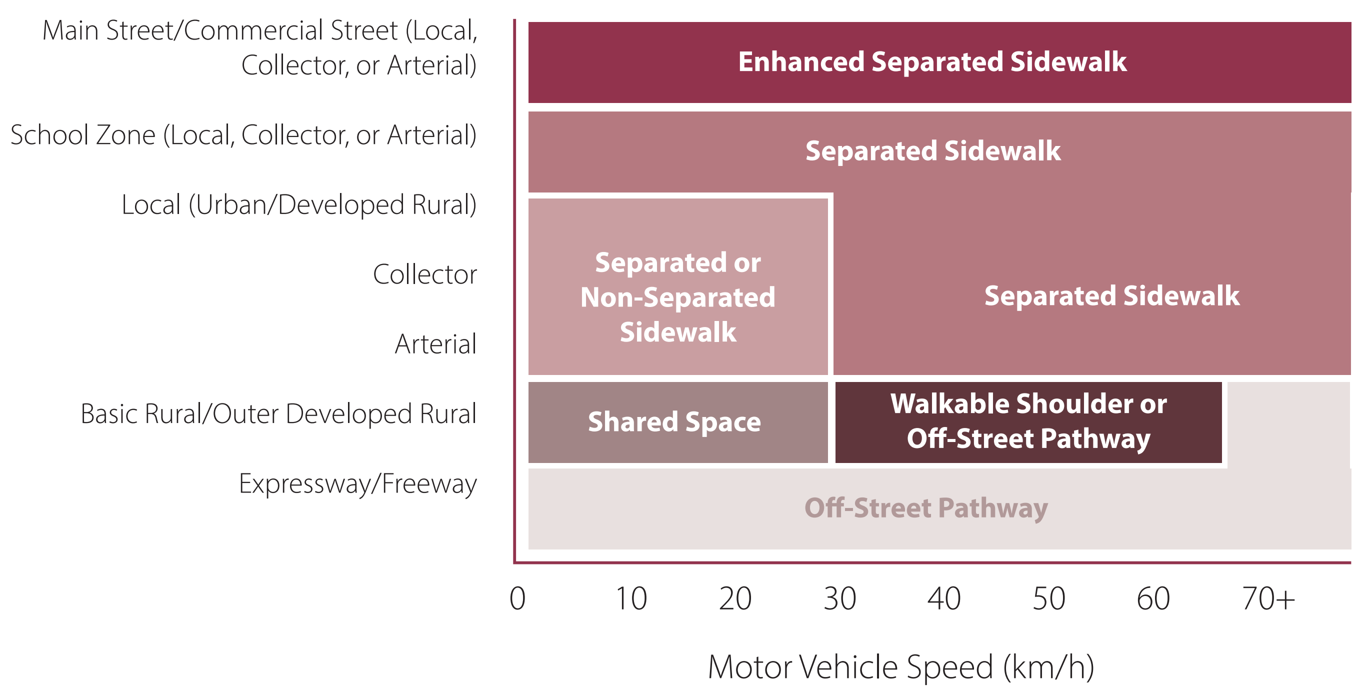
District of Coldstream, B.C.

PEDESTRIAN FACILITY SELECTION

Figure C-20 shows the Pedestrian Facility Selection Decision Support Tool, which outlines when each type of pedestrian facility may be appropriate. This decision support tool is based on motor vehicle speeds and road service classes, with some additional context added based on land-use context. The Pedestrian Facility Selection Decision Support Tool is based on the selection criteria outlined in **Chapter B.2**.

The Pedestrian Facility Selection Decision Support Tool is provided to narrow the range of appropriate pedestrian facility types and support the decision-making process for design professionals. It does not replace the need for the decision on the appropriate pedestrian facility type to be made by a qualified, experienced professional exercising sound judgement. Design professionals should also consult **Chapter B.2** to understand the contextual and local conditions that may influence the preferred pedestrian facility type.

FIGURE C-20 // PEDESTRIAN FACILITY SELECTION DECISION SUPPORT TOOL



30th Avenue, Vernon, B.C.

C.2

PEDESTRIAN THROUGH ZONE

The Pedestrian Through Zone is the area intended for pedestrian movement, where people travel, interact with each other, and access destinations along a street. Providing a Pedestrian Through Zone that is functional for people of all ages and abilities should be prioritized over other zones when designing the pedestrian environment. This area should remain clear of obstructions and provide sufficient width for the expected volume of people, including people using mobility aids.

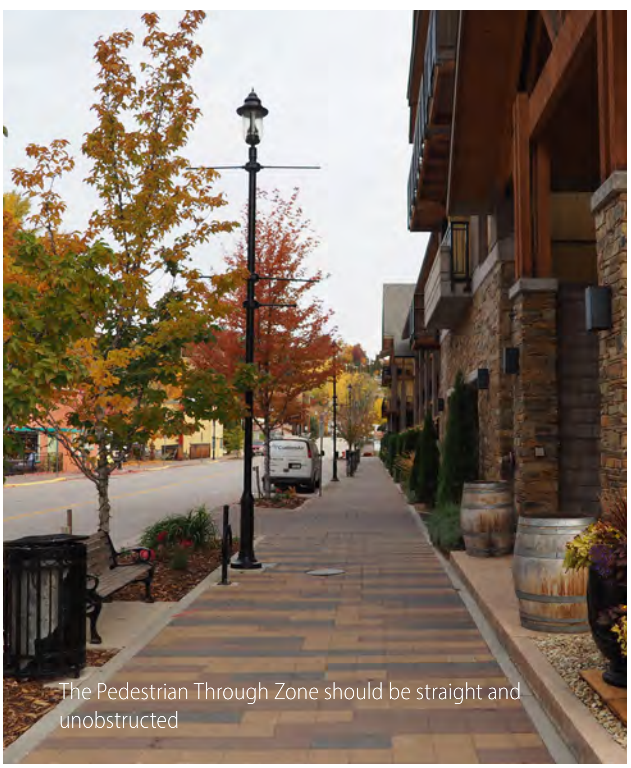
DESCRIPTION

The Pedestrian Through Zone may consist of a sidewalk (non-separated, separated, or enhanced), an off-road pathway, or a walkable shoulder depending on the context (see **Chapter C.1** for definitions). The Pedestrian Facility Selection Decision Support Tool in **Chapter C.1** outlines where each type of Pedestrian Through Zone treatment is typically applicable. In general, sidewalks are the preferred treatment in urban, suburban, and developed rural core contexts. In outer developed rural and basic rural contexts, off-street pathways, walkable shoulders, and shared spaces are more common.

The design guidance provided in this chapter is applicable to all types of facilities in the Pedestrian Through Zone, although some elements discussed may be more applicable to urban and developed rural core contexts. Additional tools for creating walkable environments in outer developed rural, basic rural, and some suburban areas are provided in **Chapter C.4**.

The Pedestrian Through Zone should be kept clear of obstructions at all times, with the minimum width maintained for the length of the corridor and through all crosswalks. When utilities, street furniture, advertising boards, vegetation, or other obstructions encroach on the Pedestrian Through Zone, access can be limited, especially for those using mobility devices. Different surface materials or detectable warning surfaces such as tactile walking surface indicators (TWSIs) may be used to define the Pedestrian Through Zone, differentiating it from other zones and ensuring that it is detectable for people who are visually impaired. The surface of the Pedestrian Through Zone should be firm, non-slip, and glare-free (see Surface Materials subsection of this chapter for more details).

The Pedestrian Through Zone should have a straight and consistent alignment, with continuity maintained across driveways, intersections, and other conflict zones. Generally, the Pedestrian Through Zone should be aligned parallel to the road centreline or the property line. This continuity helps to improve



The Pedestrian Through Zone should be straight and unobstructed

The Pedestrian Through Zone should avoid unnecessary winding turns navigation and wayfinding for people who are visually impaired. In constrained contexts, the Pedestrian Through Zone may need to occasionally meander around obstacles, but this should be avoided wherever possible. However, meandering or curvilinear sidewalks may be used to mitigate long sustained steep grades. Driveways across the Pedestrian Through Zone should be limited to minimize disruptions. Design guidance for driveway crossings is provided later in this chapter.

DESIGN GUIDANCE

Width

The recommended desirable and constrained limit widths for the Pedestrian Through Zone are shown in **Table C-5**. These widths apply predominantly to sidewalks but can be used as a general guide for other Pedestrian Through Zone treatments. For more detail on off-street pathways, refer to **Section E**. The recommended widths differ based on land-use context to ensure that in areas with higher pedestrian activity, window shopping, or large surges of activity, there is sufficient width to maintain pedestrian movement. The recommended widths also differ based on the adjacent road type, recognizing that higher motor vehicle speeds and volumes can negatively impact pedestrian safety and comfort. Design professionals should also consider a number of other factors when determining the Pedestrian Through Zone width, including the presence of parks, trails, transit stops, and other considerations.

The Pedestrian Through Zone should have a constrained limit width of at least 1.8 metres, which allows two people using mobility devices to pass one another. A width o 1.8 metres is also recommended for snow clearing operations, as this helps prevent plow damage to road amenities and utilities. Providing between 1.8 and 2.1 metres allows sufficient clearance for a pedestrian to pass someone with a service animal or another pedestrian holding a child's hand.

Table C-5 // Pedestrian Through Zone Recommended Widths

Land Use Context	Road Type	Separation	Desirable (m)	Constrained Limit (m)*
Single- Family Residential	Local	Non-Separated or Separated	1.8	1.8
	Collector/Arterial**	Separated	1.8	1.8
Multi- Family Residential	Local	Non-Separated or Separated	2.1	1.8
	Collector/Arterial**	Separated	2.4	1.8
Industrial	Any**	Separated	2.1	1.8
Commercial	Any**	Separated	2.4-3.0	2.1
Area of high pedestrian activity (including temporary, special event, or seasonal)***	Any	Separated	3.0-4.0	2.4

* The absolute minimum width of the Pedestrian Through Zone is 1.5 metres, which should only be used under constrained conditions for distances under 100 metres

** Non-separated sidewalks are not recommended on collector, arterial, or industrial roads with motor vehicle speeds greater than 30 km/h (see **Chapter C.1**). If non-separated sidewalks cannot be avoided due to site constraints, a minimum of 0.5 metres may be added to the Pedestrian Through Zone width to provide extra separation from motor vehicles.

*** Areas of high pedestrian activity have peak pedestrian volumes of 400 pedestrians/peak 15-minute period, as per Table 6.3.1. in the TAC *Geometric Design Guide for Canadian Roads.*

The absolute minimum width of the Pedestrian Through Zone is 1.5 metres, which should only be used under constrained conditions for distances under 100 metres. A Pedestrian Through Zone less than 1.5 metres wide cannot reasonably support two-way pedestrian movement. Wherever a Pedestrian Through Zone width is selected that is less than recommended based on pedestrian volumes and road type, a full width section should be provided every 30 to 60 metres to allow for passing.

Where higher pedestrian volumes are expected, such as along roads with multi-family or commercial land uses, wider Pedestrian Through Zones are recommended (see **Table C-5**). In areas of especially high pedestrian activity, including temporary, special event, and seasonal contexts, the Pedestrian Through Zone width should be further increased to allow for adequate maneuvering space. This applies to areas where pedestrian volumes are greater than 400 people in the peak 15 minutes. The constrained limit width under these conditions is 2.4 metres, and the desirable width is 3.0 to 4.0 metres, based on the volume of pedestrians and maneuvering space required. Locations that see very high pedestrian volumes may require even greater widths.

Wider Pedestrian Through Zones contribute to comfortable walking environments and can enable a number of desirable social interactions. Design professionals are encouraged to consider adding additional width where feasible and warranted. Further areas or conditions where additional Pedestrian Through Zone width should be considered include:

- Where there are connections to schools, community centres, transit hubs, and major pedestrian generators;
- Where pedestrian surges occur, such as transit stations, stadiums, and other large event areas;
- Where there is a large proportion of people using mobility devices, people pushing strollers, and visually impaired pedestrians, such as near health-care facilities and assisted living facilities;
- Where strolling, lingering, and window shopping is expected and encouraged;
- Where there are pinch points or where the Pedestrian Through Zone is directly adjacent to buildings with zero setback;
- Where driveway ramps are present; and
- Where the Pedestrian Through Zone is directly adjacent to the curb, providing additional space for road hardware, snow clearing and storage, opening doors from marked motor vehicles, and motor vehicle traffic.

Where the right-of-way is limited, design professionals should consider reducing or removing other road elements in order to maintain the desirable width for the Pedestrian Through Zone. To provide extra space, the following could be considered, in this order:

- Narrow the Frontage Zone;
- Narrow the Furnishing Zone; or
- Remove the Frontage Zone and/or Furnishing Zone.

A more expensive option for providing increased Pedestrian Through Zone width includes narrowing or removing general purpose motor vehicle travel lanes, turning bays, or on-street parking, and then moving the curb to widen the sidewalk. This option requires careful consideration of traffic volumes, parking supply, and the minimum widths required for the corridor's design vehicles, including trucks, transit, and emergency services. Moving the curb may be more cost effective if implemented alongside development or an existing road reconstruction project that already required the road or curb to be reconstructed. An overview of retrofit strategies is provided in **Chapter B.2**.

Separated sidewalks are desired in all contexts, as they create a safer and more pleasant walking experience. However, separated sidewalks may not always be necessary on local roads and may not be feasible in constrained contexts. Separated sidewalks are generally recommended along collector, arterial, or industrial roads in new construction and rehabilitation projects, where feasible.

Where site constraints necessitate that a non-separated sidewalk be installed, additional buffer width of 0.5 metres or greater may be added to the Pedestrian Through Zone width where feasible to improve pedestrian safety and provide adequate width for snow clearing. Additional width on non-separated sidewalks is especially important in areas with high motor vehicle volumes (>4,000 vehicles per day, excluding industrial areas), heavy truck traffic (>10% of total volume), or roadway design speeds over 60 km/h.

Grade and Slope

Longitudinal Grade

Flat surfaces are ideal for those with mobility impairments. B.C.'s coastal and mountainous topography can often be a challenge for communities to provide accessible and connected pedestrian networks. As a result, steep grades should be considered during the design of pedestrian facilities.

Table C-6 shows the recommended longitudinal grades for pedestrian facilities. In order to be universally accessible, the Pedestrian Through Zone should have a maximum grade of 1:20 (5%). Grades as steep as 1:12 (8.3%) are acceptable as long as intermittent landings are provided at intervals of no more than 9.0 metres.

Table C-6 // Longitudinal Grade

Maximum Longitudinal Grade	Requirements
≤ 5.0%	None
> 5.0% to 8.3%	Landings should be provided every 9.0 metres
> 8.3%	Alternative accommodations recommended

Many communities have pedestrian facilities with grades steeper than 8.3%. Where this is the case, there are a number of strategies that can be used to make the route accessible for pedestrians. Despite the strategies listed below, not all roads will be accessible for people of all ages and abilities. Wherever feasible, design professionals should ensure that where an inaccessible route exists, alternative routes or transportation modes are provided and made apparent through signage and wayfinding.

Strategies for mitigating the effects of steep topography include:

- **Maintenance**: Along steep grades, it is especially important to ensure that the Pedestrian Through Zone is clear of snow, ice, gravel, and wet leaves in the fall and winter, as these can create dangerous slipping hazards. Staircases should also be well maintained and inviting, including firm steps and solid railings.
- **Rest Areas**: Providing frequent flat landing areas with benches or other seating can allow people the opportunity to walk uphill in stages.
- **Railings**: Adding railings can help people who require extra support when navigating steep slopes.
- **Circulating Shuttle**: Providing a circulating shuttle that connects key destinations can help to lessen the impact of steep topography. For example, the City of White Rock offers a free seasonal trolley bus that connects the waterfront to the uptown area up the hill.
- **Adding Switchbacks**: While a direct pedestrian route is generally preferred, curves or switchbacks can be added to the pedestrian facility where space permits in order to minimize the grade.
- **Accessible Ramps**: If the grade is steeper than 8.3%, an accessible ramp may be provided, if space allows. The ramp should meet universal accessibility specifications, including the provision of level landing spots and railings. See **Chapter G.3** for design guidance.

- **Ladder Sidewalks**: Some communities have installed concrete bars in the sidewalk on some of their steepest roads to provide additional traction for pedestrians. These ‘ladder sidewalks’ are helpful in wet and slippery conditions. If placed across the entire Pedestrian Through Zone, they render the sidewalk inaccessible for people using wheelchairs, although these sidewalks may already be too steep for most wheelchair users to comfortably use. Other strategies include placing the bars across only half the Pedestrian Through Zone, leaving space for wheelchair users to bypass the obstruction if the sidewalk grade is not too steep.
- **Stairways**: A range of communities, including White Rock, North Vancouver, Nelson, and Tofino, have incorporated stairways to maintain connectivity where standard sidewalks or accessible ramps are not feasible. While stairways are not accessible for people using mobility devices, they provide railings and intermittent landing areas that allow people to rest, aiding their ascent. If stairways are used, a parallel accessible pedestrian route should be provided (if possible), with signage and wayfinding guiding people to the accessible route. In addition to enhancing connectivity, stairways present an opportunity for adding additional pedestrian amenities such as lighting, seating, landscaping, and public art. At locations where there are stairways, ramps can be installed to allow people cycling to easily push their bicycles up the stairways as opposed to having to carry their bicycles or find another route. See **Chapter G.6** for design guidance on staircase design.

The City of Trail has a unique system of 63 covered staircases that have become an iconic part of the community. They were installed in the 1930s and 1940s to provide access to the downtown core and were covered to help reduce winter maintenance, as Trail receives a significant amount of snowfall each winter. The staircases have become the focal point of local events, including a United Way fundraiser called ‘Storm the Stairs’ and a multi-sport race called the ‘Red Roofs Duathlon.’

Staircase alongside a steep road in Tofino, B.C.

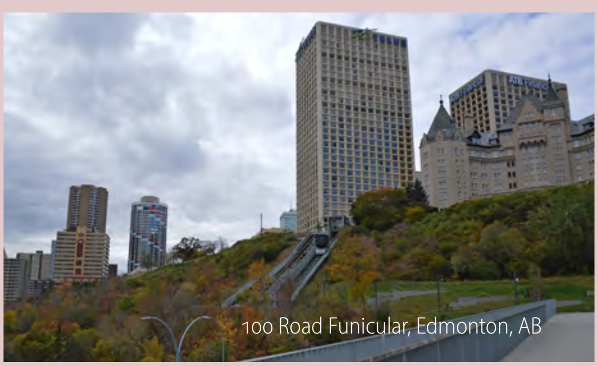
Ladder sidewalk across a portion (left) and the full (right) sidewalk, Oak Street, Vancouver, B.C.

Mechanized Solutions

Nationally and internationally, a number of communities have turned to mechanized solutions to mitigate topography. These include funiculars, cable car systems, and even outdoor escalators. These solutions are very much context-specific and require careful consideration, as they may require more space, greater initial costs, and ongoing maintenance. However, in the right contexts, they have shown potential to enhance community connectivity while also providing unique placemaking opportunities and attracting tourists. Two examples are listed below.

Funicular: The 100 Road Funicular in Edmonton, Alberta provides an all ages and abilities connection for pedestrians from downtown Edmonton to the North Saskatchewan River Valley, where well-used active transportation and recreation facilities are located. The funicular does not require an operator. Stairs are installed next to the funicular as part of a pedestrian promenade.

Escalators: The covered outdoor escalator network in Medellin, Colombia, which opened in 2011, has helped to connect the Comuna 13 neighbourhood to other areas of the city, vastly improving access to employment opportunities and community amenities for local residents. The escalator system and the associated public space improvements have helped to improve neighbourhood safety and have quickly become an international tourist destination.



100 Road Funicular, Edmonton, AB

Comuna 13 Escalators, Medellin, Colombia
Source: Dylan Passmore

Cross Slope

Cross slope is an important consideration for pedestrian comfort, universal accessibility, and drainage. A certain degree of cross slope is required to ensure proper drainage, but when a cross slope is too steep, it becomes very challenging to traverse for people using mobility aids.

The desired cross slope along a pedestrian facility is 1.0 to 2.0%, draining towards the gutter line or ditch. The lower end of this range is more comfortable for people using mobility devices, with 2.0% being the maximum slope recommended for universal accessibility. In constrained circumstances, a cross slope up to 5.0% is acceptable. Over short driveways, an absolute maximum of 8.0% may be used. The absolute minimum cross slope is 0.6%, but this may present drainage challenges.

Driveways and Alleys

Driveways

Where driveways cross the Pedestrian Through Zone, they create conflict points between motor vehicles and people walking. Additionally, driveway ramps that extend into the Pedestrian Through Zone can make it challenging for people using mobility devices to maneuver, as they require a flat surface to rest their supports. Therefore, driveways across the Pedestrian Through Zone should be limited as much as possible in order to maintain an unobstructed pedestrian facility. In areas with numerous driveways, such as in commercial areas, access management should be considered to control the location, dimensions, and frequency of driveways.

Along separated sidewalks with a Furnishing Zone, driveway ramps should be confined to the Furnishing Zone, maintaining a continuous, level Pedestrian Through Zone (**Figure C-21**). In this context, the sidewalk cross-slope should be maintained through the driveway and cane-detectable directional score lines should be used in the ramp segment of the driv5way.

Along non-separated sidewalks, there is no Furnishing Zone. As such the driveway ramp may have to be located in the Pedestrian Through Zone. If achievable, a flat segment of the Pedestrian Through Zone of at least 1.0 metre should be maintained, as shown in **Figure C-22.** The Pedestrian Through Zone may need to be widened to make room for this flat segment. Alternatively, the Pedestrian Through Zone could bend out to wrap around the driveway, as shown in **Figure C-23** If the available right-of-way and the grade necessitate ramping down the entire Pedestrian Through Zone, score lines should be used across both the Pedestrian Through Zone and ramp segments to guide pedestrians with visual impairments through the conflict zone.

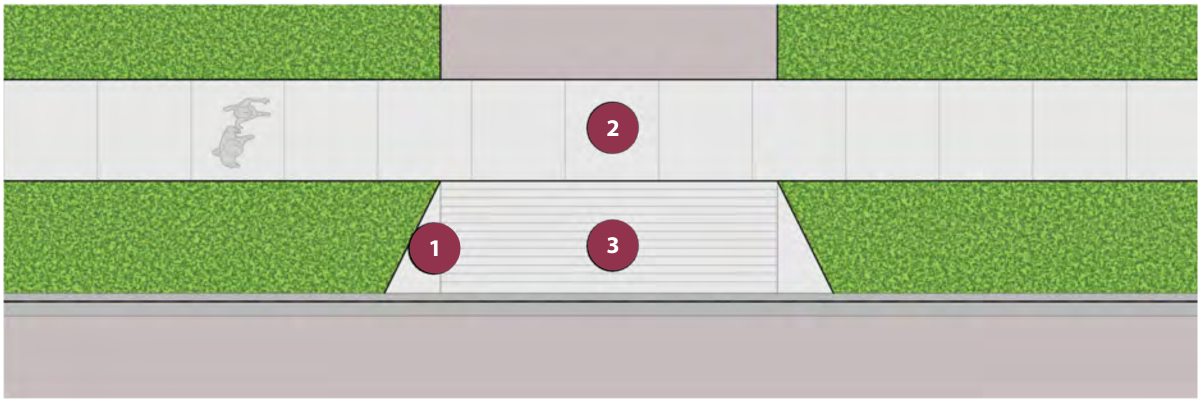


Figure C-21 // Driveway crossing of Separated Sidewalk

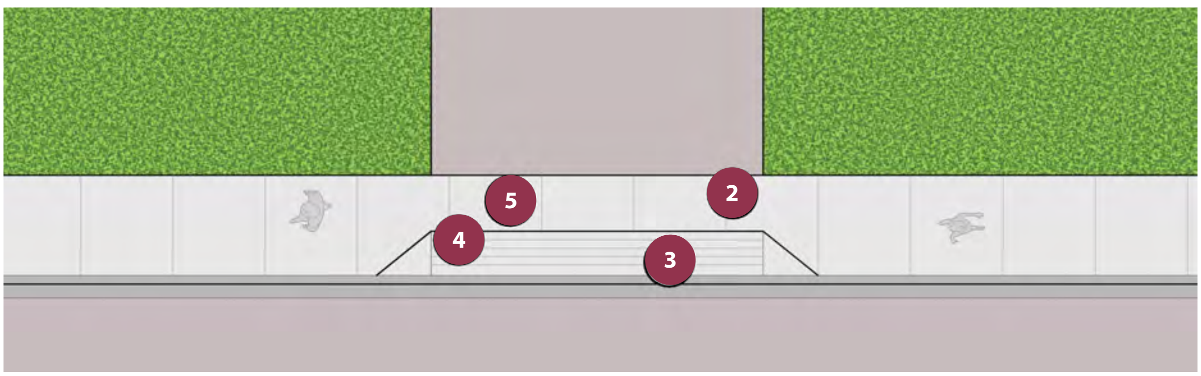


Figure C-22 // Driveway crossing of Non-Separated Sidewalk

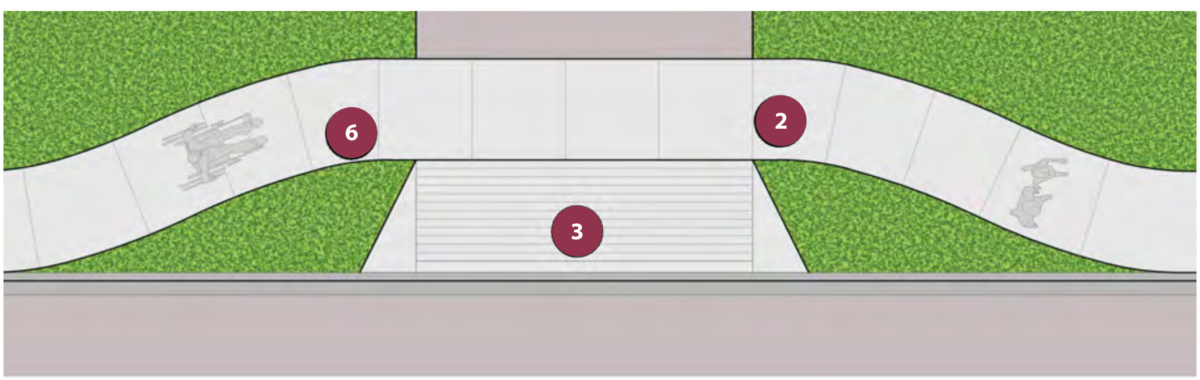


Figure C-23 // Driveway Crossing of Non-Separated Sidewalk (Wrapped Around Driveway)

1 Driveway confined to Furnishing Zone

2 Maintained sidewalk cross slope

3 Longitudinal score lines

4 Driveway located in Pedestrian Through Zone

5 Maintained sidewalk cross slope for 1.0 metre width

6 Driveway confined to Furnishing Zone due to sidewalk bend-out


Sidewalk crossing an alleyway, Vancouver, B.C.

Alleyways

Alleyways (also known as laneways) present the same conflict points between motor vehicles and people walking as driveways. Where achievable, the recommended practice is to provide a raised crosswalk across the alleyway so that the Pedestrian Through Zone is continuous (see **Chapter G.3** for further guidance on raised crosswalks). Alternatively, an accessible curb ramp should be installed to allow people walking to travel through the alleyway (see **Chapter G.3** for further guidance on curb ramps).

For high-use alleyways such as commercial or employment accesses, additional conflict zone markings can be applied through the crossing to increase visibility of the conflict zone. Alternatively, a different surface treatment may be used through the crossing, such as textured coloured concrete (as shown to the right). For example, the City of Vancouver uses a concrete Pedestrian Through Zone in alleyway crossings and applies score lines to aid with navigation, as shown in **Figure C-24**.

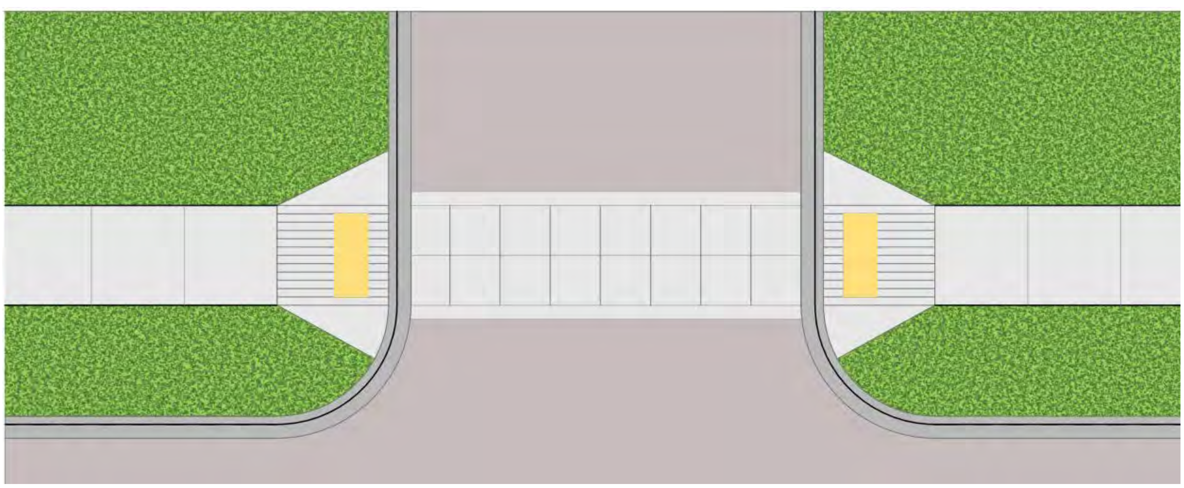


Figure C-24 // Alleyway Crossing of Separated Sidewalk with Different Surface Treatment

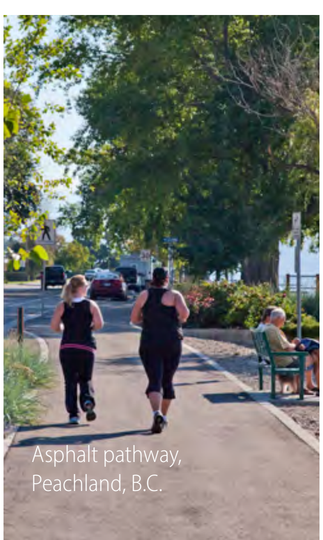
Surface Materials

The surface materials used for the Pedestrian Through Zone should be firm, even, and slip-resistant, providing good traction in all weather conditions. Surface materials should provide a smooth rolling surface for people using mobility devices. If differences between materials are intended to be detectable by people with visual impairments, they must be sufficiently detectable under foot and when using a cane, and should be tested before being applied (see **Chapter B.3** for more details).

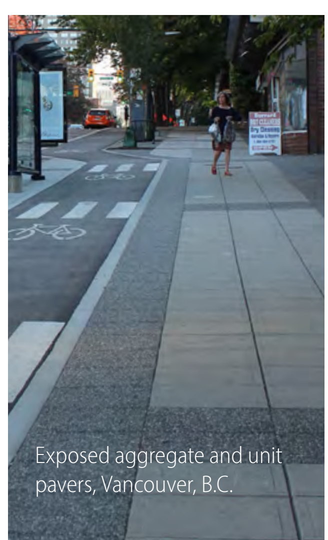
Portland cement concrete is the standard material used on sidewalks, as it provides a durable surface that meets the above criteria. Concrete that is broom-finished with saw-cut control joints provides the best experience for people using mobility devices, as this application cuts down on vibrations caused by rolling over sidewalk joints. This approach is beneficial throughout the pedestrian network, but widespread implementation may be cost prohibitive. Key areas of high pedestrian activity such as main commercial areas, or where people with mobility impairments are concentrated such as around healthcare facilities, should be prioritized for this type of sidewalk treatment.

Other surface materials include:

- **Asphalt:** Asphalt may be used as an alternative to concrete, although it has a shorter lifespan and may be affected by root heaving. Asphalt may be appropriate in more rural areas and in park settings. It may also be used as a less expensive interim option (see **Chapter C.4** for further details).
- **Brick:** Brick is often used in downtown areas with high pedestrian volumes. Brick accents may be installed in concrete sidewalks to enhance the look of the pedestrian facility. However, brick may not be a comfortable surface for people using mobility devices, and it requires significant maintenance.
- **Decorative paving materials (cobblestone, unit pavers, exposed aggregates, exposed glass):** Decorative paving materials may be used to enhance the visual aesthetic of the streetscape; however, these materials should not detract from the basic function of the Pedestrian Through Zone. Surfaces that are slippery, uneven, or that create glare should be avoided in the Pedestrian Through Zone. Decorative paving materials may be better suited to the Furnishing Zone to help delineate the Pedestrian Through Zone. Simply adding decorative scoring patterns or colour to a concrete sidewalk is a simple way to add visual interest to the Pedestrian Through Zone without compromising accessibility. Some decorative materials may not be ideal for people with mobility impairments, as the surface may be more slippery or bumpy than standard concrete. Additionally, unique maintenance considerations may be required.
- **Permeable pavement:** Permeable pavement can include permeable concrete or porous unit pavers. Permeable pavement allows water to infiltrate into an infiltration bed below the sidewalk, helping to manage stormwater.

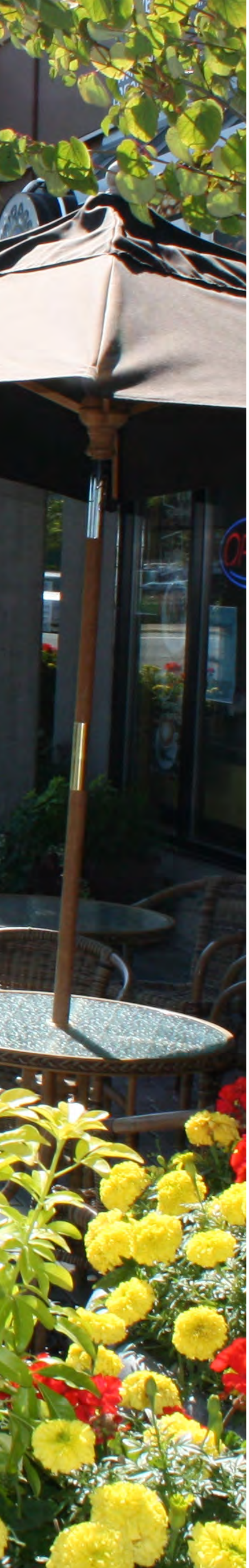

Asphalt pathway, Peachland, B.C.


Historic brick, Vancouver, B.C. Source: Rod Preston


Exposed aggregate and unit pavers, Vancouver, B.C.


Permeable pavement, West 10th Avenue, Vancouver, B.C.

Goldstream Avenue, Langford, B.C.



C.3

FRONTAGE, FURNISHING, AND ANCILLARY ZONES

This chapter is divided into three sections, one for each of the Furnishing Zone, Frontage Zone, and Ancillary Zone. These zones contain many of the elements that make the road functional, accessible, and enjoyable for all users. This includes providing space for people to rest, socialize, shop, eat, get information, or transfer between transportation modes.

Not all of these zones are present or required in all contexts. It is most common to see all three in urban contexts as well as some suburban and developed rural core contexts. The road context and available right-of-way will determine the design, width, and type of amenities that are appropriate in each zone.

As discussed in **Chapter C.2**, providing a clear, unobstructed Pedestrian Through Zone that meets accessible width requirements is the most important priority in the pedestrian realm. Once that criterion is met, design professionals may then proceed to providing a Furnishing Zone, Frontage Zone, and/or Ancillary Zone that meets the needs of all pedestrians and other road users.

Furnishing Zone, Squamish, B.C.

FURNISHING ZONE

Description

The Furnishing Zone is located between the Pedestrian Through Zone and the curb or pavement edge (and the Ancillary Zone if one is provided). The Furnishing Zone provides space for utilities, street furniture, landscaping, street trees, and snow storage. It should be provided wherever sufficient right-of-way is available, as it provides a buffer between motor vehicles and people walking, and it can contribute significantly to a more functional and pleasant pedestrian environment. There is no Furnishing Zone on roads with no curb and gutter.

Snow storage is important to factor in when planning the Furnishing Zone width and the type and placement of elements. Local snowfall levels and maintenance practices should be considered – plowing will often result in snow accumulation along the roadside, in either the Ancillary Zone or the Furnishing Zone. It is necessary to provide adequate longitudinal space between elements such as benches, street trees, and bicycle parking to allow for snow storage and removal, while still ensuring that these amenities are functional all year round.

Width

As discussed above, the Furnishing Zone is not a required element and may not be present in all contexts. Where present, the width of the Furnishing Zone can vary depending on the available right-of-way, land-use context, adjacent motor vehicle speeds and volumes, the amount of snow storage required, and the types of utilities, street furniture, and/or landscaping that is desired. **Table C-3** contains the recommended desirable and constrained limit widths for the Furnishing Zone and has been broken down into two categories: basic and enhanced. Providing an accessible and contextually-appropriate Pedestrian Through Zone width takes precedence over enhancing the Furnishing3Zone.

Table C-7 // Furnishing Zone Recommended Widths

Furnishing Zone Type	Desirable Width (m)	Constrained Limit Width (m)
Basic	2.0	0.6
Enhanced	3.0 – 5.0	3.0

Additional width considerations for each category of Furnishing Zone are listed above in **Table C-7**. An Enhanced Furnishing Zone provides sufficient space for all of the Basic Furnishing Zone elements described below, and provides additional width to accommodate the additional considerations listed.

Basic Furnishing Zone

- The constrained width of 0.6 metres provides minimal functionality.
- 0.75 metres provides a buffer between people walking and the opening doors of parked motor vehicles.
- 0.9 metres is the absolute minimum required for streetlights and utility poles.
- The space required for street trees varies by species. 1.2 metres is the absolute minimum required for the tree pit for most small- to medium-sized street trees. However, larger street trees and trees that develop a wide root flare will require at least 1.5 metres or more. Root flare is an important consideration, as this can damage sidewalks and obstruct the Pedestrian Through Zone. Landscape design professionals should be consulted to ensure the correct tree species is chosen for each location.
- 2.0 metres is beneficial for creating universally accessible pedestrian environments. A 2.0-metre wide Furnishing Zone generally provides sufficient setback of the Pedestrian Through Zone to align the Pedestrian Through Zone with accessible curb ramps and crosswalks, maintaining a straight line of travel. This alignment is beneficial to people with mobility and visual impairments, aiding them to navigate the pedestrian environment and shortening walking distances. This distance varies based on the width of the Pedestrian Through Zone and the corner radius. See **Chapter G.3** for design guidance on corner radii.

Enhanced Furnishing Zone

- Along commercial, mixed-use, or main streets, larger furnishing zones allow for enhanced landscaping and street furniture as well as overflow pedestrian traffic where there are high volumes of pedestrian traffic.
- Roads with transit stops require a desired width of 3.0 metres for passenger landing pads, benches, and bus shelters (see **Chapter H.1**).
- A larger buffer between people walking and motor vehicles is recommended along roads with motor vehicle speeds ≥50km/h and motor vehicle volumes ≥4,000 vehicles per day.
- In locations with heavy snowfall, a wider Furnishing Zone provides greater snow storage and space for maneuvering snow clearing equipment.

Grade and Slope

The grade and slope of the Furnishing Zone should typically match that of the adjacent Pedestrian Through Zone (see **Chapter C.2**). Where grass is used as landscaping, a cross slope of 3.0-10.0% may be acceptable.

Surface Materials

The Furnishing Zone surface materials vary based on the context. Generally, Furnishing Zones in residential areas are made of absorbent topsoil and sod. In commercial areas, hard surfaces are recommended for the Furnishing Zone to accommodate pedestrian access to the road and the Ancillary Zone. In this context, the Furnishing Zone materials should be firm and slip-resistant (see **Chapter C.2**).

Where hard surfaces are used in the both the Pedestrian Through Zone and Furnishing Zone, different pavement materials may be used to help demarcate the zones. If the two materials are sufficiently different (visually and in feel), the demarcation can help people navigate the road, especially those with visual impairments. Hardscape materials can include unit pavers, bricks, and permeable pavement.

Decorative materials or imprints may be used in the Furnishing Zone to add to the streetscape, as long as these aesthetic elements do not impact accessibility.

Bioswale in the Furnishing Zone, Saanich, B.C.

Landscaping and Rainwater Management

Landscaping is key for creating an attractive, sustainable, and pleasant pedestrian environment. The Furnishing Zone is the ideal place to add vegetation to the streetscape. Landscaping in the Furnishing Zone typically consists of grass and street trees, but can also include a range of shrubs, bushes, flowers, and other plants. Landscaping in the Furnishing Zone should not obstruct sightlines, especially around crossings and intersections. Landscaping maintenance requirements will vary greatly by geographic and land-use context.

Street trees are an especially valuable and important streetscape element with myriad benefits, including:

- Creating a barrier between people walking and motor vehicles;
- Reducing the urban heat island effect;
- Capturing carbon dioxide and producing oxygen;
- Intercepting rainfall and helping to absorb stormwater;
- Supporting native wildlife systems;
- Providing shade and weather protection;
- Visually enhancing the streetscape; and
- Providing social and psychological benefits.

Ensuring that street trees grow and remain healthy in the urban environment can be a challenge, as trees are competing for space with the roadway, bicycle facilities, sidewalk, utilities (both at grade and below the road), and other street furniture. Selecting the appropriate tree species, providing sufficient clearance from obstructions, providing sufficient soil volumes, and utilizing tools such as structural soil cells and continuous tree trenches can help ensure a tree's survival. Careful consideration is needed to ensure that tree roots will not develop a wide root flare that will damage sidewalks and obstruct the Pedestrian Through Zone.

In urban environments, tree grates are often provided. Tree grates allow proper exposure to the air for tree soil while maximizing the available space for people walking. The trunk of the tree should be set back at least 0.75 metres from the curb to allow space for motor vehicle doors and for people to enter and exit vehicles. This clearance also minimizes the intrusion of tree roots into the substrate and reduces the frequency of salt and other harmful minerals being splashed onto the tree.

Vegetation in the Furnishing Zone can also provide rainwater management and phytoremediation services – the cleaning, removal, and stabilization of contaminants in the air and soil. This is especially important along industrial roads and on brownfield sites and any other locations where contaminants may be located. Bioswales, rain gardens, tree grates, pervious surface, and street trees can absorb, store, and filter stormwater, easing the burden on municipal sewer systems. Permeable pavement can also be used to allow water to infiltrate and be stored in the soil below.

Stormwater management system between two Pedestrian Through Zones in Victoria, B.C.

Road Hardware

Road hardware includes elements that are required for the regular function of the road and surrounding buildings. These items are typically located in the Furnishing Zone. Common items include:

- Road lighting;
- Traffic signals;
- Pedestrian and cycling push buttons;
- Traffic signage;
- Utilities;
- Fire hydrants;
- Parking metres; and/or
- Bollards, fences, or other barriers.

Detail of drainage system, Victoria, B.C.

Pedestrian Amenities

In addition to road hardware and landscaping, the Furnishing Zone is often where pedestrian amenities such as benches, mail boxes, and waste receptacles are located. A toolkit of potential pedestrian amenities is provided in **Table C-8**. Pedestrian amenities enhance the pedestrian environment, adding convenience, comfort, security, and coherence to the streetscape.

TABLE C-8 // PEDESTRIAN AMENITIES TOOLKIT – FURNISHING ZONE

Pedestrian Amenity	Design and Placement Considerations
Benches, tables and chairs, other seating	■ Desirable at transit stops, mid-block areas, places where queuing is likely to occur, along steeper grades, and along parks and greenways. ■ Installation should consider legroom and weather protection. ■ Additional clear space should be left on all sides of the seating for people with strollers, mobility aids, and wheelchairs to be able to stop on an accessible surface.
Waste receptacles	■ Garbage and recycling bins should be located together to encourage recycling. ■ In communities with municipal compost collection, compost bins should be considered where organic waste is expected, such as near food vendors.
Mailboxes and newspaper corrals	■ May be wrapped with artistic patterns to improve aesthetics and discourage graffiti.
Drinking fountains	■ Design should allow children to reach the fountain. ■ Fountains may also have a spout at the bottom that allows dogs to drink or a bog bowl to be filled up.
Bicycle parking	■ See **Chapter H.2**
Transit stops and shelters	■ See **Chapter H.1**
Wayfinding signage	■ See **Chapter H.3**
Public art (sculptures, murals, fountains, clocks, and other decorative features)	■ Important for beautification, culture, and community identity. ■ See Urban Design considerations on next page.
Road banners, flags, and other graphics	■ Valuable for community identity and branding. ■ Can be used to advertise upcoming events.
Public washrooms	■ Accessible public washrooms enable and encourage more people to walk and explore their community.

Pedestrian amenities and road hardware should be visually and physically integrated in a way that reduces clutter and maximizes the space available for pedestrian movement. Individual pieces of street furniture can be grouped together to save space, and they can serve more than one purpose simultaneously; for example, a planter or sculpture may also serve as seating. The placement of these elements should be consistent in order to make navigation more predictable for people with visual impairments.

Pedestrian amenities should be durable, weather-resistant, vandalism-resistant, cost-effective, easy to maintain, and have modular parts that are simple to repair or replace. The design and installation of pedestrian amenities must also consider long-term maintenance implications, including snow clearing and snow storage in winter climates.

Pedestrian amenities must also be placed in a way that does not obstruct other modes. The Pedestrian Through Zone must remain clear at all times, and if adjacent to motor vehicle parking, pedestrian amenities should not interfere with the opening of motor vehicle doors.


Water fountain with dog fountain attachment.

Urban Design Considerations

The Furnishing Zone provides the opportunity to add visual interest and community identity to the pedestrian environment. The choice of surface materials and the design of streetscape elements such as road hardware and pedestrian amenities should be co-ordinated to provide a consistent look and feel throughout the community. The Furnishing Zone also provides an opportunity to highlight unique portions of a community, signalling to people that they are in a special area. This can apply to historic areas, cultural areas, or different neighbourhoods.

Co-ordinating the elements in the Furnishing Zone (and the Frontage and Pedestrian Through Zones, if applicable) with other design elements in the neighbourhood, such as banners on street lights and architectural features, can create a unique and memorable environment that draws in pedestrians. The case study on Victoria's Public Realm Plan provides an excellent example of this co-ordination.


Public art adjacent to Pedestrian Through Zone in Tofino, B.C.

Case Study

Victoria's Public Realm Plan

Victoria is known for having a vibrant and walkable downtown, with evident history and distinct character zones. This unique character is thanks in part to the design of the city's buildings and public realm, including roads, sidewalks, and plazas. In 2017, the City of Victoria approved the Downtown Victoria Public Realm Plan and Streetscape Standards, a design document that lays the framework and standards for public realm design in five unique character areas, including Canada's oldest Chinatown.

The Downtown Victoria Public Realm Plan and Streetscape Standards provides direction for paving materials and application, planting details, recommended tree species, colour palette, and custom road hardware and pedestrian amenities. All of these items are co-ordinated to reflect each character area's unique heritage. This co-ordination, in addition to the Chinatown gate and lion statues of Fisgard Road, signals to pedestrians when they have entered Chinatown and help to mark its importance to the city.

Chinatown streetscape elements, Victoria, B.C.

Public Washrooms

Providing access to washroom facilities helps make active transportation inclusive and accessible. However, providing public washrooms can be a challenge. Private businesses may offer washrooms, but these are not always accessible, and they may require people to make a purchase in order to access the washroom. Programs such as the GoHere Washroom Access Program, supported by Crohn's and Colitis Canada, encourage businesses to open their washrooms to the public. The program includes a washroom finder app and a decal that businesses can put up to advertise their open washroom. More information about the GoHere Washroom Access Program can be found on-line at http://www.crohnsandcolitis.ca/Support-for-You/GoHere-Washroom-access

Public toilets have also been installed by municipalities across Canada, including the installation of 11 free, self-cleaning toilets in Vancouver. This type of automated facility can provide increased access to washrooms but also faces challenges including the accumulation of garbage and the occurrence of elicit activity.

Source: Crohn's and Colitis Canada

Public Washroom in Vancouver, B.C.

Commercial display in the Frontage Zone outside of a business in Summerland, B.C.

FRONTAGE ZONE

Description

The Frontage Zone is located between the Pedestrian Through Zone and the property line. It provides clearance from adjacent building fronts, architectural features, and entrances. In some contexts, the Frontage Zone may also contain utilities, street furniture, and street trees. Utilities and street furniture are described in more depth in the Furnishing Zone section of this chapter .

The Frontage Zone can also act as an extension of the land uses along a road, containing outdoor patios, landscaping, retail displays, and signage. It may contain open space that supports the adjacent land use, including space for queuing, lingering, and window shopping. The Frontage Zone's functional area may extend from the public realm into private space beyond the property line.

Width

The width of the Frontage Zone is highly variable, changing significantly based on the adjacent land use, available right-of-way, and the location of property lines and building fronts. However, some general width considerations are listed below. Frontage Zones upwards of 3.0 metres wide may be appropriate in urban areas with active commercial land uses, such as where patio seating is desired or where large groups of people are likely to congregate. In residential areas, Frontage Zones between 1.2 and 1.5 metres provide ample space for softscape landscaping and can provide enhanced privacy, preserve street trees, and maintain space for future road widening if necessary. In both commercial and residential contexts, a minimum Frontage Zone width of 0.3 metres is recommended to provide an offset between pedestrians and fences or buildings, and to accommodate construction, and prevent people from being hit by building doors that open outward. Adjacent to lawns, parks, or other open space, the Frontage Zone may not be necessary.

Providing a Pedestrian Through Zone that meets the desired width described in **Chapter C.2** should always be the priority. Providing a Furnishing Zone is the next priority, as this creates a buffer between pedestrians and motor vehicles. Where additional space remains, it may be added to the Frontage Zone. Where the right-of-way is constrained, providing a Frontage Zone may not be possible.

Surface Materials

The Frontage Zone surface materials vary based on the context. Generally, Frontage Zones in residential areas are made of absorbent topsoil and sod, although hard surfaces are recommended where the width of the Frontage Zone is less than 0.6 metres wide. In commercial areas, hard surfaces are recommended for the Frontage Zone to accommodate greater pedestrian volumes and movement in and out of buildings. In this context, the Frontage Zone materials should be firm and slip-resistant.

Private Space Considerations

The Frontage Zone can help to activate the streetscape, creating a vibrant and interesting space that attracts people. However, many of these uses require the direct involvement of private businesses and land owners. The Frontage Zone can extend beyond the property line and up to a building front, and land owners may utilize that space to connect to the public realm through advertising boards, retail displays, and seating. Building awnings that extend over the Frontage Zone and at least a portion of the Pedestrian Through Zone can also provide valuable weather protection for pedestrians. The awning or overhang should drain back towards the building to prevent water from dripping onto the Pedestrian Through Zone.

While much of the Frontage Zone activation is reliant on private businesses and land owners, local and regional governments can enact policies and provide incentives to encourage these groups to engage with the pedestrian realm. Local and regional governments can also work with developers to ensure that building frontages provide weather protection and are animated and interesting to people from the sidewalk, as a way to make the streetscape more inviting. To encourage year-round outdoor use, even in winter climates, businesses should be encouraged to provide heated patios, blankets, and wind-blocking elements. Buildings should be pedestrian facing, providing two-way interaction and eyes on the street.

Commercial seating and retail displays in the Frontage Zone in Gibsons, B.C.

ANCILLARY ZONE

Description

The Ancillary Zone is a flexible space located on-street within the roadway that is not designated for motor vehicle through traffic. Instead, it is designed to support the primary functions of either the roadway or the sidewalk. The Ancillary Zone can contain on-street motor vehicle or bicycle parking, bicycle facilities, docked bike share stands, loading zones, transit stops, taxi or ride hailing zones, curb extensions, parklets, or patios. Depending on context and local maintenance practices, the Ancillary Zone may also be used for snow storage. The Ancillary Zone use can vary along a road corridor or block face – for example, along a single block, there could be motor vehicle parking, a bicycle corral, and curb extensions at corners and/or mid-block locations.

Curb extensions are one ancillary use of the roadway that can benefit pedestrians in a number of ways. Curb extensions are a form of traffic calming that helps to reduce motor vehicle speeds by narrowing the road. They also reduce crossing distances for pedestrians and make them more visible to motor vehicles, especially where on-street motor vehicle parking is present. Additionally, curb extensions provide space for landscaping, rainwater management (including rain gardens and bioswales), and street furniture, and can provide a protective envelope around parking spaces.

Parklets and patios are two other Ancillary Zone uses that can significantly enhance the pedestrian realm by re-purposing one or more on-street motor vehicle parking stalls. Parklets are open public spaces that can contain seating, tables, landscaping, and bicycle parking. Patios are typically private spaces that are extensions of the adjacent business, with seating, tables, and table service. Parklets and patios create spaces to socialize and relax within the pedestrian realm without obstructing the Pedestrian Through Zone.

Width

The width of the Ancillary Zone is dependent on the road context but is typically the width of a standard motor vehicle parking stall (refer to local land-use bylaws). Similar to the Furnishing Zone, the Ancillary Zone provides a buffer between people walking and motor vehicle through traffic. In order to increase pedestrian safety and comfort, the TAC *Geometric Design Guide for Canadian Roads* recommends including an Ancillary Zone and/or Furnishing Zone on all commercial roads and where motor vehicle speeds are 50k m/h or higher. Rural roadways typically do not include an Ancillary Zone, but often have a shoulder between the motor vehicle travel lane and the roadside.

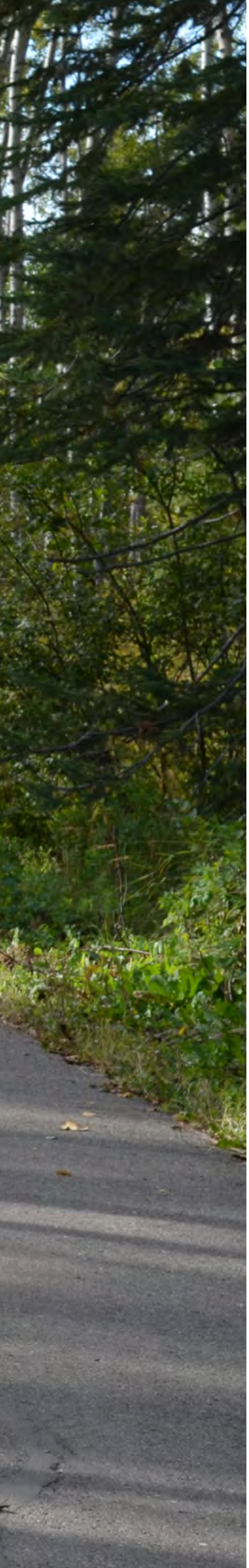
Curb Design

In urban and developed rural core contexts, the curb is located between the Ancillary Zone and the Furnishing Zone or Pedestrian Through Zone. There is typically no curb along rural roadways or on shared streets. Curbs prevent water on the road from entering pedestrian space and discourage motor vehicle incursion into the Pedestrian Through Zone. Rolled or mountable curbs should be avoided as these allow motor vehicle access to the sidewalk.

The curb can also help define the pedestrian environment and is an important navigational tactile element for people with visual impairments, as described in **Chapter B.3**. **Section D** provides more detail on curb design, specifically in relation to protected bicycle lanes.

Public parklet in the Ancillary Zone, Fort Street, Victoria, B.C.


Multi-use pathway, Fort St. John, B.C.



C.4

RURAL PEDESTRIAN DESIGN CONSIDERATIONS

Sidewalks may not always be feasible, appropriate, or desirable in many basic rural, outer developed rural, or suburban contexts. It is therefore important to find flexible, alternative designs that still provide adequate pedestrian comfort, accessibility, and safety. Rural (and some suburban) roadways can present a different set of risks than urban roads, including high motor vehicle speeds, run-off road collisions, and a lack of night-time lighting. These risks must be factored in when designing rural pedestrian facilities.

This chapter provides a brief overview of rural and suburban pedestrian facility types and design guidance. It then provides a toolkit for flexible, alternative pedestrian facilities. For a full overview of pedestrian facilities on roadways under provincial jurisdiction, including active transportation facility selection guidance for provincial roadways that run between communities and through rural environments, refer to **Chapter F.1**.

RURAL AND SUBURBAN FACILITY SELECTION PRINCIPLES

There are a range of facility types that can be found in basic rural, outer developed rural, and suburban contexts. The Pedestrian Facility Selection Decision Support Tool in **Chapter C.1** provides a high-level overview of when each facility is appropriate, based on motor vehicle speeds and road classification. The principles below add to this discussion by laying out considerations for design professionals working in rural and suburban areas.

Principle 1: Dedicated Space over Mixed Conditions

Providing dedicated pedestrian facilities is recommended over mixed conditions, where people walking and cycling all share the same space (see **Figure C-25**). This mixed condition is the default in many rural and suburban areas, and it may be acceptable when motor vehicle speeds and volumes are low. As outlined in **Chapter C.1**, shared spaces are generally only recommended up to motor vehicle volumes of 30 km/h. Providing a dedicated space for see people walking or cycling, such as a shoulder, creates a more predictable environment for all road users. Note that shared spaces are not the same as shared streets, which are a distinct road design treatment (see **Chapter E.4**).

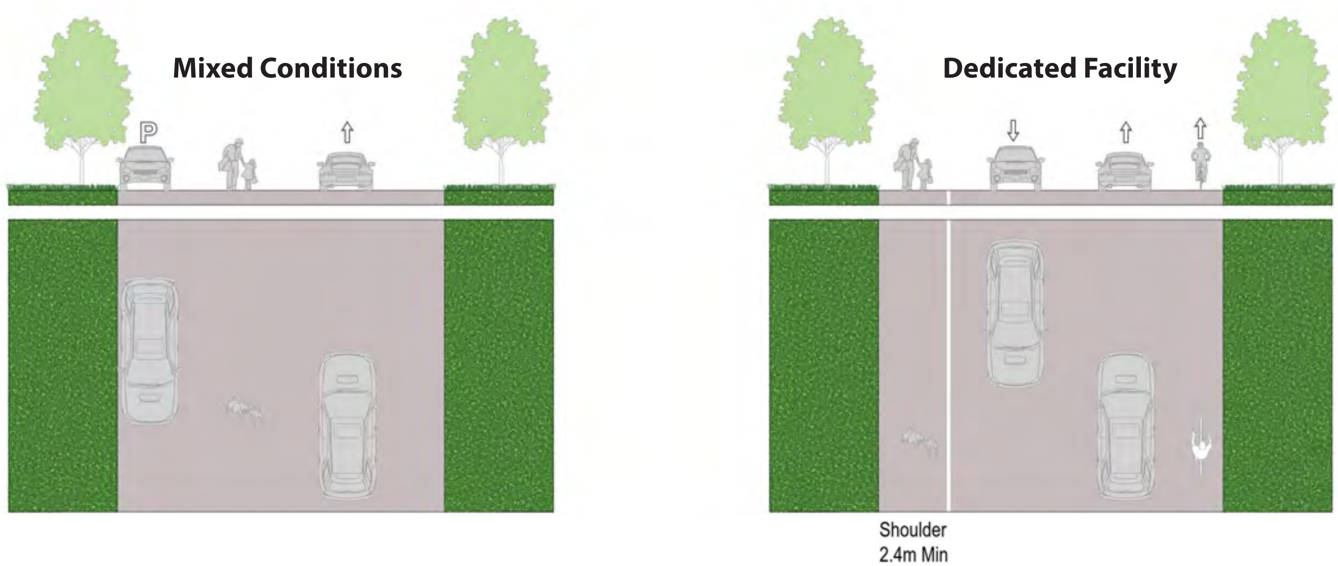


Figure C-25 // Dedicated Facility vs. Mixed Conditions

Principle 2: Physical Separation over Pavement Marking

Physical separation provided by curbs or other means of physical separation is preferred over walkable shoulders (**Figure C-26**). Providing physical protection can raise both the perceived and actual safety for people walking, creating a more comfortable environment that is more appropriate for people of all ages and abilities. Where a sidewalk with curb and gutter is not appropriate, other means of physical protection, such as wheel stops and bollards, may be considered. Refer to the Toolkit section on page C41 for examples.

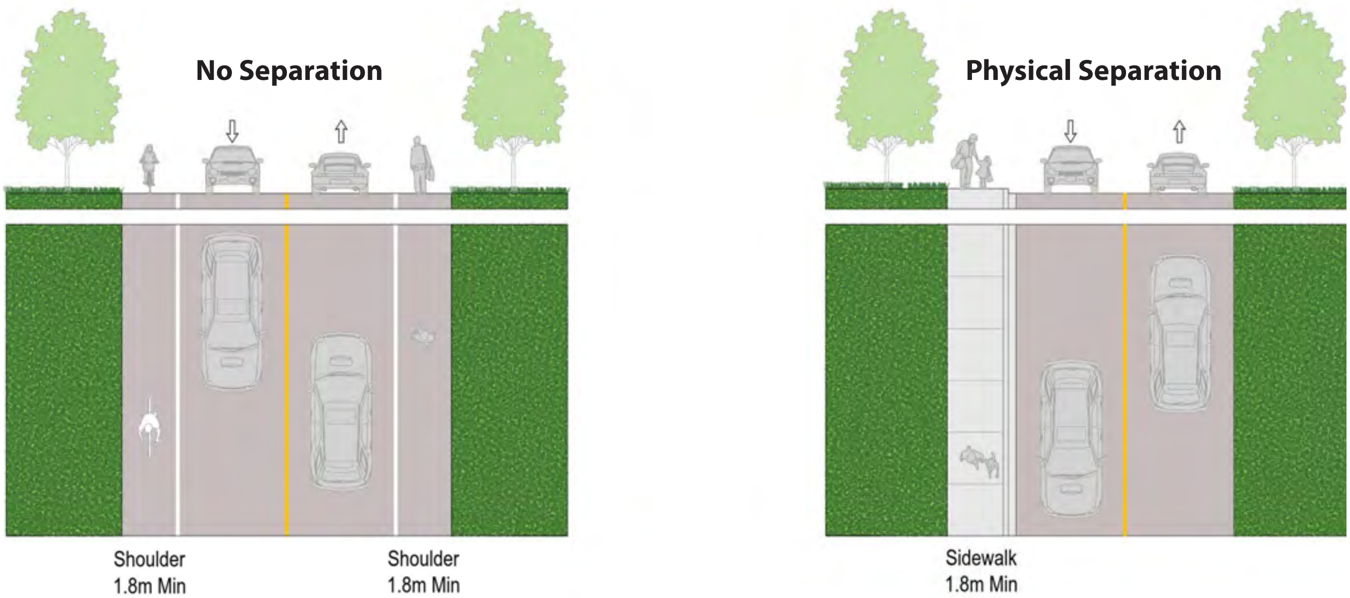


FIGURE C-26 // PHYSICAL SEPARATION VS. NO SEPARATION

Principle 3: Off-Street Pathways over Walkable Shoulders

Off-street pathways are preferred on roads with high motor vehicle speeds or volumes (see **Figure C-27**). Removing pedestrians from the roadway and providing a buffer between them and motor vehicle traffic creates a comfortable space for people of all ages and abilities. Refer to **Section E** for design guidance for off-street facilities and **Chapter F.1** for guidance pertaining to off-street pathways on roadways under provincial jurisdiction.

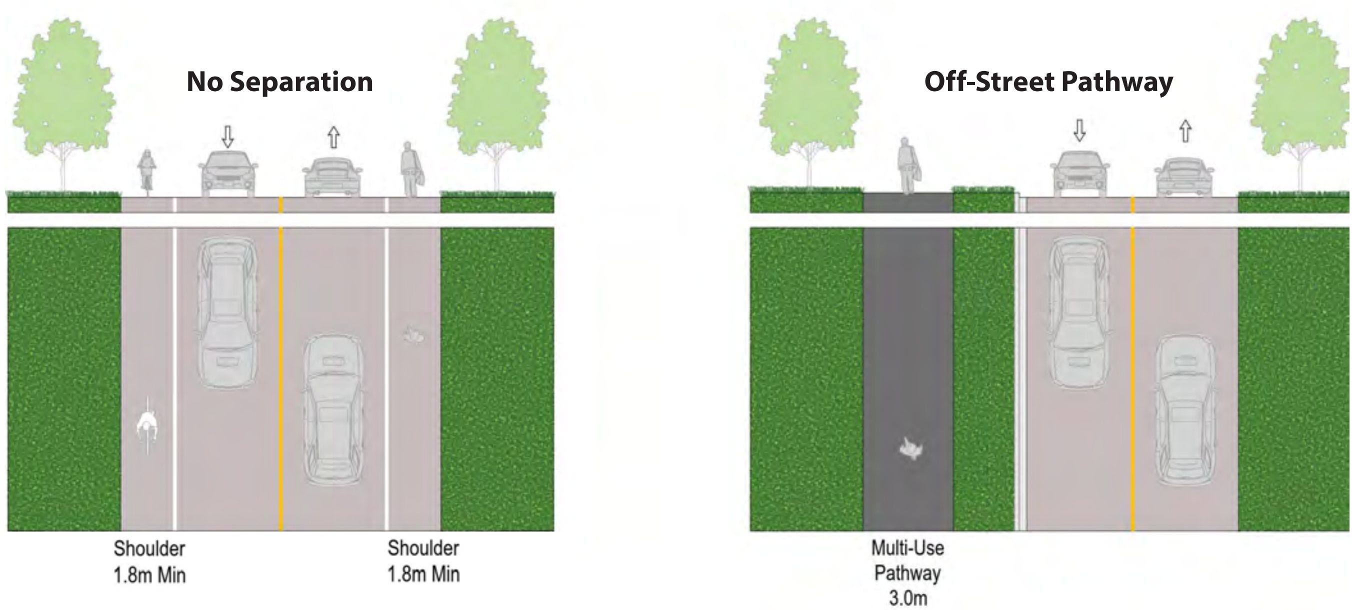


FIGURE C-27 // OFF-ROAD PATHWAY VS. NO SEPARATION

Design Guidance

The following design guidance is applicable when designing pedestrian facilities in basic rural, outer developed rural, and suburban contexts. Refer to **Chapter F.1** for more guidance on active transportation facilities on roadways under provincial jurisdiction.

The design guidance below is particularly relevant in areas with relatively high pedestrian activity and where a higher proportion of children or people using mobility devices are expected, such as near schools and health-care facilities.

- Ensure that rural pedestrian facilities meet the accessible width, longitudinal grade, and cross slope specifications described in **Chapter C.2**. Additionally, design professionals should consider the universal design strategies discussed in **Chapter B.3**.
- Where feasible, provide lighting that effectively illuminates the entire roadway, including shoulder areas and pedestrian facilities. Provide additional pedestrian lighting wherever needed, such as at crossings and intersections. Lighting installation may be staged in order to improve facilities as budget becomes available. Refer to **Chapter H.4** for more detail on lighting.
- Provide signage and pavement markings to alert motor vehicles of the presence of pedestrians on the roadway. Wayfinding is also important, especially when connecting between communities.
- Consider drainage and maintenance when designing rural pedestrian facilities, especially where physical barriers or curbs are installed. In rural contexts, overland drainage into ditches is a common approach. Design professionals must consider how to manage, store, or divert water. See **Chapter I.3** for more details on maintenance.

Rural Pedestrian Facility Toolkit

The options presented below are intended to provide design professionals with flexible alternatives to the standard concrete sidewalk that is prevalent in urban environments. When considering these facility options, pedestrian safety must always be prioritized, and all facilities should meet the universal accessibility criteria discussed throughout **Section C**.

Cost-effective Materials

Asphalt Paving

In some cases, sidewalks may be desirable but standard construction methods may be infeasible due to cost. In this case, design professionals may opt to use less expensive materials as a way of providing a pedestrian facility for less cost. One example of this is to construct sidewalks using asphalt instead of concrete.

For example, the City of Maple Ridge has used asphalt sidewalks to fill in gaps in the pedestrian network. Asphalt sidewalks enable the City to provide pedestrian facilities where they would otherwise be unable to do so due to construction costs. Maple Ridge requires concrete sidewalks in pedestrian areas, along bus routes, and on all urban arterial and collector roads, but allows asphalt sidewalks on urban local roads and rural arterial and collector roads, as necessary.

Unpaved Pathways

Paved pathways should be provided wherever feasible. Unpaved pathways are inaccessible for certain user groups, including skateboarders and in-line skaters. They may also be more difficult to navigate for people cycling and people using mobility devices. Unpaved pathways can also be difficult to maintain during the winter. However, paved pathways are more costly to construct than unpaved pathways. Where paving cost is a barrier to providing an active transportation facility, an unpaved pathway may be considered.

Unpaved pathways should be formed using firm materials that offer adequate stability. Crushed aggregate and stabilized earth are two materials that may be considered. Additionally, in some circumstances, wood chip trails may be appropriate, although these are appropriate mostly for people walking and jogging.

Proper subsoil preparation when constructing an unpaved pathway can help reduce the future maintenance needs. If it is anticipated that the unpaved pathway may be paved in the future, the subsoil should be prepared as per an asphalt trail. This can facilitate a less disruptive upgrade in the future.

When an unpaved pathway crosses a paved roadway, it is recommended that the unpaved trail approach be paved for 4 metres from the edge of road on either side. Paving this segment of the pathway helps to prevent loose trail surface materials from accumulating on the roadway.

Unpaved portion of the Lochside Trail, B.C.


Buffered pedestrian lanes in Tofino, B.C., delineated with coloured pavement markings.


Buffered pedestrian lanes in Tofino, B.C., delineated with wooden bollards.


Buffered pedestrian lanes in Tofino, B.C., delineated with concrete wheel stops.

Buffered Pedestrian Lanes

Buffered pedestrian lanes are a flexible, low-cost facility that can be used on an interim basis where a sidewalk will eventually be constructed or where a sidewalk is not feasible due to cost or other constraints. Buffered pedestrian lanes provide designated space for pedestrians at-grade on the roadway and are intended to function like a sidewalk. They can be used on one or both sides of the roadway and are useful for filling gaps between pedestrian destinations.

The Pedestrian Through Zone width of a buffered pedestrian lane should be a minimum of 1.8 metres wide, although 2.0 metres of width is recommended where no vertical separation is provided. At minimum, buffered pedestrian lanes should include double longitudinal pavement markings that separate the pedestrian lane from motor vehicle traffic. Decorative pavement markings can also be used to identify the pavement as a pedestrian space while adding the aesthetics of streetscape.

Along roads with speeds below 60 km/h, vertical separation may be provided between the buffered pedestrian lane and motor vehicle traffic. Flexible bollards, rigid bollards, concrete wheel stops, and other forms of vertical separation may be used to discourage motor vehicle incursion. Design professionals should carefully consider the context, motor vehicle speeds, and the type and installation method of the vertical separation. Where physical barriers are used, drainage and maintenance are important considerations to ensure that the Pedestrian Through Zone remains free of gravel and does not collect ponding water that could turn into ice.

White concrete wheel stops have been used in Saanich to delineate pedestrian spaces. Tofino has also used concrete wheel stops, wooden bollards, and contrasting surface materials to create at-grade pedestrian lanes, with curb extensions and motor vehicle parking providing additional physical separation from motor vehicles.

Walkable Shoulders

Walkable shoulders are paved spaces on the side of a roadway, delineated from motor vehicle traffic by a white longitudinal pavement marking. They are not a dedicated pedestrian facility as they may be used by people cycling and motor vehicles that need to pull off the roadway. Walkable shoulders may be considered as a pedestrian facility on basic and outer developed rural roadways with posted speed limits of 60 km/h or less and low pedestrian volumes, but they are not suitable for people of all ages and abilities. When posted speed limits are 70 km/h or above, off-road pathways that provide increased separation from motor vehicle traffic are preferred over walkable shoulders. Providing off-road pathways will not always be feasible due to cost and right-of-way constraints. See off-street pathway subsection below for further details.

Wherever feasible, walkable shoulders should provide a Pedestrian Through Zone that is a minimum of 1.5 metres wide. In locations where a higher volume of pedestrians is expected, such as in resort villages, a Pedestrian Through Zone of 1.8 metres is recommended. Additional shoulder width is required as motor vehicle speeds and volumes increase and as the road class changes. See **Chapter F.1** for shoulder width requirements on roadways under provincial jurisdiction.

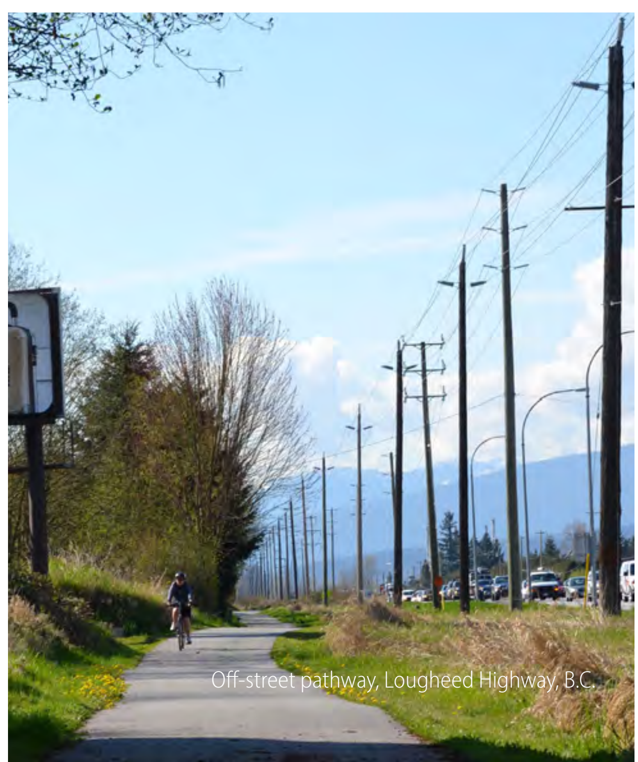
Walkable shoulders should be provided on both sides of the roadway. They should be delineated from the motor vehicle travel lane with longitudinal pavement markings. A painted buffer zone may be used to provide further separation between users and discourage motor vehicle encroachment. If rumble strips are used, they should not reduce usable pedestrian space. See **Chapter F.1** for design guidance regarding rumble strips on roadways on provincial rights-of-way.

Off-Street Pathways and Trails

Off-street pathways and trails provide the most pleasant experience for active transportation users, as they have a dedicated space separated from motor vehicle traffic. Off-street pathways must be placed outside of the roadway clear zone. A barrier or fencing may also be required, depending on motor vehicle speeds and volumes.

Off-street pathways are generally paved with a hard surface such as asphalt, although cost-effective materials such as gravel and chip may be considered, as described above. Off-road pathways and trails are typically shared between pedestrians and other active transportation users. Design guidance for off-road pathways is provided in **Section E**.


Walkable shoulder in Mission, B.C.


Off-street pathway, Lougheed Highway, B.C.

D.

CYCLING FACILITIES

D.1 General Design Guidance

D.2 Neighbourhood Bikeways

D.3 Protected Bicycle Lanes

D.4 Painted + Buffered Bicycle Lanes

D.5 Advisory Bicycle Lanes

D.6 Rural Cycling Design Considerations

Columbia Ave, Castlegar B.C.

D.1

GENERAL DESIGN GUIDANCE

Level 2: This chapter provides general design guidance for on-street bicycle facilities, including the range of possible bicycle facility types and the approach to bicycle facility selection. The subsequent chapters provide detailed design guidance for each of the major bicycle facility types: Neighbourhood Bikeways (**Chapter D.2**), Protected Bicycle Lanes (**Chapter D.3**), Painted and Buffered Bicycle Lanes (**Chapter D.4**), Advisory Bicycle Lanes (**Chapter D.5**), and Rural Cycling Design Considerations (**Chapter D.6**). Design guidance for off-street facilities is provided in **Section E**.

BICYCLE FACILITY TYPES

There are a number of different types of bicycle facilities that can be applied in various contexts in communities throughout B.C. There are various terms used to describe each facility type. For the purposes of the Design Guide, a standardized nomenclature has been developed with the following types of bicycle facilities.

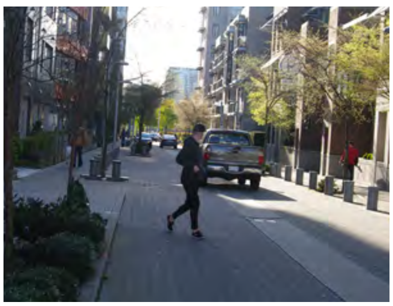
ON-STREET FACILITIES		
	**Neighbourhood Bikeways** Streets with low motor vehicle volumes and speeds that are suitable for motor vehicles and people cycling to share the road. Neighbourhood bikeways may include treatments such as signage, pavement markings, traffic calming, and traffic diversion to prioritize bicycles and make the facility comfortable for people of all ages and abilities.	**Chapter D.2**
	**Protected Bicycle Lanes** Separate travel lanes designated exclusively for bicycle use and other forms of active transportation (such as in-line skating, using kick scooters, and skateboarding, where permitted) that are physically separated from motor vehicles and pedestrians by vertical and/or horizontal elements.	**Chapter D.3**
	**Painted and Buffered Bicycle Lanes** Separate travel lanes designated exclusively for bicycle use that are delineated by a painted line and, in some cases, a painted buffer area.	**Chapter D.4**
	**Advisory Bicycle Lanes** Bicycle-priority travel lanes on a narrow road with a single, narrow centre travel lane for motor vehicles that accommodates two-way motor vehicle traffic but that may require one motorist to allow the other to pass. Motor vehicles may temporarily enter the advisory bicycle lane to pass on-coming motor vehicles.	**Chapter D.5**

ON-STREET FACILITIES

Bicycle Accessible Shoulders

Paved spaces on the right side of a rural road or highway, and certain urban roads, that can be used by bicycle users. The shoulder may also be used by other road users for safety, operations, and maintenance purposes

Chapter D.6



Shared Street

A road with very low motor vehicle speeds and volumes in which the living environment dominates over the through movements. A shared street functions first as a meeting place, residence, playground, and pedestrian area. The road is shared among people walking, cycling, and driving.

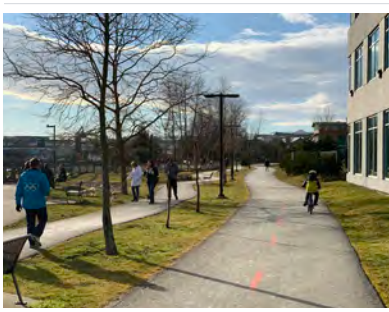
Chapter E.4

OFF-STREET FACILITIES

Multi-Use Pathways

Off-street facilities that are shared between people walking, cycling, and using other forms of active transportation such as skateboarders and in-line skaters.

Chapter E.2



Bicycle Pathways

Off-Street facilities that are designated exclusively for people cycling and using other active modes (such as in-line skating, using kick scooters, and skateboarding, where permitted), but are separated from pedestrians.

Chapter E.3

All Ages and Abilities Cycling Facilities

Each of the bicycle facility types included in the Design Guide can be considered part of a comprehensive bicycle network. However, many communities are increasingly focusing on 'all ages and abilities', or 'AAA', bicycle facilities that offer a greater degree of safety and comfort. An overview of all ages and abilities mobility considerations is provided in **Chapter B.1**.

The NACTO *Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities* provides a cycling-specific overview of the all ages and abilities concept. NACTO emphasizes that all ages and abilities bicycle facilities that are safe, comfortable, and equitable have the following benefits:

- Help to achieve growth in cycling mode share by creating welcoming, low-stress cycling conditions.
- Bicycle facilities that eliminate stress will attract traditionally underrepresented cyclists, including women, children, and seniors.
- Investing in jurisdictions that have a distinct need for enhanced mobility can help ensure that people of all incomes and cultures have access to bicycle facilities. This helps to reduce barriers by providing a safe way to travel for daily needs.
- Better bicycle facilities are directly correlated with increased safety for people cycling, walking, and driving. Poor or inadequate infrastructure forces people cycling to choose between feeling safe and following the rules of the road. Where road design provides safe places to ride and manages motorist behaviour, unsafe cycling decisions tend to disappear, making it easier to ride in a safe and legal manner and resulting in more riders.

A number of bicycle facility types have the potential to be suitable for people of all ages and abilities, depending on the design and context. Other facilities, such as bicycle accessible shoulders, are never considered suitable for people of all ages and abilities but may serve as a supporting facility that enhances the overall active transportation network. The Design Guide does not limit guidance to all ages and abilities bicycle facilities. However, wherever possible, design professionals should strive to provide all ages and abilities facilities.

BICYCLE FACILITY SELECTION

Motor vehicle speeds and volumes are perhaps the most important considerations in selecting the appropriate bicycle facility type. Generally, higher motor vehicle speeds and volumes necessitate a greater degree of separation between motor vehicles and bicycles, as conceptually illustrated in **Figure D-28**.

Figures D-29 and **D-30** show the Bicycle Facility Selection Decision Support Tool, which outlines when each type of bicycle facility may be appropriate. The Bicycle Facility Selection Decision Support Tool may be used to narrow the range of possible facility types based on motor vehicle speed and average daily motor vehicle volume. There are, however, a range of other contextual and local conditions that should be understood and may impact the selection of the preferred bicycle facility type. Key facility selection criteria are outlined in **Chapter B.2**. The Bicycle Facility Selection Decision Support Tool is a guide that should be applied with professional judgement and careful consideration of the real-world context.

The Bicycle Facility Selection Decision Support Tool consists of two separate decision support tools: one for urban, suburban, and developed rural core contexts, and one for outer developed rural and basic rural contexts. Each decision support tool is based on motor vehicle speed and average daily motor vehicle volume.

For the purpose of facility selection, it is assumed that motor vehicle operating speed and the posted speed limit are approximately consistent. Where they differ, the operating speed should be used as the basis for motor vehicle speed. Additionally, it should be noted that the speed and volume thresholds listed in the Design Guide are not intended to be absolute. This process is inherently flexible and context-specific. In particular, there is flexibility in defining motor vehicle volume thresholds, and suggested values may be adjusted by +/- 500 to 1,000 vehicles per day based on professional judgement.

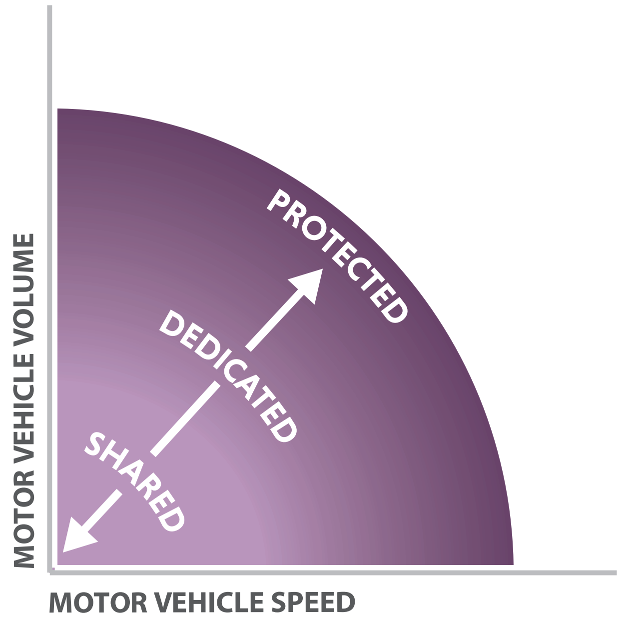


FIGURE D-28 // CONCEPTUAL BICYCLE FACILITY SELECTION DIAGRAM

The design decision support tools are provided to narrow the range of appropriate bicycle facility types and support a design professional's decision-making process. They do not replace the need for the decision on the appropriate bicycle facility type to be made by a qualified, experienced professional exercising sound judgement. Design professionals should also consult **Chapter B.2** to understand the contextual and local conditions that may influence the preferred bicycle facility1type.

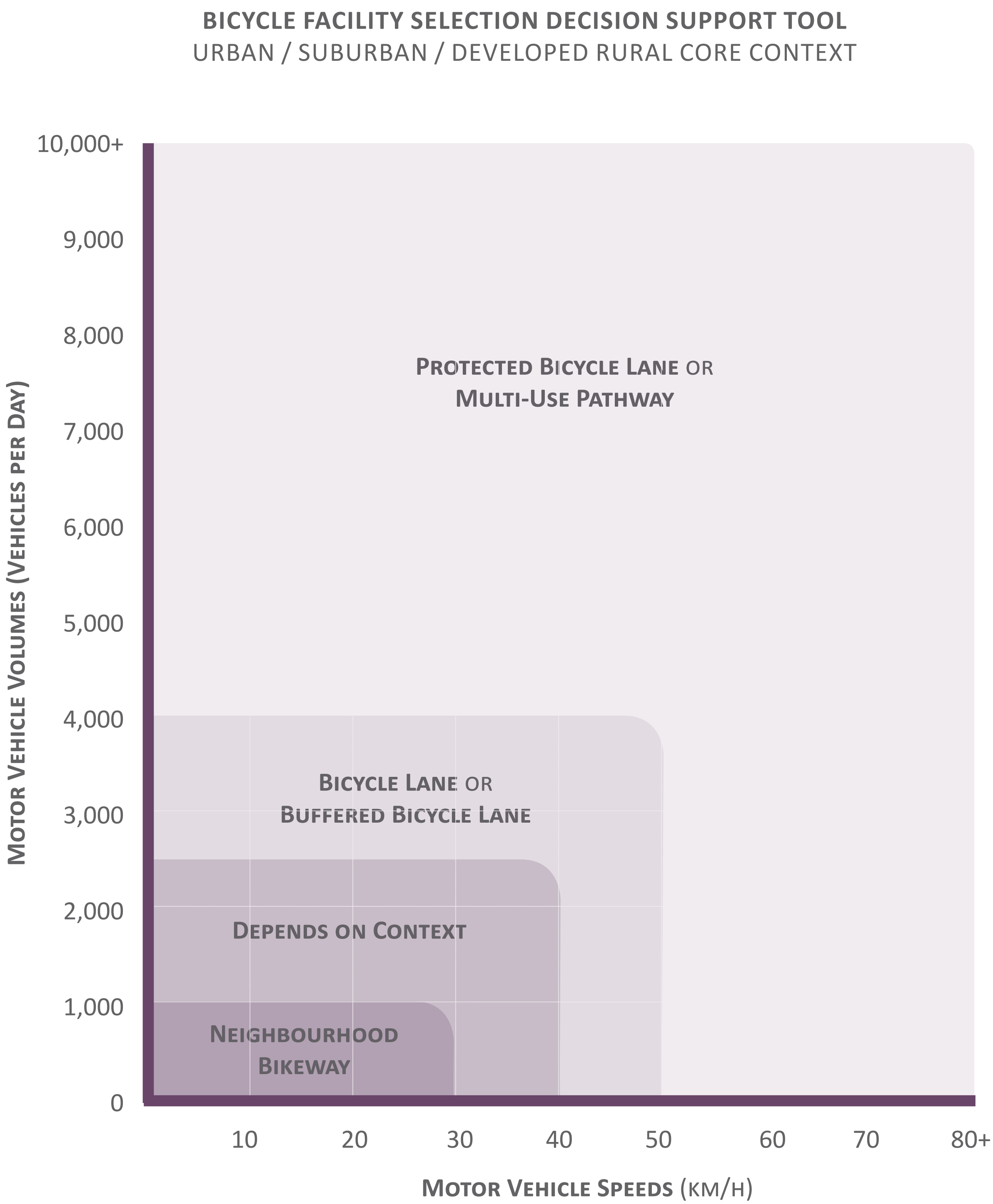


Figure D-29 // Bicycle Facility Selection Decision Support Tool - Urban / Suburban / Developed Urban Core Context

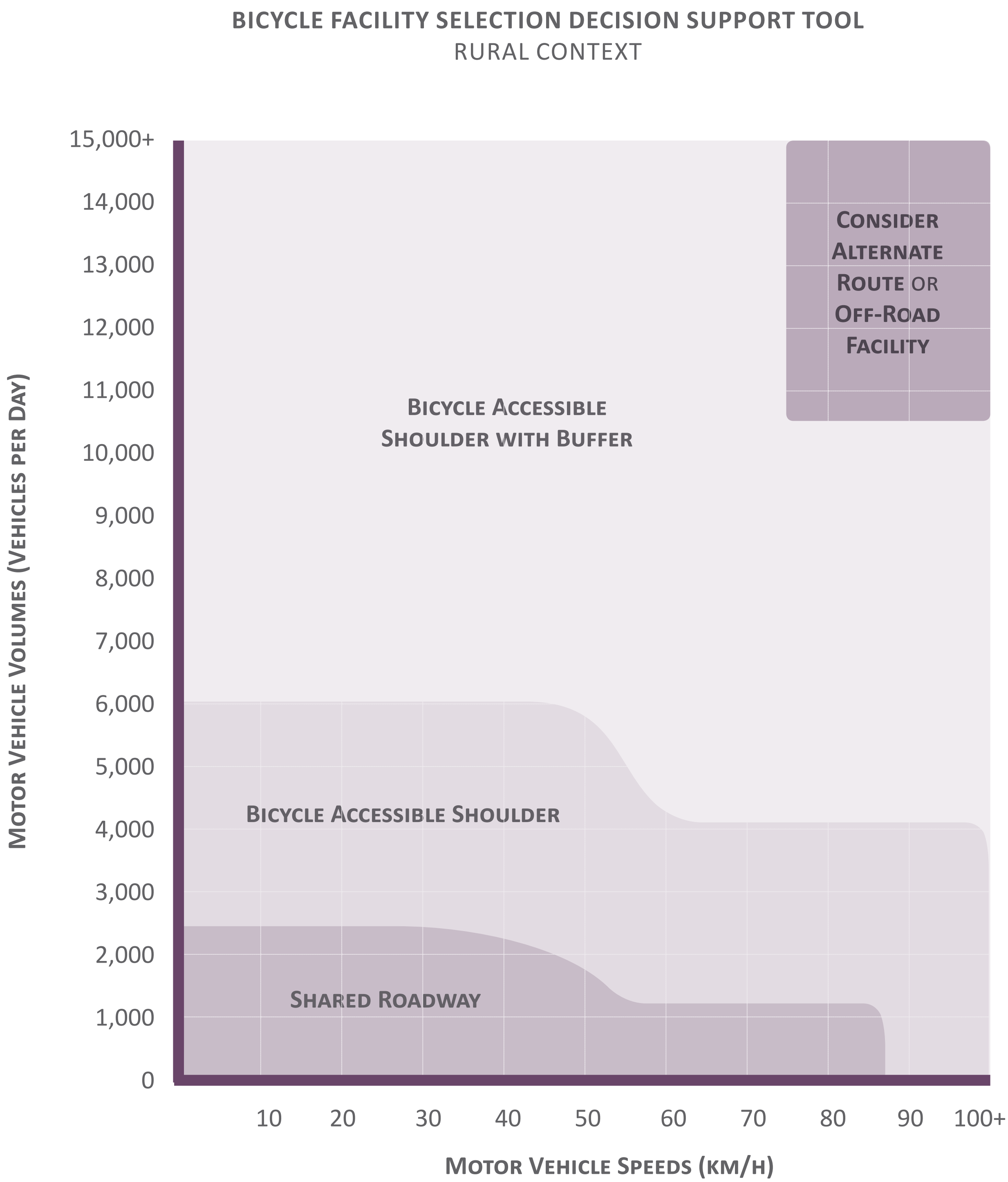


Figure D-30 // Bicycle Facility Selection Decision Support Tool - Rural Context

City of Vancouver, B.C.
Source: Modacity

D.2

NEIGHBOURHOOD BIKEWAYS

Neighbourhood bikeways (also often referred to as bicycle boulevards, local street bikeways, or bicycle priority streets) are streets with low motor vehicle volumes and speeds that have been enhanced to varying degrees to prioritize bicycle traffic. Because motor vehicle volumes and speeds are relatively low, neighbourhood bikeways can be comfortable facilities for people of all ages and abilities.

KEY FEATURES

Neighbourhood bikeways are streets with low motor vehicle traffic volumes and speeds, which create conditions that are comfortable for people cycling to share the road with motor vehicles (see **Figure D-31**).

Neighbourhood bikeways should include **signage and pavement markings** to raise awareness to all road users that this is a shared facility between people cycling and driving 1. They can also include a range of traffic calming measures to reduce motor vehicle speeds (such as traffic circles, **curb extensions** 2, chicanes, and **speed humps** 3) and a range of traffic diversion measures to reduce motor vehicle volumes (such as right-in/right-out islands and **median barriers across intersections** 4). These traffic calming and diversion measures help to facilitate through movement by bicycles, while reducing motor vehicle volumes and speeds as necessary. Neighbourhood bikeways should also include treatments at major intersections to facilitate crossings for people walking and cycling, including either full signals or pedestrian and cycling activated **signals** 5 (see **Chapter G2**).

Figure D-31 // Key Features of Neighbourhood Bikeways

DESCRIPTION

Local motor vehicle traffic is permitted along neighbourhood bikeways, but short-cutting motor vehicle traffic should be discouraged. This helps to create a comfortable environment for people cycling and driving to share the road. In addition, the most critical design treatments for neighbourhood bikeways are crossings of major roads. Neighbourhood bikeways should include signalized and non-signalized crossing treatments at major intersections to facilitate bicycle crossings.

Neighbourhood bikeways are most effective in road networks with a strong, continuous grid pattern, although they can also be suitable in suburban contexts with curvilinear streets with appropriate wayfinding and connections between streets.

Neighbourhood bikeways can provide reasonable access within a short cycling distance to commercial destinations for people who do not feel comfortable riding on major streets. They can also provide a more pleasant cycling experience compared to major roads – with fewer motor vehicles, less pollution, and less noise.

However, neighbourhood bikeways can also sometimes be a less visible and less intuitive part of a bicycle network when compared to bicycle facilities on major roads. This results in bicycle users potentially being less visible to motorists, particularly at intersections. As such, an important goal of a neighbourhood bikeway is to make the bicycle facility as visible as possible at crossings of higher volume and higher speed roads to ensure motorists are expecting people cycling to be crossing. Because of their many benefits, neighbourhood bikeways are an effective type of bicycle facility to encourage cycling for people of all ages and abilities on streets with low motor vehicle volumes and speeds. However, because of their limitations in terms of lack of visibility and the fact they may not provide direct connections to destinations on major streets, they should be considered a complementary type of bicycle facility

Neighbourhood bikeway, Vancouver, B.C.

Adanac Street neighbourhood bikeway, Vancouver, B.C. (Source: Mike Zipf)


W 7th Avenue neighbourhood bikeway, Vancouver, B.C. (Source: Dylan Passmore)

Neighbourhood Bikeways are for People of All Ages and Abilities

Neighbourhood bikeways are considered an all ages and abilities bicycle facility as they increase the comfort of users by creating a safe and comfortable environment for people cycling and people driving motor vehicles to share the road. Research from the Cycling in Cities Program at the University of British Columbia found that neighbourhood bikeways are one of the safest and most preferred types of bicycle facilities. Neighbourhood bikeways, therefore, provide a broad level of appeal to a variety of people, including experienced bicycle users (who benefit from the lower motor vehicle volumes without significant increases in trip times), and less experienced bicycle users (who may not be comfortable cycling on higher volume roads). For less experienced bicycle users, neighbourhood bikeways can also serve as 'stepping stone' facilities that help increase their comfort level using on-street facilities.

and should not be considered a replacement for bicycle facilities on major streets.

Because neighbourhood bikeways are generally located on local roads, they are often not located on roads that have been identified as priority routes for winter maintenance. To ensure they are comfortable for people throughout all seasons, communities should review their snow and ice control programs and procedures to consider winter maintenance priorities and the impacts of traffic calming treatments on snow and ice control practices (see **Chapter I.3**).

BENEFITS + LIMITATIONS

Benefits

- Traffic calming and diversion measures can reduce motor vehicle volumes and speeds, which can improve compliance with traffic laws, and reduce the need for traffic enforcement.
- Traffic calming can be popular with neighbours near neighbourhood bikeways and can improve the aesthetics of the road.
- Treatments at major intersections facilitate safe crossings for people walking and cycling.
- Appealing to most types of bicycle users and particularly appealing to newer or less experienced bicycle users.
- Can be a 'stepping stone' for newer, or less experienced bicycle users.
- Can be a pleasant environment to cycle with less noise and pollution from motor vehicle traffic than bicycle facilities on busier roads.
- Often located parallel to arterial and collector roads, which can still provide adequate access to main street destinations with proper wayfinding.
- Can be cost-effective depending on the context and level of traffic calming and diversion treatments required.

Limitations

- People cycling must still share the road with motor vehicles.
- People cycling may be less visible or expected by motorists.
- Facilities with insufficient traffic calming and diversion treatments may increase short-cutting motor vehicle traffic.
- Treatments at major intersections and geometry changes can result in significant costs.

- Additionally added operating costs may be required to maintain pavement quality and clear snow and ice.
- Traffic calming and traffic diversion may present challenges for emergency services.

Level of Treatments

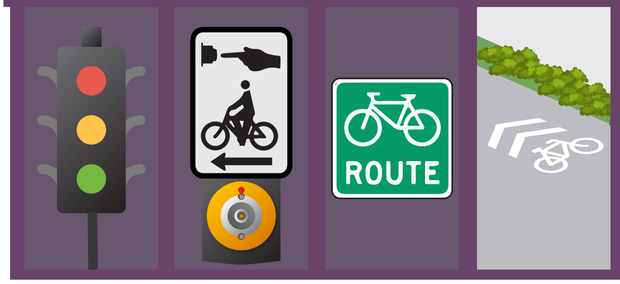
Neighbourhood bikeways are categorized based on the degree to which bicycles are prioritized through design treatments. A basic treatment level can be applied on roads that already have low motor vehicle volumes and speeds, where the only required measures consist of bicycle route signage and pavement markings, along with intersection treatments to aid bicycle users in crossing major roads. Where existing traffic speeds or volumes are higher, treatments may also include a range of traffic calming measures designed to reduce motor vehicle speeds, and traffic diversion measures designed to restrict motor vehicle access while maintaining full access for people walking and cycling. Each of these different treatments builds upon the last, adding to the level of prioritization for non-motorized modes (see **Figure D-32**).

Canadian Guide to Traffic Calming – 2nd Edition (2018)

Published by the TAC in 2018, the *Canadian Guide to Traffic Calming – 2nd Edition* provides information and guidance related to the planning, design, installation, operation, and maintenance of traffic calming measures on local, collector, and arterial roads within Canada. The document is intended to assist design professionals to better understand the principles of traffic calming and properly apply the processes, tools and techniques detailed in the guide. Application of traffic calming as part of a neighbourhood bikeway should be undertaken consistent with guidance provided in the TAC *Canadian Guide to Traffic Calming - Second Edition*.

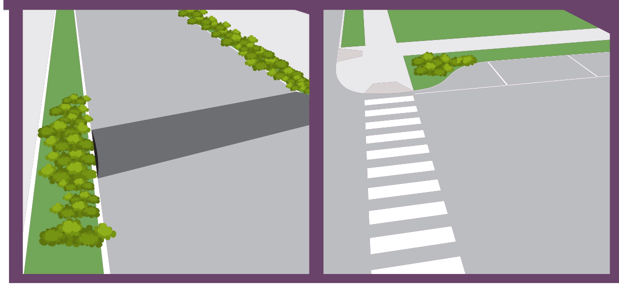
Neighbourhood bikeway connection sign, Vancouver, B.C.

LEVEL 1: REQUIRED TREATMENTS ((INTERSECTION TREATMENTS, SIGNAGE, PAVEMENT MARKINGS)



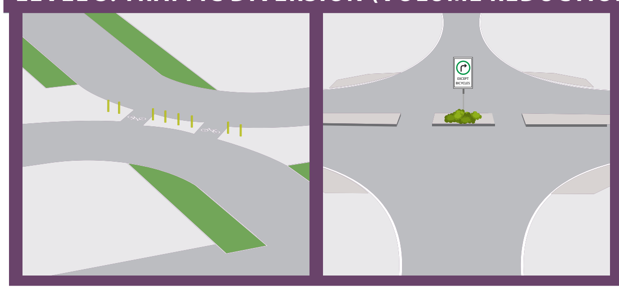
Intersection treatments such as signalization with bicycle detection should be used to help people cycling, walking, and using other forms of active transportation in crossing major roads and to minimize potential conflicts with motor vehicles. Signage and pavement markings can help to identify neighbourhood bikeways to both bicycle users and motorists and raise awareness to motorists. In cases where motor volumes and speeds are already sufficiently low, signage, pavement markings, and intersection treatments may be the only required treatments.

LEVEL 2: TRAFFIC CALMING (SPEED MANAGEMENT)



In addition to the Level 1 treatments, traffic calming measures can be provided to reduce motor vehicle speeds and bring them closer to those of people cycling. Reducing speeds along neighbourhood bikeways improves the cycling environment and is critical to creating a comfortable and effective cycling facility.

LEVEL 3: TRAFFIC DIVERSION (VOLUME REDUCTION)



In addition to the Level 1 and Level 2 treatments, traffic diversion measures can also be provided to reduce motor vehicle volumes and discourage through motor vehicular traffic, while maintaining through access for people cycling and walking.

Figure D-32 // Level of Treatments

Treatments may vary along a corridor as required, with distinct treatments at each intersection and along every block. As such, the design of neighbourhood bikeways is unique compared to other types of bicycle facilities, and includes a 'toolbox' of treatments that can be considered by design professionals based on the unique conditions along the corridor. Various traffic calming measures and traffic diversion measures can be considered. Note that vertical deflection measures such as speed humps and raised crosswalks are not permitted on roadways under provincial jurisdiction. This chapter introduces the 'toolbox' of treatments that can be considered along neighbourhood bikeways, but does not provide detailed guidance on traffic calming and diversion measures. More detailed guidance is provided in the TAC Canadian Guide to Traffic Calming – 2nd Edition. Additional guidance is also provided in **Appendix C**.

TYPICAL APPLICATIONS

Road Network Characteristics

Neighbourhood bikeways work best in road networks with a continuous grid pattern, which are found in many urban contexts and established neighbourhoods in communities throughout B.C. The logical and interconnected layout of these road networks are generally easy to navigate and provide numerous route options to destinations. Neighbourhood bikeways work best in grid networks on local roads that are spaced approximately up to 400 metres from major roads.

In some locations, a large city block, park, or other barrier may reduce connectivity in the grid road system, requiring people cycling to use higher speed roads. In these instances, design professionals should design treatments that will increase cycling comfort and safety when travelling along the segments of higher speed road, or should identify opportunities to develop connections for people walking and cycling. For example, while parks may sometimes be considered a barrier to connectivity, providing an off-street pathway through the park can improve network connectivity for people walking and cycling while providing access to community amenities and green space. Careful consideration should be given to the impact that an active transportation facility may have on the existing function of the park and should mitigate any negative impacts on park users and activities.

In suburban and rural contexts, development of effective neighbourhood bikeways can often be challenging due to a lack of alternate through roads and the concentration of motor vehicle traffic on arterial streets. The 'loop and lollipop' road patterns commonly found in many suburban developments may be reasonably good at keeping traffic speeds low and discouraging through traffic on residential roads, but limits connectivity between roads. In these contexts, the through roads are generally the major roads with higher volume and higher speed traffic with limited crossing opportunities — conditions that can be intimidating for less comfortable bicycle users. In these contexts, off-street pathway connections between subdivisions and through parks, for example, can provide critical opportunities to provide connections for people walking and cycling to create a continuous neighbourhood bikeway. Wayfinding signage is particularly important in these contexts to ensure the neighbourhood bikeway is easy to navigate (see **Chapter H.3**).

Traffic Speeds and Volumes

The desired average daily traffic on a neighbourhood bikeway is 500 motor vehicles per day or less. The maximum average daily traffic is 1,000 motor (vpd).

Neighbourhood bikeways should have posted speed limits and operating motor vehicle speeds of 30 km/h or less.

Neighbourhood bikeways can be considered if existing conditions are higher than these thresholds, only if sufficient traffic calming and diversion measures are provided to reduce traffic speeds and volumes to meet these thresholds. As shown in the Bicycle Facility Selection Decision Support Tool in **Chapter D.1**, neighbourhood bikeways can be considered if existing average daily traffic is 2,500 vpd or less, and if posted speed limits and operating motor vehicle speeds are 50 km/h or less, if the design treatments are anticipated to change traffic volumes and speeds to meet the recommended thresholds.

It should be noted that roadways under provincial jurisdiction typically cannot be posted at speeds lower than 50 km/h, except for in special circumstances such as school zones.

If the resulting motor vehicle volumes are above 1,000 vpd and/or posted or operating traffic speeds are over 30 km/h, the facility may not be considered comfortable for people of all ages and abilities. **Table D-9** identifies the level of treatment required depending on existing motor vehicle volumes and speeds.

An alternative motor vehicle volume measurement based on motor vehicles per hour (vph) may be used in lieu of (or in addition to) the vpd measurement. This can be particularly important if a road has unique travel patterns during peak periods or other times of day. In such cases, the target should be to design, build, and maintain for an average of 50 vph in the peak direction. A neighbourhood bikeway can operate at an average of 75 vph in the peak direction but should be improved or maintained to not exceed 100 vph in the peak direction.

TABLE D-9 // NEIGHBOURHOOD BIKEWAY TREATMENTS BY MOTOR VEHICLE SPEED AND VOLUME

Existing Motor Vehicle Volumes (VPD)	Existing Posted Motor Vehicle Speeds	Level of Treatments		
		Level 1: Required Treatments (Intersection Treatments, Signage, and Pavement Markings)	Level 2: Traffic Calming (Speed Management)	Level 3: Traffic Diversion (Volume Management)
<1,000	30 km/h or less	✓		
<1,000	30 to 50 km/h	✓	✓	
1,000 – 2,500	30 km/h or less	✓		✓
1,000 – 2,500	30 to 50 km/h	✓	✓	✓
>2,500	> 50 km/h	Consider alternate facility type		

Table D-10 // Neighbourhood Bikeway Desirable + Constrained Width

FACILITY	DESIRABLE (m)	CONSTRAINED LIMIT (m)
Parking lane	Refer to local bylaws	
Clear width (excluding parking lane)	5.5	4.0

Road Width

Clear width refers to the road's operating space, either between curbs (if there is no on-street motor vehicle parking) or between parked motor vehicles (if there is on-street motor vehicle parking). The clear width can impact both the speed at which motor vehicles travel and the comfort of people cycling. Roads with a wider clear width provide more comfortable passing and increased cycling capacity, but also encourage higher motor vehicle speeds. Conversely, roads with a narrower clear width may result in lower motor vehicle speeds but may not provide a comfortable space for people to ride abreast and/or for bicycles and motor vehicles to pass each other.

The desired clear width on a neighbourhood bikeway is between 4.0 metres and 5.5 metres (see **Table D-10** and **Figure D-33**). This provides the ideal width to allow motor vehicles and bicycles to comfortably share the road, while helping to ensure that bicycles and motor vehicles travel at similar speeds. A clear width of 4.0 metres will not allow two motor vehicles to pass one another. Instead, one motor vehicle may need to pull over to the side to allow the other to pass. The presence of driveways and/or vacant on-street parking spaces dictates the frequency of passing opportunities for motor vehicles and should be considered in the design of a neighbourhood bikeway.

The following may be considered where a neighbourhood bikeway has a clear width less than 4.0 metres:

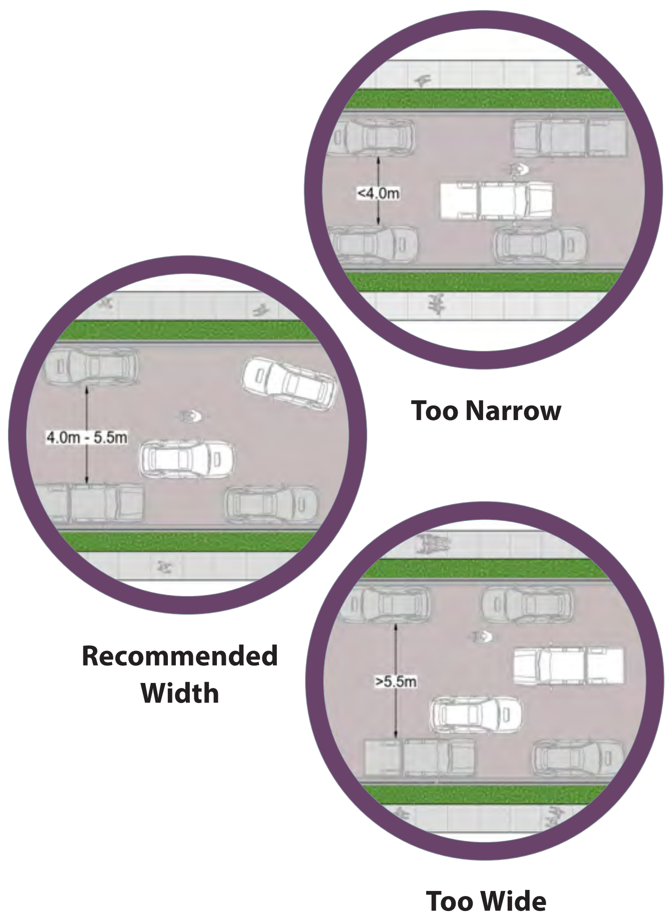
- Remove on-street parking on one or both sides of the road (if present);
- Widen the road;
- Convert the road to one-way operation for motor vehicles and add a contraflow bicycle lane; or
- Choose another corridor.

The following may be considered where a neighbourhood bikeway has a clear width greater than 5.5 metres:

- Add on-street parking (if not present); or
- Consider traffic calming options to visually narrow the road such as curb extensions or chicanes.

It should also be noted that neighbourhood bikeways should not include a directional dividing line and as such, the entire clear width is intended to be used for both directions of traffic.

Figure D-33 // Neighbourhood Bikeway Clear Widths



DESIGN GUIDANCE

Level 1: Intersection Treatments

Intersections with major roads are the most critical locations in the design of neighbourhood bikeways. Crossing treatments should be used to assist people cycling in crossing major roads and to minimize potential conflicts with motor vehicles. The range of standard crossing treatments considered where a neighbourhood bikeway intersects a road are discussed below.

- **Minimize Stops at Local Road Crossings:** Stop signs increase cycling trip length and energy expenditure due to frequent starting and stopping. This can lead to non-compliance by people cycling and/or the use of alternate routes. The frequency of interruptions to people cycling should be minimized on neighbourhood bikeways by re-orienting stop signs so that they do not face the direction of the neighbourhood bikeway and instead control cross traffic. Any increase in motor vehicle speeds on the neighbourhood bikeway facilitated by the change in traffic control may be mitigated by installing traffic calming (see below).

  This treatment only applies where a neighbourhood bikeway crosses a local road and should not be applied when crossing a busier road of a higher classification.
- **Signalized Crossings:** Signalized crossings are used where the number of people crossing the road is higher. Traffic signals should be *required treatments* when crossing arterial roads, multi-lane roads, and/or roads with high traffic volumes. Traffic signals are *recommended treatments* when crossing collector roads depending on the context and traffic volumes. It should be noted that many factors go into the decision around the orientation of traffic controls, including relative volumes on the intersecting roads, road patterns, and other factors. Refer to **Chapter G.2** for more More information regarding traffic signals.
- **Bicycle Detection:** Detection should be provided where people cycling on a neighbourhood bikeway approach a traffic signal. The following are the most common methods of detection:
  1. Loop detectors (marked so that people cycling know where to position their bicycle);
  2. Bicycle push buttons; and
  3. Video detection.

  In many cases, the same detector that is used for motor vehicles can be used for bicycles; however, these should have bicycle detection marking symbols applied denoting stopping locations for people cycling.
- **Crossing at Off-Set Intersections:** Off-set intersections are created when the legs of an intersection do not line up directly across from one another. There are a number of options for transitioning a neighbourhood bikeway through an off-set intersection, as follows:
  1. The preferred design treatment is to provide a bi-directional bicycle pathway on one side of the road to facilitate the connection, as shown in **Figure D-34**.
  2. An alternative option is to install traffic signals to provide breaks in through motor vehicle traffic to allow people cycling to navigate through the intersection, as shown in **Figure D-35**.
  3. Another alternative option is to create two bicycle centre left turn lanes on the through road allowing people cycling to make a two-stage left turn, as shown in **Figure D-36**. This is the least desirable option and is not considered comfortable for people of all ages and abilities.

Figure D-34 // Neighbourhood Bikeway Crossing at Off-Set Intersection Using Bicycle Pathway

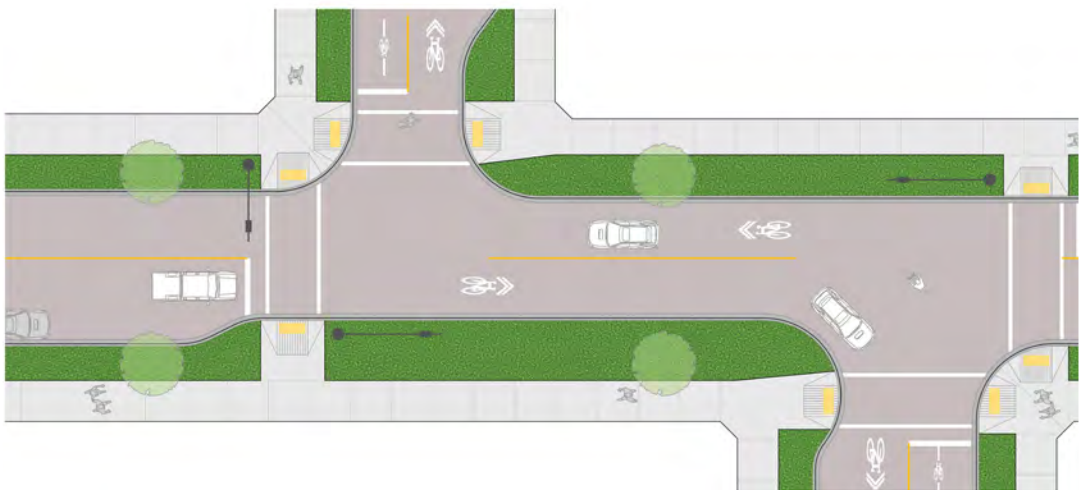


Figure D-35 // Neighbourhood Bikeway Crossing at Off-Set Intersection Using Traffic Signal

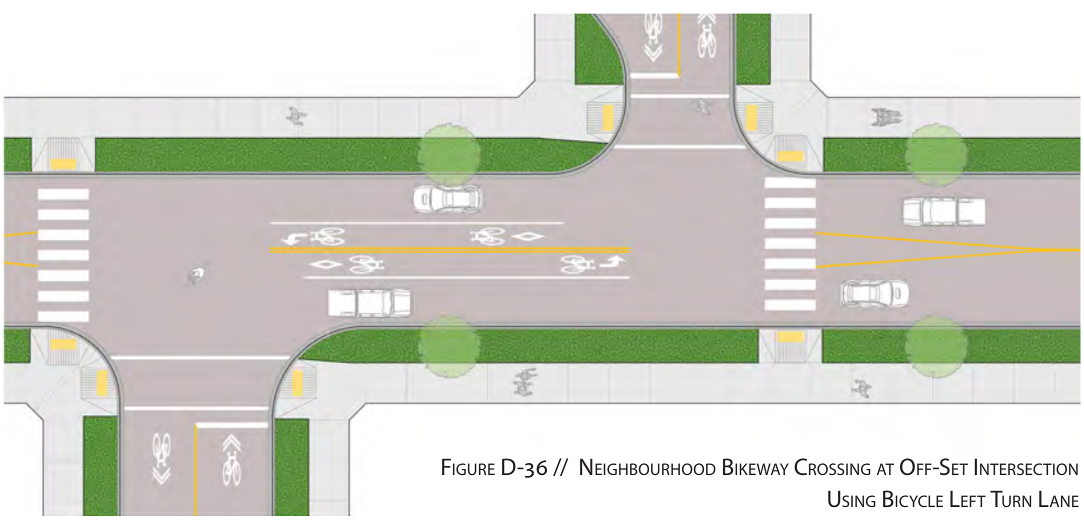


Figure D-36 // Neighbourhood Bikeway Crossing at Off-Set Intersection Using Bicycle Left Turn Lane

Level 1: Signage and Pavement Markings

Signage and pavement markings alone do not necessarily create the conditions necessary for a neighbourhood bikeway. However, if motor vehicle volumes and speeds are already low (less than 1,000 vpd) and posted and operating motor vehicle speeds of 30 km/h or less, and if existing intersection treatments facilitate bicycle travel, then signage and pavement markings may be all that is required to create a neighbourhood bikeway.

The following is recommended for signage on a neighbourhood bikeway (see **Appendix B** for more details):

- The Bicycle Route sign (MUTCDC IB-23; B.C. B-G-001) should be used. Sign location and spacing should be consistent with guidance in Section A. 4.3.3 of the MUTCDC or the *B.C. Manual of Standard Traffic Signs & Pavement Markings* (for roadways under provincial jurisdiction).
- Wayfinding signs should be used to provide information regarding direction, distance, and/or estimated travel time to destinations (further guidance on wayfinding is provided in **Chapter H.3**).
- Shared use lane pavement markings should be used to indicate the desired positioning of bicycle users within the road.
- Custom directional pavement markings (also known as 'breadcrumbs') may be used to reinforce to people cycling that they are on a neighbourhood bikeway and/or to indicate where a change in direction is required to continue to navigate along the neighbourhood bikeway.
- Road sign plates may include a bicycle symbol to enhance bicycle wayfinding and route visibility.

Level 2: Traffic Calming (Speed Management)

Traffic calming measures consist of devices that reduce motor vehicle speeds closer to cycling speeds, and/or reduce motor vehicle volumes, thereby making the neighbourhood bikeway a safer, more pleasant bicycle route. The types of traffic calming devices suitable for a neighbourhood bikeway can generally be categorized as *vertical deflections* and *horizontal deflections*, both of which are described below. These measures are distinct from those that restrict motor vehicle access, which are described in detail under Level 3 – Traffic Diversion (Volume Management).

The TAC *Canadian Guide to Traffic Calming* provides design guidance on various traffic calming treatments, some of which may be appropriate to reduce motor vehicle speeds along a neighbourhood bikeway as described below. Refer to the TAC *Canadian Guide to Traffic Calming* for further information and detailed design guidance.

Vertical Deflection

Vertical deflection measures cause a vertical upward movement of the motor vehicle, thereby lowering motor vehicle speeds as motorists slow to avoid an unpleasant sensation as they traverse the traffic

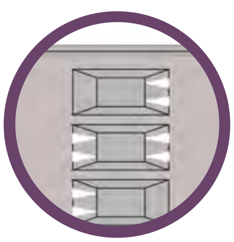
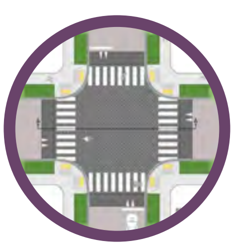
A Note on Speed Limits

The maximum speed limit on a neighbourhood bikeway should be no more than 30 km/h if it is to be considered an all ages and abilities cycling facility. Simply changing the speed limit, however, is unlikely to reduce motor vehicle speeds. As such, posted speed limit changes should be implemented in conjunction with the vertical and horizontal deflection measures described below that create physical change in the road and effectively reduce motor vehicle speeds. Note that speed limits below 50 km/h are not typically appropriate on roadways under provincial jurisdiction.

calming measure. Vertical deflections have the secondary benefits of reducing motor vehicle volumes and deterring neighbourhood short-cutting traffic.

It should be noted that vertical deflection measures are not permitted on roadways under provincial jurisdiction. However, other traffic calming and diversion methods, in addition to intersection treatments, may be considered.

Examples of vertical deflection measures that can be considered along neighbourhood bikeways are provided below. Further details are provided in **Appendix C**.

VERTICAL DEFLECTION		
 **Speed Hump**	A speed hump is a raised area of a road that causes the vertical upward movement of a traversing motor vehicle, intended to create discomfort for motorists travelling at higher speeds and to reduce motor vehicle speeds. Speed humps should be used on local roads only where transit vehicles, buses, emergency vehicles and other large vehicles are not anticipated at high volumes. It should be noted that speed humps may reduce appeal to people cycling if they also have to travel over them. People cycling at greater than 20 km/h can be destabilized riding over a speed hump.	▪ Speed humps should be located no less than 75 metres from a traffic signal and spaced between 80 and 150 metres apart from one another to maintain desired motor vehicle speeds.
 **Speed Table**	A speed table is an elongated raised speed hump with a flat-topped section that is long enough to raise the entire wheelbase of a motor vehicle. Speed tables may be used on public transit and emergency response routes.	▪ Speed tables should be located no less than 75 metres from a traffic signal and spaced between 80 and 150 metres apart from one another to maintain desired motor vehicle speeds.
 **Speed Cushion**	A speed cushion is a raised area on a street similar to a speed hump, but which does not cover the entire width of the street. The width is designed to allow a large motor vehicle, such as a bus, to 'straddle' the cushion, while light motor vehicles will have at least one side of the motor vehicle deflected upward. Speed cushions are intended to produce sufficient discomfort to limit motor vehicle travel speeds, yet allow the motorist to maintain motor vehicle control and allowing larger motor vehicles such as buses and emergency vehicles to pass without difficulty.	▪ The optimal width of a speed cushion is 1.8 metres.
 **Raised Intersection**	A raised intersection is constructed at a higher elevation than the approach roads, resulting in a vertical change upon entry to the intersection. The purpose of a raised intersection is to reduce motor vehicle speeds and reduce conflicts, as they often are provided in conjunction with a stop control on one or both intersecting roads	▪ Raised intersections should be raised to the same level as the adjacent sidewalk (typically 80 millimetres)

Horizontal Deflection

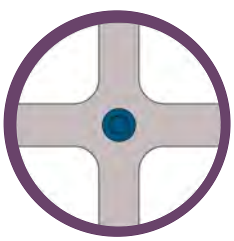
Horizontal defection measures include a lateral shift in the travel pattern of motor vehicles and cause motorists to slow down in response to either a visually narrower road or a need to navigate a curving travel lane. Various horizontal deflection measures are described below.

HORIZONTAL DEFLECTION

Curb Extension

A curb extension (also referred to as a neckdown, choker, curb bulb, or bulb-out) is a horizontal intrusion of the curb into the road, resulting in a narrower section of the road. When placed on a neighbourhood bikeway, they both visually and effectively narrow the road width. This reduces motor vehicle speeds, reduces pedestrian crossing distances, prevents parking close to an intersection, and increases motorist and cycling sightlines.

In some cases, people cycling may feel forced into the path of motor vehicles if the curb extensions do not provide adequate spacing for people cycling. The design of the curb extension should ensure that it does not create pinch points for people cycling.

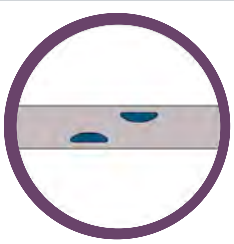


Traffic Circle

A traffic circle is an island located at the centre of an intersection that requires motor vehicles to travel through the intersection in a counter-clockwise direction around the island. A traffic circle is applied on lower road classifications and acts as a traffic calming measure.

A traffic circle is distinct from a roundabout in that its primary objective is to calm traffic rather than intersection traffic control. Traffic circles typically replace either uncontrolled intersections or intersections controlled by stop signs. Traffic circles are effective in reducing motor vehicle speeds, and also eliminate the need for people cycling to stop as is the case where stop signs are provided. Traffic circles also provide opportunities for landscaping to improve the aesthetics of the bicycle route.

Design professionals should consider the potential safety risks of traffic circles before installing them along a neighbourhood bikeway (see Research Note on page D26).



Chicanes

Chicanes are a series of curb extensions on alternating sides of a street, which narrow the street and require motorists to steer from one side of the street to the other to travel through the chicane. Chicanes are not considered a 'typical' treatment and should be used with caution along with appropriate lighting and signage. Chicanes are effective at reducing motor vehicle speeds by forcing a lateral shift of the pathway of motor vehicles travelling past chicanes.

Level 3: Traffic Diversion (Volume Reduction)

Traffic diversion measures refer to devices that restrict motor vehicle movements at intersections, while allowing unrestricted movements for people walking and cycling. These devices are effective in reducing motor vehicle volumes on neighbourhood bikeways. Since emergency vehicle access can be an issue with traffic diversion devices, municipalities should work with emergency service providers prior to implementing these devices. In addition, municipalities should consult with the community to ensure that impacts to traffic ingress and egress are understood and managed.

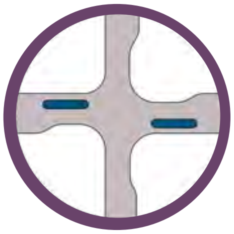
Research Note

Some studies have found that traffic circles have an increased safety risk compared to other intersection controls. Research from the Cycling in Cities Program at the University of British Columbia has found that traffic circles can present a challenge if used on hills where people cycling can travel through an intersection at high speeds, and if used where a high volume of turning movements are expected.[1]

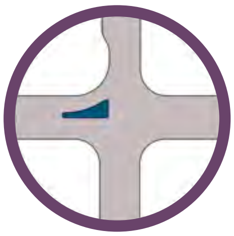
In addition, some people cycling and motorists may make incorrect 'wrong way' left turns around traffic circles, which can present additional safety issues. Good visibility across the traffic circle and to cross-street traffic is critical as people cycling may turn left in front of them, increasing the crash risk with motorists. The NACTO Urban Bikeway Design Guide also notes that people on bicycles often complain that motorists overtake them when approaching the circles, creating a hazardous condition. Although traffic circles can be effective in reducing motor vehicle speeds and volumes, design professionals should apply caution in the use of traffic circles.

1 Kay Teschke et al., 'Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study' (2018).

The following traffic diversion measures can be considered to restrict motor vehicle access and reduce motor vehicle volumes while retaining bicycle route continuity as part of a neighbourhood bikeway. Details are provided in **Appendix C**.

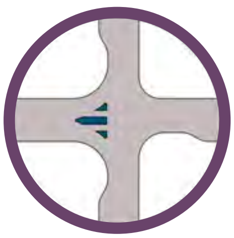
TRAFFIC DIVERSION / VOLUME MANAGEMENT	
 **Directional Closure**	A directional closure consists of curb extensions or vertical barriers extending to approximately the directional dividing line of a road, effectively prohibiting one direction of motor vehicle traffic. Bicycles are permitted to travel through a directional closure in both directions, including the direction in which motor vehicle traffic is obstructed.
 **Diverter**	A diverter is a raised barrier placed diagonally across an intersection that forces motor vehicle traffic to turn and prevents through movements. Diverters should incorporate gaps for people walking and cycling, and may be mountable by emergency vehicles.

TRAFFIC DIVERSION / VOLUME MANAGEMENT



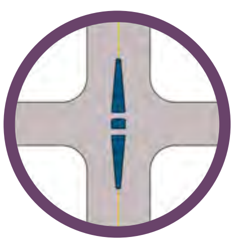
Intersection Channelization

Intersection channelization is the use of raised islands or bollards in an intersection to obstruct traffic movements and physically direct motor vehicle traffic through an intersection. People cycling are typically permitted to make all movements, including those which motor vehicles are prevented from making. Gaps in channelizing islands should be provided to accommodate bicycles.



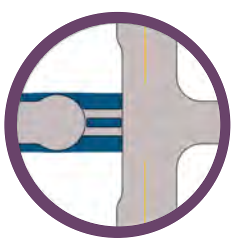
Right-In / Right-Out Island

A right-in/right-out islands is a raised triangular island at an intersection approach which obstructs left turns and through movements by motor vehicles to and from the intersecting street or driveway. People cycling are typically permitted to make left turns and through movements from the side street, either through gaps or depressions in the island.



Raised Median

A raised median through an intersection is a concrete or asphalt island located on the directional dividing line of a two-way road through an intersection that prevents left turns and through movements for motor vehicles to and from the intersecting roads. This can create a refuge for people walking and cycling, enabling them to cross one direction of travel at a time, thereby reducing waiting time for gaps when crossing the road.



Full Closure

A full closure consists of a barrier extending the entire width of the road that obstructs all motor vehicle traffic movements from continuing along the road. A closure can change a four-way intersection to a three-way intersection, or a three-way intersection to a non-intersection. Gaps should be provided for people walking and cycling and to allow for emergency vehicle access.

Other Considerations

Green Roads / Stormwater Treatments

Traffic calming and traffic diversion measures on neighbourhood bikeways (as well as on other roads) provide an important opportunity to achieve other important benefits, such as reducing the impact of stormwater runoff by using stormwater collection swales and pervious asphalt or concrete. These design features capture excess stormwater runoff, filter stormwater impurities, increase groundwater recharging, and reduce the load of excess stormwater on existing drainage systems. They can be applied to a variety of measures such as curb extensions, traffic circles, and medians. In addition to stormwater benefits, these techniques can also help improve environmental sustainability, beautify the landscape, and create a more attractive and livable environment.

Public Art

Public art can define the space along a neighbourhood bikeway and is also a great way to increase public involvement. The art can even be functional, such as decorative bicycle parking. Ideas for public art along neighbourhood bikeways include:

- Public competitions for artistic bicycle parking or intersection mural designs;
- Commissioned sculptures that identify the terminus of a neighbourhood bikeway;
- Vinyl wraps of utility boxes that have art or educational information; and
- Themed artwork or logos that identify a particular neighbourhood bikeway route.

The inclusion of public art along neighbourhood bikeways should ensure that clear sightlines are maintained along the length of the corridor.

Pedestrian Amenities

The design features that make neighbourhood bikeways comfortable places to cycle can also make them great places to walk. These features can be further enhanced through the installation of pedestrian amenities such as park benches, water fountains, and pedestrian-oriented road lighting that create an inviting and comfortable pedestrian environment. Additionally, pedestrian safety and accessibility improvements are a key consideration when upgrading neighbourhood bikeways. The addition of pedestrian amenities improves safety and accessibility while advancing the notion that the benefits of neighbourhood bikeways extend beyond people cycling.

Landscape and Street Trees

Corridors landscaped with street trees and landscaping beautify the streetscape and can help to slow motor vehicle traffic by providing visual friction at the roadside. Funding for landscaping can come through partnerships with parks and recreation and environmental services departments, as well as private funding sources.

Ideally, plants used for landscaping are native and low maintenance. Cooperative agreements may be formed with nearby residents and business owners to provide for minor maintenance activities such as watering and pruning. Pruning and maintenance is important to ensure that street trees do not block signage or reduce sightlines, and to ensure they continue to perform as intended.

Hornby Street protected bicycle lane, Vancouver, B.C.
Source: Paul Krueger

D.3

PROTECTED BICYCLE LANES

Protected bicycle lanes are dedicated facilities for the exclusive use of people cycling and using other active modes (such as in-line skating, using kick scooters, and skateboarding, where permitted through local and regional government bylaws). Protected bicycle lanes are physically separated from motor vehicles and pedestrians by vertical and/or horizontal elements. Protected bicycle lanes are distinct from painted or buffered bicycle lanes (**Chapter D.4**) as they provide physical separation between bicycle users and motor vehicles.

DESCRIPTION

Protected bicycle lanes combine the user comfort benefits of off-street pathway with the route directness and access to destination benefits of on-street infrastructure. Protected bicycle lanes have different forms and go by different names (such as cycle tracks, separated bicycle lanes, or on-street bicycle pathways) but all share common elements – they provide space that is intended to be exclusively for people cycling (and other active modes where permitted) and they are physically separated from motor vehicle travel lanes, parking lanes, and sidewalks.

Protected bicycle lanes can be designed for either one-way or two-way operation and can be constructed at sidewalk level, street level, or an intermediate level in between. They can be physically separated from motor vehicles and pedestrians using a variety of possible treatments, including flexible delineators, curbs, medians, concrete barriers, planters, parked motor vehicles, or a combination of these elements.

Protected bicycle lanes are typically positioned directly next to a curb and separated from general purpose travel lanes or parking by a type of separation that is appropriate for the speed and volume of the adjacent motor vehicle traffic.

Protected bicycle lanes are considered an all ages and abilities bicycle facility, as they increase the comfort of users by providing a clear physical separation between people cycling and motor vehicles. Protected bicycle lanes can minimize conflicts between bicycles and parked motor vehicles, and they can reduce the frequency and likelihood of 'dooring'. This increased comfort can play a significant role in increasing bicycle use, particularly among less experienced bicycle users and among women, children, and seniors.

TYPICAL APPLICATIONS

Protected bicycle lanes are most appropriate on roads with higher motor vehicle volumes and speeds, multiple motor vehicle lanes, relatively high bicycle volumes, and relatively few laneways and driveways. Protected bicycle lanes should be considered the preferred design treatment under the following conditions:

- Where motor vehicle speeds are posted at 50 km/h and motor vehicle volumes are greater than 4,000 vpd.
- Where motor vehicle speeds are posted at 60 to 80 km/h, at any motor vehicle volume.
- Locations with high curbside activity, regardless of posted motor vehicle speeds or motor vehicle volumes.

Research Note

Research has found that protected bicycle lanes are the safest type of bicycle facility. The Cycling in Cities Program at the University of British Columbia found that protected bicycle lanes were the safest type of bicycle facility, with a 90% decrease in safety risk compared to a major street with no cycling infrastructure.[1]

Another recent study examined thirteen years of data from twelve large U.S. cities, including 17,000 fatalities and 77,000 severe injuries. The study found that cities with protected bicycle lanes had 44% fewer deaths and 50% fewer serious injuries than the average city. Furthermore, the study found that painted bicycle lanes provided no road safety improvements, and that shared use lanes were actually less safe than having no pavement markings at all.[2]

1 Kay Teschke et al., 'Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study' (2018).

2 Marshall and Ferenchak, 'Why Cities with High Bicycling Rates are Safe for All Road Users' (2019).

PROTECTED BICYCLE LANE CONSIDERATIONS

Protected Bicycle Lane Zones

Protected bicycle lanes are typically characterized by three separate zones (**Figure D-37**):

- **Bicycle Through Zone:** The space in which people cycling operate. It is located between the Street Buffer Zone and the Furnishing Zone.
- **Furnishing Zone:** The area that provides physical separation between the protected bicycle lane and the sidewalk.
- **Street Buffer Zone:** The area that provides physical separation between the protected bicycle lane and the motor vehicle lane.

The design choices made for each of these zones affect one another and can result in the need for trade-offs based on the available right-of-way. The following general design principles should be considered with respect to the design of the various zones:

- Changes in the Bicycle Through Zone elevation and horizontal alignment should be minimized, and where present, changes should be gradual;
- The Bicycle Through Zone should be wide enough to accommodate existing and anticipated bicycle volumes, facilitate passing of slower bicycle users and allow side-by-side travel where feasible;
- The Bicycle Through Zone should be free from pedal and handlebar hazards;
- The Street Buffer Zone should provide adequate horizontal and vertical separation from motor vehicles, including curbside activities such as parking, loading, and transit;
- The Furnishing Zone should discourage pedestrians from walking in the protected bicycle lane;
- The Sidewalk Buffer and Street Buffer Zones can provide space for signage; and
- Pedestrian travel should be accommodated within the sidewalk and without impeding on the Furnishing Zone.

A description of the width and characteristics of the Bicycle Through Zone, Furnishing Zone, and Street Buffer Zone are provided in the Design Guidance subsection later in this chapter.

Figure D-37 // Protected Bicycle Lane Zones

Additional Considerations

Maintenance and snow removal equipment are important considerations, as the facilities need to be wide enough to accommodate standard equipment sizes. Local jurisdictions should consider the suitability of existing maintenance and slow clearing equipment versus purchasing new equipment in determining protected bicycle lane widths. Snow clearing should be heightened in priority in the design of protected bicycle lanes in B.C. communities with frequent snow fall and colder winter weather. Additional information regarding maintenance is provided in **Chapter I.3**.

Other factors that should be given due consideration to ensure a successful protected bicycle lane design include the following:

- Stormwater management;
- Lighting;
- Underground utilities;
- Curbside activities and co-ordination with the pedestrian zones (see **Section C**); and
- Landscape and street trees.

DESIGN GUIDANCE

Bicycle Through Zone

The key design consideration for the Bicycle Through Zone is the width of the protected bicycle lane itself. There are a number of factors that influence the functional and perceived width of the protected bicycle lane that should be considered in determining the width of the Bicycle Through Zone, as follows:

- **User Volumes:** Protected bicycle lanes have the potential to attract greater number of bicycle users and introduce a need to facilitate more frequent passing.
- **Speed Differential:** Protected bicycle lanes have the potential to attract bicycle users of a variety of abilities and introduce greater variance in travel speeds.
- **Grade:** The requirement for a bicycle user to climb due to topography / slope may introduce greater speed differential between bicycle users of differing abilities and cause many people cycling to 'wobble' as they climb.
- **Elevation:** The presence of vertical barriers due to the protected bicycle lane elevation narrows the perceived width of the bicycle lane.
- **Orientation:** A bi-directional configuration allows for passing in the opposing lane, whereas a uni-directional configuration is limited to only the width of the single lane, as described on pages D34 and D36.

Table D-11 shows the desirable and constrained limit widths for each protected bicycle lane component. The widths for uni-directional and bi-directional protected bicycle lanes are described in more detail on pages D34 and D36.

TABLE D-11 // PROTECTED BICYCLE LANE WIDTH GUIDANCE

FACILITY	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Bicycle Through Zone (Uni-Directional)	2.5*	1.8
Bicycle Through Zone (Bi-Directional)	4.0	3.0
Street Buffer Zone	0.9*	0.6
Furnishing Zone**	2.0	0.25

* If Street Buffer Zone is not adjacent to on-street motor vehicle parking, the desirable width is ≥0.9 metres, with a wider buffer creating additional cycling comfort.

** Furnishing Zone in this context refers to the buffer between the Bicycle Through Zone and Pedestrian Through Zone. This is especially relevant for sidewalk level protected bicycle lanes, where there is no grade difference between people cycling and people walking. For full details on Furnishing Zone width in a pedestrian context, refer to **Chapter C.3**.

Uni-Directional Protected Bicycle Lane

As shown in **Table D-11,** the desirable width of the Bicycle Through Zone is 2.5 metres on a uni-directional protected bicycle lane to accommodate passing and side-by-side travel. If bicycle volumes are expected to be less than 150 bicycles per hour, then a width of 2.0 metres is more appropriate. The constrained limit width of the bicycle lane portion of a uni-directional protected bicycle lane is 1.8 metres.

The absolute minimum width of the bicycle lane portion of a uni-directional protected bicycle lane is 1.5 metres. This width does not facilitate people cycling passing within the lane. The absolute minimum should only be used for short distances (under 100 metres), when reasonable consideration has been given to local context, and after confirming that maintenance equipment can navigate this reduced width. **Figures D-38** and **D-39** show uni-directional protected bicycle lane configuration with no parking and with parallel on-street parking.

10th Avenue Bikeway, Vancouver, B.C.

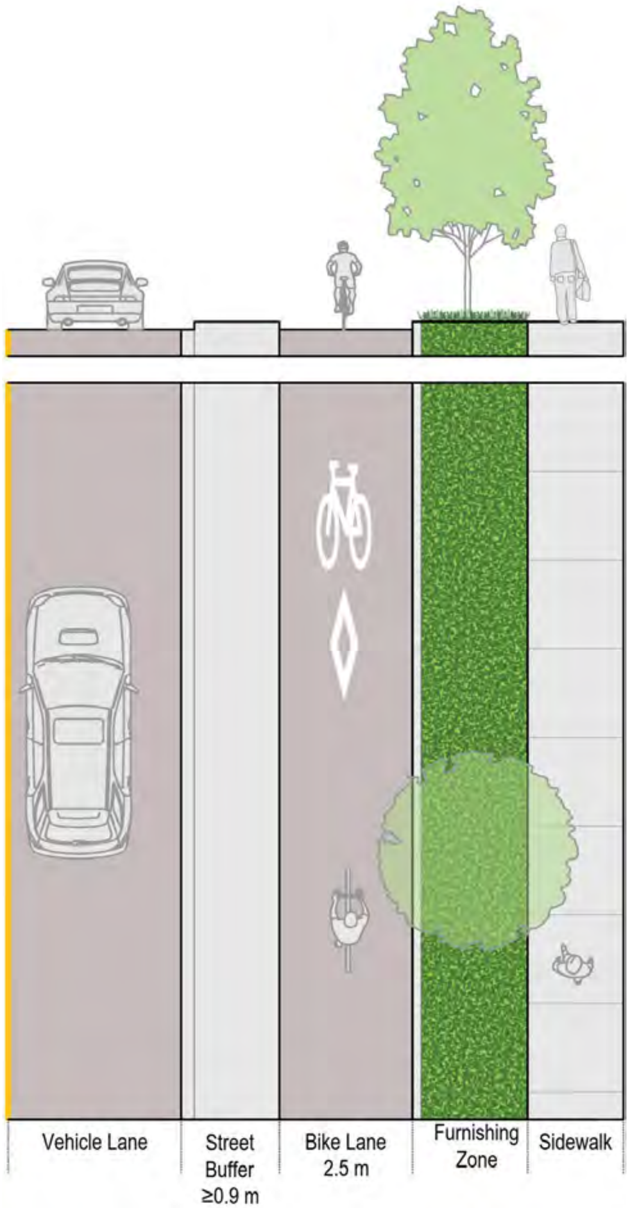


Figure D-38 // Uni-Directional Protected Bicycle Lane Cross-Section -No On-Street Parking (Desired Width)

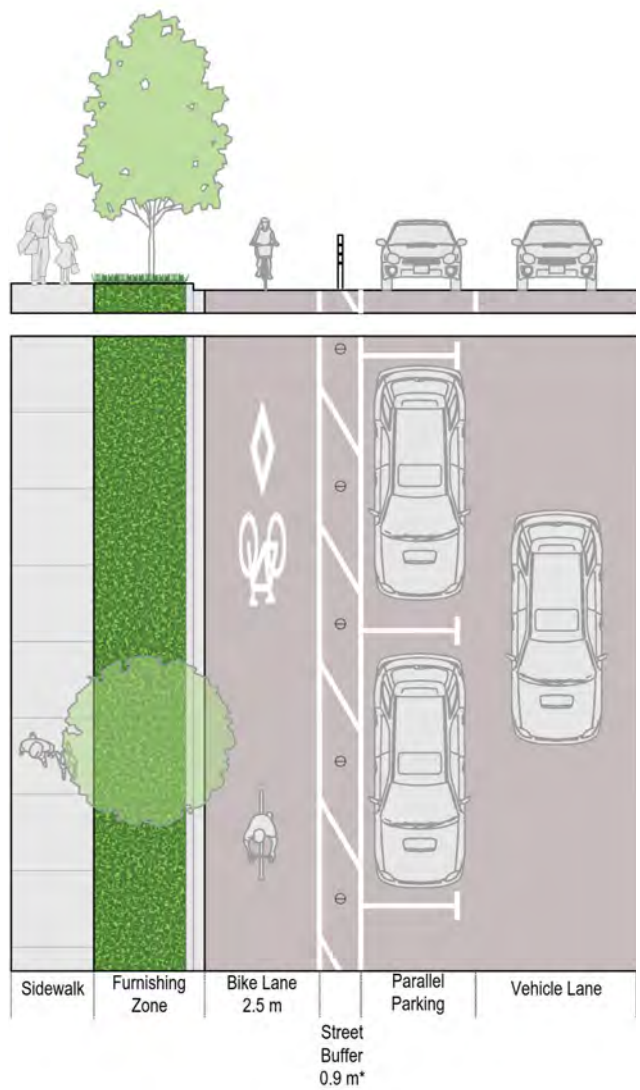


Figure D-39 // Uni-Directional Protected Bicycle Lane Cross-Section - With On-Street Parking (Desired Width)

Bi-Directional Protected Bicycle Lane

As shown in **Table D-11**, the desirable width of the Bicycle Through Zone is 4.0 metres on a bi-directional protected bicycle lane facility (2.0 metres in either direction). If bicycle volumes are expected to exceed 350 bicycles per hour, then a width of 4.5 metres is more appropriate to accommodate passing and side-by-side travel. The constrained limit width of the Bicycle Through Zone on a bi-directional protected bicycle lane is 3.0 metres. The absolute minimum width of the bicycle lane portion of a bi-directional protected bicycle lane is 2.4 metres. This would require people passing to cross into the oncoming lane. The absolute minimum should only be used for short distances (under 100 metres), and when reasonable consideration has been given to local context and confirming that maintenance equipment can navigate this reduced width.

If using the upper limits of the proposed widths, there is concern that motor vehicle drivers may confuse the bicycle lane for a motor vehicle lane. To help mitigate against motor vehicle drivers mistaking a protected bicycle lane for a motor vehicle lane, the installation of a flexible delineator can be added to the centre of the bi-directional protected bicycle lane near intersections to raise awareness of the facility. The use of the facility can then be monitored and the flexible delineator can be removed at any time, including in the winter for maintenance.

Figure D-40 shows bi-directional protected bicycle lane configurations with no on-street parking. **Figure D-41** shows bi-directional protected bicycle lane configuration with parallel on-street parking.

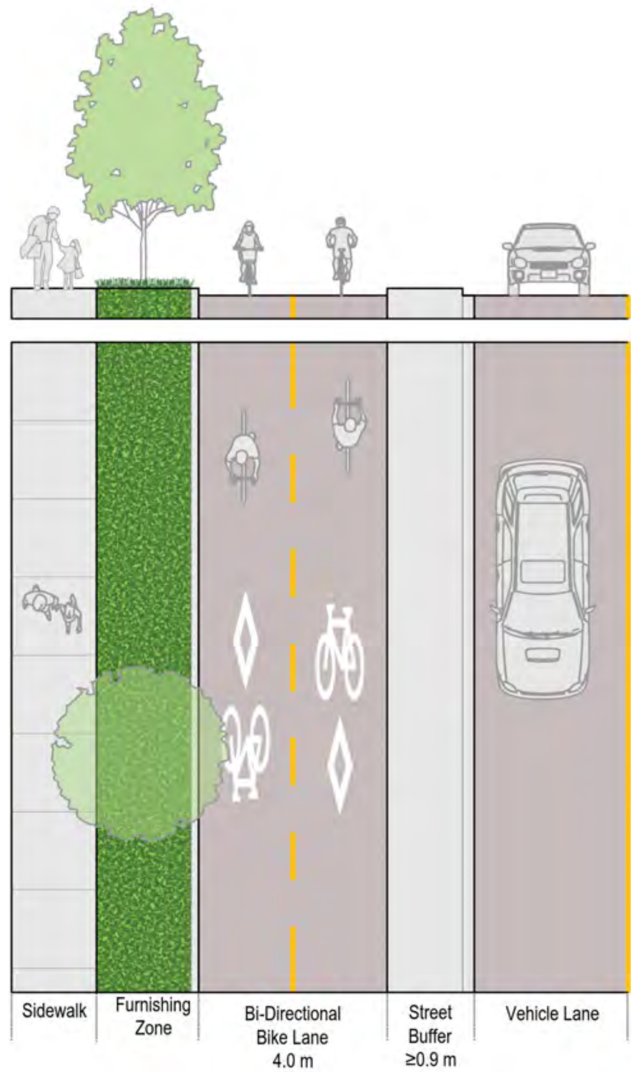


Figure D-40 // Bi-Directional Protected Bicycle Lane Cross-Section - No On-Street Parking (Desired Width)

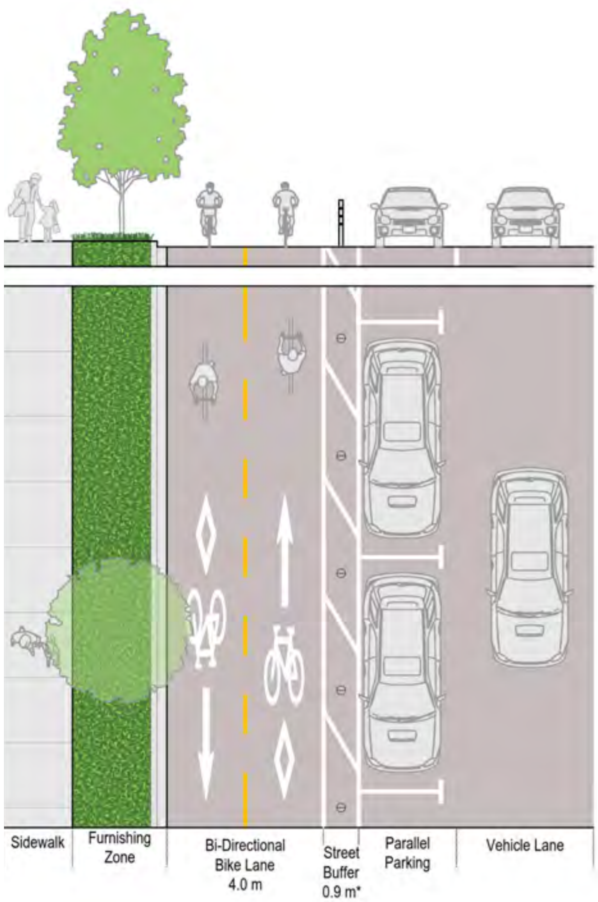


FIGURE D-41 // BI-DIRECTIONAL PROTECTED BICYCLE LANE CROSS-SECTION WITH ON-STREET PARKING (DESIRED WIDTH)

Furnishing Zone

In the context of a protected bicycle lane, the goal of the Furnishing Zone is to provide separation between people cycling in the Bicycle Through Zone and people cycling in the Pedestrian Through Zone. For full details on the Furnishing Zone in a pedestrian context, including appropriate widths, surface treatments, and amenities, refer to **Chapter C.3**.

As shown in **Table D-11**, the desirable width of buffer space between the Pedestrian Through Zone and the Bicycle Through Zone is 2.0 metres. The constrained limit width is 0.25 metres.

The Furnishing Zone also helps to distinguish between the bicycle and pedestrian facilities. Providing visual separation reduces encroachment of users, enhancing safety and comfort for all users. Separation can include placing objects in the buffer space (such as grass, trees, planters, or benches), with the use of curbs, or by using different surface materials or colours.

Providing separation between the two zones is especially relevant for universal accessibility when installing intermediate level or sidewalk level protected bicycle lanes. Specific guidance pertaining to these types of protected bicycle lanes is provided later in this chapter. TWSIs or other detectable surfaces may be installed to alert pedestrians of the protected bicycle lane's presence and guide them to a safe crossing point. See **Chapter B.3** for more details regarding TWSIs.

Street Buffer Zone

The goal of the Street Buffer Zone (between the protected bicycle lane and the road) is to provide physical separation with vertical objects between people cycling and moving, or parked motor vehicles. The width of the buffer is impacted by the use of the adjacent motor vehicle lane and whether it is a parking lane or a travel lane. Other factors that need to be considered when determining the width and materials to use for the buffer include:

- The number of travel lanes;
- Motor vehicle volumes and speeds;
- The elevation of the bicycle lane;
- Maintenance;
- Drainage;
- Existing right-of-way;
- Whether or not to include signage;
- Durability;
- Access (for emergency and service vehicles, access to parked cars);
- Cost;
- Aesthetics; and.
- Available space.

As shown **Table D-11** in the desired width of the Street Buffer Zone is 0.9 metres when it is adjacent to an on-street motor vehicle parking lane. This allows for adequate separation from parked motor vehicles and may facilitate snow storage where not adjacent to on-street parking. If the Street Buffer Zone is not adjacent to on-street motor vehicle parking, the desirable width is ≥0.9 metres. Wider buffers up to 1.8 metres improve cycling comfort, especially along multi-lane and/or higher speed roads. The wider Street Buffer Zone allows for the creation of a motor vehicle yield zone at intersections, driveways, and laneway crossings.

The constrained limit width of a Street Buffer Zone is 0.6 metres. The absolute minimum width of a Street Buffer Zone located between the protected bicycle lane and motor vehicle travel lane is 0.5 metres – the minimum necessary to accommodate standard signage on a buffer.

In addition to providing increased physical separation mid-block, the Street Buffer Zone affects cycling safety at intersections, driveways, and laneway crossings. Design guidance at intersections and crossings is provided in more detail in **Chapter G.4**.

It is important to ensure that protected bicycle lane drainage is maintained when using the Street Buffer Zone for snow storage. This can be achieved by providing gaps in snow piles at low areas. Refer to **Chapter I.3** for more detail on maintenance.

Types of Separation

The types of separation that may be used in the Street Buffer Zone are shown in **Figure D-42.** A combination of these treatments may be used along a corridor to achieve the full benefits of each separation type. The benefits of each are compared in **Table D-13**.

A raised or landscaped median provides vertical physical separation. If a raised or landscaped median is not used, then some type of vertical object within a painted buffer area is needed to provide separation. The placement of the vertical objects within the buffer should consider the need for shy distance to the protected bicycle lane and the motor vehicle lane. When placing vertical objects, preference should be given to maximizing the width of the protected bicycle lane. Additionally, sightlines should be considered when placing and choosing types of separation, especially near intersections and conflict zones.

The preferred type of protection and spacing is principally based on the posted motor vehicle speed of the adjacent roadway, as shown in **Table D-12**.

Motor Vehicle Speed and Physical Separation

Refer to the TAC *Geometric Design Guide for Canadian Roads*, Section 5.7.5 for detailed guidance on the recommended type of separation, dimensions, and spacing for the Street Buffer Zone based on the posted speed limit of the adjacent motor vehicle lane.

TABLE D-12 // PREFERRED SEPARATION ELEMENT BASED ON MOTOR VEHICLE SPEED

POSTED SPEED LIMIT	PREFERRED SPACING TYPE
50 km/h or greater	Continuous barriers offering physical protection such as a raised median
50 km/h	Intermittent vertical elements, such as flexible posts and planters are acceptable. Continuous barriers may also be considered.
Less than 50 km/h	Ability to include less physical protection due to lower adjacent motor vehicle speeds.

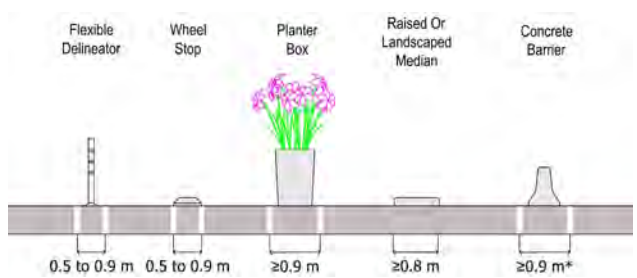


FIGURE D-42 // TYPES OF SEPARATION USED IN THE STREET BUFFER ZONE

TABLE D-13 // COMPARISON OF SEPARATION TYPES FOR STREET BUFFER ZONE

	FLEXIBLE DELINEATOR POST	WHEEL STOP	PLANTER BOX
APPROPRIATE CONTEXT	▪ Lower-speed environments; may not be appropriate for roads with posted speeds that exceed 50 km/h. ▪ Recommended treatment adjacent to motor vehicle parking to allow access.	▪ Lower-speed environments; may not be appropriate for roads with posted speeds that exceed 50 km/h.	▪ Lower-speed environments; planter boxes with periodic or intermittent spacing are not appropriate on roads with posted speeds of 50 km/h or greater. ▪ If planter boxes are used on roads with posted speeds of 50 km/h or greater, they should be constructed of a durable material and should not be periodic or intermittently spaced unless they are placed on top of a concrete median or adjacent to a median or curb to provide continuous physical protection. ▪ If they are used on roads where operating speeds are different from posted speeds, the design should be adjusted accordingly.
COST	▪ Lowest initial capital cost but may need routine replacement, resulting in higher long-term costs.	▪ Low cost.	▪ High cost, including ongoing maintenance for re-positioning and possible seasonal removal.
DESIGN FLEXIBILITY	▪ Easily removed and relocated.	▪ Easily removed and relocated.	▪ Easily removed and relocated. ▪ Can be used on a seasonal basis (removed in the winter). ▪ If they are used on roads with posted speeds of 50 km/h or less, there is more flexibility in their design.
DESIGN NOTES	▪ Small footprint compatible with a range of buffer designs. ▪ Should be combined with buffered bicycle lane pavement markings. ▪ Allows drainage and snow storage. ▪ Appearance is less 'permanent' than other forms, and may be less aesthetically pleasing.	▪ Can be used in narrower buffers than other types of separation. ▪ Must be pinned down. ▪ Consider use of end treatments such as mini-barrier noses. ▪ Must have vertical element at least at the start when adjacent to traffic; may need additional vertical elements to enhance visibility, particularly during winter months.	▪ Can add to the aesthetics and enjoyment of the facility. ▪ Planters with intermittent spacing that are not separated from adjacent motor vehicle lanes should consider clear zone . ▪ Should have reflective markings or be signed.
DURABILITY	▪ Low durability.	▪ High durability.	▪ Relatively high durability; depends on material used.

	FLEXIBLE DELINEATOR POST	WHEEL STOP	PLANTER BOX
PROTECTION	▪ May increase user comfort, but does not offer physical protection.	▪ Can be used to provide continuous protection, but low height provides less protection than other types of separation.	▪ Moderate to high degree of protection, depending on spacing and material used. ▪ The face of the planter exposed to traffic may be rounded to better absorb the energy of an impact. The planter should not be anchored to the pavement and should have sufficient mass to absorb the energy of an impact without significant deflection.
MAINTENANCE	▪ Can be impacted if buffer space is used for snow storage. ▪ Susceptible to damage and may need to be frequently replaced.	▪ Low maintenance requirements.	▪ High maintenance requirements; likely to require ongoing care and landscaping.
SIGHTLINES	▪ Minimal impacts.	▪ Minimal impacts.	▪ Need to ensure they do not restrict clear zone requirements and sightlines, particularly on roads with higher motor vehicle speeds.
SPACING	▪ Spaced 3.0 to 6.0 metres apart. ▪ Spacing may be dependent on factors such as parking and loading encroachment. ▪ Generally placed in the middle of the buffer area but may be positioned to one side or the other as site conditions dictate.	▪ May be spaced closer to create a continuous barrier. ▪ If spaced apart, spacing should be even along the corridor. Spaced 2.5 metres to 3.5 metres apart.	▪ May be spaced closer to create a continuous barrier. ▪ If spaced apart, spacing should be even along the corridor.

	CONCRETE BARRIER	RAISED OR LANDSCAPED MEDIAN	PARKING LANE
APPROPRIATE CONTEXT	▪ Recommended for locations where more physical protection from motor vehicles is needed, such as on bridges with high-speed traffic. ▪ Should not be used with on-street parking.	▪ Recommended for locations where more physical protection from motor vehicles is needed; for example, on bridges with high-speed traffic.	▪ Where on-street parking exists, the protected bicycle lane can be placed between the parking and the sidewalk.
COST	▪ Relatively low initial capital cost compared to other types of separation.	▪ Higher initial capital cost, but requires less long-term maintenance than other types of separation.	▪ Low cost, plus the cost of any additional separation elements.

	CONCRETE BARRIER	RAISED OR LANDSCAPED MEDIAN	PARKING LANE
DESIGN FLEXIBILITY	■ Relatively low flexibility.	■ Relatively low flexibility.	■ Relatively low flexibility.
DESIGN NOTES	■ Intended to provide continuous vertical separation. ■ On higher speed roads, crash cushions should be included at barrier ends. ■ Less aesthetically pleasing than other types of separation.	■ Intended to provide continuous vertical separation. ■ On higher speed roads, crash cushions should be included at barrier ends. ■ Less aesthetically pleasing than other types of separation.	■ Intended to provide continuous vertical separation
DURABILITY	■ High durability.	■ High durability.	■ Depends on type of additional separation used.
PROTECTION	■ Provide a high degree of separation and physical protection from motor vehicles.	■ Can provide a continuous curb separation from motor vehicles, though may include gaps or inlets for channelizing stormwater towards existing catch basins in retrofit facilities.	■ Parked motor vehicles provide a vertical separation that adds protection only when present. Risk of dooring if insufficient buffer is not included. When parking spots are not in use, a horizontal separation is present. Additional vertical separation elements should be used to provide protection when parking spots are not in use and allow visibility of curbs for winter maintenance.
MAINTENANCE	■ Low maintenance requirements.	■ Low maintenance requirements.	■ Low maintenance requirements; and is the same as normal on-street parking conditions.
SIGHTLINES	■ Minimal impacts	■ Need to ensure they do not restrict clear zone requirements and sightlines, particularly on roads with higher motor vehicle speeds.	■ Parking should be discontinued before intersection and driveways to provide adequate sightlines.
SPACING	■ Continuous, with breaks for emergency access as needed.	■ Continuous, with breaks for emergency access as needed.	■ N/A

PROTECTED BICYCLE LANE COMPONENTS

There are several possible configurations of protected bicycle lanes that can be implemented based on the characteristics of the road. The four components to be considered when determining the potential configuration of a protected bicycle lane are as follows:

- Travel Direction: Will the protected bicycle lane be one-way in the direction of motorized travel, one-way in a contraflow direction to motorized travel, or two-way?
- Placement: Will the protected bicycle lane be placed on the left and/or right side of the road?
- Elevation: Is the protected bicycle lane going to be placed at street level, sidewalk level, or an intermediate level in between the two?
- Type of Separation: The type, dimensions, and spacing of separating elements such as flexible delineators, raised medians, and other forms of separation.

These four main components are discussed in detail on the following pages. Travel direction, location, and elevation are independent subsections, while the various types of separation were discussed in the Design Guidance subsection above.

Travel Direction

Protected bicycle lanes can be either uni-directional (one-way) or bi-directional (two-way) and can be located on one-way or two-way roads for motor vehicle traffic. The decision to build a uni-directional or bi-directional protected bicycle lane should be influenced by the following:

- The direction of motor vehicle travel;
- Whether motor vehicle turning movements are permitted at intersections;
- The number of driveways and other potential interruptions or conflicts; and
- Connectivity to the rest of the bicycle network.

The following subsections describe the key considerations behind uni-directional and bi-directional protected bicycle lanes.

Uni-Directional

Uni-directional protected bicycle lanes provide a protected bicycle lane on one or both sides of the road in the direction of motorized vehicle travel. Uni-directional protected bicycle lanes in the direction of motorized travel are generally the preferred option to integrate bicycle facilities into the existing operation of the road. This configuration can simplify movements at intersections and provides intuitive and direct connections with the surrounding transportation network, including similar transitions to existing bicycle lanes and shared travel lanes.

Some of the key considerations with uni-directional protected bicycle lanes include:

- Uni-directional protected bicycle lanes provide access to both sides of the road. However, this can result in incidents of people cycling in the wrong direction on a one-way road along uni-directional bicycle lanes.
- Conflict points along corridors with uni-directional protected bicycle lanes can be more predictable when compared to bi-directional facilities. This is because when people are cycling in the same direction as motor vehicles, it is easier for motorists to anticipate their movements. Bi-directional facilities have sometimes been found to have higher collision rates than uni-directional facilities when comparing collisions between motorists and people cycling travelling in a contraflow direction.

- With uni-directional protected bicycle lanes, there may be less need for dedicated bicycle signals or adjusting signal phasing, depending on the number of turning motor vehicles.

Bi-Directional

In some situations, uni-directional protected bicycle lanes may not be practical or desirable. Bi-directional protected bicycle lanes may be considered on constrained corridors where there is insufficient space for a pair of uni-directional protected bicycle lanes, or on one-way roads. Some of the key considerations associated with bi-directional protected bicycle lanes include:

- Limited access to destinations on the other side of the road may result in sidewalk cycling and potential conflicts with people walking.
- Contraflow movements for people cycling through traffic signals may be less efficient (waiting for red lights at most intersections). This can lead to user frustration, red light running, and/or people concentrating on making the light and not focusing on potential safety issues. There may be increased delay for other road users as well.
- People walking and motor vehicle drivers who are turning may not expect to see people cycling in the contraflow direction. This can increase collision risk, particularly at intersections, laneways, and driveways where drivers and pedestrians fail to look for people cycling approaching from the contraflow direction.
- Contraflow movements require special attention at intersections, driveways, and other conflict points, as pedestrians and motorists may not anticipate contraflow bicycle movements. Providing a bi-directional protected bicycle lane on a two-way road introduces contraflow movement which can be challenging to accommodate. The same challenge can occur when providing a bi-directional protected bicycle lane on a one-way road.
- Challenges when bicycle facilities terminate and ensuring that people cycling in the contraflow direction re-enter traffic in the correct direction.

When choosing between uni-directional and bi-directional protected bicycle lanes, the challenges associated with travel direction need to be weighed against the connectivity benefits. A bi-directional protected bicycle lane on a road with two-way motor vehicle traffic introduces additional conflict points at intersections. Section 5.3.1.2 of the TAC *Geometric Design Guide for Canadian Roads* notes that, along wide roads with long block lengths and intensive land use, bi-directional protected bicycle lanes can provide people cycling with more direct route choices by eliminating the need to cross the road in order to travel in the opposing direction. However, this would only be applicable if there were bi-directional lanes on both sides of the road, or if only one side of the road had land uses with destinations.

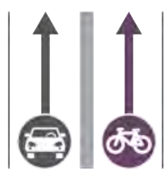
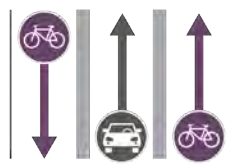
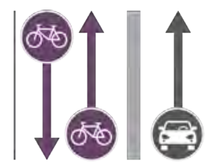
When implementing bi-directional bicycle facilities on two-way roads, additional measures to protect the bicycle movements at intersections, such as signal phasing and geometric treatments, need to be addressed to mitigate the additional conflict with motor vehicles turning. Refer to **Chapter G.4** for details on intersection treatments.

One-Way vs Two-Way Roads

Protected bicycle lanes can be installed on one- and two-way roads. **Table D-14** and **D-15** will provide an overview of the typical configurations of uni-directional and bi-directional protected bicycle lanes on one- and two-way roads, along with a summary of associated considerations.

TABLE D-14 // PROTECTED BICYCLE LANE CONFIGURATIONS ON ONE-WAY ROADS

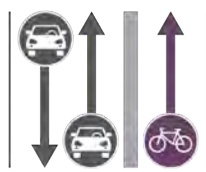
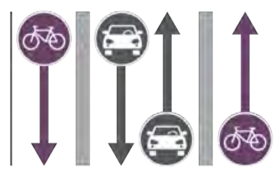
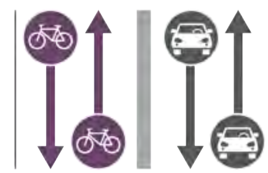
Source: Adapted from MassDot Separated Bike Lane Planning & Design Guide

	ONE-WAY PROTECTED BICYCLE LANE* 	**ONE-WAY PROTECTED BICYCLE LANE PLUS CONTRAFLOW PROTECTED BICYCLE LANE** 	**TWO-WAY PROTECTED BICYCLE LANE*** 
ACCESS TO DESTINATIONS	Provides bicycle access to only one side of the road.	Provides full access for people cycling to both sides of the road.	Provides bicycle access to only one side of the road.
NETWORK CONNECTIVITY	Does not address contraflow travel and may result in wrong way cycling.	Accommodates two-way bicycle travel, though contraflow travel through signals may be impacted by signal timing.	Accommodates two-way bicycle travel, though contraflow travel through signals may be impacted by signal timing.
CONFLICT POINTS	Has fewer conflict points when compared to other configurations, as people will be cycling the same direction as motor vehicle traffic.	Other road users may not anticipate people cycling in the contraflow direction.	Other road users may not anticipate people cycling in the contraflow direction.
INTERSECTION OPERATIONS	Can often make use of existing signals and phasing, although separate bicycle signals may be required depending on motor vehicle volumes and conflicts.	Will require additional signal equipment for the contraflow bicycle lane.	Will require additional signal equipment for the contraflow bicycle lane.
IMPACT	Requires less width when compared to the other configurations.	Requires more width and impacts both sides of the road.	Requires more width when compared to the uni-directional configuration on one side.

*An additional consideration for this configuration is the choice of which side of the road to place the protected bicycle lane. See page D49 for more information.

TABLE D-15 // PROTECTED BICYCLE LANE CONFIGURATIONS ON TWO-WAY ROADS

Source: Adapted from MassDot Separated Bike Lane Planning & Design Guide

	ONE-WAY PROTECTED BICYCLE LANE ON ONE SIDE OF THE ROAD 	**ONE-WAY PROTECTED BICYCLE LANE ON EACH SIDE OF THE ROAD** 	**TWO-WAY PROTECTED BICYCLE LANE** 
ACCESS TO DESTINATIONS	Provides bicycle access to only one side of the road.	Provides full access to both sides of the road.	Provides bicycle access to only one side of the road.
NETWORK CONNECTIVITY	Does not address contraflow travel and may result in wrong way cycling.	Accommodates two-way bicycle travel.	Accommodates two-way bicycle travel, though contraflow travel through signals may be impacted by signal timing.
CONFLICT POINTS	If bicycles and motor vehicles are travelling in the same direction directly adjacent to each other, the number of conflicts may be reduced as travel behaviour is more predictable; however, turning movements yielding to bicycles remains the primary conflict; as a result, parking should be restricted close to intersections to ensure sightlines are unobstructed.	As bicycles and motor vehicles are travelling in the same direction, the number of conflicts may be reduced as travel behaviour is more predictable; however, turning movements yielding to bicycles remains the primary conflict, as a result, parking should be restricted close to intersections to ensure sightlines are unobstructed.	There is significant potential for conflict between turning motor vehicles and bicycles. Traffic signalization is recommended to mitigate this risk. Conflicting movements should be prohibited by providing separate signal phases for bicycle users and turning motor vehicles. If this is not possible, conflicts should be mitigated with clear signage and pavement markings indicating right-of-way. This should only be considered for short segments or where there is limited to no access or driveways
INTERSECTION OPERATIONS	Can likely make use of existing signals and phasing.	Can likely make use of existing signals and phasing.	Typically requires additional signal equipment for the contraflow bicycle lane.
IMPACT	Requires less width when compared to the other configurations.	Requires more width and impacts both sides of the road	Requires more width when compared to the uni-directional configuration on one side.

Placement

On one-way roads with bi-directional protected bicycle lanes or uni-directional protected bicycle lanes only on one side of the road, placement is an important consideration. Protected bicycle lanes on the right or left side of the road can be considered. There is ongoing research regarding which side of the road uni-directional and bi-directional protected bicycle lanes should be located on.

The following includes some of the considerations for the placement of protected bicycle lanes on the right or left side of the road.

Left Side of the Road

- Bicycles and motor vehicles that are directly adjacent to one another are moving in the same direction;
- Avoids conflicts with transit vehicles and bus stops;
- Directional dividing line is to the left of all motor vehicle traffic;
- Bicycles are located on the motorist side of the motor vehicle, which may make them more visible to the motorist; and
- Additional treatments to increase awareness and visibility should be considered.

Right Side of the Road

- Road users are more familiar with slower road users, including bicycles, being located on their right side;
- Motor vehicle is directly adjacent to oncoming bicycle traffic, which may help increase visibility of bicycle users in the opposing direction; and
- When travelling in the same direction, at an intersection, there is greater lateral distance between the person cycling in the protected bicycle lane and a motorist. This may reduce awareness of bicycles travelling in the same direction as motor vehicles. However, this can also give the motorist more time to become aware of people cycling and can improve the sightline angle.

Elevation

A protected bicycle lane may be configured with a height difference between the protected bicycle lane and the motor vehicle lane, and/or between the protected bicycle lane and the sidewalk. The elevation of the protected bicycle lane may vary along a corridor and can incorporate design features such as bicycle transition ramps and raising the bicycle lane as needed at pedestrian crossings, bus stops, and intersections. The number of elevation changes is important to consider along a corridor, as too many ups and downs can result in an uncomfortable cycling experience. In most cases, the decision regarding elevation is based on physical constraints and feasibility.

There are three general protected bicycle lane elevation options, each with their own factors to consider. In each option, a catch basin is required at the low point and an inlet or cut out may be required in the median to facilitate drainage.

Bi-directional protected bicycle lane, Victoria, B.C.

Sidewalk Level Protected Bicycle Lanes

Sidewalk level protected bicycle lanes are typically separated from the road by a standard vertical curb and buffer in the Street Buffer Zone (see **Figure D-43**). In constrained circumstances, the Street Buffer Zone may not be provided (see **Figure D-44**). This facility type may be considered when the road right-of-way is constrained and there is limited space for a buffer. In an urban environment, a sidewalk level protected bicycle lane is commonly located alongside a parallel pedestrian facility. This type of protected bicycle lane and sidewalk together may be considered similar to a multi-use pathway segregated by user type, depending on intersection treatments. This facility may offer maintenance benefits if pathways and sidewalks are cleared by the local jurisdiction, particularly for snow clearing requirements and improved accessibility.

Figure D-43 // Sidewalk Level Protected Bicycle Lanes (with Street Buffer Zone)

Figure D-44 // Sidewalk Level Protected Bicycle Lanes (without Street Buffer Zone)

Intermediate Level Protected Bicycle Lanes

Intermediate level protected bicycle lanes can be built at any elevation between the sidewalk and the road (see **Figure D-45**). Similar to sidewalk level protected bicycle lanes, they are typically separated from the road by a standard vertical curb. The bicycle lane is typically raised between one-half and the full height of the curb. More details about the width of the buffer between the road and the bicycle lane and the type of treatment we discussed previously in this chapter. Providing vertical separation between people walking and cycling is the primary consideration for separated bicycle lane elevation. A separated bicycle lane flush with the sidewalk may encourage encroachment by people walking and cycling unless discouraged with a continuous sidewalk buffer. A change in elevation provides a detectable edge for the visually impaired. The change in elevation should be a minimum of 50 millimetres between the sidewalk and the protected bicycle lane.

Intermediate level protected bicycle lanes may present snow clearing challenges in B.C. communities with a winter climate, as this configuration does not allow the protected bicycle lane to be cleared as part of the sidewalk or the road and may result in additional operational resources and costs. However, there may be specific circumstances where they are still worth considering, including urban areas near transit stops and areas frequently accessed by people with visual disabilities.

Figure D-45 // Intermediate Level Protected Bicycle Lanes

Street Level Protected Bicycle Lanes

Street level protected bicycle lanes are built at the same level as the road (see **Figure D-46**). These commonly occur in retrofit scenarios where protected buffers are added to the existing road, creating a protected bicycle lane. They can be separated from the motor vehicle lane by a range of vertical separation measures, as described on page D39). Street level protected bicycle lanes also offer effective separation between people walking and cycling. As with intermediate level protected bicycle lanes, maintenance may be more difficult because the protected bicycle lane is not at the same level as the sidewalk and they are separated from adjacent travel lanes (and hence road maintenance equipment) by a vertical barrier. However, the relative ease with which protected bicycle lanes can be added to roads using this method makes road level protected bicycle lanes an important facility type for retrofit situations.

Figure D-46 // Street Level Protected Bicycle Lanes

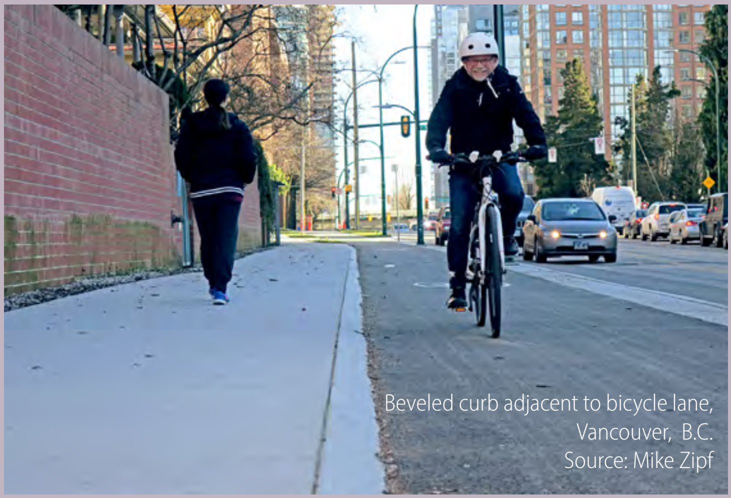
Intermediate Level Protected Bicycle Lane Accessibility Considerations

Protected bicycle lanes introduce a new path of travel alongside the sidewalk. For people with vision impairments, it may be difficult or impossible to detect the presence of a protected bicycle lane, particularly when the protected bicycle lane is at sidewalk level or intermediate level (between the sidewalk and road). Pedestrians may inadvertently step into and walk along the protected bicycle lane without realizing they have done so, creating a risk of collisions between people cycling and people walking.

Sidewalk level and intermediate level protected bicycle lanes should include a detectable edge so people with limited vision can distinguish between the protected bicycle lane and the sidewalk. Where sufficient space is available, a strip of grass (e.g., softscape) provides a clear differentiation between the two facilities. However, in constrained environments, there may not be enough space to provide this strip of softscape, so a detectable edge or curb should be used.

One advantage of an intermediate level protected bicycle lane is that the vertical delineation between the sidewalk and bicycle lane provides a detectable edge between the two facilities. This scenario applies when no horizontal separation exists between the sidewalk and the bicycle facility. This configuration may present challenges for snow clearing but it has great advantages for accessibility.

The City of Vancouver has worked with the accessibility community to test out different types of separation and it was found that a curb ratio of 1V:3H (50 millimetres tall by 150 millimetres wide) is both detectable by people with visual impairments using a cane and is also safe for wheelchair users, allowing them to enter and exit the bicycle lane when needed. This is the preferred treatment when designing intermediate level protected bicycle lanes



Beveled curb adjacent to bicycle lane, Vancouver, B.C.
Source: Mike Zipf

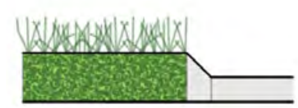
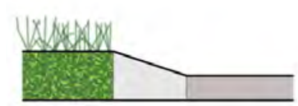
Curbs

The angle of the curb has an impact on the ease of encroachment of users and on potential pedal hazards. Three common curb types are presented below.

The curb height also impacts the safety and comfort of the bicycle facility. Curbs can be constructed at heights between 50 millimetres and 150 millimetres. Shorter curbs (50 millimetres to 75 millimetres) eliminate the risk of pedal strike, which increases the usable bicycle lane width by permitting people to safely ride closer to the edge of the protected bicycle lane. They are recommended at curbs adjacent to the protected bicycle lane and are also recommended at locations where bicycles are encouraged to exit the protected bicycle lane, such as along commercial roads to ease access onto the sidewalk. Mountable curb designs have generally been found to be detectable by people who are visually impaired.

Where taller curbs are required for drainage purposes, a beveled curb is recommended. Taller curbs help to discourage encroachment by motor vehicles and are recommended adjacent to motor vehicle travel lanes and on roads with on-street parking.

Further discussion on the maintenance considerations of different types of curbs is included in **Chapter I.3**.

CURBS		
Vertical Curb	Vertical curbs are designed to prohibit encroachment by motor vehicles or bicycles; however, they can create a hazard for pedals, particularly where the bicycle lane width is closer to the lower limit.	
Beveled Curb **(1V:1H)**	A beveled curb (1V:1H) is angled to reduce pedal strike hazards and is most often used at locations where the bicycle lane is narrow. Consideration should be taken when used to separate the bicycle lane with the sidewalk and/or sidewalk buffer; while easier for pedestrians to navigate than vertical curbs, beveled curbs may present a tripping hazard for people who are mobility or visually impaired.	
Mountable Curb **(1V:3H)**	Mountable curbs (1V:3H) are designed to be encroached on by motor vehicles and bicycles. Compared to the curb types above, they are more forgiving for bicycles that are travelling over them and provide a slight change in elevation to inform pedestrians they are entering the bicycle lane, but are gentle enough to avoid being a tripping hazard. They do, however, consume more cross-section width.	

SIGNAGE

The Reserved Bicycle Lane sign (MUTCDC RB-90, RB-91) should be installed along protected bicycle lanes. The Reserved Bicycle Lane Ends sign (MUTCDC RB-92) should be installed at the end of the reserved lane denoting the end of the protected bicycle lane.

For uni-directional protected bicycle lanes, additional signage at each entry to the protected bicycle lane can be installed to deter wrong way travel. The signage should be facing the wrong way travel, and can include Entry Prohibited signs(MUTCDC RB-23; B.C. R-009-1 Series or B.C. R-009-2 Series) or Wrong Way signs (MUTCDC RB-22; B.C. R-009-3 Series) signs. Installation of these signs should only be used if wrong way riding has been observed or if there is a likelihood that the facility would be used incorrectly; otherwise this could lead to unnecessary sign clutter.

More information on the placement and spacing of the Reserved Bicycle Lane sign and supplementary signs is provided in **Appendix B.**

PAVEMENT MARKINGS

Protected bicycle lanes should include the Bicycle symbol and Reserved Use diamond symbol. The Bicycle symbol should point in the direction of travel with the diamond below it, and should be placed at each approach to all crossings. These symbols may be supplemented by directional arrow markings to denote the protected bicycle lane movement and to deter wrong way riding.

Green pavement markings should be reserved for conflict points, including driveways and intersections, as well as bike boxes and two-stage turn boxes (see **Chapter G.4**). For bi-directional facilities, additional pavement marking is recommended to enhance awareness for motorists that there is two-way travel on the facility.

Bi-directional protected bicycle lanes should have directional dividing lines that are dashed to indicate where passing is permitted, and solid to indicate where passing is undesirable.

Additional guidance on pavement markings at intersections and crossings is provided in **Chapter G.4**.

Additional guidance on pavement marking details such as dimensions, placement, and spacing is provided in **Appendix B**. Guidance regarding pavement marking maintenance is provided in **Chapter I.3**.

Uni-Directional protected bicycle lane, Vancouver, B.C.
Source: Victor Wang

Buffered bicycle lane, District of Saanich, B.C.

D.4

PAINTED + BUFFERED BICYCLE LANES

Painted and buffered bicycle lanes are separate travel lanes designated for the exclusive use of people cycling. Other active users such as skateboarders and in-line skaters may also be permitted to use bicycle lanes depending on local bylaws. In most cases, bicycle lanes are located on the right side of the road adjacent to the curb or a parking lane.

Bicycle lanes define the road space for bicycle users and motorists, which helps to facilitate predictable behaviours and orderly movements between road users. As a result, bicycle lanes encourage motorists to stay out of the cyclists' path and discourage cyclists from riding on the sidewalk.

Bicycle lanes are different from protected bicycle lanes (described in **Chapter D.3**) as they do not provide physical separation between bicycle users and motor vehicles. A bicycle lane is also different from bicycle accessible shoulder (described in **Chapter D.6**) because bicycle lanes are reserved for the exclusive use of people cycling.

DESCRIPTION

Bicycle traffic in a bicycle lane is typically one way with bicycle users travelling in the same direction as the adjacent motor vehicle lane. In some cases, bicycle lanes can be configured in a contraflow direction on one-way roads to improve connectivity for bicycle users. Contraflow bicycle lanes are generally used on urban roads with moderate motor vehicle volumes and speeds.

Bicycle lanes are identified by signage and pavement markings, including solid longitudinal lines and bicycle and reserved lane diamond symbol pavement markings, placed at regular intervals. A dashed longitudinal line is used at locations where motor vehicle traffic can cross the bicycle lane, typically to accommodate motor vehicle turning movements.

There are several possible bicycle lane configurations that are generally categorized based on their placement across the width of road and whether they have buffers with the adjacent lanes. The configurations discussed in this chapter include:

- Curbside bicycle lanes;
- Parking adjacent bicycle lanes;
- Left side bicycle lanes; and
- Contraflow bicycle lanes.

Buffered vs. Unbuffered Bicycle Lanes

Bicycle lanes can be unbuffered or buffered:

- An **Unbuffered Bicycle Lane** includes only a white longitudinal line running parallel to the alignment of the road to visually separate the bicycle lane from the motor vehicle and/or parking lanes.
- A **Buffered Bicycle Lane** provides additional separation between the bicycle lane and the motor vehicle travel lane and/or parking lane by way of an additional white longitudinal line that runs parallel to the bicycle lane. Depending on the width of the buffer space, the buffer space can be defined with additional markings such as hatched striping. A buffer may be used to visually narrow the bicycle lane width to reduce the perception that a wider bicycle lane may be used as a motor vehicle parking or travel lane.

Bicycle Lanes Adjacent to On-Street Parking

In many North American communities, bicycle lanes have been provided between motor vehicle lanes and on-street parking lanes (referred to as parking adjacent bicycle lanes). Research has shown that parking adjacent bicycle lanes are one of the least comfortable, least preferred, and least safe types of bicycle facilities among all users. In fact, research from the Cycling in Cities Program at the University of British Columbia has found that parking adjacent bicycle lanes are not safer than no cycling infrastructure.[1,2] Parking adjacent bicycle lanes present the following issues:

- They present additional conflict points for bicycle users;
- They have a greater risk of 'dooring' as all vehicles have a driver, but many do not have a passenger;
- Should a person cycling get 'doored' or have to enter the travel lane to avoid 'dooring,' they risk serious injury in a collision with a moving motor vehicle; and
- They are often blocked by delivery vehicles, taxis, and other private vehicles.

Design professionals are reminded that the provision of on-street parking should not be prioritized over cycling safety.

The recommended practice is to avoid the use of parking adjacent bicycle lanes. If bicycle facilities are recommended on a street with on-street parking, the following mitigation measures should be considered (in order of priority):

1. Remove on-street parking.
2. If on-street parking cannot be removed, provide a parking protected bicycle lane (see **Chapter D.3**);
3. If a parking protected bicycle lane cannot be provided, provide a buffered bicycle lane, with a sufficient buffer width between parked motor vehicles and the bicycle lane; or
4. If a buffered bicycle lane cannot be provided, consider another corridor or facility type.

The use of parking adjacent bicycle lanes without a buffer is not recommended in the Design Guide.

1. Meghan Winters and Kay Teschke, Route Preferences among Adults in the Near Market for Bicycling: Findings of the Cycling in Cities Study (American Journal of Health Promotion, 2010).

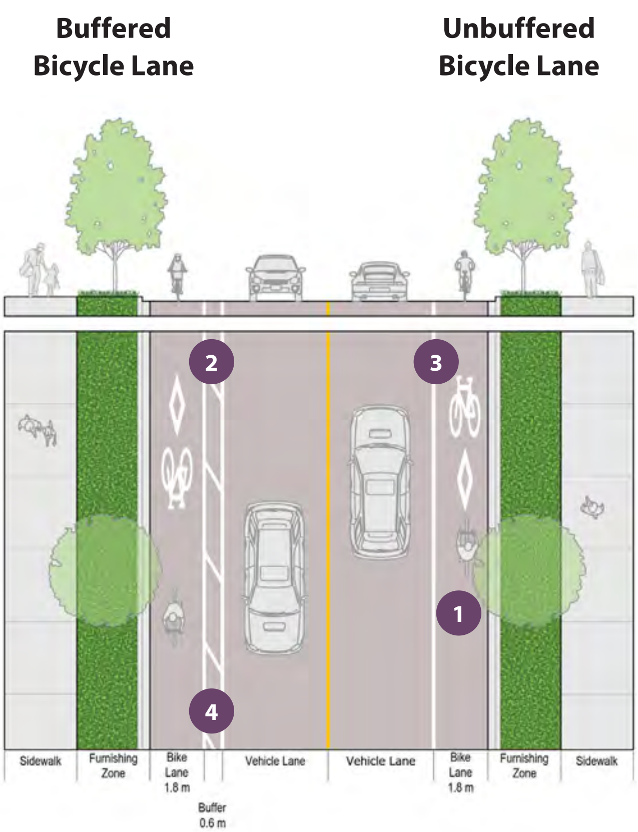
2. Kay Teschke et al., Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study (American Journal of Public Health, 2012).

DESIGN GUIDANCE

This section provides geometric design guidance for the different types of bicycle lanes. More detailed design guidance on bicycle lane treatment at intersections, transitions, and crossings is provided in **Chapter G.4**.

Curbside Bicycle Lanes

Figure D-47 and **Table D-16** provide design guidance for unbuffered and buffered curbside bicycle lanes. Detailed guidance is provided on page D60.



1. *Desirable width of 1.8 metres*
2. *For widths greater than 1.8 metres, provide buffer between motor vehicle travel lane and bicycle lane.*
3. *100-200 mm solid white longitudinal line*
4. *If buffer space is provided, diagonal hatch markings can be provided for buffers of at least 0.6 metres*

Figure D-47 // Curbside Bicycle Lane Cross-Section - Desired Widths and Key Features

Table D-16 // Curbside Bicycle Lane Width Guidance

FACILITY	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Curbside bicycle lane	1.8*	1.5**
*****Buffer** (between bicycle lane & motor vehicle lane)	0.6	0.3

*For any width greater than 1.8 metres, a buffer should be provided to avoid the bicycle lane being mistaken or used for other purposes, such as parking or motor vehicle travel.

**The absolute minimum width of an unbuffered curbside bicycle lane is 1.2 metres. A bicycle lane width between 1.2 metres and 1.5 metres should only be considered for short distances (less than 100 metres), in constrained areas, and when reasonable consideration has been given to an alternate design.

*** Where motor vehicles speeds are 50 km/h or greater, adding a buffer is strongly recommended.

Unbuffered Curbside Bicycle Lanes

In this application, the bicycle lane is located on the right side of the road between the curb and an adjacent vehicle travel lane, where bicycle users and motorists are travelling in the same direction, and where on-street parking is not provided. The bicycle lane is visually separated from adjacent motor vehicle lanes with a solid white longitudinal line running parallel to the alignment of the road .

The desirable width of an unbuffered curbside bicycle lane is 1.8 metres. This provides sufficient width for single file bicycle traffic with some visual separation from motor vehicle lanes and to avoid any obstacles in the roadway. This width also accommodates a wider variety of bicycle types such as those pulling trailers and cargo bikes. The maximum recommended width of an unbuffered curbside bicycle lane is 1.8 metres; if the bicycle lane is wider than this, it may encourage motor vehicle drivers to use the lane by mistakenly considering it as another motor vehicle lane or a parking lane. A buffered bicycle lane should be provided where more than 1.8 metres width is available.

The constrained limit width of an unbuffered curbside bicycle lane is 1.5 metres. If the bicycle lane is narrower than 1.5 metres, it loses much of its capability to provide separation between bicycles and adjacent motor vehicles.

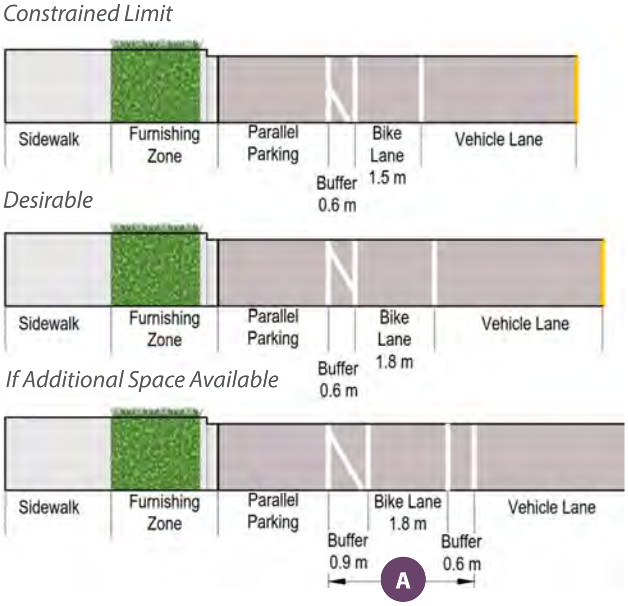
Widths of less than 1.5 metres should only be provided in exceptional circumstances and require justification through a design exception in accordance with the TAC *Geometric Design Guide for Canadian Roads*. The absolute minimum width of an unbuffered curbside bicycle lane is 1.2 metres based on the horizontal operating envelope of a person cycling. This minimum reflects the additional width provided by the gutter pan with curbside bicycle lanes. Further, a bicycle lane width between 1.2 metres and 1.5 metres should only be considered for short distances, in constrained areas, and when reasonable consideration has been given.

Buffered Curbside Bicycle Lanes

The additional width provided by a buffered curbside bicycle lane is desirable to accommodate bicycle passing movements and to provide additional space between bicycles and moving motor vehicles. A curbside bicycle lane should include a buffer where motor vehicle speeds are 50 km/h or greater and bicycle volumes are greater than 1,500 bicycles per day, or where space is available.

A buffer can also be added to provide additional separation between people cycling and motor vehicles. The desired buffer width is 0.6 metres. In constrained situations, the buffer can be 0.3 metres wide. The maximum width of a buffer is 0.9 metres; if at least 0.9 metres of additional space is available, a protected bicycle lane should be considered instead. Wider buffers (greater than 0.6 metres) may be enhanced with additional hatch markings.

Additional information on bicycle lane pavement markings including hatching dimensions is provided in **Appendix B**.



A *Consider adding a buffer next to the vehicle lane or implementing a protected bicycle lane if extra space is available.*

FIGURE D-48 // BUFFER SPACE OPTIONS FOR BICYCLE LANE ADJACENT TO PARALLEL PARKING

Parking Adjacent Bicycle Lanes

Design professionals should carefully consider user comfort and safety risks prior to designing a bicycle lane adjacent to motor vehicle parking (see Research Note). In the event that this facility type is chosen, the design guidance below should be considered.

A buffer is strongly recommended between the parked motor vehicles and the bicycle lane where a bicycle lane is provided adjacent to motor vehicles. The buffer provides space for motor vehicle doors to open without presenting a hazard to adjacent bicycle users. Bicycle lanes adjacent to on-street parking without a buffer are not recommended in the Design Guide. **Figure D-46** shows various buffer configurations, including the constrained limit width, desirable width, and an additional buffer space where space is available.

Assigning Extra Buffer Width

Buffers can be located on one or both sides of the bicycle lane, either between moving and/or parked motor vehicles (see **Figure D-48**). Where the total width available is greater than 2.1 metres, space should be allocated first to the bicycle lane to achieve the desirable width of 1.8 metres, and the balance of the width should go towards increasing the buffer. Where the parking turnover frequency is less than 10 motor vehicles per hour and/or the motor vehicle volumes are greater than 5,000 motor vehicles per day, increasing the buffer width between the bicycle lane and motor vehicle lane is recommended. However, along corridors with higher parking turnover and/or motor vehicle volumes less than 5,000 motor vehicles per day, additional width should instead be allocated to the buffer between the bicycle lane and the parking lane to mitigate the risk of 'dooring.'

Where the total width available for the bicycle lane and buffer is 2.4 metres or greater, a protected bicycle lane should be considered rather than a buffered bicycle lane. Refer to **Chapter D.3** for more information on protected bicycle lanes. If a protected bicycle lane is not desired or applicable and more than 2.7 metres of space is available, additional buffer space may be provided between the bicycle lane and the motor vehicle lane, as outlined in **Table D-16**, or between the bicycle lane and the curb. The extra width should be marked differently so that the bicycle lane is not confused with a motor vehicle lane.

The desired width of a bicycle lane adjacent to on-street parking is 2.4 metres, including a 1.8 metre bicycle lane and a 0.6 metre buffer between the parking lane and the bicycle lane. Refer to **Figure D-48**. The constrained limit width of a bicycle lane adjacent to parallel parking is 2.1 metres, including a 1.5 metre bicycle lane and 0.6 metre buffer.

The parking lane width is generally dictated by local bylaws and/or design standards, but should generally accommodate the width of the parallel parked vehicle and leave some additional space if parked sub-optimally. Consideration may also be given to added space for snow storage where no buffer is provided.

Bicycle Lane Adjacent to Angled Parking

Angled parking is often used where a road has sufficient width to increase the available parking supply. However, in general, angled parking is not preferred adjacent to a bicycle lane. If angled parking is already provided, protected bicycle lanes located adjacent to the curb are recommended (see **Chapter D.3**). Where protected bicycle lanes are not feasible, bicycle lanes may be a suitable type of facility. However, note that many of the same challenges associated with bicycle lanes next to parallel parking exist for bicycle lanes adjacent to angled parking. Design professionals should carefully consider user comfort and safety risks prior to designing a bicycle lane adjacent to angled motor vehicle parking (see Research Note in the previous subsection).

There is currently little design guidance in other documents for installing a bicycle lane adjacent to angled parking and whether front-in or back-in is the preferred configuration. Design professionals should consider a variety of factors when deciding whether to implement back-in or front-in angled parking such as: safety, motor vehicle access, pedestrian realm impacts, and ease of maneuver. Angled parking treatments should only be considered in retrofit projects where the angled parking already exists and bicycle facilities are being added to the roads.

The main concern with front-in angled parking is the lack of sightlines for drivers backing out. Conversion of the angled parking to back-in angled parking can increase motorist's sightlines and reduce the risk of drivers blindly backing out of the parking stall into the bicycle lane. However, for many drivers, driving front-in is a more familiar and common action than backing into an angled parking stall.

If space allows, it is recommended that the bicycle lane is protected and located between the sidewalk curb and the angled parking (refer to **Chapter D.3** for more information).

Where a bicycle lane is located adjacent to angled parking on the road side, the desirable width of the bicycle lane is 1.8 metres (see **Figure D-49**). Additionally, when designing a bicycle lane adjacent to angled parking, a buffer should be provided between the bicycle lane and the edge of the angled parking lane. This provides space for people riding bicycles to maneuver around a motor vehicle coming into the travel lane, for people to load their motor vehicles, and for longer motor vehicles to park without impeding the bicycle lane. The constrained limit width of the buffer is 0.9 metres for front in angled parking and 0.6 metres for back in angled parking, with a maximum width of 1.4 metres.

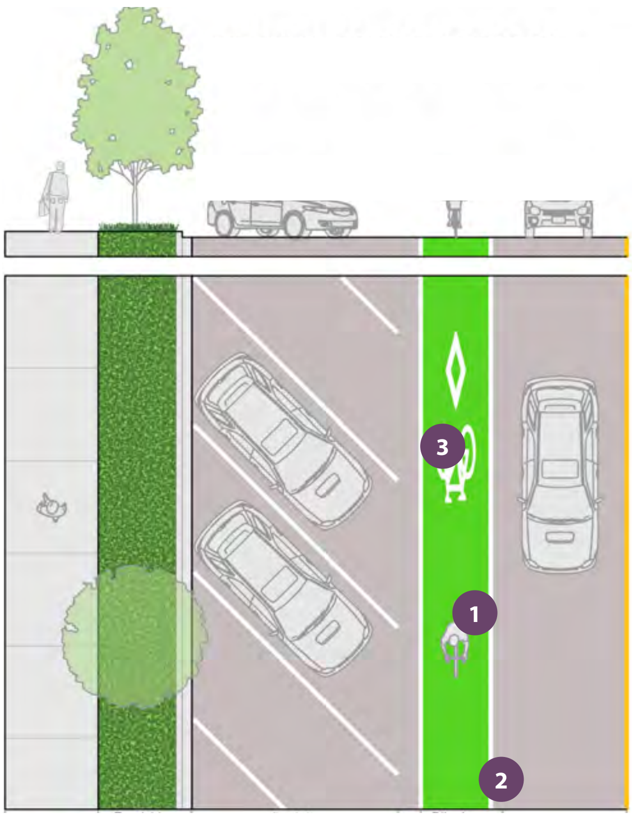


FIGURE D-49 // BICYCLE LANE ADJACENT TO BACK-IN ANGLED PARKING - DESIRED WIDTHS AND KEY FEATURES

1 *Desirable width of 1.8 metres*

2 *Green conflict zone markings can enhance visibility*

3 *Buffer area between angled parking and bicycle lane. Buffer area can be enhanced with different surface materials (such as textured surface)*

When implementing a treatment that shifts users' expectations, such as back-in angled parking, an educational campaign is imperative and should be implemented in advance of implementing the measure.

Similar to bicycle lanes adjacent to parallel parking, space should be allocated to the bicycle lane first, followed by the buffer adjacent with the parking lane, then with the motor vehicle lane. If further additional space exists, buffer space may be provided between the bicycle lane and the motor vehicle lane. If there is insufficient width available to provide an adequate bicycle lane width and buffer width, other design options should be considered, including converting the angled parking to parallel parking.

Left Side Bicycle Lanes

Left side bicycle lanes are on the left side of a one-way road. Refer to **Figure D-50**. Some of the circumstances where left side bicycle lanes may be considered include locations where:

- There are a significant number of left turning bicycle users;
- There are conflicts with right side transit stops, loading and delivery activity, and/or on-street parking; and
- There are more destinations are on the left side of the road, particularly destinations that attract people cycling.

Some of the benefits of left side bicycle lanes include:

- Avoids potential right side bicycle lane conflicts on roads;
- May improve bicycle visibility for motor vehicle drivers as the bicycle lane is located on the motorist's side, although drivers may not typically expect to see people cycling on the left side;
- Parking lane is typically located on the right side;
- If there is left side parking, left side bicycle lanes minimizes door zone conflicts because of fewer doors openings on the passenger side; however, there is more impact to the sightline of approaching bicycle users for motorists pulling out of the parking lane; and
- No transit conflicts as bus stops are on the right side of the road.

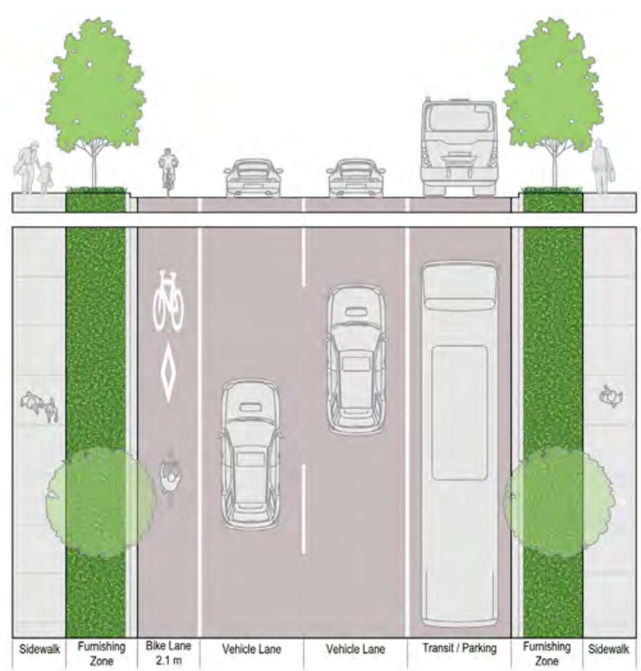


Figure D-50 // Left Side Bicycle Lane Cross-Section - Desired Width

The desirable width of a left side bicycle lane is 2.1 metres. For any width greater than 1.8 metres, a buffer should be provided to avoid the lane being mistaken or used for other purposes, such as parking or motor vehicle travel. Recommendations for the bicycle lane width and buffer are consistent with the above sections on curbside and parking adjacent bicycle lanes. Design professionals should give careful consideration to ensure safe, intuitive transitions are provided at either end of a left side bicycle lane as this facility type is less familiar to bicycle users and motorists, and has the potential to lead to confusion.

Additional signage and pavement markings should be provided when installing left side bicycle lanes to clearly demarcate the bicycle lane for motor vehicle drivers and reduce wrong way cycling. However, design professionals should use caution when installing signage to ensure to not result in reduced effectiveness of existing signage.

Contraflow Bicycle Lanes

A contraflow bicycle lane is a painted bicycle lane with bicycle users travelling against the flow of motor vehicle travel. A contraflow bicycle lane is used to facilitate two-way bicycle movement on a road that is one-way for motor vehicles. The bicycle lane and the motor vehicle lane should be separated by a directional dividing line (see **Figure D-51**).

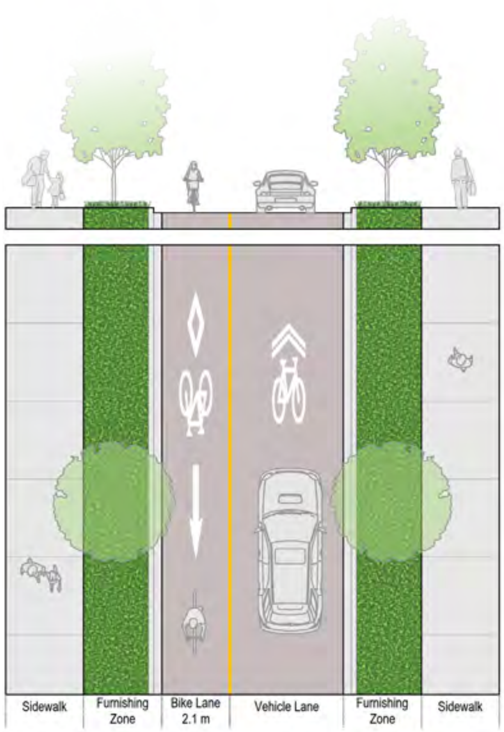
A contraflow bicycle lane may be considered in the following scenarios:

- On roads where a large number of people cycling are already riding the wrong way;
- On corridors where alternate routes require excessive out-of-direction travel;
- On corridors where alternative routes include unsafe or uncomfortable roads with high motor vehicle volumes and/or no bicycle facilities;
- On corridors where the contraflow lane provides direct access to destinations on the road under consideration; and
- Where two-way connections between bicycle facilities are needed along one-way roads.

The desirable width of a contraflow bicycle lane is 2.4 metres, including a 1.8 metre bicycle lane and a 0.6 metre buffer (see **Table D-17**).

It is preferable to have lower volumes and speeds where contraflow lanes are used without protection to reduce cycling workload. Additionally, they work well on roads with few intersections or accesses. These measures help to mitigate potential conflicts stemming from bicycles approaching from the opposite direction than expected for motor vehicle traffic.

As a part of implementation, design professionals need to determine an effective signage plan to accompany this facility, and can include the Contraflow Bicycle Lane Crossing sign (MUTCDC WC-43). Additional details on signage are provided in **Appendix B**.



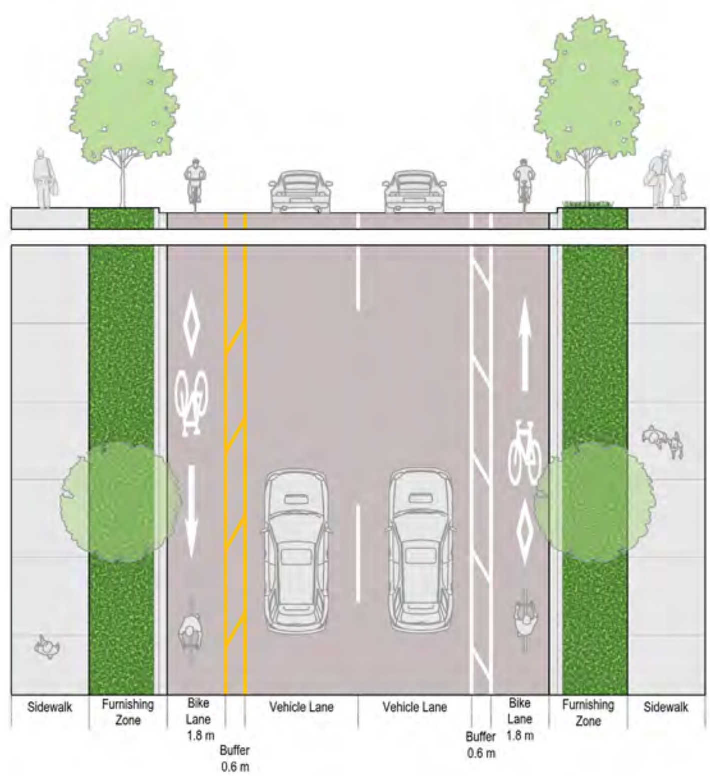


Figure D-51 // Contraflow Bicycle Lane Cross-Section - Desired Widths

TABLE D-17 // CONTRAFLOW BICYCLE LANE WIDTH GUIDANCE

FACILITY	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Bicycle Lane	1.8*	1.5
Buffer (between bicycle lane and motor vehicle lane)	0.6	0.3

*For any width greater than 1.8 metres, a buffer should be provided to avoid the lane being mistaken/used for other purposes, such as parking or motor vehicle travel.

Contraflow bicycle Lane, Vancouver, B.C.


Bicycle stencil, Vancouver, B.C.

SIGNAGE

The Reserved Bicycle Lane sign (MUTCDC RB-90, RB-91) should be installed continuously along the length of the bicycle lane. In an urban environment, signs should be placed after every intersection and spaced mid-block at least every 200 metres. In a rural environment, signs should be placed after every intersection and spaced mid-block at least every 200 to 400 metres The Reserved Bicycle Lane Ends sign (MUTCDC RB-92) should be installed at the end of the reserved lane denoting the end of the bicycle lane. Additionally, if there are not by-laws in place that restrict parking in bicycle lanes, then No Parking signs (MUTCDC RB-51; B.C. P-001 Series) and/or No Stopping signs (MUTCDC RB-55; P-058 Series) should be installed along the curbside bicycle lanes. These signs can also be used in areas where there is frequent non-compliance with parking in bicycle lanes where bylaw restrictions are in place. However, design professionals should use caution when installing signage to ensure to not result in reduced effectiveness of existing signage.

For contraflow bicycle lanes, a One-Way sign (MUTCDC RB-21; B.C. R-008LR Series) with the Except Bicycles tab (MUTCDC RB-9S; B.C. R-009 Tabs) is the preferred signage treatment along the facility and at intersecting roads, alleys, and driveways. Additionally, an Entry Prohibited sign (MUTCDC RB-23; R-009-1 Series) with the Except Bicycles tab (MUTCDC RB-9S; B.C. R-009 Tabs) is also recommended. Additional signage may also be required for motor vehicle drivers, depending on whether the contraflow bicycle lanes are on a one-way road or two-way road.

More information on this signage is provided in **Appendix B**, including supplementary signs that can be used depending on conditions.

PAVEMENT MARKINGS

Bicycle lanes are delineated by one to two longitudinal lines that border a designated area for bicycle use. The longitudinal line(s) directs motor vehicle and bicycle traffic into appropriate lanes and provides clarity for safe use of the road.

Directional bicycle lane lines are white in colour with a width of 100 to 200 millimetres.

Bicycle lane lines are typically solid, except in locations where motor vehicles are permitted to cross the bicycle lane to complete turning movements. At these locations, dashed white line markings are used. The dashed white line segments should consist of a minimum 1.0 metre long line segment with a one metre gap between the segments, with a 1:10 ratio. For example, for a 1.5 metre wide bicycle lane, a minimum length of 15.0 metres of dashed white line is used.

Similarly, dashed white lines should be used when the bicycle lane is shared with a transit stop. In those instances, the dashed marking should be 30.0 metres long measured from 5.0 metres in front of the transit stop sign, or in line with the transit stop area.

Where a buffer is provided, the buffer is also delineated with two solid white lines and can be located between the bicycle lane and the motor vehicle or parked motor vehicle lane or both. One white line is shared with the bicycle lane. The buffer lines should be a width of 100 millimetres, except when adjacent to the motor vehicles. In that case, they should be 200 millimetres wide and the shared line with the bicycle lane should be 100 millimetres. For the parking buffer, alternatives to the solid white line include cross hatch or ‘parking Ts’ to delineate the stalls. Cross hatching is more visible, but may require more maintenance than ‘parking Ts’. A drawback of ‘parking Ts’ is that they define specific parking stalls, which may result in an inefficient use of space.

Buffer markings can be enhanced with hatching to decrease ambiguity of the space. If the buffer is greater than 0.6 metres, hatching should be considered; for buffers greater than 0.9 metres hatching is recommended to deter improper use of the space.

Dedicated bicycle lanes also need to include the white bicycle and reserve lane diamond pavement marking symbols. These symbols may be supplemented by directional arrow markings to denote the bicycle lane movement.

Refer to **Appendix B** for more information on pavement marking details.

Advisory bicycle lane, Shaw Road, Gibsons, B.C.

D.5

ADVISORY BICYCLE LANES

Advisory bicycle lanes (also referred to as advisory shoulders, non-compulsory lanes, or dashed bicycle lanes) are bicycle-priority areas within a shared street environment. Bicycle users have priority within dedicated lanes, but motorists may legally enter the advisory bicycle lanes to pass oncoming motor vehicles. Advisory bicycle lanes are not considered an all ages and abilities bicycle facility type.

KEY FEATURES

Advisory bicycle lanes are generally used on narrow roads that are not wide enough for dedicated bicycle lanes, or on roads with higher motor vehicle volumes and/or speeds than are unsuitable for a neighbourhood bikeway. Advisory bicycle lanes provide dedicated (but not exclusive) space for where motor vehicle volumes and/or speeds may make it uncomfortable to share the road. Advisory bicycle lanes are uni-directional and run along either side of a single bi-directional motor vehicle lane.

Where no sidewalk exists, such as in rural contexts, advisory bicycle lanes may be used for both walking and cycling, in which case the facility would be called 'advisory shoulders'. People walking should walk facing traffic, while people cycling should ride in the same direction as traffic on the right side of the road. See **Chapters C.4** and **D.6** for more guidance on rural pedestrian and cycling facilities. Key features of advisory bicycle lanes are shown in **Figure D-52**. Advisory bicycle lanes are located on either side of a **single bi-directional centre motor vehicle lane** 1.

Advisory bicycle lanes are delineated by white dashed longitudinal lines 2, indicating that motor vehicles may legally enter the bicycle lanes. This allows motor vehicles travelling in opposite directions to pass one another by temporarily **pulling into the advisory bicycle lane when safe to do so** 3. Motorists are required to yield to people cycling and walking in advisory bicycle lanes, so they should expect frequent yielding, mixing, and merging. In addition to dashed lines, advisory bicycle lanes may be differentiated from the central motor vehicle lane by using **colour or contrasting pavement materials** 4.

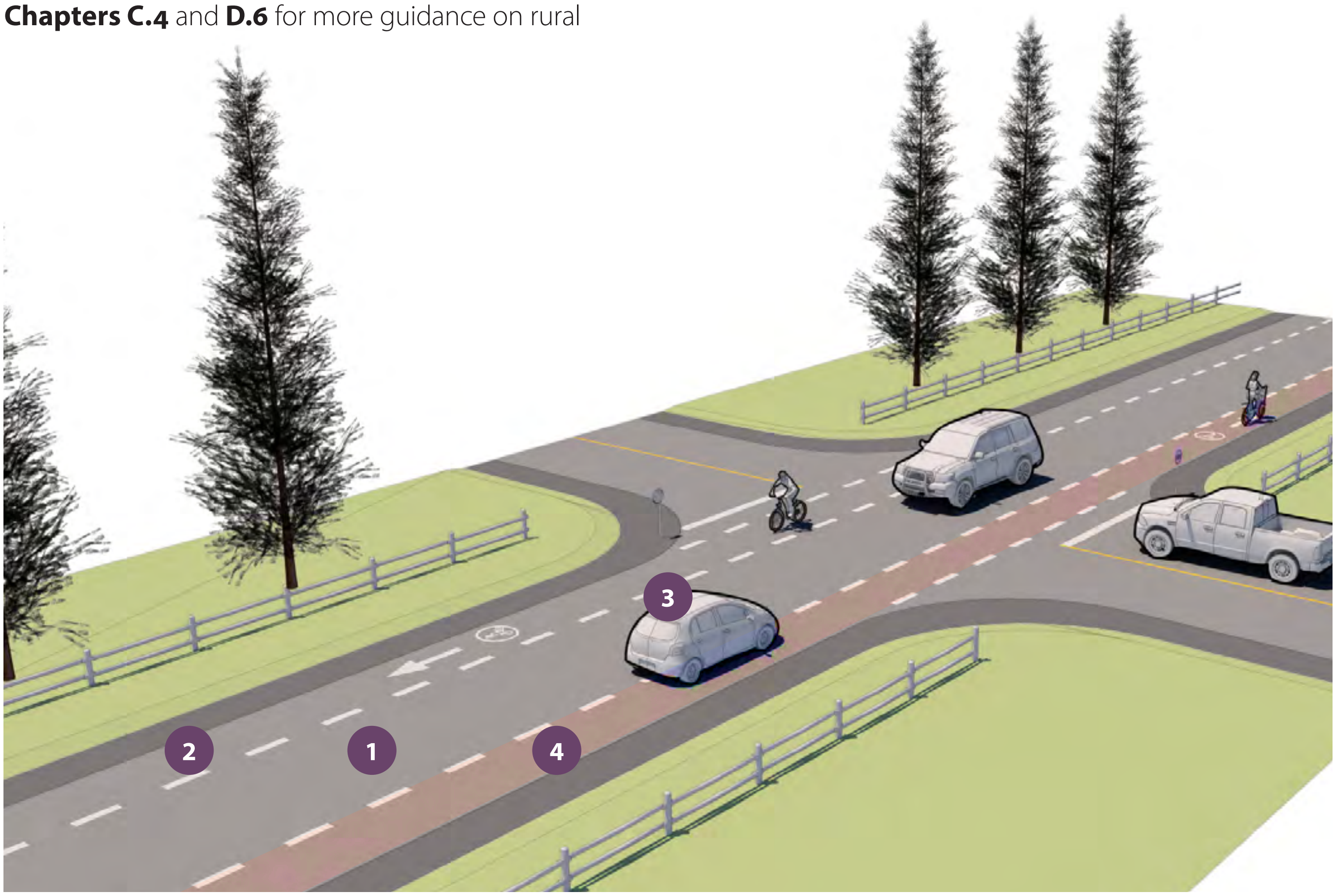


FIGURE D-52 // ADVISORY BICYCLE LANE

Advisory bicycle lanes are common in Western Europe, with more than 1,000 kilometres of lanes installed in the Netherlands, Scandinavia, and the United Kingdom. In North America, advisory bicycle lanes are a relatively new bicycle facility type, having only been in use since 2011. As such, it is strongly recommended that installation of advisory bicycle lanes is supplemented with a strong public education program and materials, and that appropriate signage is installed. Various North American municipalities have recently installed experimental advisory bicycle lanes and are evaluating their impact.

Advisory bicycle lanes are a relatively new bicycle facility type in North America. Little design guidance and research on the application of advisory bicycle lanes in a North American context exists at the time of publication of the Design Guide. In addition, many road users in a North American context are unfamiliar with the operation of advisory bicycle lanes. As such, design professionals should consider advisory bicycle lanes in conjunction with a comprehensive data collection and monitoring program to monitor their use and effectiveness, along with a public education program to inform all road users about how to use these facilities.

TYPICAL APPLICATIONS

Advisory bicycle lanes are appropriate on narrow roads where there is insufficient space to add dedicated bicycle lanes without widening the road or removing other road amenities. They should only be considered along roads with less than 5,000 motor vehicles per day, and preferably less than 2,500 motor vehicles per day, where it would be rare for two motor vehicles travelling in opposite directions to meet while one or more people are cycling in the same vicinity. For this reason, rural contexts may be more appropriate than urban contexts. It is recommended that the posted speed limit be lowered to 40 km/h or less when implementing an advisory bicycle lane.

Roads with advisory bicycle lanes should be relatively straight and flat with few visual obstructions, as motorists require a clear view of oncoming motor vehicles. This may limit their application in many coastal or mountainous B.C. communities. Advisory bicycle lanes are not appropriate on roads with directional dividing lines (yellow centre lines). Any existing directional dividing lines should be removed when installing an advisory bicycle lane.

When implementing a treatment that shifts users' expectations, such as advisory bicycle lanes, an educational campaign is imperative and should be implemented in advance of installing the facility.

BENEFITS + LIMITATIONS

Benefits

- Can be relatively low cost. Advisory bicycle lanes can often be accommodated through road re-striping or re-configuration, requiring little to no widening of the road.
- Requires little right-of-way and can be used on narrow roads that cannot accommodate a dedicated bicycle lane, opening the possibility for adding bicycle facilities to more roads.
- People cycling have a dedicated (but not exclusive) area where they have priority.
- Increases predictability of bicycle positioning on the road.
- On-street bicycle facilities can be maintained with other road maintenance activities.
- Can serve as an interim solution until fully dedicated bicycle facilities are built.

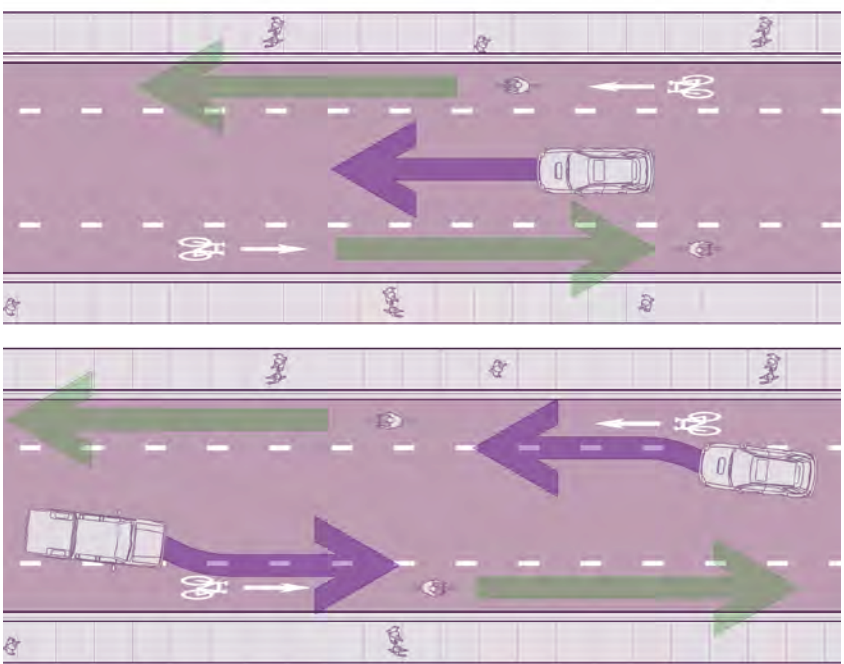


Figure D-53 // Passing on an Advisory Bicycle Lane

Limitations

- Do not provide for the exclusive use of bicycles. Motor vehicles are legally allowed to enter the advisory bicycle lane when passing (see **Figure D-53**), which increases potential for conflicts and collisions.
- Some people cycling may be uncomfortable riding adjacent to motor vehicle traffic. Advisory bicycle lanes are not an all ages and abilities facility.
- Narrow advisory bicycle lanes or advisory bicycle lanes without a buffer adjacent to parked motor vehicles can result in risk of 'dooring.'
- Not a well-known or widely used facility type, which may result in user confusion.
- A public education campaign is required when implementing an advisory bicycle lane. Additional signage and markings may also be required for education and awareness.
- Contrasting pavement materials and colours are costly.
- Requires removal of directional dividing line if one exists.
- Striping may not be intuitive, with a white painted line on both sides of motor vehicles but on a two-way road.
- If separate pedestrian facilities are not provided, advisory bicycle lanes may be utilized by people walking, which may lead to additional confusion and potential conflicts.
- Road should be relatively straight and flat with few visual obstructions, as motorists require a clear view of oncoming motor vehicles.

Case Study

Shaw Road Advisory Bicycle Lane, Gibsons, B.C.

In 2016, the Town of Gibsons received a provincial grant to create a cycling link between Upper and Lower Gibsons, which was divided between a new low-gradient trail through a wooded natural space ('Helen's Way') and a new advisory bicycle lane on Shaw Road between Inglis Road and Gibsons Way (approximately 700 metres). This was the first advisory bicycle lane in B.C. and the first known installation in Western Canada.

Gibsons, B.C.

The initial planning of the corridor included conventional bicycle lanes. However, the public concern over a loss of on-street parking required that the town develop an alternative solution. The advisory bicycle lane was a design solution that fit within the existing roadway and retained the majority of the on-street parking. The final design includes an advisory bicycle lane in the northbound direction and a shared lane (bicycles and motor vehicles) buffered from on-street parking in the southbound direction. The northbound advisory bicycle lane is on an incline and provides space for bicycle users to climb that is separated from vehicles.

Gibsons, B.C.

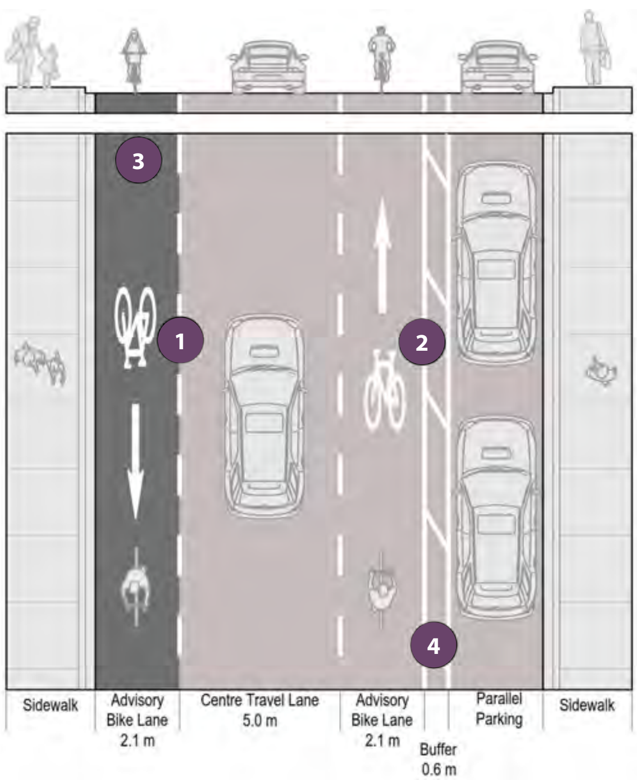
The Shaw Road cycling facilities have been received by the public with mixed results. The Sunshine Coast does not generally have non-conventional transportation facilities and the introduction of uncommon cycling facilities has resulted in both motorist and cyclist comprehension issues, as follows:

- The buffer area used for scooter travel;
- Southbound motorists using unoccupied on-street parking areas to pass people cycling; and
- Uncertainty over the meaning of lane markings.

Overall, the town has viewed the installation as a success and a good use of available right-of-way in response to the need to preserve parking. It will pursue opportunities to install advisory bicycle lanes on other corridors in Gibsons, which staff anticipate will make them more broadly understood and therefore more effective in future.

DESIGN GUIDANCE

Advisory bicycle lanes are located on either side of a single bi-directional motor vehicle lane and distinguished from the adjacent motor vehicle lanes with a dashed white longitudinal line. See **Figure D-54** and **Figure D-55**).



1. *100-200mm dashed white Line*
2. *100mm solid white line adjacent to on-street parking*
3. *Recommended Contrasting Pavement Treatments*
4. *Buffer between parked motor vehicles and advisory bicycle lane, with optional diagonal hatch pavement markings*

Figure D-54 // Advisory Bicycle Lane Cross-section - Desired Widths and Key Features

If the available width of the centre travel lane is in excess of 5.5 metres, dedicated or protected bicycle lanes may be a more suitable facility type.

Width

The desirable width of an advisory bicycle lane is 2.1 metres. This provides sufficient width for single file bicycle traffic, allows for basic bicycle passing movements, and provides spacing between bicycle users and the central motor vehicle travel lane. In constrained conditions, the advisory bicycle lane width can be 1.8 metres with an absolute minimum width of 1.5 metres.

The desired width of the centre travel lane for roads with a maximum posted speed limit of 40 km/h is 5.0 metres to allow for two-way motor vehicle travel with minimal intrusion into the advisory bicycle lanes (see **Table D-18**). The centre travel lane may be no narrower than 3.0 metres in constrained locations and no wider than 5.5 metres to ensure it can be differentiated from a full width two-way road.

Where both the desired advisory bicycle lane and centre travel lane widths cannot be achieved, the desired advisory bicycle lane width should be prioritized to ensure comfortable cycling conditions.

Table D-18 // Advisory Bicycle Lane Width, Desirable and Constrained Limit

FACILITY	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Road with advisory bicycle lanes on both sides	9.2	6.6
Advisory bicycle lane component	2.1	1.8
Bi-directional centre travel lane component	5.0	3.0

On-Street Parking

A separate parking area should be provided where on-street parking is adjacent to an advisory bicycle lane. The advisory bicycle lane and parking area should be separated by a solid white line and/or contrasting pavement material. A buffer zone is strongly recommended to provide separation between the advisory bicycle lane and the parking area to allow for doors opening and loading/unloading from parked motor vehicles without presenting a hazard to through bicycle users. The desired width for the buffer zone is 0.9 metres, and may be reduced to 0.6 metres in constrained locations.

Parallel parking configurations are appropriate adjacent to advisory bicycle lanes, while angled or perpendicular configurations should be avoided. Additionally, on-street parking that experiences low utilization should be avoided adjacent to an advisory bicycle lane. Where low utilization of on-street parking is anticipated adjacent to an advisory bicycle lane, dedicated or protected bicycle lanes may be more suitable facility types.

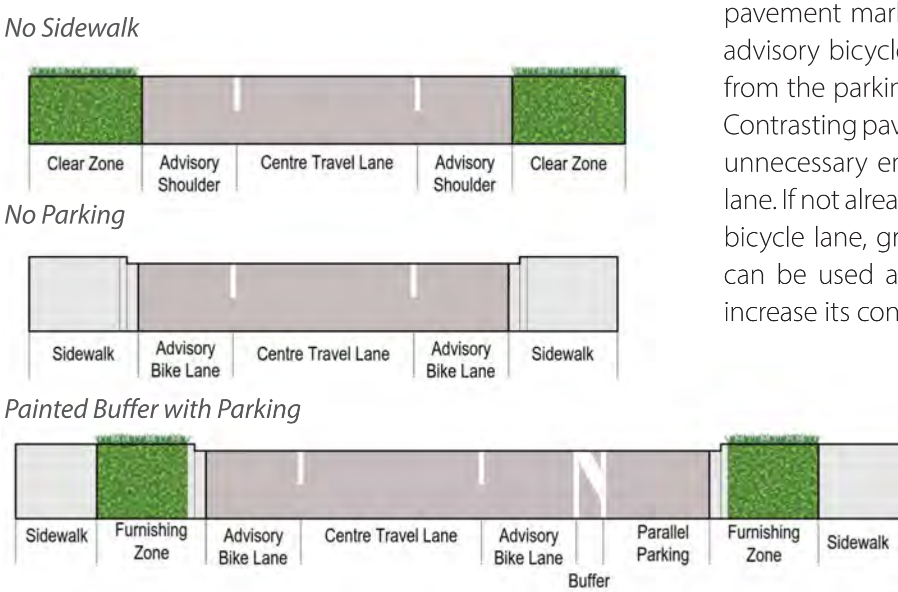


FIGURE D-55 // ADVISORY BICYCLE LANE CROSS-SECTION, POSSIBLE CONFIGURATIONS

Because advisory bicycle lanes are a new facility in B.C., contrasting pavement materials are strongly recommended with all advisory bicycle lanes.

End Treatments

Advisory bicycle lanes should be discontinued 50 metres in advance of any intersections controlled by a stop sign or traffic signal. When discontinued, one of the following should take the place of the advisory bicycle lane:

- Widen the road and provide conventional bicycle lanes;
- Provide a bicycle accessible shoulder; or
- Integrate motor vehicle and bicycle travel in a shared lane.

Advisory bicycle lane striping (and construction material or colour, if applicable) should be maintained at crossings of driveways and minor intersections.

Contrasting Pavement Materials

Contrasting pavement materials and/or coloured pavement markings may be used to differentiate the advisory bicycle lane from the centre travel lane, and from the parking lane if applicable (see **Figure D-52**). Contrasting pavement materials can help to discourage unnecessary encroachment into the advisory bicycle lane. If not already being used along the entire advisory bicycle lane, green conflict zone pavement markings can be used as a backing to the bicycle symbol to increase its conspicuity in this application.

SIGNAGE

Providing signage along advisory bicycle lanes is important, as it is a relatively new and uncommon bicycle facility type in North America. At the time of writing, neither the TAC *MUTCDC* nor the B.C. Provincial Sign Program have a specific sign for advisory bicycle lanes. A standard sign that may be used is the Bicycle Route Marker sign (MUTCDC IB-23). Two-Way Traffic Ahead signs (MUTCDC WB-3; B.C. W-020 Series) are also recommended to indicate two-way road use for motor vehicles.

Some jurisdictions, including Gibsons, B.C., have also created custom signs and display boards that explain the movement of bicycles and motor vehicles and warn motorist to yield to bicycles. A custom dedicated sign can be created following the MUTCDC and examples from other jurisdictions. Where advisory bicycle lanes will be used by both people walking and cycling, a custom sign that includes both people walking and cycling should be created. See **Appendix B** for more details on signage.

PAVEMENT MARKINGS

Advisory bicycle lanes require two basic pavement markings, as follows:

1. White dashed longitudinal lines should delineate the advisory bicycle lane from the adjacent roadway.

2. The bicycle symbol in combination with an arrow oriented in the cycling travel direction should be used to mark an advisory bicycle lane.

The reserved lane diamond symbol should not be used, as the advisory bicycle lane is not reserved exclusively for use by bicycles and can also be used by motor vehicles. In contexts where advisory bicycle lanes are also intended to be used by people walking, the bicycle symbol should not be used; instead, a shared-use symbol with the bicycle and pedestrian symbol in a circular plate (wayfinding pavement marking) may be used.

No directional dividing line (e.g. yellow centre line) should be on roads with advisory bicycle lanes. If a directional dividing line exists when an advisory bicycle lane is installed, it should be removed. Short sections of the directional dividing line may be reintroduced to denote the separation of traffic at potential conflict points such as approaches to at-grade crossings and at bridges.

Refer to **Appendix B** for more information on pavement marking details including dimension, spacing and placement.

Advisory bicycle lane, Province of Groningen, Netherlands
Source: Modacity

Village of Queen Charlotte, B.C.

D.6

RURAL CYCLING DESIGN CONSIDERATIONS

Shoulders are often provided along rural roadways for a variety of reasons and can be shared by a variety of users, including pedestrians and motor vehicles when required for safety, operations, and maintenance. However, not all shoulders are considered to be 'bicycle accessible.'

On many roadways throughout B.C., particularly in rural contexts, paved shoulders can be used as on-street bicycle facilities. Shoulders are paved spaces on the edge of rural roads and highways outside of the vehicle travel lanes, but within the road right-of-way, that can be used by people cycling and, in some cases, also by people walking and using other active modes. The focus of this chapter is bicycle accessible shoulders on roadways under local and regional government jurisdiction in rural contexts. Refer to **Chapter C.4** for design guidance on pedestrian facilities in rural contexts. Refer to **Chapter F.1** for rural design consideration on roadways under provincial jurisdiction.

The Difference Between a Shoulder and a Bicycle Accessible Shoulder

Shoulders can provide a separate space for people riding their bicycle, similar to painted bicycle lanes. They are delineated by a solid white longitudinal line and can be supplemented by signage and pavement markings alerting motorists to expect bicycle travel along the roadway. Unlike painted bicycle lanes, however, shoulders do not provide an exclusive space for people cycling, as the shoulder space can be shared by a variety of users, including pedestrians and motor vehicles when required for safety, operations, and maintenance.

While not considered an all ages and abilities bicycle facility, shoulders can attract a range of bicycle users and help to provide a space for some people to feel comfortable riding in rural areas. Shoulders can be used to provide connections between communities and help to provide more transportation choices. There are, however, conditions where cycling in shoulders is not appropriate, which are outlined in more detail in this chapter.

As highlighted in the TAC *Geometric Design Guide for Canadian Roads,* shoulders may be considered to be bicycle accessible if:

- Pavement markings are present that separate the shoulder from adjacent motor vehicle traffic;
- There is sufficient operating space; and
- There is a smooth, paved surface that is clear of snow and debris. Bicycle travel on bicycle accessible shoulders is always one-way in the same direction as motor vehicle traffic. In some cases, particularly in rural areas, bicycle accessible shoulders may also be shared with pedestrians. This chapter does not provide detailed design guidance on the design of shoulders in general, but focuses specifically on design considerations to make shoulders bicycle accessible.

TYPICAL APPLICATIONS

Bicycle accessible shoulders are typically found along rural roads that provide connections between communities or destinations. This chapter focuses on bicycle accessible shoulders on roadways under local or regional government jurisdiction. Refer to **Chapter F.1** for design guidance on bicycle accessible shoulders on roadways under provincial jurisdiction. Arterial and collector roadways are often the most direct route through a community; however, the higher motor vehicle volumes and speeds can make them less comfortable for people cycling.

Bicycle accessible shoulders on are a lower cost option when compared to off-street pathways; however, they do not provide an all ages and abilities facility particularly on roadways that are typically characterized as having higher motor vehicle speeds and volumes. If widening a roadway to enhance the shoulder space is required, it can be cost prohibitive depending on road condition and constraints. Ultimately, in many cases, a bicycle facility that is separated from the roadway, such as an off-street pathway, that provides a direct route to destinations is a preferred bicycle facility type. Where this treatment is not feasible and/or funding is not available, a bicycle accessible shoulder can be considered an interim measure.

Bicycle accessible shoulders are generally suitable on roads with posted speeds of 50 km/h or less and with 5,000 or fewer motor vehicles per day. In the following situations, a physically separated bicycle facility such as an off-street pathway or a alternative quieter route may be more appropriate.

- On roads where the posted speeds are greater than 80 km/h and motor vehicle volumes are higher than 10,000 vehicles per day; or
- If the road contains a large proportion of heavy motor vehicles.

DESIGN GUIDANCE

Width

This section reflects the desirable width of a bicycle accessible shoulders on roadways under local or regional government jurisdiction. The appropriate width of bicycle accessible shoulders on is dependent on the speed of motor vehicles.

Table D-19 outlines the desirable and constrained limit widths for bicycle accessible shoulders based on posted motor vehicle speeds and volumes on municipal roadways under local and regional government jurisdiction. As shown in **Figure D-56**, shoulder widths of 1.8 metres are the desired width for lower speed roadways (50 km/h or less). This width provides sufficient space for single file bicycle traffic and allows for basic bicycle passing movements. Bicycle accessible shoulders are not a desired facility if posted speeds are greater than 50 km/h, unless additional buffer width or separation is provided. However, if bicycle accessible shoulders are provided on roadways with speeds above 50 km/h, the desired width is 2.5 or greater, as shown in **Figure D-57**. This width can accommodate people cycling side-by-side.

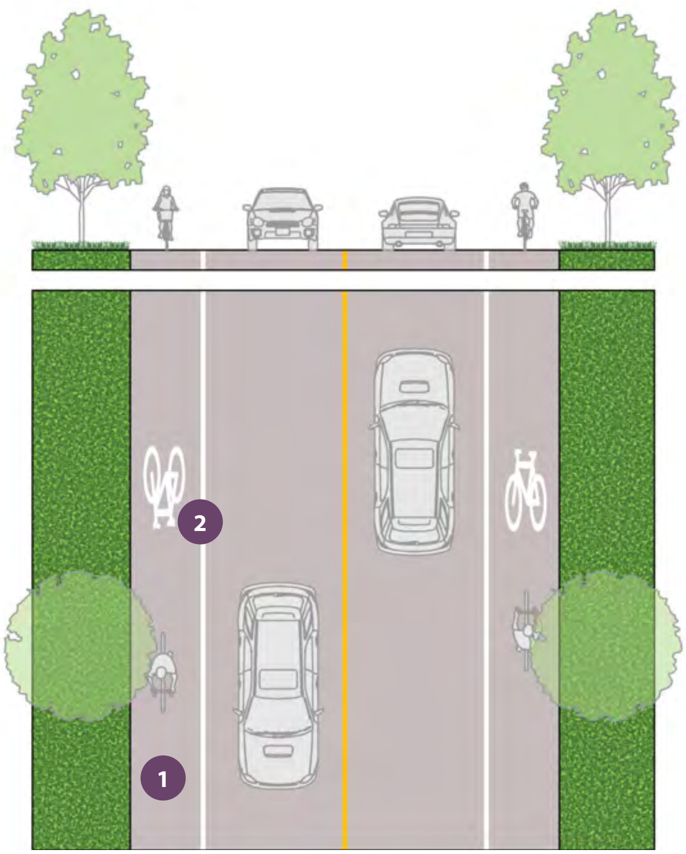
A width between 1.2 metres and 1.5 metres should only be considered for short distances (less than 100 metres) in constrained areas. Shoulder widths of 1.2 metres or less should not be signed or marked as a bicycle accessible facility. The absolute minimum shoulder width is 1.2 metres based on the horizontal operating envelope of a person cycling.

Table D-19 // Bicycle Accessible Shoulder Width Guidance

FACILITY BY DESIGN SPEED	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Rural ≤50 km/h	1.8	1.5
Rural < 70 km/h	2.5	1.5
Rural > 70 km/h	3.0	2.0
Buffer (between shoulder and motor vehicle lane for higher posted speed and/or higher motor vehicle volumes)	1.2	0.9

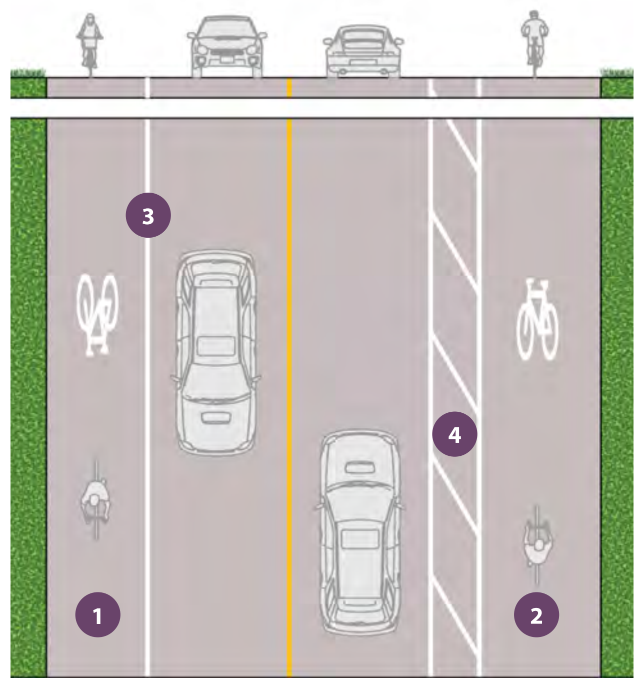
A painted buffer can provide additional separation between people cycling and motor vehicles. If the width of the buffer is between 0.9 to 1.2 metres, additional hatch markings or thicker longitudinal striping may be considered to more clearly denote the space for users such that they can position themselves appropriately.

When shoulders are located adjacent to a continuous vertical barrier, an additional 0.5 metres should be provided in the shoulder width to account for horizontal clearance. Bicycle accessible shoulders should be free of obstructions such as drainage aprons. Parking along rural roads and highways is typically not permitted; however, where parking currently exists, accommodation should be made to address the loss of this parking. Accommodation could include adding periodic laybys, alternative parking spaces nearby, and/or adding signage to prohibit parking to reduce conflicts between people cycling and parked motor vehicles.



1. *Desired width of 1.8 metres if speeds are 50 km/h or less*
2. *White longitudinal lines should be painted as a single 100mm-200mm solid white line*

Figure D-56 // Bicycle Accessible Shoulder – Low Motor Vehicle Speed



1. *Desired width of 2.5 metres if speeds are 70 km/h or less*
2. *Desired width of 3.0 metres or more if speeds are over 70 km/hr. Additional buffer space is recommended.*
3. *If buffers are not provided or are less than 0.9 metres, white longitudinal lines should be painted as a single 100mm-200mm solid white line*
4. *Buffers > 0.9m can be enhanced with two lines and hatched striping*

Figure D-57 // Bicycle Accessible Shoulder – High Motor Vehicle Speed

SIGNAGE

Regulatory signage is not required on bicycle accessible shoulders. Unlike bicycle lanes, Reserved Bicycle Lane signs (MUTCDC RB-90/RB-91) should not be used. However, there are opportunities to install guide and information signage that can be used as wayfinding and help to raise awareness of the presence of people cycling on the roadway. The Bike Route sign (IB-23, B-G-001) may be used to identify a facility as a designated bicycle route. It does not indicate the type of facility and can be used on a number of facility types including bicycle accessible shoulders.

PAVEMENT MARKINGS

Bicycle accessible shoulders are delineated by a solid white longitudinal line along the side of the travelled lane.

A solid white line of 100 to 200 millimetres is recommended to delineate the lane edge line and separate motor vehicle travel lanes from the shoulder.

Pavement markings within bicycle accessible shoulders are typically installed in conjunction with an appropriate bicycle sign. When placed in conjunction with a bicycle route guide sign, the stencil should be located within 10 metres of the sign location, preferably in advance of the sign. Bicycle stencils should be installed after every signalized intersection. Supplementary symbols may also be placed between intersections. On rural shoulders, it is recommended they are spaced every 1.5 to 2 kilometres.

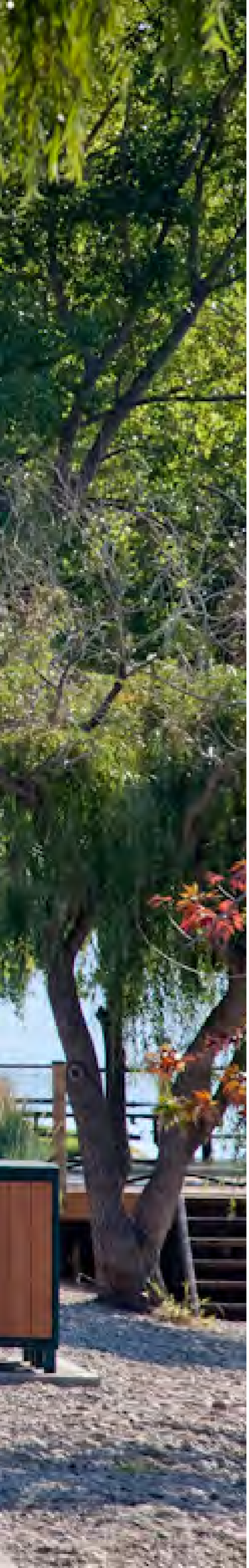
The typical pavement marking used to identify bicycle routes should be the standard TAC bicycle pavement marking. This elongated bicycle symbol is 1.0 metres wide by 2.0 metres tall.

Coloured bicycle pavement markings are not intended to be used on bicycle accessible shoulders, except at intersections or crossing points (see **Chapter G.1**).

E.

MULTI-USE FACILITIES

Off-street pathway, Peachland, B.C.



E.1

GENERAL DESIGN GUIDANCE

Multi-use facilities are generally defined as facilities that can be used by more than one user group. Multi-use facilities include multi-use pathways, separated bicycle and pedestrian pathways, and shared spaces. This chapter provides general design guidance for multi-use facilities, including the context for when each of these multi-use facilities as applicable, a general discussion on user types, and additional considerations when designing multi-use facilities.

The Design Guide provides guidance on the following three types of multi-use facilities:

Multi-use pathways (**Chapter E.2**) are off-street pathways that are physically separated from motor vehicle traffic and can be used by any non-motorized user. This includes people walking, cycling, skateboarding, kick scootering, in-line skating, and using other active modes. Multi-use pathways may also be referred to as shared-use pathways, multi-use trails, and boulevard multi-use pathways. Typically, multi-use pathways accommodate bi-directional travel for all users. Multi-use pathways can be located in a variety of contexts, including rail corridors, greenway corridors, utility corridors, parks, along waterfronts, and adjacent to a road or highway.

Separated bicycle and pedestrian pathways (**Chapter E.3**) are similar to multi-use pathways. The key difference is the provision of a separation between people cycling from other users. The type of separation between users can vary from a painted line or visual separation to a vertical or horizontal feature. Separated bicycle and pedestrian pathways can be located in a variety of contexts, including rail corridors, greenway corridors, parks, along waterfronts, and adjacent to a road.

Shared spaces (**Chapter E.4**) are roads in which the living environment dominates over the vehicular movements. A shared space functions first as a meeting place, playground, pedestrian area, and extension of any surrounding residences. The road is shared among people walking, cycling, and driving motor vehicles. Shared spaces can differ in many ways. However, in general, they are places in which all modes can share in the same space, but with the possibility for more clearly designated zones in which some modes may be excluded or where others are encouraged to navigate.

APPLICABILITY

Multi-Use Pathways

Multi-use pathways can be installed within or adjacent to different types of rights-of-way and in various land-use settings. They can be found in a number of contexts, including but not limited to: rail corridors, greenway corridors, utility corridors, parks, along waterfronts, and adjacent to a road or highway.

Because multi-use pathways are typically bi-directional, special consideration should be given to confirm the appropriateness of installing them adjacent to roads with two-way motor vehicle traffic where motor vehicle speeds and volumes are high, and where there are numerous intersections, alleyways, and driveways. Refer to **Chapter G.5** for more detail on off-street crossings.

Generally, multi-use pathways located adjacent to a roadway would be considered appropriate when:

- Motor vehicle traffic is one way; or
- Motor vehicle volumes are greater than 4,000 vehicles per day.

Multi-use pathways can be considered in other conditions, including adjacent to roads with two-way motor vehicle traffic, provided intersection and crossing conflicts are mitigated. Multi-use pathways are typically not considered necessary adjacent to roads with volumes of less than 4,000 vehicles per day.

When multi-use pathways are being considered within linear rights-of-way, such as rail and greenway corridors, the number and location of intersections and crossings are particularly important, as is the available right-of-way width and number of anticipated users.

Separated Bicycle and Pedestrian Pathways

For the purpose of the Design Guide separated bicycle and pedestrian pathways are considered different facilities depending on the land-use and roadway context within which they are located.

Not Adjacent to a Road

Separated bicycle and pedestrian pathways can be implemented in similar settings to multi-use pathways, including through park space, within greenway and rail corridors, and along waterfronts. The key difference between multi-use pathways and separated bicycle and pedestrian pathways is that people cycling are separated and have their own designated space. Pathways within this context are discussed in more detail in **Chapter E.3**.

Similar to multi-use pathways, when considering the location and design of separated bicycle and pedestrian pathways that are being considered within linear rights-of-way, the number and location of intersections and crossings are particularly important. Other important factors include the available right-of-way width and number of anticipated users.

Adjacent to a Road in a Built-Up Land-Use Context

In areas where separated bicycle and pedestrian pathways are being considered adjacent to a road, particularly in a built up land-use context, separating people cycling from other road users is particularly important. Uni-directional bicycle pathways are more appropriate within this context, as people cycling will be travelling adjacent to a road. Uni-directional separated bicycle pathways, which are also referred to as sidewalk level protected bicycle lanes in this context in the Design Guide, allow people cycling to travel in the same direction as motor vehicle traffic and also provide greater access to destinations than a bi-directional multi-use or bicycle only pathway on one side of the road. In some contexts, such as areas with fewer motor vehicle interactions, bi-directional bicycle pathways may be considered. Design guidance for separated bicycle pathways in this context are provided in the discussion on sidewalk level protected bicycle lanes in **Chapter D.3**.

Shared Spaces

Shared spaces can allow motor vehicle access, but generally have no or limited function for through motor vehicle traffic. Shared spaces are suitable on one-way roads or roads with no directional dividing line where operating motor vehicle speeds are less than 30 km/h and motor vehicle volumes are less than 1,000 vehicles per day.

ADDITIONAL CONSIDERATIONS

Maintenance

Maintenance of multi-use facilities is an important consideration and can be particularly challenging. In many jurisdictions, winter maintenance procedures may differ for roads, sidewalks, and pathways with different agencies or departments that may be responsible for maintenance in each of these contexts. A jurisdiction would need to review its operational procedures and clearly define the responsibility for snow clearing on multi-use facilities. Refer to **Chapter I.3** for more details regarding maintenance.

Amenities, Wayfinding, and Branding

Providing amenities along multi-use facilities can help to enhance the comfort and function of the facility by making it feel like a destination in itself. Amenities can include benches, picnic tables, rest areas, shelters, drinking fountains, public toilets, bicycle parking, and recycling and garbage receptacles. These amenities can help to extend the amount of time someone may choose to spend using a facility.

When installing amenities, it is important to ensure that they are accessible to all users and to consider

Multi-use pathway signage, City of North Vancouver, B.C.

the location in which they are installed. Preferred locations include:

- Areas where people are inclined to stop, such as scenic areas and lookouts, the top of a hill, or in front of a natural attraction;
- Near existing amenities or destinations; and
- Areas that are sheltered from wind and inclement weather.

More information about pedestrian amenities can be found in **Chapter C.3**.

Wayfinding on multi-use facilities is also an important consideration to ensure users are aware of destinations along the facility and connections to the larger active transportation network. Branding pathway and other multi-use facilities can help with wayfinding and promotion. More guidance on wayfinding can be found in **Chapter H.3**.

Lighting

Lighting is important to identify potential hazards and to ensure that users are visible to each other and to motor vehicle traffic at intersections and crossings. Providing well-lit multi-use facilities can help make the facility safe and comfortable in all seasons and at all times of day. This is especially applicable for pathways that are intended for commuter use. However, providing lighting along the length of a multi-use pathway may be cost prohibitive and may require additional maintenance. More guidance about lighting design, application, and staging, including future- proofing pathways for the future addition of lighting, can be found in **Chapter H.4**.

Controlling Access

Access control devices are often used at locations where multi-use facilities intersect roads. These devices restrict access by unauthorized motor vehicles while still accommodating periodic access (such as maintenance and emergency vehicles). They can also visually indicate to users of the multi-use facility the need to slow down as they approach intersections and road crossings. There are a number of physical features and treatments that can be used as access control devices.

Controlling access is a more significant consideration during the design of multi-use pathways and separated bicycle and pedestrian pathways. The nature of a shared space is to provide access for all modes and not restrict access. However, providing clear gateway features at the entrance to shared spaces is critical. More information about gateway features for shared spaces can be found in **Chapter E.4**.

For pathways, current best practice is to avoid the use of rigid bollards or maze gates at pathway points of entry unless there is a demonstrated history of motor vehicle encroachment, and/or a collision history. The use of rigid bollards or maze gates (offset gates) for controlling speed of pathway users is also not appropriate, as the slowing effect is achieved by creating a potential safety hazard to the pathway users. Bollards and other obstructions placed within the operating space of a bicycle facility have been shown to present a significant injury risk to bicycle users. Refer to **Chapter G.5** for further details about access restrictions.

Research Note

The Cyclists' Injuries & the Cycling Environment (BICE) study conducted for the Cycling in Cities Program at the University of British Columbia found that 12% of all cycling injury collisions requiring emergency room treatment were a result of impacts with infrastructure such as bollards, street furniture, curbs, fences, speed bumps, or stairs. Maze gates can also impact snow clearing as it creates a barrier, which may lead to lower operational standards for people cycling.

Multi-use pathway, Saanich, B.C.

Galloping Goose Trail, Victoria, B.C.

E.2

MULTI-USE PATHWAYS

Multi-use pathways are off-street pathways that are physically separated from motor vehicle traffic and can be used by any non-motorized user. This includes people walking, cycling, and using other forms of active transportation such as skateboarding, kick scootering, and in-line skating Multi-use pathways may also be referred to as shared-use pathways, multi-use trails, and boulevard multi-use pathways.

Typically, multi-use pathways accommodate bi-directional travel for all users, although there are some cases where bicycle travel may be uni-directional. Multi-use pathways may be installed in a variety of land-use contexts and environments, including but not limited to:

- Parallel to an adjacent **roadway or highway** (most appropriate when unbroken by frequent driveways and alleyways);
- Parallel to or within **rail corridors**;
- Within **utility corridors**;
- Within **greenway corridors**; or
- Other contexts such as within **park sites** or **adjacent to water features** such as rivers, lakes, or the ocean.

Longer pathways will often use a variety of rights-of-way and pass through many diverse environments. This section discusses multi-use pathways under local and regional government jurisdiction Refer to **Chapter F.1** for guidance on multi-use pathways along or adjacent to roadways under provincial jurisdiction.

In many communities, multi-use pathways are considered a comfortable active transportation facility appropriate for people of all ages and abilities. However, multi-use pathway conditions may feel less comfortable if there is a high volume and a diverse mix of users, as this can make the pathway feel congested and can be uncomfortable if the speed differential between users is high. The growth in popularity of electric bicycles and small, one-person electric vehicles has the potential to compound this conflict. Obstructions and other physical features commonly located along multi-use pathways, including signage, bollards, and overgrown vegetation, may create safety hazards and should be managed or positioned appropriately.

Research Note

Research at the Cycling in Cities Program at the University of British Columbia found an increased injury risk associated with multi-use pathways as compared to bicycle pathways, which separate bicycle users from other modes.[1] This was due to the increased potential for conflicts with other pathway users. The planning and design of multi-use pathways must be done with the same care and attention to different user needs as the design of other transportation facilities. As such, the intended function and use of the pathway is a key consideration that is addressed at the facility planning stage and is necessary to inform facility design. Multi-use pathway infrastructure needs to serve the intended use while minimizing potential conflicts between users of varying speeds, abilities, and purposes. When designing a multi-use pathway, design professionals must consider how to balance the number of expected users with the intended purpose of the facility.

1 Kay Teschke et al., 'Bicycle Crash Circumstances Vary by Route Type: A Cross-sectional Analysis', BMC Public Health, 14:1205 (2014): 1471-2458.

BENEFITS + LIMITATIONS

Benefits

- Separated from motor vehicle traffic and generally have limited impacts on roadway operations, except at crossing points.
- Physical separation from motor vehicle traffic helps to increase the real and perceived safety along the corridor. They are typically considered appropriate for people of all ages and abilities.
- Can encourage recreational walking and cycling trips and are appealing to families and less experienced bicycle users.
- Can be a tourist attraction and destination by providing a long-distance route to or within a natural or recreation area.
- Can provide continuous and direct routes with minimal stops and jogs.
- May be cost effective if utilizing existing corridors or upgrading existing facilities.

Limitations

- There is potential for conflict between different pathway users. The speed differential associated with people cycling and pathway users of different skill or fitness levels can be a risk. This is an issue along the corridor and at intersections. These conflicts can be mitigated by separating users.
- Potential conflicts with motor vehicles at intersections, mid-block crossings, alleyways and driveways.
    - *Conflicts can be more significant if bicycle traffic is bi-directional.*
    - *There may also be issues with pathway user visibility at crossings.*
    - *Crossings at major roads can be inconvenient and unsafe.*
    - *May need to reduce the number of existing accesses and alleyways in urban areas.*

- *Crossings at intersections can impact road operations as additional signalization and protected phasing may be necessary to promote safety.*
- *May not be considered all ages and abilities facilities if conflicts at intersections and crossings are not mitigated.*
- Additional lighting needs to be considered to ensure hazards and pathway users are visible along the corridor and at crossings.
- Ongoing operations and maintenance costs can be greater than some on-street facilities. Drainage can be a concern, particularly in the winter with ice accumulation. Additional snow removal or clearance from the pathway may be required. Vegetation may encroach on the pathway and debris may collect, requiring frequent maintenance.
- A bi-directional pathway located on one side of the road does not provide equal access and connection to the other side.
- May not be attractive to people cycling for commuter purposes.
- Costs are highly variable and based on existing conditions. Costs can be greater where property needs to be acquired or utilities need to be relocated.

TYPES OF USERS

Multi-use pathways are intended to be used by a wide range of users with varying ages, abilities, operating speeds, and dimensions. The full range of active transportation users is outlined in **Section B**. Notable potential uses of multi-use pathways include horseback riding and winter-based modes, such as snowshoeing, cross-country skiing, and kicksledding. Electric bicycles and small, one-person electric vehicles also warrant special consideration as well. See **Chapter H.5** for more details on these new mobility modes.

Multi-use pathways are used for a wide variety of trip purposes. As such, user behaviour, such as travel speed and willingness to make stops, varies considerably. It is intended that users share the multi-use pathway in an equal manner – no one user type is given priority over another.

In some communities, multi-use pathways may also be used by motorized vehicles such as all-terrain vehicles (ATVs), utility-terrain vehicles (UTVs), off-road motorcycles, and snowmobiles. As the intent of this guide is to focus on active modes, design guidance for multi-use pathways that facilitate motorized vehicles is not included in the Design Guide.

Off-street pathway groomed for cross-country skiing, Fort McMurray, AB
Source: Amie McGowan

TYPICAL APPLICATIONS

There are several different contexts where multi-use pathways are appropriate and can be installed. Specific applications of multi-use pathways are described in more detail below.

Highway Corridors

Multi-use pathways may be located adjacent to provincial highways and other roadways under provincial jurisdiction. More information about considerations for pathways adjacent to or within provincial rights-of-way can be found in **Chapter F.1**.

Road Corridors

Multi-use pathways can be located adjacent to the road within the road right-of-way in urban, suburban, and rural contexts. Multi-use pathways can be installed parallel to the road with a horizontal buffer separation in the Street Buffer Zone, or they can be located directly adjacent to the road with vertical separation. Pathways that follow roadway corridors are considered to be an attractive option as they provide the benefits of a direct route offered by on-street facilities, while providing a high level of comfort for users.

Multi-use pathways that are located adjacent to a road can be considered along corridors where the number of interactions with motor vehicles (such as at driveways, alleyways, and intersections) are kept to a minimum, and where the interactions that already exist are mitigated. As such, considerations for multi-use pathways adjacent to an existing road should include: reviewing the number of locations of possible interactions with motor vehicles, pedestrian volumes, proximity to the road, access to destinations, and whether land use is road oriented. In cases where there are a higher number of interactions with motor vehicles and/or higher anticipated volumes of certain types of users, separated pedestrian and bicycle pathways are recommended, as described further in **Chapter E.3**.

Multi-use pathways that are located within a road right-of-way can be considered when the following conditions apply:

- There is sufficient right-of-way width;
- The pathway is located outside of the highway clear zone (see **Chapter F.1**);
- The pathway will be separated from all motor vehicle traffic;
- There is a limited number of crossings (such as intersections, alleyways, and driveways);
- Pathway continuity can be provided;
- The pathway can be terminated at each end of the corridor onto roads or other pathways;
- There is adequate access to local cross-streets and other facilities along the corridor; and/or
- The land use along the corridor is not built up.

If a multi-use pathway is located within an urban land-use context, separating bicycle users from other users is generally recommended. If the boulevard right-of-way is available, a sidewalk level protected bicycle lane would be the preferred facility over a multi-use pathway. Design guidance on this facility can be found in **Chapter D.3**.

When a multi-use pathway is located adjacent to a road, there is typically some form of separation between the pathway and the motor vehicle lane in the Street Buffer Zone. A variety of treatments can be used in the Street Buffer Zone including a landscaped boulevard, vertical objects such as barriers, fences, or wooden posts, or a strip of grass. When selecting the type of Street Buffer Zone treatment, ongoing operations and maintenance costs, the horizontal clearance, as well as obstructions to signage and sightlines should be considered.

Rail Corridors

Multi-use pathways in rail corridors include pathways that are located within abandoned rail corridors or adjacent to active rail corridors. Rail corridors have gentle grades, an existing base and sub-base, access to the centre of communities, and typically offer scenic views, making them good multi-use pathway routes. There can, however, be challenges to installing multi-use pathways within rail corridors, including personal security concerns associated with lighting and isolation, emergency services access, maintenance access, right-of-way acquisition or easement, potential environmental contamination, land ownership, rehabilitation issues, and liability (e.g. who is at fault in the event of an injury on multi-use pathways located within a rail right-of-way).

Greenway Corridors and Waterfronts

Greenway corridors can include multi-use pathways that are incorporated into linear natural areas such as parks or conservation areas, along stream or river valley corridors, along waterfronts including beaches and shorelines, or along dykes and canals. Similarly, as seen with rail corridors, personal safety concerns and lighting can be an issue associated with facilities at these locations. Other issues can include managing potential environmental impacts, reducing stormwater runoff, and protecting against erosion. Additionally, network connections and facilitating trips being made for transportation purposes can be a challenge.

DESIGN GUIDANCE

Width

The desirable width of a multi-use pathway (see **Table E-20**) is influenced by a number of factors, including:

- Adjacent land uses;
- Available space/right-of-way;
- Topography;
- Location of the pathway (adjacent to a major road, local road, or located within another context); and
- Anticipated volume and type of users.

Because multi-use pathways can be considered all ages and abilities facilities, they often attract a variety of users, some of which may operate at slower speeds. As a result, providing sufficient space to pass others is an important consideration when designing this type of facility. In addition, planning for pathway maintenance – including snow storage and the width of maintenance equipment, such as sweepers and snow plows suitable for maintaining pathways – is another important consideration.

Highway Corridor

Guidance on the width of multi-use pathways within or adjacent to provincial roadways is discussed in **Chapter F.1**.

Road Corridors

For bi-directional multi-use pathways adjacent to arterial and collector roads, the desirable width is 4.0 metres (see **Figure E-58**). For multi-use pathways along local roads or within rural contexts, the desirable width is 3.0 metres.

The constrained limit width of a multi-use pathway is 3.0 metres. The minimum width of a multi-use pathway is 2.7 metres, based on the operating envelope of a single bicycle user (1.2 metres) and the operating envelope of two people walking abreast (1.5 metres).

In more urban settings, connectivity to the active transportation network and accessibility to land use are important considerations for pathway users. A pathway on only one side of the road is only appropriate where there are limited or no destinations on the other side, or if it is physically impossible to provide a facility on both sides. If 4.0 metres is available on both sides, a separate sidewalk and uni-directional sidewalk level protected bicycle lane should be considered.

The recommended width of the buffer in the Street Buffer Zone varies based on the characteristics of the road. On arterial, collector, and rural roads, the desirable buffer is 2.0 metres or greater, with a constrained limit of 0.6 metres. On lower volume local roads, the desirable width is 1.5 metres or greater, with a constrained limit of 0.6 metres. This space can be used for landscaping, road trees, lighting, and snow storage in winter months.

All Other Contexts

Multi-use pathways in all other contexts include pathways located within parks, rail and greenway corridors, and along waterfronts. For bi-directional multi-use pathways in all other contexts, the recommended width of the multi-use pathway is 3.0 metres. An additional 0.6 metres should be provided on both sides of the multi-use pathway for additional clear width. When steep side slopes or large drops are present, the shoulder width should be increased to 1.5 metres on each side (discussed in more detail in the Side Slope section on page E19).

It is important to monitor multi-use pathway use to determine if the width of the facility is appropriate for the number and ratio of users over time. While the Design Guide identifies desirable and constrained limit widths, if space is available, providing a wider facility should be considered particularly if a high volume of users is anticipated.

Table E-20 // Multi-Use Pathway Width Guidance

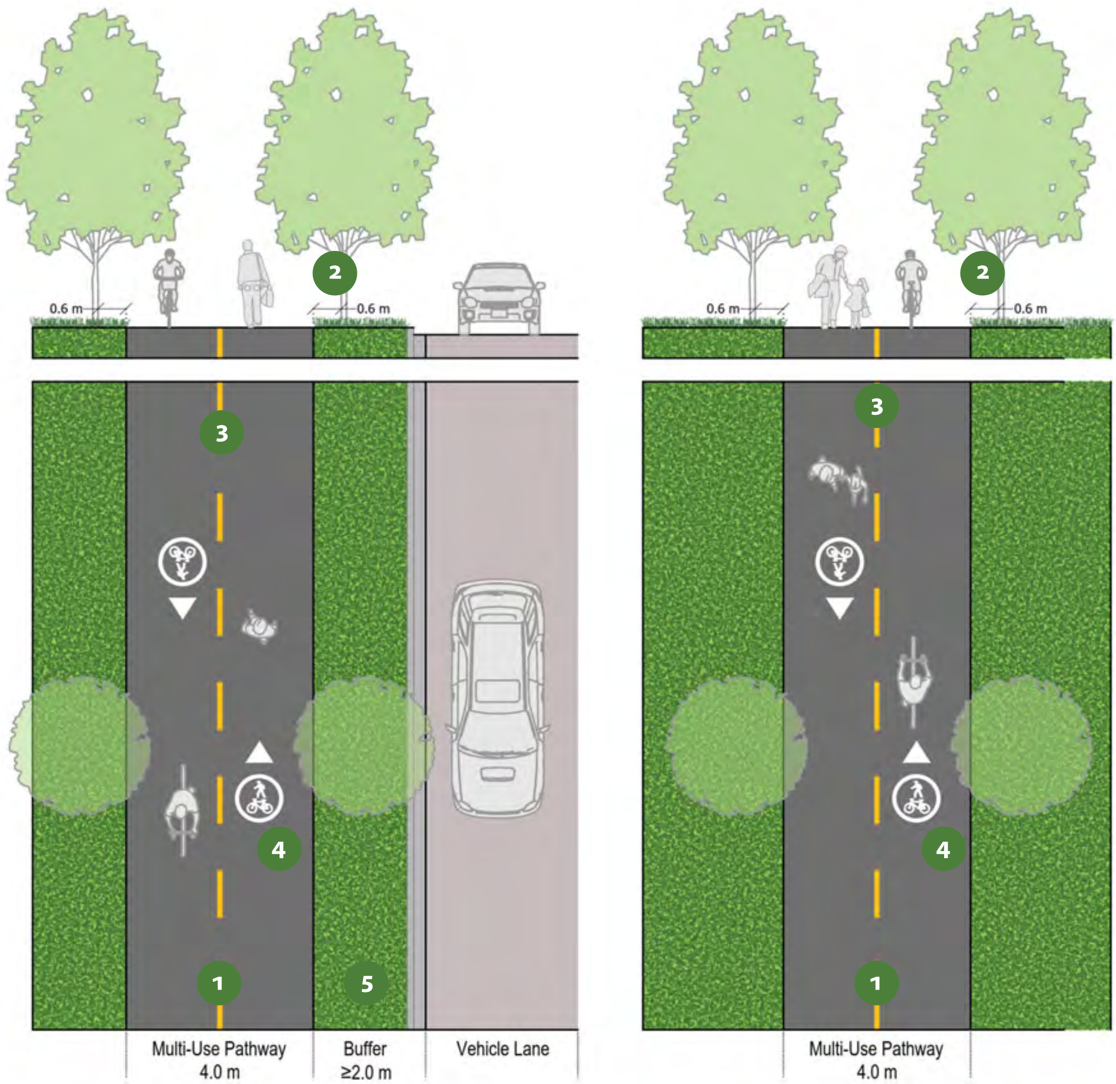
CONTEXT	DESIRABLE (M)	CONSTRAINED (M)
Highway Corridor		
See **Chapter F.1**		
Roadway Corridor (Arterial and Collector Roads)		
Pathway Width	4.0	3.0
Street buffer Zone Width*	≥ 2.0	0.6
Roadway Corridor (Local Roads)		
Pathway Width	3.0 – 4.0**	3.0
Street Buffer Zone Width*	≥ 1.5	0.6
All Other Contexts		
Pathway Width	3.0 – 4.0**	2.7
Lateral Clearance	0.6***	0.6

*Where a paved shoulder is present, the separation distance begins at the outside edge of the shoulder. The paved shoulder is not included as part of the separation distance.

** For high volume facilities with a variety of different user types, consider using widths at the higher end of the design domain.

*** Desirable lateral clearance increases depending on side slope (see side slope section below).

Saanich, B.C.



Roadway Context (Arterial or Collector)

Non-Roadway Context

1. Desired width of 4.0 metres
2. Horizontal buffer of 0.6 metres on both sides of pathway
3. Optional dashed directional dividing line striping to separate direction of travel
4. Pavement markings providing guidance for types of users and direction of travel
5. Buffer from motor vehicle travel lanes

Figure E-58 // Multi-use Pathway Cross-Section - Desired Widths and Key Features

Separating Pathway Users

The decision to separate bicycle users from other users is based on a number of factors including: right-of-way width available, the total volume of current and anticipated pathway users, and the ratio of pedestrians to all daily pathway users. If the required space is available, it is recommended to provide separation between bicycle users and other pathway users. This can help to enhance pathway safety and make the facility more comfortable for all users.

For multi-use pathways that have already been constructed, the *TAC Geometric Design Guide for Canadian Roads* provides the following guidance for when to separate users:

- Where there is a high percentage of pedestrians (more than 20% of users) and total user volumes greater than 33 persons per hour per metre of pathway width; or
- Where there is a low percentage of pedestrians (less than 20% of users) and a total user volume greater than 50 persons per hour per metre of pathway width.

In locations where no pathway is currently in place, existing and future land use should be considered as well as ridership numbers on existing facilities within a similar context to obtain an understanding of projected volumes. The width of the pathway is also another important consideration for separating users, as indicated in **Table E-21.** This table applies the guidance described on the left from the TAC *Geometric Design Guide for Canadian Roads* and summarizes when separation is required based on pathway width. For example, if a 3.0 metre pathway has more than 1,000 daily users, and at least 20% of those users are pedestrians (at least 200 pedestrians), then it is recommended that separate pedestrian and bicycle pathways be provided. If the ratio of pedestrians to bicycle users is smaller, then a higher number of pathway users may be appropriate before separation is needed. For example, if the same 3.0 metre pathway has higher volumes (more than 1,500 users), but with a lower mix of pedestrians (less than 20%), then it is recommended that separate pedestrian and bicycle pathways be provided.

More generally, communities such as the City of Vancouver and guidance from Australia suggest that if there are 1,500 combined users on a facility that is between 3.0 to 4.0 metres in width, and if space is available, separation of people walking and cycling is recommended.

The type of separation provided can vary. Separation can involve anything from painted lines to physical separation. More information about types of separation is provided in **Chapter E.3**

Table E-21 // Calculation Guidance for Separating Pathway Users

USER RATIO FOR SEPARATION	DAILY ANTICIPATED USER VOLUME FOR VARIOUS PATHWAY WIDTHS (USERS)		
	3m	3.5m	4m
More than 20% of users are pedestrians and total user volumes are greater than 33 persons per peak hour	1,000	1,200	1,400
Less than 20% of users are pedestrians and total user volume is greater than 50 persons per peak hour	1,500	1,750	2,000

Direction

Multi-use pathways typically accommodate bi-directional travel for all users. However, there may be some cases where bicycle travel is limited to uni-directional. When considering a bi-directional facility, particularly if it is adjacent to a roadway, it is important to review all constraints and challenges with contraflow travel by all users of the pathway. Contraflow bicycle movements in particular requires special attention at intersections, alleyways driveways, and other conflict points as people walking and driving may not anticipate contraflow movements. Appropriate sight distances between motorists and bicycle users are important to allow both parties to react accordingly.

Potential conflicts can be mitigated through additional signage and pavement markings, as well as adjusting signal phasing at intersections. Protected signal phasing may be provided if warranted; alternatively, a leading signal phase may be provided for people walking and cycling. Refer to **Chapter G.2** for more detail on signal phasing strategies.

Surface Material

As multi-use pathways are intended to be accessible and accommodate a wide range of users and trip purposes, asphalt is the preferred surface type. Asphalt surface treatment provides a smooth continuous surface that is accessible for all user groups at a relatively modest cost. Asphalt is a resilient and flexible material that can last a decade or longer if installed properly.

There are some contexts where other materials such as compact aggregate, paving stones, saw cut concrete, stabilized earth, or other special treatments may be considered. These materials may be appropriate for multi-use pathways through parks, plazas, as well as other environmental and context sensitive areas. As discussed in **Chapter C.4**, unpaved pathways are lower cost and add an extra degree of flexibility to pathway design in rural and suburban areas. However, it is important to note that these surface materials can have an impact on varying types of users. They can be challenging for those with limited mobility or visual impairments, people using mobility aids, and can cause discomfort for people cycling by creating additional vibrations. They are not recommended if the pathway is intended to be accessible and used for a variety of trip purposes.

Design Speed

The design speed of a multi-use pathway should be able to accommodate the preferred speed of the fastest pathway users, while also considering the need to control speeds in a multi-use setting. There is no single design speed that works for all contexts. However, the following guidance can be used to determine the appropriate design speed:

- For most off-street pathways in relatively flat areas with grades of less than 2%, a design speed of 30 km/h is generally sufficient for the common user. The minimum design speed should be no lower than 20 km/h, except in rare circumstances where the context and user types support a lower speed. Lower design speeds (20 km/h) should be considered along paved pathways and where multiple conflict zones occur, such as driveways, intersections, and where there is a mix of users.
- In areas of hilly terrain and long steep grades, the design speed of multi-use pathways should be based on the anticipated travel speed of bicycle users travelling downhill. Upright bicycle users are generally considered the critical users on most multi-use pathways with respect to design speed guidelines. In most cases, 50 km/h is the maximum design speed that should be used.

Longitudinal Grade

Longitudinal grade is an important consideration for both accessibility and drainage. A minimum grade of 0.6% is required to facilitate drainage. The recommended longitudinal grade for a multi-use pathway, where feasible, is 0.6%, as a flatter pathway is easier to navigate for a pathway user. The ideal longitudinal grade from a pathway user perspective is 4.0% or less. The recommended maximum longitudinal grade of a multi-use pathway is 5%.

When a pathway is any steeper than 5%, flatter resting areas should be provided at set intervals, depending on the severity of the longitudinal grade. For pathways with grades between 5% and 6%, a flatter resting area of 3% or less should be provided every 100 metres. For pathways with grades between 6% and 8%, a flatter rest area should be provided every 50 metres. Where a pathway has grades steeper than 8%, alternative treatments should be explored, such as including switch backs or locating the pathway along a route with a flatter grade.

Cross Slope

The recommended minimum and maximum cross slope for a multi-use pathway is 2% to ensure adequate drainage and to ensure that the multi-use pathway will be accessible for people in wheelchairs or with other mobility challenges. The maximum cross slope is 5%, which should only be used for short distances, such as across driveways.

Typically, the cross slope should angle in one direction, as this design is easier for maintenance and snow removal.

Side Slope

The side slope that is located alongside a multi-use pathway can present a hazard to pathway users when the slope reaches a certain percentage and creates a drop off. For example, a multi-use pathway may run alongside a ditch. If a pathway user were to veer off the pathway and into the ditch, this has the potential to cause injury to the pathway user.

As outlined in the section on page E15, multi-use pathways should have a minimum of 0.6 metres of clear space on either side of the facility. At certain side slope thresholds, this space should be increased to 1.5 metres. If 1.5 metres of clear space cannot be provided in these settings, a railing or barrier should be installed to help mitigate potential hazards. The railing or barrier should be located at least 0.6 metres from the pathway. Side slope considerations are shown in **Figures E-59** to **E-61**. A minimum railing height of 1.4 metres should be used on multi-use pathways in order to accommodate people cycling.

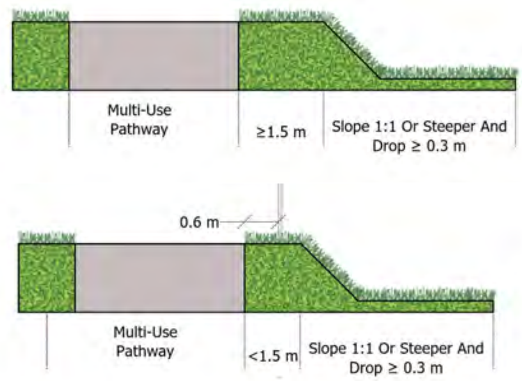


FIGURE E-59 // SIDE SLOPE OF GREATER THAN 1:1 AND A DROP OFF GREATER THAN OR EQUAL TO 0.3 METR3S

Source: Adapted from Trails in Alberta Highway Rights-of-Way, Figure 4.3

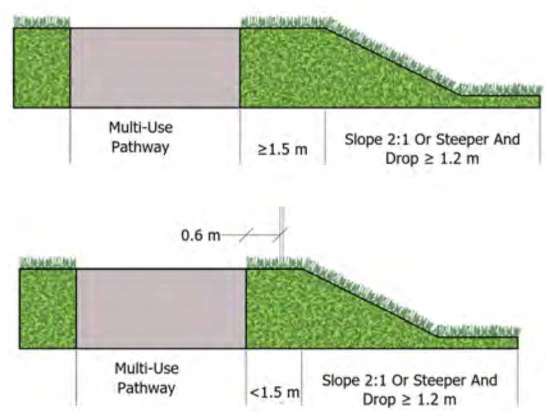


FIGURE E-60 // SIDE SLOPE OF GREATER THAN 1:2 AND A DROP OFF GREATER THAN OR EQUAL TO 1.2 METRES; OR

Source: Adapted from Trails in Alberta Highway Rights-of-Way, Figure 4.3

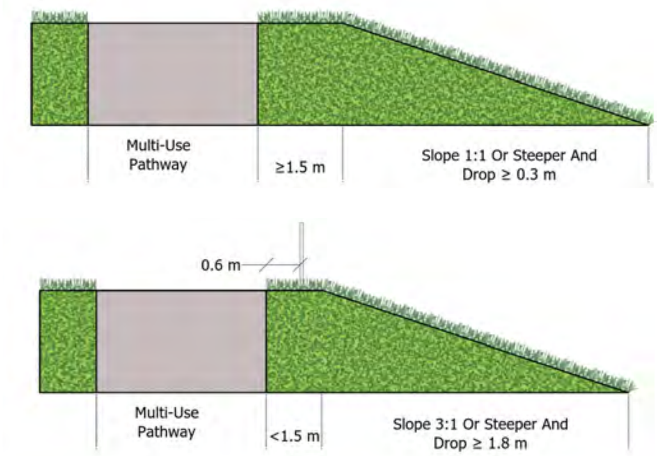


Figure E-61 // Side slope of greater than 1:3 and a drop off greater than or equal to 1.8 metres, to a hazard (such as a water body)

Source: Adapted from Trails in Alberta Highway Rights-of-Way, Figure 4.3

Sight Distance

Multi-use pathway sight distance is the length of the pathway that is observable by a user. Providing appropriate sight distance allows the pathway user to recognize an obstruction such as debris, other pathway users, and intersections, with enough time to take the appropriate action to avoid conflict. Similarly, it allows motorists to recognize pathway users at crossings or intersections and react accordingly. This section focuses on appropriate sight distance for pathway users along the corridor. Design guidance for sight distances at intersections and crossings is included in **Chapter G.1**. There are three sight distances to consider for pathway design that are discussed in this section.

Stopping Sight Distance

Stopping sight distance provides adequate space for users to react to and make a fully controlled stop before encountering a conflict along a pathway. This can be calculated based on a user's speed, the coefficient of friction between a vehicle's tires and the pathway surface, and the vertical grade of the pathway. Section 5.5.2 of the TAC *Geometric Design Guide for Canadian Roads* includes an equation that should be referenced to determine stopping sight distance for multi-use pathways:

$$SSD = 0.694V + \frac{V^2}{255\left(f + \frac{G}{100}\right)} \qquad (5.5.1)$$

Where: SSD = stopping sight distance

V = design speed or velocity (km/h)

F = coefficient of friction

G = grade (m/m; % upgrade is positive and downgrade is negative)

Source: TAC *Geometric Design Guide for Canadian Roads*, Section 5.5.2

The first term in the expression is the distance travelled during a perception-reaction time of 2.5 s. The second term is the distance travelled after brakes are engaged.

Sight Distance on Vertical Crest Curves

Vertical crest curves can pose limitations on available sight distance and make it difficult for pathway users to identify hazards at ground level if the vertical curve is small. Section 5.5.4.2 of the TAC *Geometric Design Guide for Canadian Roads* includes an equation that should be referenced to determine the appropriate length of a crest vertical curve in order to ensure adequate sight distance for multi-use pathway (see **Table E-22**).

Table E-22 // Crest Vertical Curves for Bicycles (Paved Surface, Wet Conditions)

MINIMUM CURVE LENGTH									
Algebraic Changes of Grade - A (%)	Design Speed (km/h)								
	10	15	20	25	30	35	40	45	60
2	-	-	-	-	-	-	-	-	11
5	-	-	-	-	15	32	51	71	100
10	-	-	13	27	44	69	102	145	199
16	-	10	22	40	67	104	153	-	-
20	3	14	20	54	-	-	-	-	-
25	8	18	37	-	-	-	-	-	-

Source: TAC *Geometric Design Guide for Canadian Roads*, Table 5.4.2

Notes (from TAC *Geometric Design Guide for Canadian Roads*, Table 5.5.4):

Above the heavy line, stopping sight distances are greater than the curve length:

$$L = 2(SSD) - \frac{274}{A} \qquad (5.5.4)$$

Where: SSD = minimum stopping sight distance from Table 5.5.1 of the 2 of the TAC *Geometric Design Guide for Canadian Roads*

A = algebraic difference in grades (%)

Below the heavy line, stopping sight distances are less than the curve length:

$$L = \frac{A(SSD)^2}{274} \qquad (5.5.5)$$

For multi-use pathways, the height of the eye is taken to be 1.37 metres and the object height is taken to be zero metres. Note that where a multi-use pathway is expected to have a significant number of users that are children, a lower eye height may be appropriate.

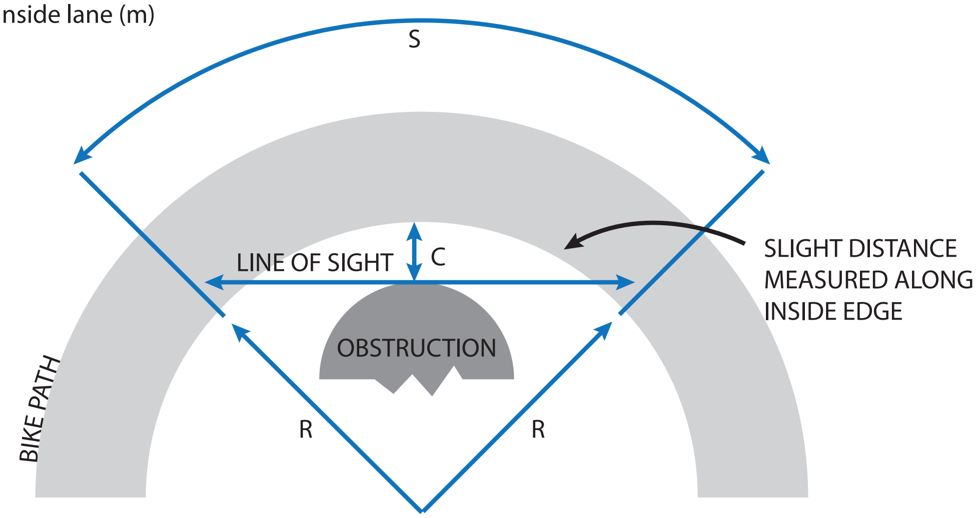
Horizontal Sightline Offset

The horizontal sightline offset (HSO) is the minimum lateral clearance that should be provided for line-of-sight obstructions at the inside of horizontal curves (see **Figure E-62**). Objects found to be between the centreline of the inside of a curve and the HSO limit are considered a sightline obstruction to pathway users and should be eliminated where feasible. Examples of obstructions that may be found within the HSO include barriers, bridges, cut slopes, and trees or brush. On narrower pathways, users will likely travel closer to the centre of the pathway, creating a higher chance of collisions occurring on curves.

Where feasible, it is recommended that the HSO be calculated based on the summation of the individual stopping sight distances of pathway users travelling in both directions along the curve. Section 5.5.3.2 of the TAC *Geometric Design Guide for Canadian Roads* includes an equation that should be applied to determine the appropriate horizontal sightline offset, which is based on stopping sight distance.

$$C = R\left[1 - COS\left(\frac{90S}{\pi R}\right)\right] \qquad (5.5.3)$$

S = stopping sight distance (m)
R = radius of inside lane (m)
C = distance from inside lane (m)



NOTE: Formula applies only when
'S' ≤ length of circular curve

Figure E-62 // Horizontal Sightline Offset for Off-Street Pathways

Source: TAC *Geometric Design Guide for Canadian Roads*, Figure 5.5.1

Drainage

Providing proper drainage along a multi-use pathway is important to ensure that the facility can be used safely by all users all year-round. Proper drainage can also help ensure the durability of the pathway and help to reduce maintenance costs. Additional drainage design considerations should be given to pathways located in drainage ditches and/or low-lying areas. Opportunities to mitigate deterioration from weather events and annual precipitation can also be considered during the design process.

Overland drainage (surface runoffs) should be designed such that water does not run across the pathway, as this can lead to pooling or ice formation on the pathway. In addition, the overland drainage should not be directed such that it compromises the pathway subgrade, in particular during freeze/thaw cycles. Ditches or curbs and culverts can be used to redirect up-slope drainage so that it does not drain across the pathway. The pathway should be sloped or crowned, allowing water to drain off. Consideration of whether to crown or slope the pathway will depend on a number of factors including the adjacent landscape condition, the longitudinal grade, and the horizontal curvature of the pathway. Additionally, construction costs and site challenges, including accommodating drainage on both sides of the pathway, can make crown construction challenging. Where crowned construction is not feasible, a sloped pathway may be appropriate.

General drainage principles for multi-use pathways include:

- Ensure surface water flows away from the pathway by angling side slopes down and away from the edge of the pathway;
- Ensure subsoil drains away from pathway edge by placing and compacting subgrade in such a way that water flows down and away from the area directly beneath the pathway;
- Prevent water from becoming trapped in the subsoil by using a sandy/gravely subsoil; when this is not possible, take extra precaution to ensure that surface run-off does not run across the pathway;
    - *Where ditches are implemented, the ditch bottom should be maintained at a lower elevation than the aggregate base layer.*
- Prevent stormwater from running across the pathway surface by intercepting water with a ditch and locating the ditch bottom as far away from pathway edge as possible; and
- Keeping water moving off the pathway by providing a cross-slope on the pathway.

If drainage grates are required, they should be placed outside of the travel path for pathway users. If grates must be placed on the multi-use pathway, they should be bicycle-friendly, including grates that have horizontal or diagonal slats on them or no grate, so that bicycle tires and assistive devices do not fall through the vertical slats. Catch basins should be regularly cleared of debris so that drainage is not compromised.

SIGNAGE

The Shared Pathway sign (MUTCDC RB-93; B.C. B-G-002 Series) indicates that both people walking and cycling are permitted to use the pathway.

The Pathway Organization sign (MUTCDC RB-94; B.C. B-G-003 Series) indicates to people walking and cycling how to share a pathway on which there is a designated area provided for each.

PAVEMENT MARKINGS

Pathway Markings

Multi-use pathway symbols along the pathway can be used to supplement signage and enhance awareness of the shared-use function of the pathway. If multi-use pathway symbols are being installed along the pathway, markings should be placed every 50 to 100 metres, depending on the context; tighter spacing may be considered near sharp corners and in areas of high conflict. Multi-use pathway symbols should also be used at pathway entrances and on the far side of crossings.

Directional Centreline Striping

Centreline striping is generally not recommended along multi-use pathways. Although the use of a centreline can reduce the possibility of a conflict between users travelling in different directions, it can contribute to conflicts that arise when faster moving pathway users cross the centreline to pass slower moving users. Many pathway users also disregard centrelines, which can create conflicts. In addition, a centerline implies a 'rule' that is likely to generate complaints but not be enforced.

However, in certain scenarios, centreline striping may provide safety and wayfinding benefits. Centreline striping is recommended when multi-use pathways are located on hills with a grade steeper than 5%, at locations where passing is dangerous due to space constraints and limited visibility, and/or as a way of wayfinding and demarcating the pathway at locations such as pathway access points and at intersections. The wayfinding benefits can be especially important where the pathway is not lit. Centreline striping is also recommended at locations where pathways experience high bi-directional volumes and where a pathway is commuter-oriented or a high volume of commuters are present, as the centreline may help to delineate space and minimize conflicts.

Hazard Striping

Longitudinal or traverse hazard striping should be added around objects on the pathway to guide users away from the hazard.

Edge Line Striping

Longitudinal or traverse edge line or fog line striping may be added to help delineate the edge of a pathway. This is especially applicable when the pathway is adjacent to a hazard such as a fence or drop off, or where the pathway is not well lit. Edge line striping will require increased maintenance to ensure that the lines are visible in all seasons.

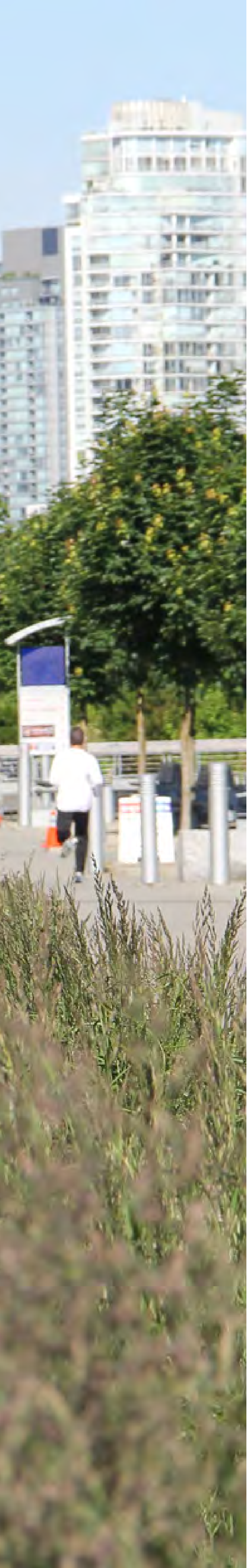
Intersection and Conflict Zone Markings

There are two types of pavement markings that are most often used at intersections and conflict zones along multi-use pathways: pedestrian crosswalks and cross-rides for people cycling. Pedestrian crosswalks are typically marked with either parallel white painted lines aligned along the crossing direction or zebra pavement markings that are painted perpendicular to the crossing pedestrian crossing direction (see **Chapter G.3** for more details). Cross-ride pavement markings (also called elephant's feet) are white broken lines painted along the cycling crossing direction and can either be installed on the outside of a crosswalk or alone. Cross-rides are not currently described in the *B.C. Motor Vehicle Act* but have been used in a number of B.C. municipalities (see **Chapter G.4** for more details).

For multi-use pathways, green conflict zone pavement markings should be reserved for conflict points with motorists, including driveways and intersections where the bicycle and pedestrian facilities have been separated. See **Chapters G.4** and **G.5** for more information on conflict zone markings and off-road pathway crossings.

Signage and pavement markings on the Green Necklace Pathway in North Vancouver, B.C., showing shared pathway signage (top left), multi-use pathway pavement marking and green directional centre line striping (special colour used as pathway branding/wayfinding) (top right), hazard striping (bottom left) and edge line striping (bottom right).

Seaside separated off-street pathway, Vancouver, B.C.
Source: City of Vancouver



E.3

SEPARATED BICYCLE + PEDESTRIAN PATHWAYS

Separated bicycle and pedestrian pathways function similar to multi-use pathways. The key difference is the provision of separation between people cycling and other users. The type of separation between users can range from a painted line or visual separation to a vertical or horizontal feature.

Separated bicycle and pedestrian pathways can be located in a variety of contexts, including those similar to multi-use pathways. This includes rail corridors, greenway corridors, parks, and along waterfronts.

Separated bicycle and pedestrian pathways can also be located adjacent to a road. If the facility is located adjacent to a road, and the bicycle users and other users are separated by a painted line, then the facility design guidance (with the exception of width) would be the same as a multi-use pathway as described in **Chapter E.2**. If a separated bicycle and pedestrian pathway is located adjacent to a roadway and users are separated by some type of physical separation, the facility would be considered a sidewalk level protected bicycle lane with an adjacent sidewalk. Guidance for these facilities can be found in **Chapter D.3** and **Chapter C.2** respectively.

Regardless of land-use context, a bicycle pathway should always be located parallel to a pedestrian pathway or a sidewalk. If a parallel facility for pedestrians is not provided, it is likely that a bicycle pathway will be used by pedestrians and function as a multi-use pathway.

BENEFITS + LIMITATIONS

Separated bicycle and pedestrian pathways share many of the same benefits and limitations as multi-use pathways, as outlined in **Chapter E.2**. The key benefits and limitations as compared to multi-use pathways are listed below.

Benefits compared to multi-use pathways

- Separated bicycle and pedestrian pathways create a more comfortable environment and minimize the potential safety conflicts between people walking and faster-moving active transportation users, such as people cycling, in-line skaters, and other modes.
- These benefits are especially important where greater separation from motor vehicles and pedestrians is warranted, such as along pathways with high volumes of active transportation users.

Limitations compared to multi-use pathways

- Additional space and engineering treatments are required for separated bicycle and pedestrian pathways. This can be more costly especially if more property needs to be acquired.
- Separate facilities may require different levels of snow and ice control, including the use of specialized maintenance equipment to clear the width of the facility.
- Visual cues are needed to ensure separation is clear. In addition to visual cues, tactile cues can be provided to reinforce that there are two facilities with different user groups.

TYPES OF USERS

The difference between multi-use pathways and separated bicycle and pedestrian pathways is that the latter has space allocated to bicycle users that is separate from other users. As a result, two active transportation facilities are provided: a bicycle pathway that should be designed for the exclusive use of bicycle users, and a parallel pathway, sidewalk, or trail for people walking and other users. The type of pedestrian facility, and the type of users, is typically dependent on the context and location of the facility.

Bicycle pathways help to reduce the potential for conflict between people cycling and other non-motorized users. It is possible that other non-motorized users, including people using wheelchairs, scooters, and other mobility devices, may find bicycle pathways attractive depending on the location, surface material, and width of the pedestrian facility. Therefore, a bicycle pathway must be accompanied by a pedestrian facility that is equally as convenient, appealing, and connected.

TYPICAL APPLICATIONS

Separated bicycle and pedestrian pathways may be installed in a variety of contexts, within different types of rights-of-way, and in a variety of land-use settings. Two of the most typical applications of separated bicycle and pedestrian facilities are described below.

Not Adjacent to a Road

Separated bicycle and pedestrian facilities can be implemented in similar settings to multi-use pathways, such as through park spaces, within greenway and rail corridors, and along waterfronts. The difference in these contexts is that people cycling are separated and have their own designated space. This separation can be provided at the time of installation or retrofitted as the volume of multi-use pathway users exceeds threshold values as discussed in **Chapter E.2**.

Adjacent to a Road

In areas with built-up land use and where the bicycle and pedestrian pathway is located adjacent to a road, separating bicycle users from other road users is particularly important. A multi-use pathway is not ideal in situations where the pathway space is being used for utilitarian purposes such as access to homes and shops, patio space, etc.

Therefore, uni-directional bicycle pathways are more appropriate within this context. Uni-directional pathways travel in the same direction as motor vehicle traffic and also provide greater access to destinations than a bi-directional multi-use or bicycle pathway on one side of the road. In some contexts, such as areas with fewer motor vehicle interactions, bi-directional bicycle pathways may be considered. Design guidance for bicycle pathways can also be found in the section on sidewalk level protected bicycle lanes in **Chapter D.3**.

DESIGN GUIDANCE

As noted previously, additional design guidance for sidewalks can be found in **Chapter C.2** and additional design guidance for sidewalk level protected bicycle lanes can be found in **Chapter D.3**. This section focuses on guidance for designing separated bicycle and pedestrian pathways. Specifics on design speed, longitudinal grade, cross slope, side slope, sight distance, and drainage can be found in **Chapter E.2**. This section also provides design guidance on the types of separation that can be used to separate bicycle users from other users.

Bicycle Pathways

Direction of Travel

Both uni-directional and bi-directional bicycle travel can be considered for bicycle pathways. When considering a bi-directional facility, it is important to review the challenges associated with having contraflow bicycle travel. Contraflow movements require special attention at intersections, alleyways, driveways, and other conflict points as people walking and driving may not anticipate contraflow bicycle movements. Recommended widths for bicycle pathways and pedestrian pathways are provided in **Table E-23** and **E-24**, respectively.

Width

For uni-directional bicycle pathways, the desirable width of the pathway component is 2.0 metres to allow for two bicycles to pass each other or for side-by-side cycling. If bicycle volumes are expected to exceed 150 people cycling per peak hour of bicycle traffic, a width of 2.5 to 3.0 metres may be more appropriate. The constrained limit width of a uni-directional bicycle pathway is 1.8 metres. The absolute minimum width is 1.5 metres and should only be used for segments of the pathway that are less than 100 metres in length.

For bi-directional bicycle pathways, the desirable width is 4.0 metres with a constrained width of 3.0 metres. If bicycle volumes are expected to exceed 350 people cycling in both directions per peak hour of bicycle traffic, a width of 4.5 metres may be more appropriate. The absolute minimum width of a bi-directional bicycle pathway is 2.4 metres and should only be used for segments of the pathway that are less than 100 metres in length.

An additional 0.6 metres wide should be provided on both sides of the bicycle pathway for additional clear width4

TABLE E-23 // BICYCLE PATHWAY WIDTH GUIDANCE

FACILITY	DESIRABLE (m)	CONSTRAINED LIMIT (m)
Bicycle Pathway (Uni-Directional Bicycle)	2.0*	1.8
Bicycle Pathway (Bi-Directional Bicycle)	4.0	3.0

*If uni-directional bicycle pathway has greater than 150 bicycle users per peak hour for bicycle traffic, or there is a desire for side-by-side riding, then pathway should be 2.5 metres to 3.0 metres.

Surface Material

The preferred material for a bicycle pathway is asphalt. In natural or environmentally sensitive areas, compact aggregate or other special treatments may be considered but they should be firm, stable, and slip-resistant.

Pedestrian Pathways

Pedestrian pathways can take a number of different forms depending on the context of the location. If they are located adjacent to a road in a built-up land-use context, the pedestrian facility is likely to take the form of a sidewalk (see **Chapter C.2**). The information below outlines design guidance for a pedestrian pathway within a park/greenway context, similar to a multi-use pathway. For the purpose of the Design Guide, which is focused on providing active transportation facilities that welcome people of all ages and abilities, the guidance on this section focuses on providing pedestrian pathways that are universally accessible and can be used in all seasons by a variety of user types (excluding people cycling).

Direction of Travel

Pedestrian pathways should be designed to be bi-directional and allow people to travel side-by-side and for passing users travelling in the opposite directions.

Width

The desirable width for a pedestrian pathway is between 2.4 metres to 3.0 metres. For pathways with higher volumes, additional space may be required. For example, the preferred width of the pedestrian pathway in newer areas of the Seaside Greenway in the City of Vancouver is 4.5 metres or wider. The constrained limit width of a pedestrian pathway is 1.8 metres; however, this may need to be wider to account for higher volumes and a mixture of users.

Table E-24 // Pedestrian Pathway Width Guidance

FACILITY	DESIRABLE (M)	CONSTRAINED LIMIT (M)
Pedestrian Pathway (Adjacent to a Separated Bicycle Pathway)	2.4 – 3.0*	1.8

*For high volume facilities with a variety of different user types, use the higher end of the design range

An additional 0.6 metres wide should be provided on both sides of the pedestrian pathway for additional clear width.

Surface Material

To ensure the pedestrian facility is accessible and can accommodate a variety of users, the preferred pathway material is asphalt or concrete. Like bicycle pathways, if the pedestrian pathway is located in a natural or environmentally sensitive area, other materials may be considered. However, it is important to recognize the trade-offs and the intended users of the facility.

SEPARATION

When to Separate

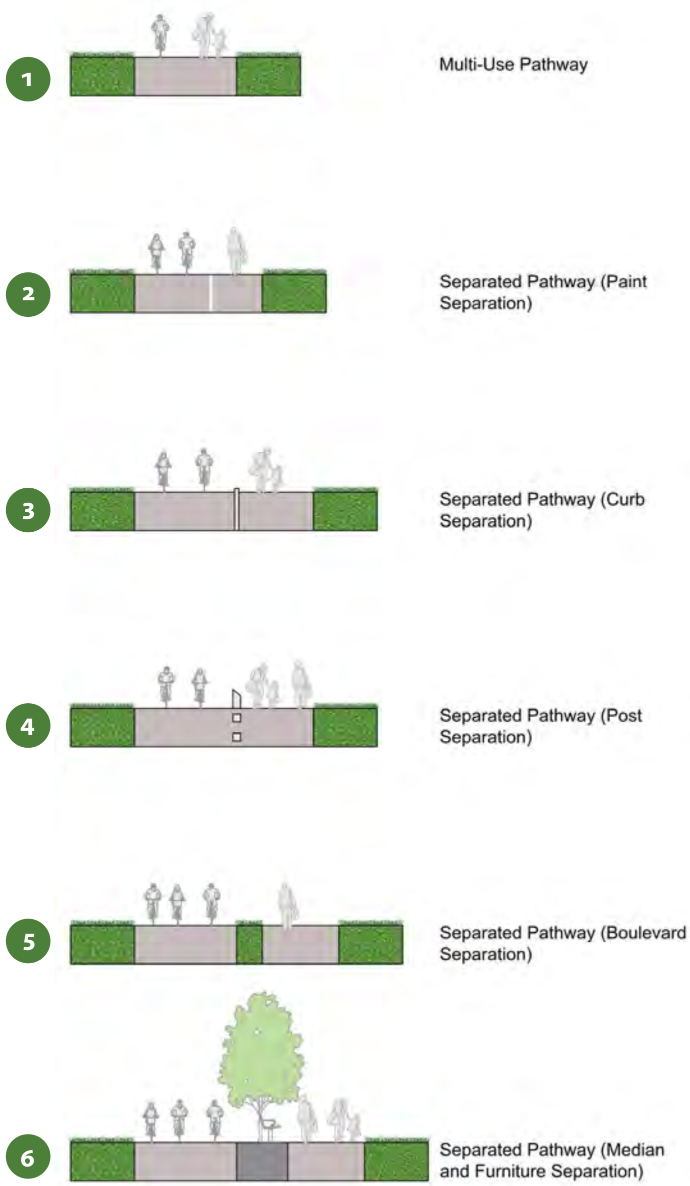
Guidance on when bicycle users should be separated from other pathway users can be found in **Chapter E.2**.

Types of Separation

This section provides guidance on the space or treatment that can be used to separate bicycle users from other pathway users. For guidance on the separation between bicycle facilities and sidewalks located adjacent to roads, refer to **Chapter D.3**.

When the volume of users on a multi-use pathway is (or is expected to be) high, separating bicycle users from other pathway users may be required. This can be done by providing a painted line or visual separation or by providing a physical separation between users (see **Figure E-63**). There are varying levels of separation between users that range in cost and the amount of space separating users. The levels of separation and some of the considerations associated with each are described on the next page.

Figure E-63 // Types of Pathway Separation between People Walking and Cycling



1 Multi-Use Pathway (no separation)

- See **Chapter E.2**

2 Paint Separation

- Provides a visual cue to pathway users that a separate space is designated for different user types.
- Can be difficult to detect the presence of the separated bicycle pathway with this type of treatment as there is no physical separation between users. As a result, there is likely to be encroachment of users into both spaces.
- Has a minimal impact on the overall width of the facility.
- Paint can be applied to an existing multi-use pathway with limited service interruption or cost.

3 Curb Separation

- Provides physical separation and a detectable separation between facilities, creating a clear indication to pathway users of the separate facilities.
- Depending on the width of the curb, this treatment may not require widening the pathway.
- Can make the width of the two facilities feel more constrained with less room to maneuver when passing.
- Can create an obstruction if visibility of the separation treatment is limited due to lighting or weather conditions.
- Can impact pathway drainage and restrict crossing opportunities.

4 Post Separation

- Provides a vertical separation between facilities.
- Creates breaks in the separation to allow users to cross into or over the adjacent facility.
- Can create an obstruction if visibility of the separation treatment is limited due to lighting or weather conditions. Reflective materials should be applied to ensure visibility.

- This type of treatment has a minimal impact on drainage.

5 Boulevard Separation

- Provides a buffer space between the two facilities, resulting in a greater degree of separation.
- Can be a grass boulevard but also creates space for landscaping, vegetation, and facilitates drainage.
- Increased maintenance may be required to prevent overgrown vegetation and ensure upkeep.

6 Median and Furniture Separation

- Provides the highest degree of separation between users.
- Offers space to provide furniture, lighting, and other amenities for pathway users.
- Creates an inviting environment and provides opportunities to enhance the character of the facility.
- Requires a significant amount of right-of-way.

If a buffer is provided between users, it is recommended that the buffer be between 0.5 to 1.0 metres in width. Buffers can take the form of an elevated curb, planters, a landscaped buffer with vegetation, or a swale.

One key consideration for designing buffers adjacent to pedestrian facilities is to provide a detectable edge to allow people with limited vision to distinguish between the bicycle pathway and the pedestrian pathway. For people with visual impairments, it can be difficult or impossible to detect the presence of a separated bicycle pathway, particularly when the bicycle pathway is at the same elevation as the pedestrian facility. These pedestrians may inadvertently encroach onto the bicycle pathway without realizing they have done so. This is a significant limitation of using paint as a form of separation.

If an edge is added to the buffer for detection, consideration also needs to be made to ensure the design can accommodate those with limited or restricted mobility and does not present a tripping hazard to any users.

It is also important that crossing locations are provided with gaps in the separation to allow users to cross over the respective facilities.

SIGNAGE

If the separated bicycle pathway is separated by paint or situated close to the sidewalk or pedestrian pathway, then the Pathway Organization sign (MUTCDC RB-94; B.C. B-G-003 Series) can be used. Wayfinding signage can also be used to identify the intended users of the facilities. Custom pathway organization signage has been used in a number of communities to help with pathway branding.

PAVEMENT MARKINGS

Pathway Markings

Bicycle Pathways

Bicycle pathway symbols along the pathway can be used to supplement signage and enhance awareness of the function of the pathway. If bicycle pathway symbols are being installed along the pathway, spacing should be placed every 50 to 100 metres, depending on context; tighter spacing may be considered near sharp corners and in areas of high conflict. Bicycle pathway symbols should also be used at pathway entrances and on the far side of crossings. On bi-directional bicycle pathways, stencils are paired and centered in the right half of the facility in each direction. Bicycle stencils should be oriented in the travel direction and directional arrows can be used on bicycle only pathways.

Pedestrian Pathways

Pedestrian pathway symbols can be used to supplement signage and enhance awareness of the function of the pathway. If pedestrian pathway symbols are being installed along the pathway, spacing should be placed every 50 to 100 metres. A single pedestrian stencil may be placed in the centre of the pedestrian facility. The orientation of the stencil may alternate along the length of the corridor (for example, along the pathway, half of the stencils will be upward facing for pathway users travelling in opposite direction).

Pavement Marking Separating Users

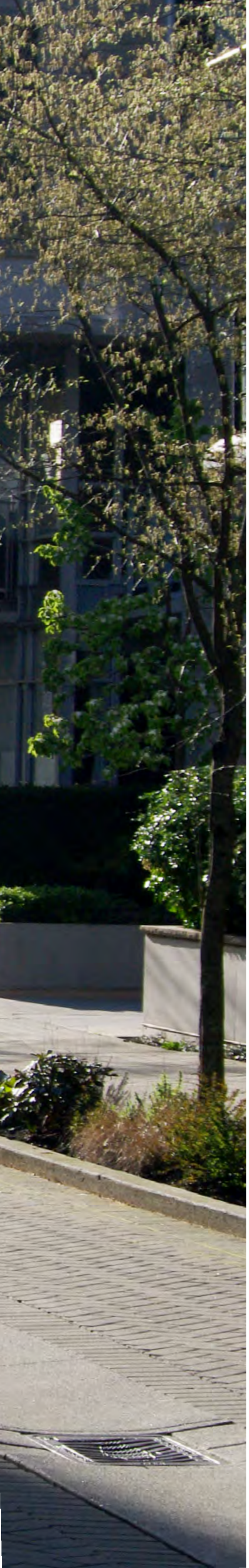
If the separation between the bicycle pathway and the pedestrian pathway is a painted line, this line is typically 20 cm wide.

Directional Dividing Line for Bicycle Facility

Centreline striping is not always necessary on separated bicycle pathways. However, in certain scenarios, centreline striping may provide safety and wayfinding benefits. Centreline striping is recommended when bicycle pathways are located on hills with a grade steeper than 5%, at locations where passing is dangerous due to space constraints and limited visibility, and/or as a way of wayfinding and demarcating the pathway at locations such as pathway access points and at intersections.

Spirit Trail signage, District of West Vancouver, B.C.

Walter Hardwick Avenue shared space, Vancouver, B.C.



E.4

SHARED SPACES

A shared space is a road in which the living environment dominates over the vehicular movements. A shared space functions first as a meeting place, playground, pedestrian area, and extension of any surrounding residences. The road is shared among people walking, cycling, and driving motor vehicles. Shared spaces are applicable along short blocks, with 200 to 400 metres between cross streets.

Shared spaces can differ in many ways, but can generally be described as places in which all modes share the same space and where pedestrians are prioritized. Shared spaces function more so as an extension of the surrounding land uses than a transportation facility. Shared spaces may be completely open for all modes, or in some cases, there may be designated zones that exclude or encourage certain modes and activities. Shared spaces are also known by the Dutch term 'woonerf,' which translates to 'living yard' or 'living road.' They are common across the Netherlands – where they were formally established in the 1970s – and can be found across Europe and internationally, with many recent applications in North America. They are intended to function foremost as public spaces, with the following functions:

- Socializing;
- Recreation;
- Shopping; and
- Acting as an extension of surrounding land uses (such as residences, commercial and retail activity, offices, and entertainment venues)

The essence of the shared space concept is to provide fewer traditional traffic management tools (such as curbs, signage, and lane markings) and replace them with pedestrian elements such as street furniture, trees, and other placemaking elements. This less structured environment relies on social behaviour to navigate conflicts and encourages users to operate more cautiously than usual, scanning for unexpected events and relying on eye contact and behavioural cues to navigate conflicts. This can result in slower, more comfortable environments.

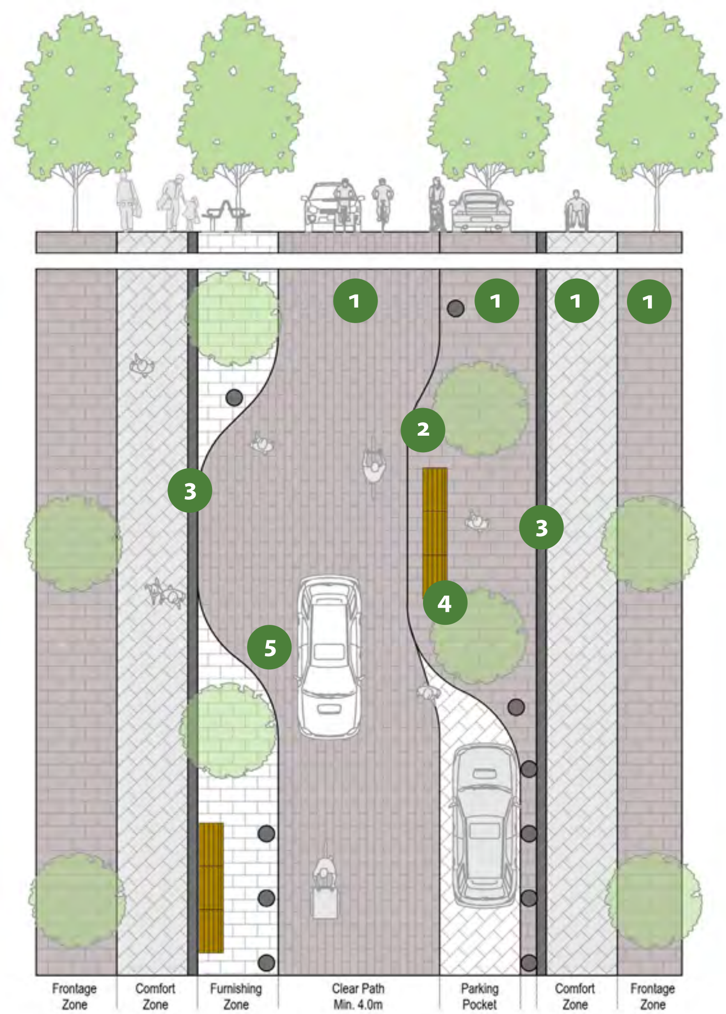
In commercial settings, shared spaces can add vibrancy through outdoor seating, patios, artwork, and landscaping that helps to attract people and encourage lingering. In residential settings, shared spaces can serve as extensions of the front yard, providing a space for play and socializing with neighbours.

TYPICAL APPLICATIONS

Shared spaces can allow motor vehicle access, but generally have no or limited function for through motor vehicle traffic. They function best where there are high pedestrian volumes and limited demand for motor vehicle through traffic. Shared spaces are suitable on one-way roads or roads with no directional dividing line where operating motor vehicle speeds are less than 30 km/h and motor vehicle volumes are less than 1,000 vehicles per day. During peak times, motor vehicle volumes should be less than 100 motor vehicles per hour. Shared spaces can be implemented on any width of road, but may be more complicated to manage on wider roads. A shared space should be no more than 400 metres in length between cross streets, with a preferred length of 200 metres between cross streets. This allows motor vehicles to quickly exit the shared environment if they want to proceed at a faster speed, reducing motorist frustration.

Figure E-64 shows a conceptual shared space layout with key features. In some contexts, shared spaces may be completely closed off to motor vehicle traffic for specific portions of the day. Treatments such as regulatory signage at the shared space entrance, bollards, or movable planters can be used to regulate the space. Shared spaces may also restrict access to personal motor vehicles but permit commercial vehicles, taxis, and transit vehicles (although shared spaces are typically not appropriate along transit routes). Along shared commercial roads, consideration should be given to providing loading and unloading, either within the shared space or along adjacent roads.

Shared spaces should not be implemented in isolation but should instead be considered as part of a wider walking and/or cycling network strategy. Shared spaces can also be suitable for cycling and can provide access to destinations along shared commercial roads. However, they may not offer the same directness or speed as an on-street bicycle facility, as they are pedestrian-focused and encourage slower cycling.



1. Distinct surface material and patterns for each zone
2. Lack of curb between Clear Path and other zones.
3. Optional detectable edge surface treatment for visibility
4. Amenities such as benches and street trees to define space
5. Flexible and meandering road helps to reduce vehicle speeds

Figure E-64 // Shared Space Conceptual Layout and Key Features

BENEFITS + LIMITATIONS

Benefits

- Creation of flexible, public, and social spaces provides unique placemaking and beautification opportunities, encouraging social interaction.
- Potential for increased commercial and retail activity in the road, which may contribute to economic benefits and increased vibrancy.
- Lower motor vehicle speeds and volumes contribute to a quieter, safer, and more comfortable road for active transportation users. International studies on shared spaces have shown reductions in both the number and severity of collisions compared to traditional roads.[2]
- Lack of curb can make it easier to navigate for people with mobility impairments, but may present concerns for people with visual impairments (as described below).


Social interactions along a private shared street, Vancouver, B.C.

Limitations

- Limitations to motor vehicle access may have impacts on the broader transportation network.
- Limited access for emergency vehicles and larger motor vehicles, including delivery trucks. Shared spaces should not by implemented on emergency access routes or bus routes.
- Potential for motor vehicle traffic to shift to adjacent road(s).
- Reduced on-street motor vehicle parking capacity. Parking demand and available on- and off-road capacity in the surrounding area should be assessed prior to shared space implementation.
- May require additional maintenance.
- Can be costly to retrofit existing roads.
- Unique accessibility considerations.

ACCESSIBILITY CONSIDERATIONS

Shared space design requires special consideration for universal accessibility. Given the shared nature of the road and the less structured operating environment, it is crucial that all users are aware of the road's unique function. Design professionals should also ensure that motor vehicle speeds and volumes will remain

2 Eran Ben-Joseph, 'Changing the Residential Road Scene,' Journal of the American Planning Association 61, no. 4 (1995): 504.

sufficiently low to ensure a comfortable environment for pedestrians and other active transportation users of all ages and abilities, including children and people with disabilities. While the entire road is intended to be shared, portions of the shared space may be physically separated from motor vehicle traffic to provide areas for resting and play. Design guidance for separating space is provided later in this chapter.

Special consideration should also be given to accommodating people with visual impairments. Visually impaired people should be actively involved in the shared space design process, including testing detectable surface materials. Potential concerns for visually impaired people using shared spaces include the following:

- **Safe Spaces**
  - *Lack of pedestrian-only space free of conflict with other modes – this can be partly addressed by creating a Comfort Zone (see page E40 for design guidance).*
  - *Lack of clear path without obstacles.*
- **Negotiation Between Users**
  - *Negotiation between users can be difficult for people with visual impairments, as it relies on eye contact, hand signals, and other visual cues.*
- **Pattern of Use**
  - *Traffic along shared spaces operates in a more informal, atypical manner compared to conventional roads. Shared spaces maintain a corridor for movement while also consisting of open spaces for a range of activities.*
  - *Traffic patterns can be difficult to detect by ear, especially when there are quiet electric vehicles and bicycles. Rain, snow, and background noise can also make it difficult to hear traffic movements.*
- **Orientation and Wayfinding**
  - *Typical orientation and wayfinding cues may be missing from shared spaces These include curbs, curb ramps, score lines, crosswalks, TWSIs, and other detectable surfaces.*
  - *Street furniture, utilities, and landscaping elements may not be organized in a typical or intuitive manner.*
  - *Low motor vehicle volumes and speeds can make it difficult to use the sound of traffic to navigate.*
- **Surface Materials**
  - *Coloured, patterned, and textured surface materials are often used on shared spaces, both for aesthetics and for delineating space. For people with vision impairments, it may be difficult to interpret the surface materials; dark lines may look like a step or grade change, while patterns may be visually confusing.*
  - *Puddles, snow, and debris can make it difficult to detect changes in surface material under foot or cane.*
- **Crossing Locations**
  - *Crossing locations, either at intersections or mid-block, may not be well defined along shared spaces, making it challenging to know when and where to cross safely.*

In order to mitigate some of these concerns and improve navigation for people with vision impairments, design professionals should aim to provide multiple layers of navigational information when designing shared spaces These navigational layers include:

- **Aligning streetscape features** to provide a reasonably direct and clear pedestrian route.
- **Providing shoreline edge cues** such as detectable changes in surface material and tactile direction indicators.

- Ensuring the **consistent and appropriate application of TWSIs**.
- Ensuring **adequate visual and tactile contrast** in surface materials.
- Utilizing **signage and pavement markings** where appropriate.;
- Providing **audible information** such as accessible pedestrian signals and environment information (see **Chapter G.2**.
- Providing **tactile and/or electronic wayfinding** information.

DESIGN GUIDANCE

Shared space design is flexible and contextually sensitive, and should consider adjacent land uses, road characteristics, multi-modal circulation patterns, available right-of-way, and other factors. The design of a shared space should be intuitive, using design features to simply and effectively convey the expected behaviour for users. There should be a balance between creating an open, flexible space and providing sufficient structure and predictability to ensure that people of all ages and abilities are able to safety navigate the space. Key shared space design considerations include: gateway features, road geometry, providing a dedicated pedestrian zone, streetscape, and social space – each of which are described below.

Gateway Features

- Shared spaces should include dedicated **signage, pavement markings, and/or gateway features** that clearly indicate to all users that they are entering or exiting a shared space environment. Custom 'Shared space signs have been used in communities such as Victoria and Colwood to signal the entrance to shared spaces
- A **grade change** relative to adjacent roads can help motorists recognize the transition between shared and separated space.
- **Entrances can be narrowed** using curb extensions or street furniture in order to reduce motor vehicle speeds.
- The **surface material** should be changed to one with a noticeably different colour and/or texture from the standard road surface.
- Consider providing **information kiosks, tactile maps or wayfinding**, or other tools at the entrance to provide visually impaired people with layout and wayfinding information about the shared space Information can be provided about the shared space to map and app providers such as Google Maps and Apple Maps to ensure their platforms are up to date.
- The **transition** from shared to separated space should be made clear to people with vision impairments in order to prevent them from inadvertently walking into motor vehicle traffic.


Gateway signage for a shared space in Colwood, B.C.

A grade change at the gateway may serve this purpose if it is steep enough to be detectable. A tactile attention indicator, detectable edge treatment, or a detectable change in surface materials may also be used. When tactile attention indicators are used to indicate the transition, they should align with a marked crosswalk. Tactile attention indicators should not be used across the entire entrance to a shared space, as pedestrians may interpret that to mean they area at a safe crossing location.

Road Geometry

- **Operating motor vehicle speeds** should be between 10 km/h and 30 km/h. In addition to utilizing geometric design elements, consideration should be given to posting speed limits of 30 km/h or less, where feasible. Note that roadways under provincial jurisdiction may not be posted at speeds below 50 km/h except in special circumstances.
- Include **traffic calming treatments** that lower motor vehicle speeds and discourage through traffic. Traffic calming treatments should be separated by no more than 50 metres to prevent long stretches of clear road. Applicable treatments include:
  - *Narrowing the shared travel lane and creating visual 'side friction' by placing street furniture, bollards, street trees, on-street motor vehicle parking, or other obstacles;*
  - *Staggering groups of obstacles on alternating sides of the road to create a chicane effect to reduce sightlines and slow motor vehicle speeds;*
  - *Adding curves or chicanes;*
  - *Reducing corner radii; and*
  - *Applying different pavement treatments.*
- Maintain a **clear path width** of at least 4.0 to 5.5 metres for motor vehicles on two-way shared spaces or 3.0 metres on one-way shared spaces Clear path widths should consider transit vehicles, if applicable. The clear path width can be defined by street furniture, utilities, landscaping, and/or surface materials.
- **Emergency access** should be provided by including staging areas for emergency vehicles every 30 metres along the shared space Emergency staging areas should be a minimum of 6.0 metres wide.

Comfort Zone

- Where there is sufficient right-of-way available, an accessible Comfort Zone can be provided on one or both sides of the shared space The Comfort Zone is the shared space equivalent of the Pedestrian Through Zone, providing a clear path of travel for pedestrians. This space is beneficial to pedestrians who are not comfortable in a shared environment, including people with vision impairments.
- Since there is no curb, the Comfort Zone can be separated from the shared Traffic Zone using street furniture, bollards, and/or street trees.
- The Comfort Zone should have a clear width of at least 1.8 metres.
- Detectable surfaces or tactile direction indicators may be used along the Comfort Zone to define the edges and aid navigation. The detectable surface should be used on the road side of the Comfort Zone, rather than the building side, in order to align pedestrians at crossings.
  - *Tactile attention indicators should not be used along the edge of the Comfort Zone and should be reserved for designated crossing areas.*
- Where Comfort Zones are used, mid--block crossings may also be provided to ensure that people with vision impairments can safely access both sides of the shared space at regular intervals.

- *Crossings may be considered along shared spaces that are longer than 100 metres, particularly where motor vehicle volumes are higher or in commercial or mixed-use locations;*
- *Tactile attention indicators or score lines should be used to help people detect the crossing and align themselves properly;*
- *Ideally, crossings should be perpendicular to the Comfort Zone, to be consistent with standard road alignments; and*
- *See* **Chapter G.3** *for detailed guidance on pedestrian crossings.*

Streetscape

- **Grade differences** between the curb and the road should be eliminated or reduced, which increases accessibility for people walking and using mobility devices.
- Shared streets may be completely open, with no **delineation between spaces or modes**. In some cases, there may be designated zones that exclude or encourage certain modes and activities – for example, the inclusion of a Comfort Zone, as described above. Regardless of the delineation of space, pedestrian activities dominate over through movements – motor vehicles may travel through the road, but they are never the priority.
- **Coloured and/or textured surface materials** should be used to delineate space and notify all users of the shared space environment.
  - *Colour can be used to indicate dedicated spaces for parking, activities, and through movement; visually narrow the clear path to help slow motor vehicles; and dictate priority of movement at crossings.*
  - *Texture can apply as a speed control device – the tactile and auditory feedback provided by rougher surface materials such*


Surface materials differ in colour and texture by area, Colwood, B.C.

as cobblestone will encourage slower bicycle and motor vehicle speeds. The surface material should not be so rough that it becomes uncomfortable for people cycling. Smoother surfaces should be provided in areas that are dedicated to pedestrian use. Texture changes can also indicate crossings and intersections.

- **Ample lighting** is important to ensure adequate visibility between all shared users. Pedestrian-scale lighting may be used to make the shared space more inviting.
- If provided, **on-street motor vehicle parking** should be placed in intermittent pockets along the shared space so that it does not become the dominant element. Parking spaces should be clearly demarcated from the streetscape using alternative surface materials or physical elements.
- **Drainage and maintenance considerations** should be considered when selecting and placing road elements and surface materials. Streetscape design should facilitate snow and ice clearing, and consideration should be given to snow storage locations where necessary. All surface materials should be compatible with snow clearing equipment.
- Special considerations may be required for **vegetation and landscaping**, including planters, hanging baskets, and rain gardens. Permeable surface materials may also be considered.

Shared street in London, England
Source: mrlaugh (Flickr)

Case Study

Local, National, and International Shared Spaces

Shared spaces are most common in the Netherlands and other international locales, but the concept has made its way to North America. Some examples of shared spaces exist in B.C., although they range in design and application:

- **Colwood, B.C.**: Colwood has implemented a shared residential road, featuring a Comfort Zone, shared Traffic Zone, and dedicated on-street parking areas, delineated with pavement materials and bollards.

- **Vancouver, B.C.**: Walter Hardwick Avenue in Vancouver's Olympic Village showcases certain shared space design elements, including level grades, brick pavers, bollards, and landscaping that alters from side to side, creating a slight chicane that slows motor vehicle traffic.

- **Banff, Alta:** The Town of Banff has recently completed a four-year seasonal pilot project that explored tuning Bear Road into a shared space, with the intent of making it a livelier and more vibrant commercial road. During the summers of 2015 to 2018, the town replaced 16 on-street parking stalls with landscaping, public seating, commercial patios, and bicycle parking. The approach was to gradually introduce change and trial shared space design elements, then collected public and stakeholder feedback. The town is now moving forward with design options for a more permanent shared space, with construction slated to begin in 2020. The Banff shared space project is a great example for similar smaller and resort communities in B.C.

Bear Street 'Woonerff' signage and concept design
Source (both images): Town of Banff

- **International Examples:** Shared spaces originated in Europe. As a result, there are a number of examples throughout the continent. A few European examples are featured here. Additionally, Bell Road in Seattle, Washington represents a recent Cascadian example of a shared space.

Göteborg, Sweden
Source: La Citta Vita (Flickr)

Bilbao, Spain
Source: Eric Fischer

Activated alleyway, Vancouver, B.C.

Social Space

- In addition to including a designated space for through movement, shared spaces may include flexible social spaces that can be used for gathering, eating, shopping, and play. As social interaction increases and greater numbers of people utilize the road, the perception of safety will increase.
- Social spaces should be protected by street furniture, trees, or bollards, while still allowing for pedestrian permeability.
- The clear travel path and on-street parking should not be located too close to buildings, as this area should be reserved as social space.
- There should be an interface between the shared space and the land uses along it, enabling direct access to buildings and encouraging interaction. Land uses, whether residential or commercial, should essentially spill out into the road.
- Shared spaces are well suited to hosting programed events such as festivals, farmers' markets, and other public events. A clear, accessible route for pedestrians should be maintained at all times.

ALLEYWAYS

Alleyways are narrow, low speed, and low volume roads that provide access to residential and commercial buildings. They can serve a number of additional purposes, including providing motor vehicle parking, loading, utility access, waste collection, and emergency access. Additionally, alleyways can provide valuable active transportation connections and may be more comfortable to use than adjacent roads. Alleyways function as a shared space, typically containing only a shared Traffic Zone without separation for people walking or cycling.

Alleyways represent a significant and underutilized piece of public infrastructure that could be better utilized for active transportation, housing, and placemaking. In many urban areas, the growth of garden suites, alleyway houses, accessory units, and other forms of infill housing has elevated the importance of alleyways, with many homes now designed to face a alleyway rather than a road. It is important to ensure that these residences are accessible via active modes of transportation, while still accommodating utilitarian uses.

In non-residential areas, alleyways can be activated using tactical urbanism techniques to create vibrant social spaces, on either a temporary or permanent basis. Alleyways such as Fan Tan Alley in Victoria are permanently used for commercial access, whereas the Alley Oop and Ackery's Alley projects in Vancouver provide exciting placemaking opportunities while still serving deliveries, utilities, and garbage pickup in the early morning hours. These alleys can also serve as valuable pedestrian and cycling connections.

Enhanced residential alleyway, Vancouver, B.C.

Case Study

Residential Alleyway Improvement

Jepson-Yung Lane, behind Vancouver's Mole Hill Community Housing Society, is an excellent example of an enhanced residential alleyway. The alleyway is designed to serve infill housing that is part of the Mole Hill Community Society, providing valuable outdoor space to residents while also serving as a calm, attractive thoroughfare for pedestrians. Jepson-Yung Lane, along with a number of other alleyways in Vancouver's West End, was given a name in 2018 as part of the City's Alleyway 2.0 initiative, which seeks to create infill housing and make alleyways more walkable public spaces. The new alleyway names honour locally significant women, Indigenous persons, and members of the LGBTQ2S+ community.

Alleyways, especially in downtown cores, are often perceived as unappealing and unsafe areas. However, Jepson-Yung Lane between Bute Road and Thurlow Road has been redesigned as a shared space that feels safe and welcoming. It contains community gardens, public seating, pedestrian scale lighting, bicycle parking, and even a small book exchange, all while maintaining motor vehicle access, parking, and garbage pickup. Landscaping and road elements have been placed to create a gentle curve, helping to maintain low motor vehicle speeds.

Jepson-Yung Lane is lush and green, a stark contrast to most other alleyways in Vancouver's downtown. A study comparing Jepson-Yung Lane to an adjacent hardscape lane found that people were 50% happier, 70% more trusting of strangers, and 110% more likely to pick up garbage in Jepson-Yung lane than in the adjacent hardscape lane[21]. Researchers suspect that the presence of lush, attractive greenery, in addition to evidence of local culture and signs of maintenance by local residents, contributed to these results.

1 'Happy Roads: Green Alleyway vs. Hardscaped Alleyway,' Happy City, accessed April 4, 2019, *https://thehappycity.com/project/happy-roads/*


Mole Hill Book Exchange

Case Study

Laneway Living Rooms

In the summer of 2017, the Vancouver Public Space Network (VPSN), with support and funding from VIVA Vancouver, hosted the Laneway Living Room project, which activated two alleyways with themed parties: 'Grandma's House' and 'Backyard BBQ.' The idea was to take the concept of 'roads as places' and bring two traditionally private spaces – the living room and backyard – and make them public, inviting people into the otherwise underutilized alleyways to eat, socialize, and play.

VPSN and VIVA Vancouver used 'lighter, quicker, cheaper' tactical urbanism techniques to transform the alleyways, using materials such as milk crates, pallets, refurbished furniture, decorative lighting, and small purchases from flea markets and thrift stores. These photos compare the alleyways on a regular day to their fun, transformed state.

Grandma's House:

Before

After

Source (all images): Paul Krueger

Backyard BBQ:

Before

After

Source (all images): Paul Krueger


F

CONTEXT SPECIFIC APPLICATIONS

F.1 Current Practices for Highway Rights-of-Way

Lougheed Highway, Pitt Meadows, B.C.

F.1

CURRENT PRACTICES FOR HIGHWAY RIGHTS-OF-WAY

This chapter outlines the current context for planning and designing active transportation infrastructure within provincial rights-of-way in a variety of contexts. Many communities throughout B.C. have developed plans that outline short-, medium-, and long-term investments in active transportation. These plans typically include priorities for infrastructure that would be considered appropriate for both recreational and commuter trips. These proposed projects can also be found in a variety of contexts, including facilities that connect communities, are located in rural and small communities, or pass through urban contexts. For some communities, many of the projects are found on, or adjacent to, provincial rights-of-way. In addition, the provincial government is committed to active transportation and considering the needs of active transportation users within provincial rights-of-way.

Through the Ministry of Transportation and Infrastructure (MOTI), the provincial government's mandate for transportation is to plan transportation networks, provide transportation services and infrastructure, develop and implement transportation policies, and administer many related acts, regulations, and federal-provincial funding programs across the Province of B.C. The provincial government strives to build and maintain a safe and reliable transportation system and provide affordable, efficient, and accessible transportation options for all British Columbians. This work includes:

- Investing in road infrastructure, public transit, and active transportation improvements;
- Reducing transportation-related greenhouse gas emissions; and
- Strengthening the economy through the movement of people and goods.

The provincial government's investments generally include highway construction and rehabilitation and side road improvements, which include road resurfacing, bridge rehabilitation and replacement, seismic retrofits, intersection improvements and upgrades to smaller side roads to help connect communities throughout the province.

In addition, the provincial government is committed to encouraging healthy living and helping to address climate change. The provincial government has established a Cycling Policy, which has a goal to integrate cycling on the province's highways by providing safe, accessible, and convenient bicycle facilities and by supporting and encouraging cycling. The Cycling Policy states that:

1. Provisions for people cycling are made on all new and upgraded provincial highways. All exceptions to this policy will be subject to an evaluation procedure.
2. Route evaluations that impact people cycling will include consultations with cycling stakeholders. An evaluation can be applied on existing routes to identify measures that will improve cycling conditions.
3. The Province will involve cycling interests and local government officials responsible for cycling in all highway planning consultations. Municipal bicycle advisory committees and/or recognized cycling advocacy organizations can be utilized to provide advice on cycling needs, facilitate issues, and monitor the effectiveness of the Cycling Policy.
4. To accommodate the safety and travel requirements for different types of bicycle users, the provincial government plans, designs, and builds for the appropriate type of bicycle user based on the type of facility.
5. The cost of meeting the Cycling Policy will be managed within normal business practices and annual budgets.
6. Uniform signing and marking will be provided for cycling on all provincial highways.
7. The Cycling Policy will be monitored on a regular basis.

The provincial government works to incorporate pedestrian and cycling improvements as part of most major highway capital projects. This can range from the provision of grade-separated active transportation facilities in urban areas, such as the McKenzie Interchange Project within the District of Saanich, to smaller scale projects, such as shoulder widening during a road rehabilitation project, when feasible. It is important to note that shoulder widening can come with a significant cost if property acquisition or provision of clear zone is required.

In addition, the provincial government supports cycling through the cost-sharing of active transportation with local and regional governments through its grant program, which provides up to 50% of total eligible project costs (up to 75% for communities with a population under 15,000). Various project types are eligible for grant funding.

The New Building Canada Fund - Small Communities Fund can also be used to fund cycling projects. The provincial and federal governments will each allocate funding to support infrastructure projects in communities with a population of less than 100,000 people. This 10-year funding program runs from 2014 to 2024.

City of Nanaimo, B.C.

ACTIVE TRANSPORTATION INFRASTRUCTURE ON PROVINCIAL RIGHTS-OF-WAY

Design speed, road classification, topography, and other elements are considered when deciding where walking and cycling are permitted. Walking and cycling are permitted on all roadways in B.C., with the exception of some Schedule 1 highways, including the Trans-Canada Highway 1, Hope-Princeton Highway 3, Coquihalla Highway 5, and others. On these Schedule 1 highways, cycling is prohibited except to cross an intersection or where signs are in place permitting cycling. Some portions of the highway are excluded, meaning that cyclists are permitted. More details on the sections of the highways that are restricted, along with a list of exceptions, can be found on-line[1]. Walking and cycling is permitted on all other roadways under provincial jurisdiction.

For roadways under provincial jurisdiction, design guidelines for walking and cycling facilities are outlined in the MOTI *B.C. Supplement to TAC Geometric Design Guide*, which outlines the recommended practice for transportation projects on roadways under provincial jurisdiction. The MOTI *B.C. Supplement to TAC Geometric Design Guide* is the primary resource and design guide to follow for all projects that fall under provincial jurisdiction. The MOTI *B.C. Supplement to TAC Geometric Design Guide* classifies the different types of roadways under provincial jurisdiction (see **Table F-25**). There are specific guidelines for various design features, including vehicle lane width, shoulder width, and design speed. Guidance is provided on the accommodation of people walking and cycling within the context of paved shoulders on provincial rights-of-way, new roadway projects including new subdivisions, and alpine ski village roadways.

The remaining sections in this chapter outline the current mechanisms and process for implementing active transportation infrastructure on roadways under provincial jurisdiction, as well as applicable guidelines that should be followed based on the MOTI *B.C. Supplement to TAC Geometric Design Guide*.

1. 'Cycling Regulations, Restrictions & Rules of the Road,' Government of British Columbia, accessed June 12, 2019, *https://www2.gov.bc.ca/gov/content/transportation/driving-and-cycling/cycling/cycling-regulations-restrictions-rules*

TABLE F-25 // MOTI DESIGN STANDARDS

Source: MOTI *B.C. Supplement to TAC Geometric Design Guide*, Table 430.A

ROAD CLASSIFICATION	DESIGN SPEED (KM/H)	VEHICLE LANE WIDTH (M)	SHOULDER WIDTH (M)
Lower Volume Road (LVR)	30-90	3.25 - 3.6 m	0.5 m gravel
Rural Local Undivided (RLU)	50-80	3.6	1.0
Rural Collector Undivided (RCU)	50-80 60-90	3.6 3.6	1.5 1.5
Rural Collector Divided (RCD)	60-90	3.6	2.5
Rural Arterial Undivided (RAU)	70-90 80-100	3.6 3.6	1.5-2.0 2.5
Rural Arterial Divided (RAD)	80-100	3.7	3.0
Rural Freeway / Expressway (RED / RFD)	80-100	3.7	3.0

CURRENT MECHANISMS FOR IMPLEMENTING INFRASTRUCTURE ON PROVINCIAL RIGHTS-OF-WAY

The provincial government supports the goals and desires of local and regional governments to provide more active transportation facilities that are separated from provincial rights-of-way. There are a number of mechanisms available for local and regional governments, developers, and others agencies to help with the installation of active transportation infrastructure within provincial rights-of-way. The most common approaches are permits, licences of occupation and new development opportunities, each of which are described below.

The mechanism for implementation is strongly influenced by several factors, including: the facility type, project complexity, integration with provincial infrastructure (location adjacent to the roadway or separated from the roadway), and design standards.

- **Permits**: The provincial government permits certain infrastructure to be constructed within provincial rights-of-way. The details of this are outlined in Section 62 (Authorization of Use or Occupation on Provincial Public Highways) of the *Transportation Act*. Permits are often issued for projects such as sidewalks, off-street pathways, landscaping, bus shelters, benches, and other structures. A permit application is submitted to provincial government staff to review permit applications and make the final decision in the permitting process. Typically, projects that are approved through the permit process are funded by the applicant, including installation, operations, and maintenance.
- **Licence of Occupation:** A licence of occupation is typically issued for the installation of semi-permanent facilities where a licensee anticipates frequent use either by the broader public or specific user groups and will require significant and ongoing oversight (such as rail trails, parking lots, and transit amenities). Licences are typically issued for sections of provincial rights-of-way that are either unopened or adjacent to existing roadways where there is excess space available. A Temporary Licence of Occupation may also be issued to allow an applicant to investigate a potential location for new infrastructure/ structures.
- **New Developments / Subdivisions:** Decisions on new infrastructure installed through development opportunities are made by the provincial approving officer (PAO). The PAO functions as an independent body with authority over various types of land development. Their role is applicable for development and subdivision application approvals but not permits. Their role is to approve or deny various infrastructure proposed through development applications. This includes transportation infrastructure (roads as well as pedestrian and bicycle facilities) but also includes all other types of utilities. The PAO reviews and approves the designs while working with provincial government staff.

  Any infrastructure that gets constructed through this process becomes the provincial government's responsibility (unless it is built as part of a strata or unless there is agreement from the owner), which requires an allocation of funding and resources towards operations and maintenance. Developers and agencies can propose various designs, but it is ultimately up to the approvals official to approve any new infrastructure installed.

  It is important to note that new developments and subdivisions are a mechanism for installing active transportation infrastructure; however, this process on its own does not address responsibility for operations and maintenance after installation.

Currently, the provincial government reserves the right to remove any infrastructure built within provincial rights-of-way if it is determined that the space is required for provincial use. The provincial government will attempt, where feasible, to accommodate existing active transportation infrastructure within capital expansion projects. The provincial government will explore opportunities to work with jurisdictions to identify funding opportunities to improve and maintain active transportation infrastructure.

Current Process for Project Approval (All Mechanisms)

This section outlines the current process for project approval of active transportation infrastructure within provincial rights-of-way. This process is typical for the three mechanisms listed above.

1. There are often **preliminary conversations** about the proposed project between provincial government staff and the applicant prior to submitting the application.
2. **Detailed design plans** are required to be submitted with the application. The review of these plans often requires some back and forth between provincial government staff and the applicant. The design plans are often reviewed before the application is formally submitted.
3. The application with project details and final detailed design plans are **submitted** to the provincial government.
4. The provincial government begins the **application review process**. This review is based on the facility design standards that are currently in place. Some of the context specific factors that the provincial government is looking for include:
   - **Location and Type of Facility**: A major factor that influences the project review process is the impact the proposed facility will have on existing provincial infrastructure. For example, if the proposed facility is physically separated from the roadway under provincial jurisdiction, and/or outside the clear zone or within an unused right-of-way, then generally, the review process is less onerous. This is an important factor considered by the provincial government, as it impacts who is responsible for the ongoing operations and maintenance of the facility. If the active transportation infrastructure is physically separated from a roadway under provincial jurisdiction, the new infrastructure tends to be the responsibility of the applicant. This includes ongoing operations and maintenance responsibilities.
   - **Right-of-Way Width**: The provincial government determines if there is space available to install the proposed facility and if the width and design of the facility comply with the provincial government's design standards.
   - **Drainage:** Drainage is an important factor that the provincial government considers when reviewing projects. It is one of the main reasons the installation of sidewalk infrastructure in particular can be challenging. The need for drainage can have a significant impact on the cost of installing new facilities, as well as ongoing maintenance and operations. Drainage is also an important consideration if an off-street pathway is being built close to an adjacent roadway under provincial jurisdiction. The design must consider how the two facilities will interact with each other and the impacts on roadway operations and maintenance (even if they are not 'touching').

- **Provincial Roadway Classification**: The provincial government reviews the existing volumes and speeds of the roadway adjacent to a proposed active transportation facility. It also reviews the existing land use and topography. This is an important consideration, as the classification of the roadway influences the appropriateness of the proposed active transportation infrastructure and significantly factors into the design criteria and future highway plans.
- **Safety Considerations**: The provincial government reviews the proposed project from a safety perspective looking at the impact on all road users.
- **Determine Operations, Maintenance, and Liability:** Responsibility of operations and maintenance must be determined before a permit will be issued.

FACILITY SELECTION

Two critical components in determining if active transportation facilities are appropriate on roadways within provincial rights-of-way are the land use context and if the roadway travels through a more urban or rural environment. **Table F-26** outlines which active transportation facilities may be appropriate within different land-use contexts. It is important to note, however, that as discussed above, there are other considerations beyond land use that factor into whether an active transportation facility is appropriate on roadways within provincial rights-of-way.

The active transportation facility types that are most preferred along and adjacent to roadways within provincial rights-of-way are those that are physically separated from the roadway, including multi-use pathways or separated pedestrian and cycling pathways.

Table F-26 // Facility Types that May be Considered Based on Land Use*

LOCATION	FACILITY TYPE (IF FEASIBLE)	PRIMARY MODES OF ACTIVE TRANSPORTATION	MOTI INFRASTRUCTURE BY LAND USE		COMFORTABLE FOR PEOPLE OF ALL AGES AND ABILITIES
			Through Urban Environments	Between Communities / Rural Environments	
Physically Separated from Roadway	Separated Pedestrian and Bicycle Pathways	Cycling and Walking	✓	✓	✓
	Multi-Use Pathways	Cycling and Walking	✓	✓	✓
	Sidewalks	Walking	✓	X	✓
Within Roadway	Protected Bicycle Lanes	Cycling	✓	X	✓
	Painted and Buffered Bicycle Lanes	Cycling	✓	✓	X
	Bicycle and Pedestrian Accessible Shoulders	Cycling and Walking	X	X	X

*It is important to note that local context and engineering Judgement play a critical role in determining if a bicycle facility is appropriate on roadways within provincial rights-of-way.

Bicycle lanes and bicycle accessible shoulders may also be considered, provided maintenance can be accommodated and the safety of all road users is considered. Sidewalks are most appropriate in areas where drainage and maintenance can be accommodated, and are predominantly found within more urban contexts.

DESIGN GUIDANCE

This section summarizes design guidance on the types of active transportation facilities that may be considered on, or adjacent to, provincial roadways by facility type. These guidelines are based on the MOTI *B.C. Supplement to TAC Geometric Design Guide*. Design professionals should refer to that MOTI document for further guidance for active transportation facilities on roadways under provincial jurisdiction. This section outlines provincial specific guidance for the following active transportation facility types located on roadways under provincial jurisdiction.

- Physically Separated from Roadway
  - *Off-Street Pathways (including multi-use pathways and separated bicycle and pedestrian pathways)*
  - *Sidewalks*
- Within Roadway
  - *Bicycle and Pedestrian Accessible Shoulders*
  - *Painted and buffered bicycle lanes*
  - *Protected bicycle lanes*

Table F-27 outlines the recommended bicycle facility design guidance provided in the MOTI *B.C. Supplement to TAC Geometric Design Guide* (if applicable). Note that this document does not currently provide guidance for some facility types, including protected bicycle lanes and buffered bicycle lanes based on road classification and design speed on roadways under provincial jurisdiction.

TABLE F-27 // RECOMMENDED ACTIVE TRANSPORTATION FACILITY WIDTH BASED ON ROAD CLASSIFICATION

Source: Adapted from MOTI BC Supplement to TAC Geometric Design Guide

<table>
<tr><th rowspan="3">ROAD CLASS AND DESIGN SPEED</th><th colspan="6">FACILITY TYPE SUMMARY</th></tr>
<tr><th colspan="2">Bicycle and Pedestrian Accessible Shoulders</th><th colspan="2">Painted Bicycle Lanes</th><th colspan="2">Off-Street Pathways</th></tr>
<tr><th>Width</th><th>Offset</th><th>Width</th><th>Offset</th><th>Width</th><th>Offset</th></tr>
<tr><td>Rural < 70 km/h</td><td>1.5 - 2.0 m</td><td>N/A</td><td></td><td></td><td rowspan="3">3.0 - 4.0m (2.0m if constrained)[1]</td><td rowspan="2">Varies [2, 3]</td></tr>
<tr><td>Rural ≥ 70 km/h</td><td>2.0 - 3.0 [4]</td><td>N/A</td><td></td><td></td></tr>
<tr><td>Urban</td><td></td><td></td><td>1.5 - 1.8 m (1.2 m if constrained)</td><td>N/A</td><td>Boulevard [5]</td></tr>
</table>

1. A minimum width of 2.0 metres should only be considered in exceptional circumstances, including in undeveloped rural contexts with very low volumes of people walking and/or cycling and if there are significant constraints such as property or natural features including significant trees, ditches, or slopes.
2. Separated off-street pathway to be located outside the roadway clear zone.
3. Roadside off-street pathways should be offset the greater of the barrier zone of deflection or 0.5 metres
4. Bicycle and pedestrian accessible shoulders are not recommended for design speeds > 70 km/h. However, if they are provided, they should be between 2.0 - 3.0 metres. See further guidance in the Pedestrian and Bicycle Accessible Shoulder section on page F15.
5. Boulevard can be replaced with a physical barrier in constrained conditions.

PHYSICALLY SEPARATED FROM ROADWAY

Off-Street Pathways

Off-street pathways are physically separated from motor vehicle traffic and can be used by non-motorized forms of transportation (see **Figures F-65** and **F-66**). Typically, off-street pathways along or adjacent to provincial roadways are multi-use facilities, particularly in rural contexts; however, in cases of higher volumes of people walking and cycling, bicycle and pedestrian pathways may be considered (**Chapter E.3**). Off-street pathways also typically accommodate bi-directional travel for all users, although there are some cases where bicycle travel may be uni-directional. Off-street pathways along or adjacent to provincial roadways are the preferred facility type where feasible. Off-street pathways should be considered where right-of-way and clear zone space is available.

Width

The width of an off-street pathway is influenced largely by adjacent land uses, anticipated volume of users, the type of users, topography, and the space available. It is also important to note that, as off-street pathways are considered all ages and abilities facilities, they often attract a variety of users, some of which may operate at slower speeds. As a result, providing sufficient space to pass others is an important consideration.

For off-street pathways along or adjacent to provincial roadways, the desirable width is 4.0 metres. The constrained limit width of a multi-use pathway is 3.0 metres. The absolute minimum width of a multi-use pathway is 2.0 metres, based on the operating envelope of a single bicycle user (1.2 metres) and the operating envelope of one person walking (0.75 metres). However, this minimum width of 2.0 metres should only be considered in exceptional circumstances, including in undeveloped rural contexts with very low volumes of people walking and/or cycling and if there are significant constraints such as property or natural features including significant trees, ditches, or slopes. Refer to **Chapter E.2** for more details about design speed, longitudinal grade, sight distance, signage, and pavement markings for off-street pathways.

Clear Zone (Provincial Highways)

In rural contexts, a Clear Zone shall be provided. The Clear Zone includes the total roadside border area, starting at the edge of the outer through vehicle lane. This area should consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area as well as a buffer area adjacent to the off-street pathway. The desired Clear Zone width is dependent upon the design traffic volume and speed and on the roadside slope. Section 620 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* provides more detailed guidance on how to calculate the Clear Zone width on rural roads for new roadways and road rehabilitation projects. This guidance is summarized in **Table F-28**. In urban contexts where curb and gutter is provided, the Clear Zone is not required, but a boulevard in the Furnishing Zone should instead be provided (see **Figure F-65**).

In constrained urban conditions, the boulevard in the Furnishing Zone can be eliminated and replaced with a physical barrier, such as a concrete barrier or bicycle fence (see **Figure F-67**). More guidance on this treatment can be found in the Fencing and Barriers subsection on page F19.

Surface Material

As off-street pathways are intended to be accessible and accommodate a wide range of users and trip purposes, asphalt is the preferred surface type. However, local context may dictate that other materials such as compact aggregate, gravel, wood chips, or other treatments may be considered. These materials may be appropriate for off-street pathways through environmentally sensitive areas, rural communities, and situations where cost and implementation are constraints. It is important to note that these surface materials can have an impact on varying types of users (see **Chapter B.3**).

Ditches

If a ditch on one or both sides of the roadway is required, the ditch would typically be designed for a depth of 0.3 metres below the pavement structure. The design of side slopes and back slopes would typically be in accordance with the MOTI *B.C. Supplement to TAC Geometric Design Guide*, and should consider roadside safety, provincial right-of-way requirements, and geotechnical criteria.

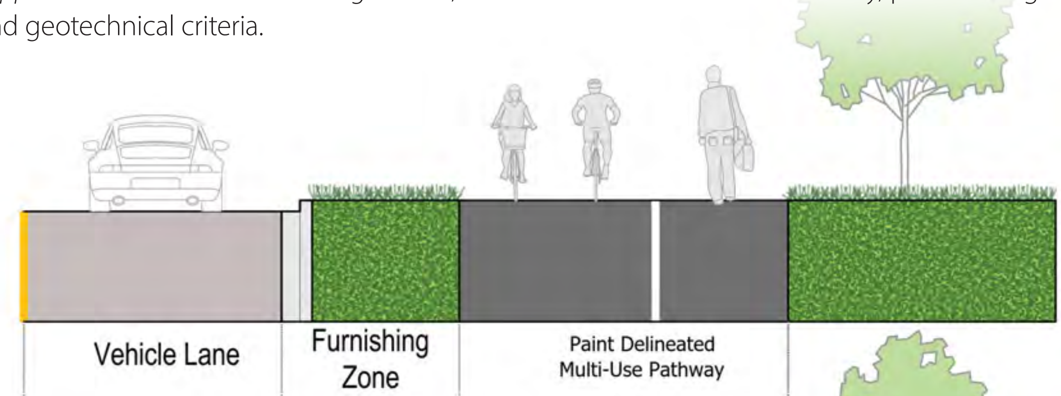


Figure F-65 // Multi-use Pathway (Urban Context)

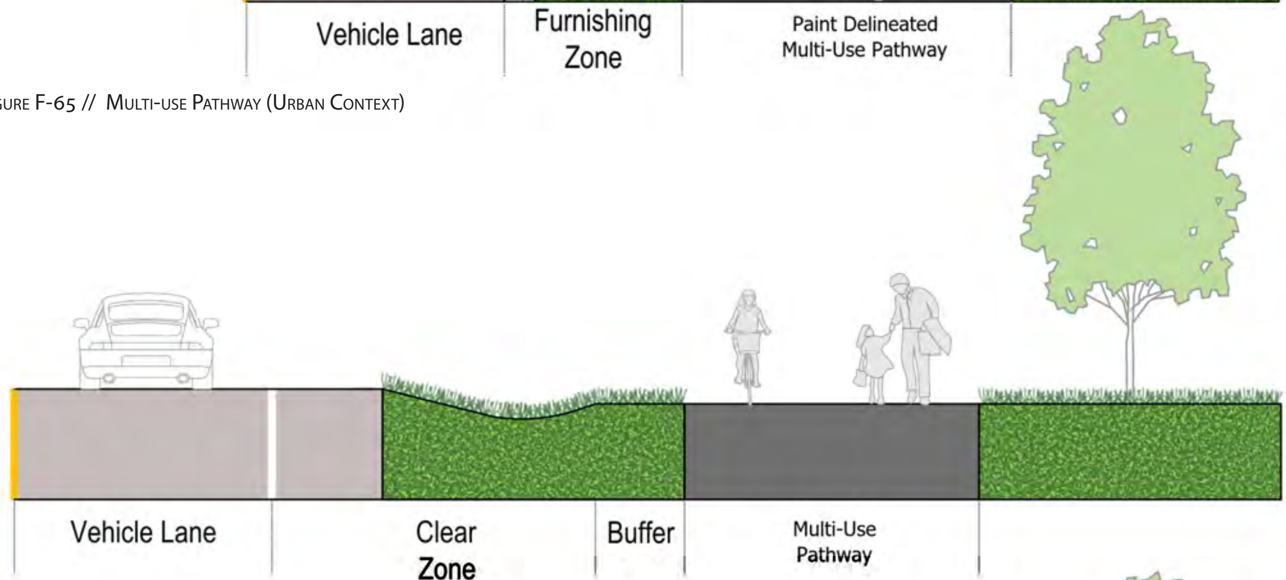


Figure F-66 // Multi-use Pathway (Rural Context)

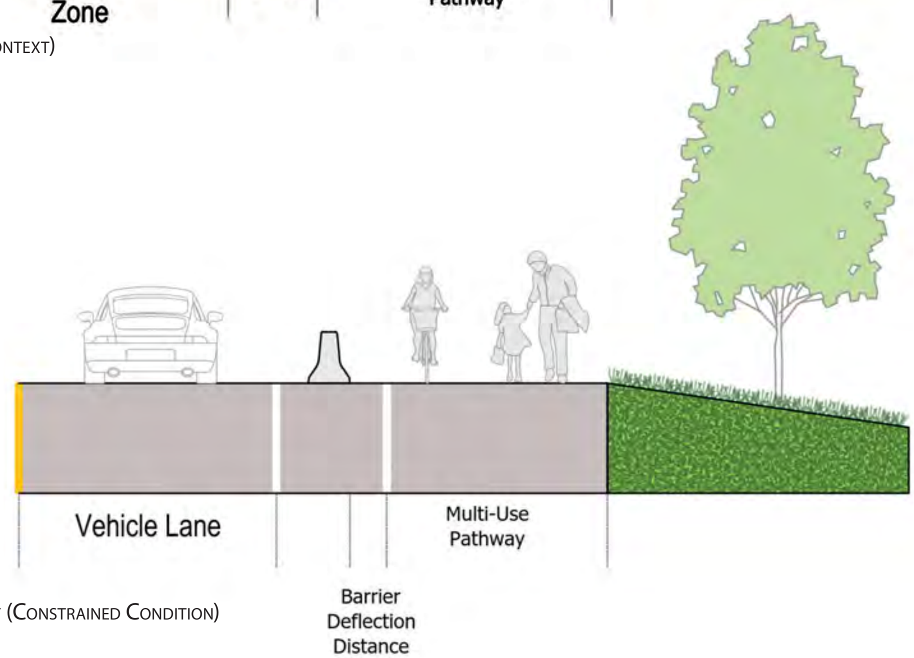


Figure F-67 // Protected Multi-use Pathway (Constrained Condition)

TABLE F-28 // SUGGESTED(¥) DESIGN CLEAR ZONE DISTANCES IN METRES FOR NEW CONSTRUCTION AND RECONSTRUCTION PROJECTS ON RURAL HIGHWAYS (¥¥)
Source: MOTI *B.C. Supplement to TAC Geometric Design Guide*, Table 20.A

DESIGN SPEED (KM/H)	DESIGN YEAR AADT (SEE NOTE 2)	FRONT SLOPES (FILL)			BACK SLOPES (CUT)		
		6:1 or flatter	5:1 to 4:1	3:1	3:1	5:1 to 4:1	6:1 or flatter
< 70	200 <AADT< 750 (see note 2)	2.0 - 3.0	2.0 - 3.0	**	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
	750 - 1500	3.0 - 3.5	3.5 - 4.5	**	3.0 - 3.5	3.0 - 3.5	3.0 - 3.5
	1501 - 6000	3.5 - 4.5	4.5 - 5.0	**	3.5 - 4.5	3.5 - 4.5	3.5 - 4.5
	> 6000	4.5 - 5.0	5.0 - 5.5	**	4.5 - 5.0	4.5 - 5.0	4.5 - 5.0
70 - 80	200 <AADT< 750 (see note 2)	3.0 - 3.5	3.5 - 4.5	**	2.5 - 3.0	2.5 - 3.0	3.0 - 3.5
	750 - 1500	4.5 - 5.0	5.0 - 6.0	**	3.0 - 3.5	3.5 - 4.5	4.5 - 5.0
	1501 - 6000	5.0 - 5.5	6.0 - 8.0	**	3.5 - 4.5	4.5 - 5.0	5.0 - 5.5
	> 6000	6.0 - 6.5	7.5 - 8.5	**	4.5 - 5.0	5.5 - 6.0	6.0 - 6.5
90	200 <AADT< 750 (see note 2)	3.5 - 4.5	4.5 - 5.5	**	2.5 - 3.0	3.0 - 3.5	3.0 - 3.5
	750 - 1500	5.0 - 5.5	6.0 - 7.5	**	3.0 - 3.5	4.5 - 5.0	5.0 - 5.5
	1501 - 6000	6.0 - 6.5	7.5 - 9.0	**	4.5 - 5.0	5.0 - 5.5	6.0 - 6.5
	> 6000	6.5 - 7.5	8.0 - 10.0*	**	5.0 - 5.5	6.0 - 6.5	6.5 - 7.5
100	200 <AADT< 750 (see note 2)	5.0 - 5.5	6.0 - 7.5	**	3.0 - 3.5	3.3 - 4.5	4.5 - 5.0
	750 - 1500	6.0 - 7.5	8.0 - 10.0*	**	3.5 - 4.5	5.0 - 5.5	6.0 - 6.5
	1501 - 6000	8.0 - 9.0	10.0 - 12.0*	**	4.5 - 5.5	5.5 - 6.5	7.5 - 8.0
	> 6000	9.0 - 10.0*	11.0 - 13.5*	**	6.0 - 6.5	7.5 - 8.0	8.0 - 8.5
≥110	200 <AADT< 750 (see note 2)	5.5 - 6.0	6.0 - 8.0	**	3.0 - 3.5	4.5 - 5.0	4.5 - 5.0
	750 - 1500	7.5 - 8.0	8.5 - 11.0*	**	3.5 - 5.0	5.5 - 6.0	6.0 - 6.5
	1501 - 6000	8.5 - 10.0*	10.5 -13.0*	**	5.0 - 6.0	6.5 - 7.5	8.0 - 8.5
	> 6000	9.0 - 10.5*	11.5 -14.0*	**	6.5 - 7.5	8.0 - 9.0	8.5 - 9.0

(¥) The designer may use lesser values than the suggested distances in this table only if these lesser values are justified using a cost-effectiveness analysis as outlined in section 620.07. The Design Clear Zone inventory form in Figure 620.C should be filled in by the designer and included in the design folder.
(¥¥) Rural highways are typically open ditch. Urban highways typically have curb and gutter with enclosed drainage. Refer to section 620.13 for a discussion of Clear Zone applied to an urban environment.
(*) Clear zones may be limited to 9.0 metres for practicality and to provide a consistent roadway template if previous experience with similar projects or designs indicates satisfactory performance.
(**) Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high-speed vehicles that encroach beyond the edge of the shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety need and collision history. Also, the distance between the edge of the through travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope. While the application may be limited by several factors, the foreslope parameters which may enter into determining a maximum desirable recovery area are illustrated in Figure 620A.

1. All distances are measured from the outer edge of the through traveled lane. Where a site specific investigation indicates a high probability of continuing crashes, or such occurrences are indicated by crash history, the designer may provide clear zone distances greater than the clear zone shown in Table 620.A.
2. For clear zones, the 'Design Year AADT' will be total AADT for both directions of travel for the design year. This applies to both divided and undivided highways.
3. For AADT ≥200, the front slope is 2:1 or flatter, the back slope is 1.5:1 or flatter. Refer to section 510.08 of the Low-volume Roads chapter for the setback to fixed objects.
4. The values in the table apply to tangent sections of highway. Refer to table 620.B for adjustment factors on horizontal curves.
5. Refer to Fig. 620.B and the TAC *Geometric Design Guide for Canadian Roads* or AASHTO *Roadside Design Guide* for worked examples of calculations.

WITHIN ROADWAY

Protected Bicycle Lanes

A protected bicycle lane is a dedicated facility for the exclusive use of people cycling and using other active modes (such as in-line skating, using kick scooters, and skateboarding, where permitted) that is physically separated from motor vehicles and pedestrians by vertical and/or horizontal elements. Protected bicycle lanes are distinct from painted or buffered bicycle lanes as they provide physical separation between bicycle users and motor vehicles. Design guidance on protected bicycle lanes is not included in the MOTI *B.C. Supplement to TAC Geometric Design Guide*. Refer to **Chapter D.3** for additional guidance on facility design and applicable context for implementation.

It is important to note that there are several factors that need to be considered before designing and implementing protected bicycle lanes. Protected bicycle lanes should only be considered within an urban land-use context where motor vehicle volumes and speeds warrant implementation. Protected bicycle lanes should only be installed if feasible based on available right-of-way, ensuring limited impact on motor vehicle operations, and where safety is considered for all users. Protected bicycle lanes should only be considered if space is available to install the facilities based on the design guidance, and without impacting the operational requirements of the roadway by ensuring that the roadway will continue to have sufficient existing and future capacity to maintains its primary function of moving people and goods. It is critical to ensure maintenance is considered when determining if protected bicycle lanes are an appropriate facility type given the context and, if so, that it is considered throughout the design and implementation. The installation of physical separation may impact the type of maintenance equipment and machinery required, which can have a significant impact on operations and maintenance budgets. Additionally, the type of separation used will impact maintenance considerations and will be dependent on the type of roadway. Design professionals should consult and work with the provincial government to consider the feasibility and design considerations regarding maintenance of protected bicycle lanes at the outset of a project.

Buffered Bicycle Lanes

A buffered bicycle lane provides additional separation between the bicycle lane and the motor vehicle travel lane and/or parking lane by way of an additional white longitudinal line that runs parallel to the bicycle lane. Design guidance for buffered bicycle lanes can be found in **Chapter D.4**. The desired buffer width is 0.6 metres. In constrained situations, the buffer can be 0.3 metres wide. The maximum width of a buffer is 0.9 metres; if at least 0.9 metres of additional space is available, a protected bicycle lane should be considered instead. Wider buffers (greater than 0.6 metres) may be enhanced with additional hatch markings.

It is important to note that there are several factors that need to be considered before designing and implementing buffered bicycle lanes on roadways under provincial jurisdiction. Firstly, design guidance on buffered bicycle lanes is not included in the MOTI *B.C. Supplement to TAC Geometric Design Guide*. Refer to **Chapter D.4** for additional guidance on facility design and applicable context for implementation. Like protected bicycle lanes, buffered bicycle lanes should only be considered within an urban land-use context where motor vehicle volumes and speeds warrant implementation. Buffered bicycle lanes should only be installed if feasible based on available right-of-way, ensuring limited impact to motor vehicle operations, and when safety is considered for all road users. Buffered bicycle lanes should only be considered if space is available to install the facilities based on the design guidance, and without impacting the operational requirements of the roadway by ensuring that the roadway will continue to have sufficient existing and future capacity to maintains its primary function of moving people ands goods. Additional maintenance considerations may also be required and must be considered prior to installation.

Painted Bicycle Lanes

Painted bicycle lanes are separate travel lanes designated for the exclusive use of bicycles. Refer to **Chapter D.4** for guidance on painted bicycle lanes.

The desirable width of a bicycle lane is 1.8 metres. This provides sufficient width for single file bicycle traffic with some buffer from motor vehicle lanes. If the bicycle lane is wider than 1.8 metres it may encourage motor vehicle drivers to use the lane by mistakenly considering it as another motor vehicle lane or a parking lane. If the bicycle lane is wider than 1.8 metres, a buffered bicycle lane should be provided. The constrained limit of a bicycle lane is 1.5 metres. If the bicycle lane is narrower than 1.5 metres, it loses much of its capability to provide separation between bicycles and adjacent motor vehicles. Widths of less than 1.5 metres should only be provided in exceptional circumstances and require justification through a design exception in accordance with the TAC *Geometric Design Guide for Canadian Roads*. The absolute minimum width of a curbside bicycle lane is 1.2 metres based on the horizontal operating envelope of a person cycling.

Guidance on signage and pavement markings for bicycle lanes can be found in **Chapter D.4**.

Pedestrian and Bicycle Accessible Shoulders

On many roadways, shoulders can be used as an on-street walking and cycling facility. Shoulders are paved spaces on the edge of rural roads and highways outside of the motor vehicle lanes but within the road right-of-way that can be used by people walking, cycling, and using other active modes. Shoulders can provide a space for people riding their bicycle, similar to a bicycle lane. They are delineated by a solid white longitudinal line and can, in some cases, be supplemented by signage and pavement markings alerting motorists to expect bicycle travel along the roadway. Shoulders do not provide an exclusive space for people cycling as the shoulder space can be shared by a variety of users, including pedestrians and motor vehicles when required for safety, operations, and maintenance.

On roadways under provincial jurisdiction, cross-sectional elements are determined based on design speed, road classification, and design volumes as seen in **Table F-29**. The province also provides guidance on the minimum width of shoulder bikeways as seen in **Table F-29**. A minimum width of 1.5 metres is required for a bicycle accessible shoulder. A wider facility is recommended on roadways with higher design speeds and vehicle volumes. Bicycle and pedestrian accessible shoulders are not recommended for design speeds greater than 70km/h. However, in some cases this may be the only option available. Guidance on the use of rumble strips can be found in the section below.

Rumble Strips

On higher speed roadways, TAC recommends the use of Shoulder Rumble Strips (SRS) within the buffer space. SRS are milled out sections of the pavement along a roadway that provide feedback to motorists through noise and vibrations in the steering wheel, notifying them when they have deviated from the travel lane into the shoulder.

The MOTI *B.C. Supplement to TAC Geometric Design Guide* notes that SRS should be considered on rural highways in the following cases:

1. New rural highway sections;
2. When re-paving, rehabilitating or re-constructing existing rural highway sections, which include shoulders; and
3. Other rural highway sections that are not part of a project but would benefit from the installation of SRS in terms of decreasing the number of single vehicle off-road crashes.

SRS are typically placed on existing or new paved shoulders that are located on two-lane highways with minimum 1.5 metre shoulders, multi-lane divided

Table F-29 // Design Widths for Pedestrian and Bicycle Accessible Shoulders on Roadways Under Provincial Jurisdiction
Source: MOTI *B.C. Supplement to TAC Geometric Design Guide,* Table 530.B

Controlling Condition	Minimum Design Width (m)
For most cases, except as below	1.5
For Design Speeds, ≥ 70 km/h and SADT > 5000	2.0
For Design Speeds > 80 km/h and SADT >10,000	2.5[1]
All Freeways and Expressways	3.0 [1]

1. If cycling facilities are being proposed adjacent to existing provincial roadways, bicycle and pedestrian accessible shoulders are not recommended for design speeds > 70km/h. However, this table provides guidance in these case where pedestrian and bicycle shoulders are provided in such contexts.

highways with a minimum 1.5 metre shoulder,s and multi-lane divided highways with minimum 0.5 metre shoulders inside and 1.5 metres outside. SRS should not be installed in the following locations:

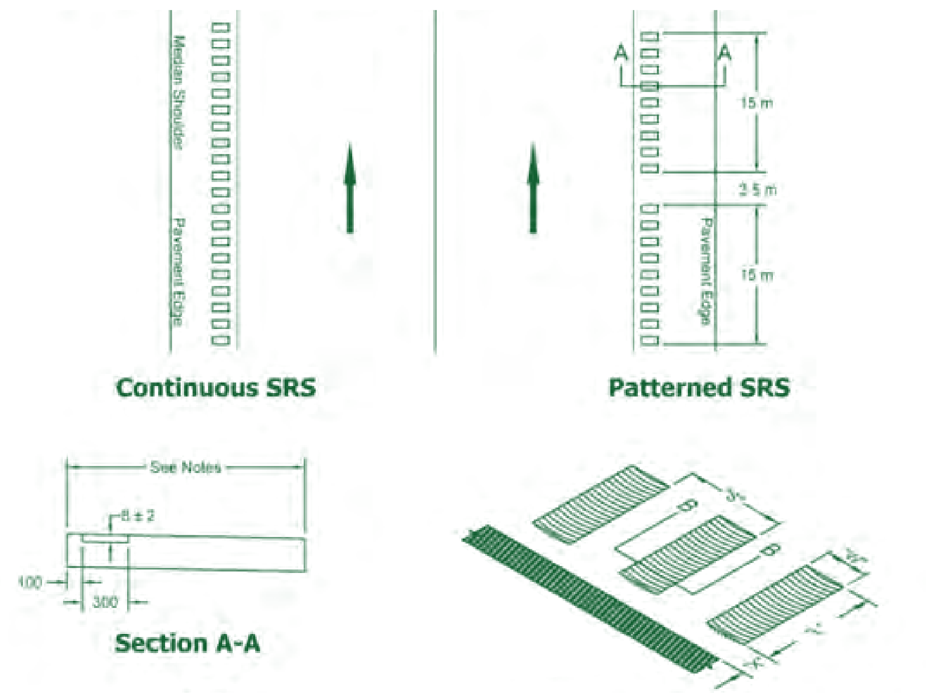
- Urban areas;
- Bridge decks;
- Overpasses; or
- Other concrete structures

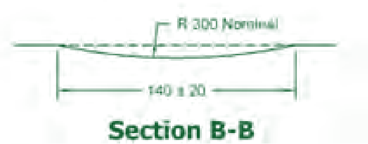
Figure F-68 outlines design guidance for SRS from the MOTI *B.C. Supplement to TAC Geometric Design Guide* and notes that shoulders with SRS that have bicycle traffic should be at least 1.5 metres wide. When people riding their bicycles in the shoulders need to access the motor vehicle lane because of debris or other riding impediments in the shoulder, they would need to cross the rumble strip. It can be hazardous to ride over rumble strips at higher speeds because of the uneven surface, which may cause a loss of control. As such, if SRS are used, their design and placement must be properly considered to ensure the safety of all users. SRS are to be interrupted prior to driveways intersections, ramps, shoulder constraints and wherever it is needed and required to allow people cycling to merge to the left of the SRS. **Figure F-69** outlines guidance on SRS interruptions at shoulder constraints.

There is an existing standard practice in B.C. for the application of rumble strips; including installing 15 metres of rumble strips with a 3.5 metre gap pattern. This is done to allow people cycling a regular opportunity to leave the shoulder area without passing over the rumble strips. Continuous rumble strips are used for medians, not shoulders where cyclists are permitted.

Figure F-68 // Milled Rumble Strip Design

Source: B.C. Supplement to TAC Geometric Design Guide, Figure 650.A





See comments below for discussion of nominal dimensions

Offset 'X' from the edge of the lane paint line is 100 mm ± 10 mm. This may be reduced to 0 mm to maintain cycling width.

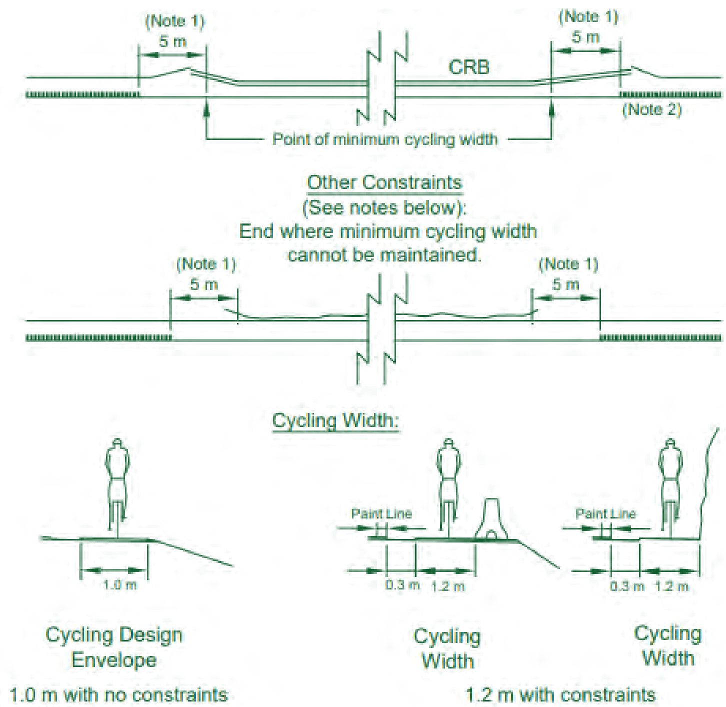
Length of Rumble Strip 'l' is 300 ± 10 mm.

Width 'W' is nominally 140 mm ± 20 mm, based on the tolerance of the cut depth (8 mm ± 2).

Spacing 'S' between strips is 300 mm.

Notes:

1. Milled-in SRS are to be placed to existing/new paved shoulders on:
• 2-Lane highways with minimum 1.5 m shoulders
• Multi-Lane undivided highways with minimum 1.5 m shoulders
• Multi-Lane divided highways with minimum 0.5 m shoulders inside and 1.5 m outside.
2. The minimum shoulder depth of pavement required is 50 mm, SRS are not to be installed if pavement deterioration or cracking is evident.
3. Milled-in SRS are to be placed on existing/new paved centre medians with a minimum 2.0 m painted width. This includes locations with existing median barrier if there is sufficient room for the milling machine to install the SRS. For widths less than 2.0 m, see Figure 650.F.
4. Patterned SRS installation is for outside shoulder locations. Continuous SRS installation is for median shoulder locations and painted flush medians.
5. Milled-in SRS may be placed where outside shoulders are less than 1.5 m if there is no cycling traffic on the shoulder.
6. Milled-in SRS are not to be placed through urban areas or in the presence of turning lanes.
7. Milled-in SRS are to be discontinued across private accesses and public road intersections. Refer to Figures 650.B and 650.C.
8. Milled-in SRS are to be discontinued in advance of all bridges and where minimum dimensions do not exist because of Roadside Barrier, Drainage Curb, Fencing, Rock Face, etc. Refer to Figure 650.D.
9. Shoulder rumble strips shall no be installed on bridge decks, overpass structures, or other concrete surfaced structures.



Notes:

1. The minimum acceptable cycling width with a longitudinal obstruction is 1.2 metres. The SRS should be discontinued 5 metres before and restarted 5 metres after where this width to longitudinal constraints cannot be maintained.
2. If there is adequate cycling width adjacent to a barrier, the SRS should not be discontinued.
3. SRS should not be installed on bridge decks, overpasses or other concrete surfaces.

Figure F-69 // SRS Interruptions at Shoulder Constraints
Source: B.C. Supplement to TAC Geometric Design Guide 2019 Figure 650.D

Sidewalks

Typically, sidewalks are not installed on roadways in rural contexts, but they may be installed as part of road renewal projects and in urban and suburban contexts, including developed rural core contexts. Operations, maintenance, and adequate drainage can impact the location of sidewalks. Sidewalks are typically proposed by a local or regional government., In such cases, the local or regional government would typically be responsible for the cost of the engineering, construction, and maintenance of the sidewalk.

Consistent with guidance in **Section C**, the minimum width of sidewalks should be 1.8 metres. The width should be increased where shared use by people walking and cycling is expected. If this is the case, refer to the design guidance for off-street pathways in **Section E**.

Fencing and Barriers on Provincial Infrastructure

The MOTI *B.C. Supplement to TAC Geometric Design Guide* outlines situations where fencing for people walking and cycling may be appropriate. One situation where fencing may be installed along a roadway under provincial jurisdiction includes locations on roadways and bridges that have a bicycle path or sidewalk where the average annual daily traffic (AADT) is greater than 35,000 vehicles or the seasonal annual daily traffic (SADT) is greater than 40,000 vehicles, and the posted speed is equal or greater than 70 km/h. The MOTI *B.C. Supplement to TAC Geometric Design Guide* suggests using fencing when the separation between the edges of the outside travel lane and the pathway or sidewalk is less than 2.1 metres (including the shoulder width). It is noted that if the outside roadway travel lane is wider than 3.6 metres, this offset requirement between the pathway or sidewalk and the vehicle lane may be decreased by the same amount that the roadway lane is in excess of 3.6 metres (**Figure F-70**). Fencing is typically installed when a slope is greater than 2:1. The standard concrete roadside barrier (CRB SP941-01.02.01/02) should be used on the side of the roadway, between the roadway and the sidewalk or pathway. Rails and posts should be installed on top of the barrier to make it conform to the sidewalk fence height for a sidewalk. The bicycle fence height should be used when a significant number of people cycling use the sidewalk or if the CRB is adjacent to a bicycle pathway. If the pathway next to a barrier is used by people cycling and walking, the minimum width from the edge of barrier to the outside edge of pavement should be:

- 2.5 metres for one-way bicycle traffic; and
- 3.5 metres for two-way bicycle traffic.

As noted in the MOTI *B.C. Supplement to TAC Geometric Design Guide*, there are no definitive guidelines to determine what constitute significant numbers of pedestrians and bicycles. Design professionals should consult with a regional Traffic Operations Engineer to determine whether and where there is significant pedestrian and bicycle traffic in the vicinity of the highway construction project. The offset between the off-street pathway and the back of the roadside barrier should be greater of the Barrier Deflection Distance or the minimum horizontal clearance between cyclists and the vertical obstruction (0.5 metre for objects >0.75 metres in height). Barrier Deflection Distance is variable and depends on the design speed of the roadway and barrier system used.

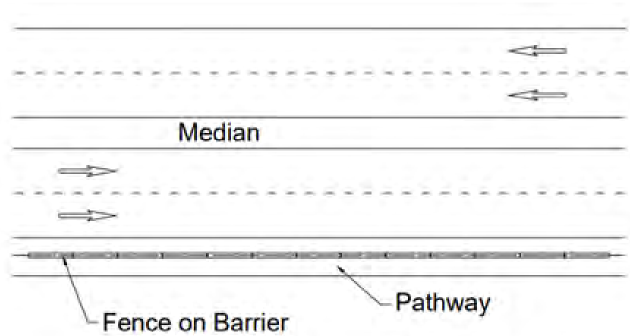


FIGURE F-70 // FENCING ALONG A HIGH VOLUME HIGHWAY

Source: B.C. Supplement to TAC 2019 Figure 660.E

G.

INTERSECTIONS + CROSSINGS

Protected Bicycle Lane Intersection, Fort Street, Victoria, B.C.

G.1

GENERAL DESIGN GUIDANCE

This chapter provides general design guidance related to all types of intersections and crossing points, including design principles and design considerations, an overview of the different types of crossings and crossing controls, and a general discussion on design factors such as sightlines, corner radii, and signage and pavement markings. This general design guidance informs the subsequent chapters on signals and beacons (**Chapter G.2**), pedestrian crossings (**Chapter G.3**), on-street bikeway crossings (**Chapter G.4**), off-street pathway crossings (**Chapter G.5**), and additional crossings and conflict areas (**Chapter G.6**).

DESIGN PRINCIPLES

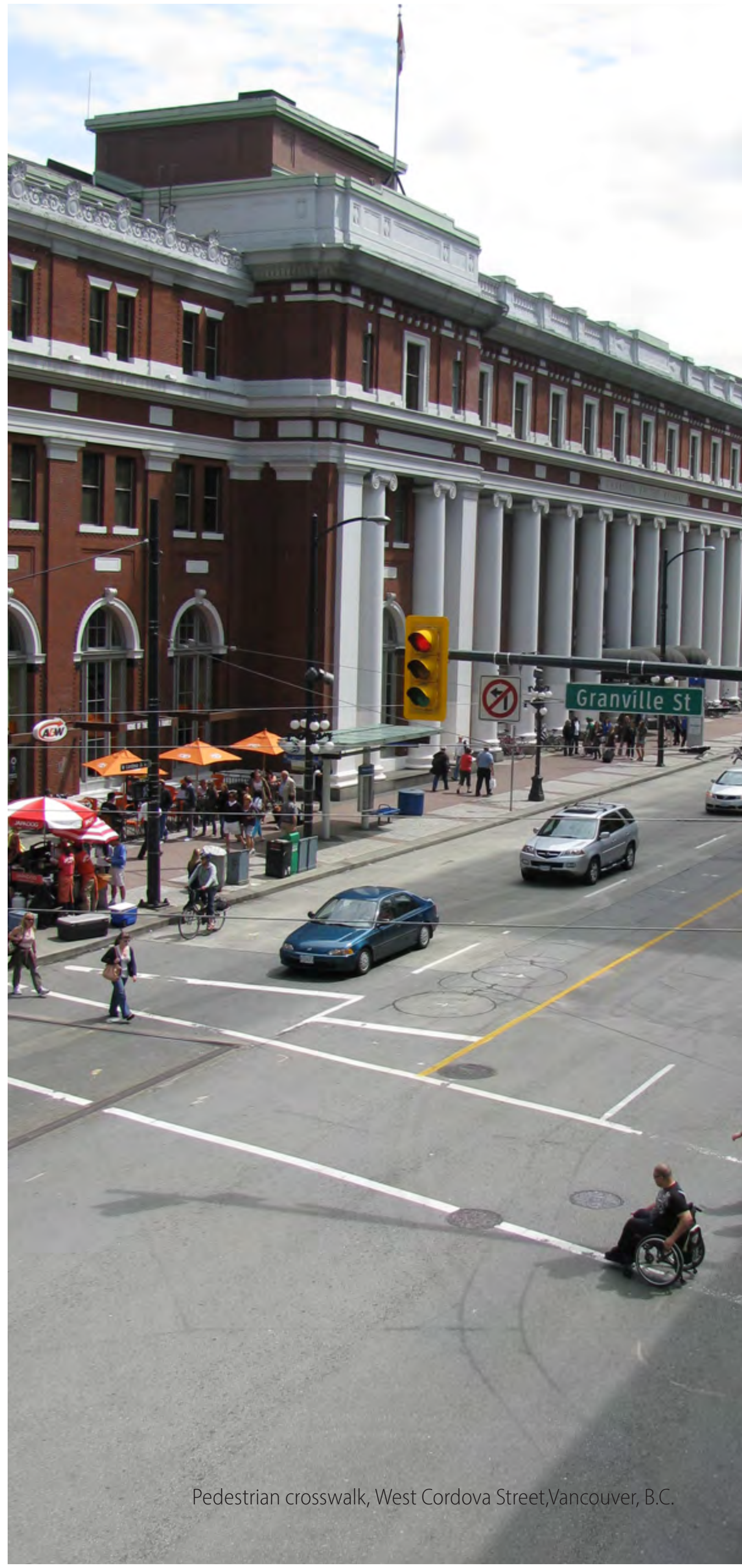
The critical locations for any active transportation facility are at intersections and crossing points. Intersections can often be the most significant real or perceived barriers for people walking, cycling, or using other forms of active transportation. Even if active transportation facilities have been provided along the corridor alignment, if active transportation facilities have been provided through intersections and their conflict points, the facility may continue to feel uncomfortable, unsafe, and inconvenient for many users.

Intersections and crossing points are the connection point between people driving, using transit, walking, and cycling. Intersections have the most conflict points along any active transportation corridor, as they involve complex interactions between all modes of transportation and are generally the locations where most collisions occur.

Turning motor vehicles present a specific risk to people walking and cycling. Special considerations are needed when designing and installing crossing treatments at locations where active transportation facilities intersect with other roads and where active transportation users are directly exposed to motor vehicles. These areas need treatments that distinguish people walking and cycling at intersections, including:

- Reducing the turning speed of motor vehicles;
- Increasing the level of visibility of people walking and cycling;
- Denoting clear right-of-way; and
- Facilitating eye contact and awareness with other modes.

Improving intersections and crossing points for people walking and cycling can allow for a reduction in the total distance travelled, and make walking and cycling more attractive for all.



Pedestrian crosswalk, West Cordova Street,Vancouver, B.C.

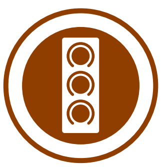
The following design principles should be considered in order to provide safe, comfortable, and accessible intersection and crossing treatments for all users:

Design for all ages and abilities

People of all ages and abilities should be able to safely and comfortably navigate an intersection, crossing, or transition area.

Minimize conflicts between users

Conflicts can be minimized by separating different users in space and/or time. Providing dedicated spaces and/or protected phasing for active modes through intersections and crossing points increases the predictability of movements and supports more compliant behaviour. Minimizing exposure between active transportation users and motor vehicle traffic can also help to reduce conflicts.



Ensure clarity of right-of-way

Providing clear and consistent traffic control devices and visual cues that indicate which user is expected to yield and/or stop ensures clarity of right-of-way. Priority of right-of-way needs to align with municipal bylaws and the *B.C. MVA* and associated regulations. Right-of-way at intersections and crossings should be intuitive for all users.

Reduce speed at conflict points

Reducing the speed differential between different road users helps to reduce the potential for collisions and reduce the severity of injury when collisions do occur. This can include using signage, pavement markings, and geometric design elements such as reducing corner radii and raised crossings to encourage reduced speeds for motor vehicles and people cycling.

Ensure clear sightlines

Sightlines appropriate for the intersection approaches and crossing areas must be provided for all users. Providing clear sightlines ensures that all users have sufficient decision and reaction time to stop or yield to conflicting traffic. Sightlines are especially important at uncontrolled intersections to ensure that all users can see each other upon approaching and entering the intersection.

Make intersection as compact as possible

Compact intersections can enhance safety for active transportation users by increasing visibility for all modes, reducing the exposure of people walking and cycling to motor vehicles, and slowing motor vehicle speeds at conflict points. Intersections may be made more compact by reducing corner radii, limiting the use of dedicated turn lanes, and removing channelized right turn lanes where feasible. Careful consideration should be given to the intersection design vehicle as well as motor vehicle volumes and turning movements prior to implementing any of the above treatments.

DESIGN CONSIDERATIONS

The following variables should be considered when designing intersections and crossing points:

- **Universal accessibility:** Design elements that facilitate access for people with all forms of physical and cognitive impairments should be included. Elements such as detectable surfaces, audible cues, curb ramps, smooth surfaces, and other accessibility features can ensure that all people can safely navigate an intersection or crossing. More detailed guidance on universal design is provided in **Chapter B.3**.
- **User types and volumes:** User types and volumes influence signal timing, user delay, facility width, and safety considerations, including the frequency of conflicts. Active transportation facilities adjacent to roadways with high motor vehicle volumes and/or high numbers of heavy trucks or transit vehicles require careful consideration. High volumes of people walking and/or people cycling also carry unique design considerations.
- **Design speed:** Design speed impacts sightlines, stopping distances, and collision severity. Design elements should be implemented at intersections and crossing points to reduce user' speed to an appropriate level.
- **Traffic controls, signage, and pavement markings:** Traffic controls, signage, and pavement markings should be applied in a consistent manner along corridors and at intersections. This will better meet user's expectations and can lead to improved compliance.
- **User delay:** Facility design should consider user delay for all modes and should balance the impact between them. If any user groups experience unacceptable levels of delay, it can lead to frustration and non-compliant behaviour, which in turn creates safety risks. Along major active transportation routes, active transportation users should be prioritized wherever feasible through favourable signal timing and traffic controls.
- **Topography:** The existing slope of the intersection approaches will impact available sightlines as well as the approach speed for people cycling and for motorists.
- **On-street parking:** On-street parking can act as a buffer between active transportation users and motor vehicle traffic. However, it can reduce sightlines near intersections and crossings, can result in increased crossing distances, and can create conflicts between people cycling and people entering or exiting motor vehicles. It may be necessary to consolidate or remove on-street parking at intersections (including at laneways, driveways, and mid-block crossings) to make active transportation facilities safer and more visible. Consolidation or removal of on-street parking stalls must be done with careful consideration of the surrounding context. On-street parking should not be prioritized over active transportation user safety.
- **Transit stops:** Transit stops are typically found near intersections and can create conflicts between transit vehicles, transit users, and people walking or cycling. Factors impacting designs include the location and type of transit stops, frequency of transit vehicles, number of boarding and alighting transit users, available right-of-way, and assignment of right-of-way in the conflict area. **Chapter H.1** provides further guidance on transit stop design in relation to active transportation facilities.

- **Lighting:** Where feasible, lighting should be provided along the entire active transportation facility. Where this is not feasible, key portions of the facility should be prioritized. Intersections and crossing points in particular need to be adequately lit for all modes to ensure the visibility of all users, clear sightlines, and an appropriate amount of contrast between surface treatments. **Chapter H.4** provides further details regarding lighting design.
- **Drainage and maintenance:** Drainage and maintenance should be considered up front in the design process to ensure that issues can be avoided. Proper maintenance ensures that all users can safely navigate the intersection in all seasons and at all times of the day. Drainage and maintenance are especially important to consider when implementing physical elements such as refuge islands and protected intersections.

Vancouver, B.C.

INTERSECTION & CROSSING TYPES

Intersections

An intersection is defined as the convergence of two or more roads. Intersections are focal points for activity and multi-modal interactions. Geometric design elements and traffic controls, including signage and pavement markings, are crucial for enabling all road users to safely navigate intersections. Design guidance for intersections is provided throughout each Chapter in **Section G**.

Laneway and Driveway Crossings

Laneways and driveways are minor crossing points, with motor vehicles having to cross over active transportation facilities before entering the road. Motorists are legally required to stop before exiting However, in places where motor vehicle encroachment into the Pedestrian Through Zone or Bicycle Through Zone is an issue, additional traffic control signage and pavement markings can be installed to reinforce that people walking, cycling, and using other forms of active transportation have right-of-way. Additional design guidance for pedestrian crossings at laneways and driveways can be found in **Chapter G.3.** Chapter G.4provides additional design guidance for bicycle facility crossings at laneways and driveways.

Mid-Block Crossings

Mid-block crossings are installed where there is demand to cross a road away from an intersection. Mid-block crossings are typically used along off-street pathways and can increase active transportation network connectivity and user convenience. However, special consideration must be given to ensuring that there are adequate sightlines and yielding expectations for both motorists and pathway users. **Chapter G.5** provides design guidance on mid-block crossings for off-street pathways.

Grade Separated Crossings

Grade separation of active transportation facilities from motor vehicle traffic improves safety and allows for the uninterrupted flow of both motorists and active transportation users. However, grade separation requires additional space, higher construction and maintenance costs, and can result in a more indirect active transportation route, which can be a deterrent for use. **Chapter G.6** provides design considerations regarding grade separated crossings.

Alleyway crossing along protected bicycle lane, Vancouver, B.C.

CROSSING CONTROLS

There are three levels of crossing control that can be applied at intersections and crossing points:

- Uncontrolled;
- Stop or Yield control; and
- Signal control.

The choice of crossing control depends on a number of factors, including: road geometry, road classification, collision history, sightlines, motor vehicle volumes, and the number of people walking and cycling. The TAC *MUTCDC* and *Pedestrian Crossing Control Guide* have established warrants (selection criteria) for the use of various traffic control devices. These warrants provide decision support (typically in the form of numeric criteria) for whether or not a traffic control device is justified in a given context and, if justified, what type of control should be used. B.C. specific guidance is also provided in the MOTI *Manual of Standard Traffic Signs & Pavement Markings*, *Pedestrian Crossing Control Manual for British Columbia*, and Section 400 of the *Electrical and Traffic Engineering Manual*.

Warrants help to promote consistency in design and installation. However, warrants are not a substitute for professional judgement, and the installation of a warranted device does not guarantee an active transportation user's safety. In order to provide flexibility in decision making, a holistic and systematic approach to choosing traffic controls that incorporates both numeric criteria and qualitative engineering judgement is recommended.

SIGHTLINES

Intersection Sight Distance

Intersection sight distance considers approach sight triangles and departure sight triangles to assess the necessary sightlines at an intersection. A sight triangle is formed by the line of sight and the sight distances of people driving, cycling, and walking that are approaching an intersection from two intersecting roads. In areas with greater volumes of active transportation users, sightlines should be maximized, and consideration should be made to lower the posted speed limit if the target design speed is lower than posted. Implementing other measures to reduce speed will also support safety at intersections.

Figure G-71 shows typical approach sight triangles for viewing cross traffic approaching from the left and the right for a motor vehicle approaching an uncontrolled or yield-controlled intersection, while **Figure G-72** shows the typical *departure sight triangles* to the left and the right for a motor vehicle stopped on the minor road or facility. The decision point shown is the location where the user on the minor facility should brake in order to stop before conflicting with a user along the major road. This sight triangle can be applied at both intersections and mid-block crossings. These figures are intended only to introduce this concept at a high level. Design professionals should refer to section 9.9.2 of the TAC *Geometric Design Guide for Canadian Roads* for details for determining appropriate sight distances and sight triangles. Sight triangles should be clear of any obstructions such as on-street parking, barriers, and street trees in order to ensure that road users have enough time to perceive and react to potential crossing traffic. Where fixed objects such as signs, buildings, or other obstructions cannot be removed, consideration should be made to implement other measures to increase awareness of active transportation users approaching the intersection. Traffic controls may also be installed to improve safety when fixed objects (such as retaining walls) cannot be removed.

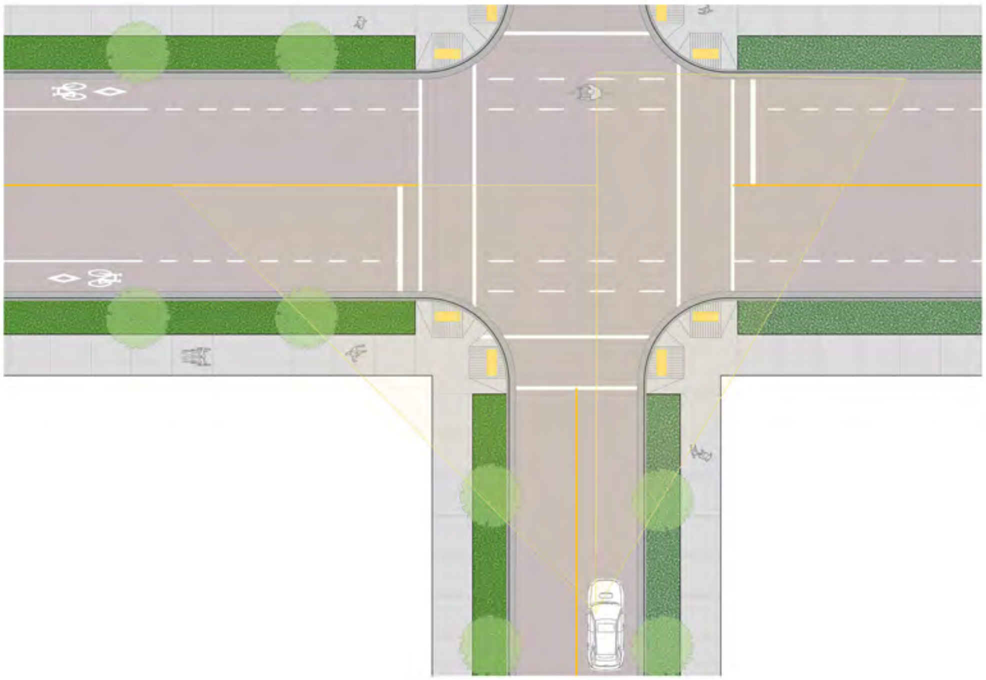


Figure G-71 // Approach Sight Triangle

Source: Adapted from TAC *Geometric Design Guide for Canadian Roads*, Figure 9.9.1

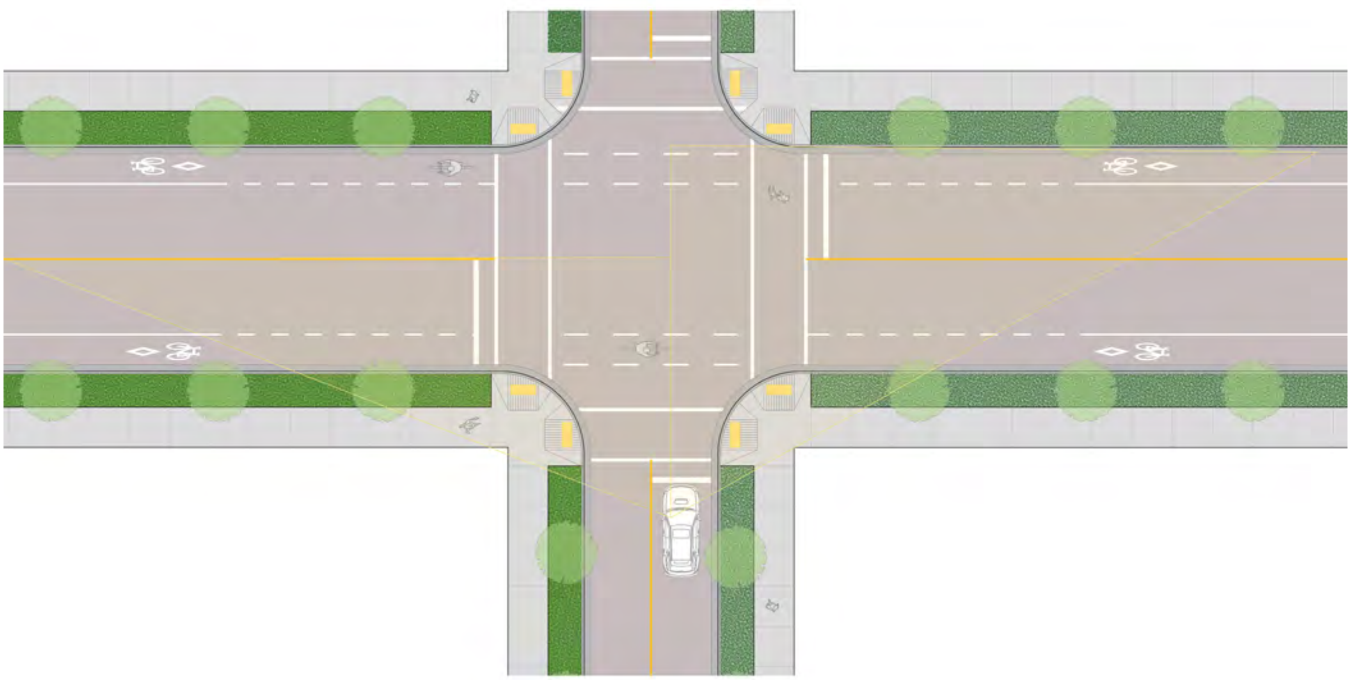


Figure G-72 // Departure Sight Triangle

Source: Adapted from TAC *Geometric Design Guide for Canadian Roads*, Figure 9.9.2

For motorists crossing from a minor road at a stop-controlled approach, it is important that the departure sight triangle to the people cycling and to motorists on the major road be met. If the stopped motorist must enter the crossing path of the active transportation facility in order to achieve the necessary sightline to cross the major road, then signalization should be considered.

Sightline considerations can vary depending on the type of maneuver being conducted in the intersection. For example, for motorists turning left on a two-way road, the provision of adequate sightlines may be insufficient to mitigate conflicts with people walking and cycling on the far side of the intersection. Left turning motorists will be looking for gaps in motor vehicle traffic flowing in the opposing direction, so they may not be paying attention to crossing active transportation users. Additional measures to minimize conflict can include protected signal phasing, conflict markings, and raised crossings.

Stopping Sight Distance

Stopping sight distance is relevant for people cycling and using other active modes other than walking. Minimum stopping sight distance for people cycling is the distance required to bring the bicycle to a controlled full stop. Stopping sight distance is a factor of the bicycle user's speed, the surface material and condition (friction between the tires and surface), bicycle user's perception-reaction time, and facility grade.

The stopping sight distance can be greater for bicycle users than motor vehicle drivers, especially on downgrades, and needs to be considered in the design of bicycle facilities. Skateboards, in-line skates, and other active modes all have slightly different stopping characteristics and should be considered where these modes are expected to make up a large proportion of users.

Section 5.5 of the TAC *Geometric Design Guide for Canadian Roads* provides more details on how to determine the minimum stopping sight distance for bicycles. The stopping sight distance is determined by the formula to the right:

$$SSD = 0.694V + \frac{V^2}{255\left(f + \frac{G}{100}\right)} \qquad (5.5.1)$$

Where SSD = stopping sight distance (m)
V = design speed or velocity (km/h)
f = coefficient of friction
G = grade (m/m; % upgrade is positive and downgrade is negative)

The first term in the expression is the distance travelled during a perception-reaction time of 2.5 seconds. The second term is the distance travelled after brakes are engaged.

Source: TAC *Geometric Design Guide for Canadian Roads*, Chapter 5

Table G-1 outlines minimum stopping sight distances for bicycles travelling at a range of speeds, from 10 km/h to 50 km/h. It also shows grades up to 12% on a paved surface under wet conditions. For bi-directional bicycle facilities, the values for the descending direction control the design. A coefficient of friction (f) of 0.25 is recommended for paved surfaces, as this accounts for the poor wet weather braking characteristics of many bicycles.

Curb Radius

The size of the curb radius (also known as corner radius) is an important intersection design consideration that influences the turning speed of motor vehicles, intersection sightlines, and pedestrian comfort and safety. **Figure G-3** shows a curb radius of 3.0 metres. **Figure G-3** also shows the *effective curb radius*, which is the radius of a motor vehicle's path of travel when turning at an intersection. The effective curb radius is related to the design vehicle and intersection geometry, and is typically larger than the curb radius. On narrower roads with curbside travel lanes or roads with curb extensions, the effective curb radius will parallel the curb radius. The presence of on-street parking, bicycle lanes, and multiple receiving lanes can contribute to larger curb radii. Larger vehicles such as trucks, buses, and fire trucks have larger turning radii. Refer to **Chapter G.3** for examples of how different curb radii impact intersection geometry and turning radius.

Table G-30 // Minimum Stopping Sight Distance for Bicycles (Paved Surface, Wet Conditions)

Minimum Stopping Sight Distance (m) with Coefficient of Friction of f=0.25									
	Design Speed (km/h)								
Grade (%)	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
12	8	13	18						
10	8	12	18	24					
8	8	13	19	25	32				
6	8	13	19	25	32	40			
4	8	13	19	26	33	41	49		
2	8	14	20	26	34	42	51	61	
0	9	14	20	27	35	44	53	63	74
-2	9	14	21	28	36	45	55	66	77
-4	9	15	21	29	38	47	58	69	81
-6	9	15	22	30	39	50	61	73	86
-8	9	16	23	32	42	53	65	78	92
-10	10	16	24	34	44	56	70	84	100
-12	10	17	26	36	48	61	76	92	110

Source: TAC *Geometric Design Guide for Canadian Roads*, Table 5.5.1

Smaller curb radii (≤5.0 metres) have a number of benefits, including:

- Facilitating shorter pedestrian crossing distances;
- Enabling better alignment between the Pedestrian Through Zone, curb ramp, and crosswalk, resulting in a more direct crossing;
- Providing more pedestrian queuing space at the curb, which is especially important in areas with higher pedestrian volumes;
- Making pedestrians crossing and waiting on the corner more visible to motorists; and
- Slowing motor vehicle turning speeds, as a sharper turning motion is required.

As the curb radius increases, pedestrian crossings either become longer or less direct, which can result in lower compliance to crossing within the crosswalk. Indirect crossings are also challenging for people with vision impairments.

Intersection and curb radius design must consider the design vehicle, control vehicle, and managed vehicle that will be using the intersection.

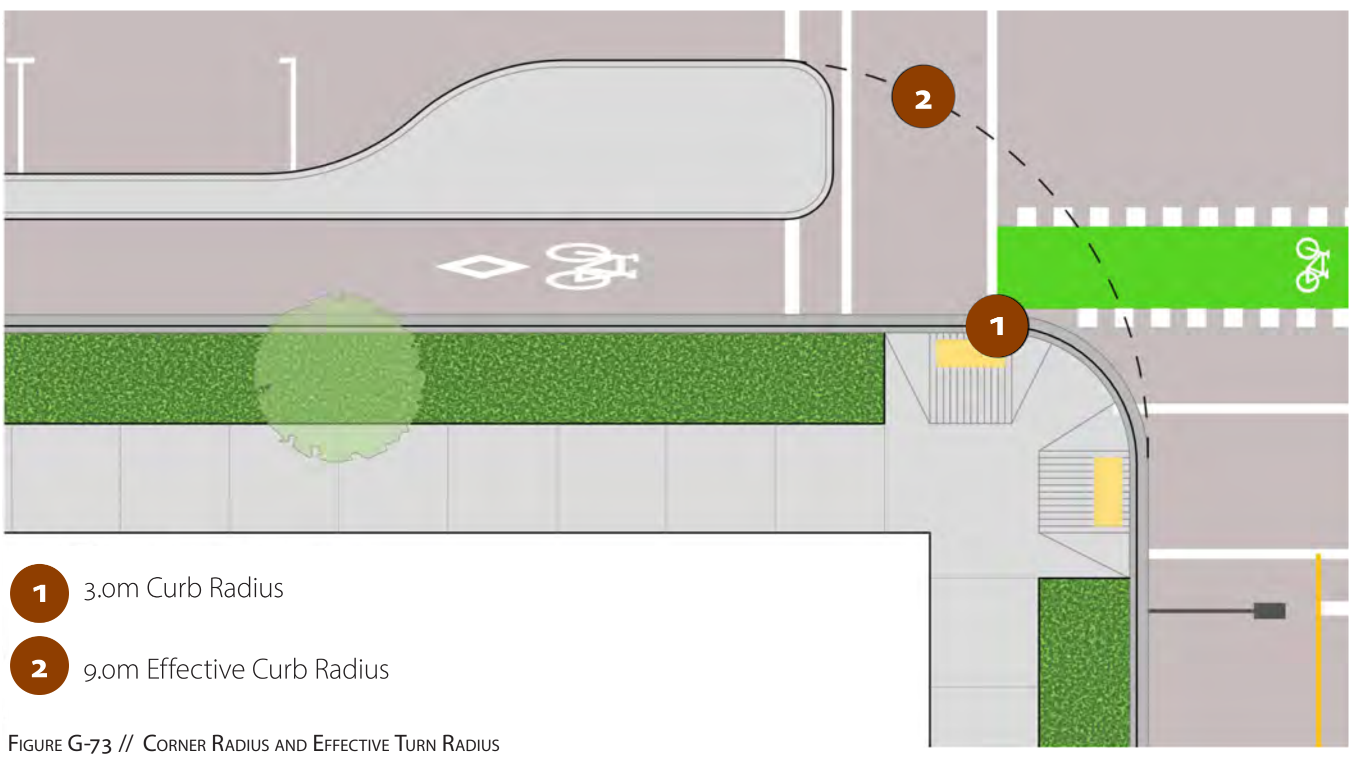
- The **Design Vehicle** is the largest and least manoeuvrable user or vehicle that *frequently uses the road*. The design vehicle directly influences road and intersection design. For more information on design vehicles for roadways under provincial jurisdiction,, see Section 720 of the MOTI *Supplement to TAC Geometric Design Guide*.
- The **Control Vehicle** is the largest and least manoeuvrable user or vehicle that will *infrequently use the road*. It should be accommodated, but not prioritized – the control vehicle may need to operate at lower

speeds and take wide or multi-point turns. For example, along a transit route or designated truck route, a large design vehicle such as truck should be chosen. However, on a local road with no transit, a smaller design vehicle may be appropriate (such as a fire truck).

- The **Managed Vehicle** is the most common vehicle to use the road. It is typically smaller than the design vehicle, which means it is capable of higher turning speeds. In most contexts, personal vehicles are considered the managed vehicle.

When designing an intersection, design professionals should aim to use the smallest possible curb radius that still meets the context and the needs of the design vehicle. Using a smaller curb radius enables the provision of pedestrian benefits without negatively impacting motor vehicle movements. However, careful consideration is required – the curb radius size should be forgiving enough that larger design vehicles do not over-track and hit the curb or any active transportation users. **Chapter G.3** describes strategies to enhance pedestrian crossings by reducing curb radii and using other tools such as curb extensions and median refuge islands.

Emergency vehicle access is an important consideration in all road and intersection designs. Mitigation techniques can be used to accommodate larger control vehicles such as fire trucks and delivery trucks at intersections with small curb radii. These techniques include mountable curb aprons and advance stop bars on cross roads, which enable larger vehicles to encroach into other lanes of travel to complete a wide turn. Flexible bollards and other devices can also facilitate emergency movements while controlling regular motor vehicle movements.



1 3.0m Curb Radius

2 9.0m Effective Curb Radius

Figure G-73 // Corner Radius and Effective Turn Radius

Temporary Curb Radius Retrofit

Where there is a desire to reduce the curb radius at an intersection but there is insufficient funding available to reconstruct the curb, a new curb radius may be delineated using temporary materials such as bollards, planters, and coloured pavement treatments. Interim curb extensions have been found to be a cost-effective measure to enforce traffic calming goals and create safer pedestrian environments[1]. However, the physical curb should be built as soon as funding is available, as this provides enhanced physical protection between pedestrians and motor vehicles.

Signage and Pavement Marking Considerations

Signage and pavement markings are crucial intersection elements that regulate all modes of travel and provide important warnings, wayfinding, and other information. There are two primary sources of signage in B.C. MOTI oversees the B.C. Provincial Sign Program and maintains the *Catalogue of Standard Traffic Signs and Supplemental Traffic Signs*, which apply on all roadways under provincial jurisdiction. Meanwhile, the TAC *MUTCDC* provides national guidance for the use of traffic control devices, including signage and pavement markings. TAC signage is typically used on roadways that are not under provincial jurisdiction.

The TAC *MUTCDC* and the B.C. Provincial Sign Program use different sign codes: for example, the sign code for a Stop sign is MUTCDC RA-1 (using TAC guidance), or B.C. R-001 Series (using the B.C. Provincial Sign Program). There is overlap between the two systems, but there are also signs that are unique to each system. There are also some signs that have similar meanings but different designs. Where two different codes exist for the same sign, each code has been referenced in the Design Guide. If the sign appears in only guide, that code has been referenced. Design professionals are encouraged to review each signage system and consider the jurisdiction and the most appropriate sign for each application.

It should be noted that the figures provided throughout **Section G** feature only signage and pavement markings that were particularly relevant to highlight specific to active transportation facility design. There are a number of other signs and pavement markings that are required along corridors and at intersections that may not be shown on the figures throughout **Section G**. Design professionals should consult relevant TAC or B.C. guidelines for a full set of required signage and pavement markings. **Appendix B** contains a full list of relevant signage and pavement markings used throughout the Design Guide, including dimensions.

1 Robert Kahn and Allison Kahn Goedecke, "Roadway striping as a traffic calming option," ITE Journal: 81 (September 2011)

Curb radius retrofit that uses flexible bollards and coloured pavement markings to delineate pedestrian space.

North Vancouver, B.C.

Vancouver, B.C.

G.2

SIGNALS + OTHER TRAFFIC DEVICES

Traffic signals and other traffic devices provide traffic control and warning at roadway and pathway crossings. There are a variety of types of signalized crossing systems that can be used to provide various levels of control or warning to gain motorists' attention. The needs of all road users need to be considered in the design of signals and other traffic devices, including people walking, cycling, driving, and using transit. This chapter summarizes considerations for people walking, cycling, and using other forms of active transportation with the design of signalized crossing systems. For projects on roadways under provincial jurisdiction, design professionals must be familiar with the MOTI *Electrical and Traffic Engineering Manual* and MOTI *Pedestrian Crossing Control Manual* to ensure consistency. Design professionals are reminded that any signal timing plans, particularly those involving bicycle signal phasing, shall be signed and sealed by a professional engineer experienced in traffic engineering.

TYPES OF SIGNALIZED CROSSING SYSTEMS

Traffic signals provide traffic control at roadway and pathway crossings. There are a variety of types of signalized crossing systems that can be used to provide various levels of control or warning to gain motorists' attention. These systems are described below. The advantages and disadvantages of each system are summarized in **Table G-31**.

Traffic Signals (Full Signals)

Traffic signals, which are also referred to as full signals, control all approaches and regulate which user can enter the intersection safely at a given time. Traffic signals are used at intersections between a combination of roads that are major and minor in functional classification. The installation of full traffic signals is determined by a warrant process and can be installed wherever warranted.

Pedestrian and Cycling Activated Signals (Half Signals)

Pedestrian and cycling activated signals are traffic signals that include all of the elements of a traffic signal, except for side road vehicle indications. Pedestrian and cycling activated signals are intended to facilitate pedestrian and cycling movements while controlling motor vehicle movements on only one road, rather than two or more roads. They can be used at the intersection of major and minor roads, or they can be used at major mid-block crossings. The decision to implement a traffic signal or a pedestrian and cycling activated signal is determined by a warrant process and can be installed wherever warranted.

Overhead Pedestrian Flashers

Overhead Pedestrian Flashers, also known as Special Crosswalks, are not a traffic signal but are instead a traffic device installed to enhance warning and awareness for motorists of a crosswalk at intersections and mid-block locations The system consists of an overhead illuminated Pedestrian Crossing sign (MUTCDC RA-5) with pedestrian-activated flashing amber beacons. Advanced warning signs and flashers can be installed where sightlines are constrained. Pavement markings and ground mounted signs also supplement the overhead flashers. At intersections, the flashers are typically only installed on one side. When used in conjunction with a bicycle crossing, a custom combined Pedestrian and Cyclist Crossing sign should be used.

Rectangular Rapid Flashing Beacons (RRFB) or Other Side Mounted Flashing Beacons

When activated, Rectangular Rapid Flashing Beacons (RRFBs) or other side mounted flashing beacons have flashing amber lights that alternate back and forth to attract motorists' attention, increasing yielding behaviour. When used, RRFBs or other side mounted flashing beacons should be installed with one on either side of the road and a two-sided RRFB in the median island, if a median exists. RRFBs or other side mounted flashing beacons can be used to mitigate conflicts at challenging crossings such as channelized right turn lanes and roundabouts. For additional information, refer to the TAC *Pedestrian Crossing Control Guide*.

TABLE G-31 // ADVANTAGES AND DISADVANTAGES OF SIGNALIZED CROSSING SYSTEMS

TYPE OF SIGNALIZED CROSSING	ADVANTAGES	DISADVANTAGES
Traffic Signal (Full Signal)	▪ All users are given a clear signal of when to cross and stop. ▪ Suitable for roads with higher volumes and larger cross sections. ▪ Ability to coordinate/delay/time the actuations and calls. ▪ May be accessible for all users.	▪ Highest installation costs due to more infrastructure required than other traffic devices. ▪ May impact traffic operations and result in delay and congestion.
Pedestrian and Cycling Activated Signal (Half Signal)	▪ People walking and people cycling are given a clear signal when to cross, and motorists on the major road see a conventional signal indicating when to stop. ▪ Suitable for roads with higher volumes and larger cross sections, where crossing opportunities are less frequent and where side mounted systems are less effective. ▪ Less delay for major streets as it is activated on demand only. ▪ Side road motor vehicle traffic can access major road from stop condition, typically with all movements, unless traffic diversion measures are installed (see **Chapter D.2)**. However, this can create a conflict between turning motor vehicles from the side street and people walking and cycling proceeding straight through the intersection if motorists are not aware of the pedestrian and cycling indications.	▪ Lower installation cost than a traffic signal, but higher installation cost compared to other traffic devices. ▪ Increased delay for major roads compared to overhead pedestrian flashers or RRFBs. ▪ If located on transit routes, could impact the predictability of transit schedule as pedestrian and bicycle activation will slow motor vehicle traffic. ▪ May increase short-cutting motor vehicle traffic on minor side streets unless implemented with traffic calming and traffic diversion measures (see **Chapter D.2**). ▪ Some concerns of potential confusion with side road being stop controlled. Motorists and bicycle users are still legally required to stop before the intersection, even if the major street has a 'red/stop' condition. This can result in confusion and non-compliance.
Overhead Pedestrian Flasher	▪ Less delay for major road, as it is activated on demand only. ▪ Can be implemented when conventional signal warrant is not met or where a conventional traffic signal is not desired. ▪ Lower installation costs than traffic signals (full or half). ▪ Requires less infrastructure than traffic signals (full or half).	▪ Does not provide a 'red/stop' condition for motorists, and may lead to variation in motorist behaviour. ▪ No platooning of crossing users so unpredictable for motor vehicle traffic. ▪ Less visibility than a traffic signal.
Rectangular Rapid Flashing Beacon (RRFB) or Other Side Mounted Flashing Beacon	▪ Less delay for major road as it is activated on demand only. ▪ Can be implemented when conventional signal warrant is not met or where a conventional traffic signal is not desired. ▪ Requires less infrastructure than all other devices as beacons are side mounted. ▪ Lowest installation cost compared to other traffic devices.	▪ Does not provide a 'red/stop' condition for motorists, and may lead to variation in motorist behaviour. ▪ Wide roads can make side of road signing more difficult for drivers to see. ▪ No platooning of crossing users so unpredictable for motor vehicle traffic.

BICYCLE SIGNALS

A bicycle signal is a three-coloured traffic control device that can be used in conjunction with a traffic signal (see Figure G-4). The signal head can have a conventional circle with a supplementary Bicycle Signal sign (CUSTOM), or it can have a bicycle symbol for each signal with an optional supplementary Bicycle Signal sign (CUSTOM). Alternatively, bicycle traffic can also be controlled with pedestrian signal indications, with a custom Bicycle Use Pedestrian Signal sign as discussed below. See **Appendix B** for custom Bicycle Signal and Bicycles Use Pedestrian Signal custom signs.

Typical Application

There are various ways in which the movement of people on bicycles through an intersection can be controlled using traffic signals. For uni-directional bicycle facilities, bicycle movements often follow motor vehicle traffic signals or pedestrian signals. However, a separate bicycle signal may be installed to provide guidance to bicycle users at intersections where they have different needs from other road users. A separate bicycle signal head and phase may also be used at locations to improve safety or operational concerns, such as where sightlines may not be achieved, where there is a high volume of conflicts with motor vehicles turning, or when there is a bi-directional bicycle facility. A review of existing motor vehicle volumes, traffic signal equipment, and traffic signal timing and phasing should be completed prior to the installation of bicycle signals to ensure that a separate signal phase can be accommodated. Guidance on separate signal phasing is provided in further detail below.

Bicycle Signal Placement

Bicycle signals should be placed in combination with existing signal infrastructure where possible to reduce the number of poles required at the intersection. Co-location of equipment reduces obstructions and improves sightlines. The bicycle signal head should be visible to people cycling, and the placement should not physically impede people walking.

Bicycle signals are typically side mounted on the far side of the intersection within 1.5 horizontal metres of the edge of the bicycle facility. The TAC *Traffic Signal Guidelines for Bicycles* indicates that if the far side of the intersection is greater than 30 metres from the stop bar of the bicycle facility, consideration may be given to the use of 300 millimetre bicycle signal lenses or the installation of a supplementary bicycle signal on the near side of the intersection or on the median of the intersecting road.

The TAC *Traffic Signal Guidelines for Bicycles* also suggests that a near side bicycle signal can include smaller 200 millimetre bicycle signal lenses that are mounted in combination with a supplemental Bicycle Signal sign (CUSTOM). In the United States, the MUTCDC Interim Approval on bicycle signals allows a 100 millimetre bicycle signal head to be used as a supplementary nearside indication. This can be used to increase understanding that bicycle signals are only for people cycling. Overhead bicycle signals can be considered if practical and only when side mounted bicycle signals are not feasible. **Figure G-5** shows an example of the recommended placement of traffic signals and bicycle signals.

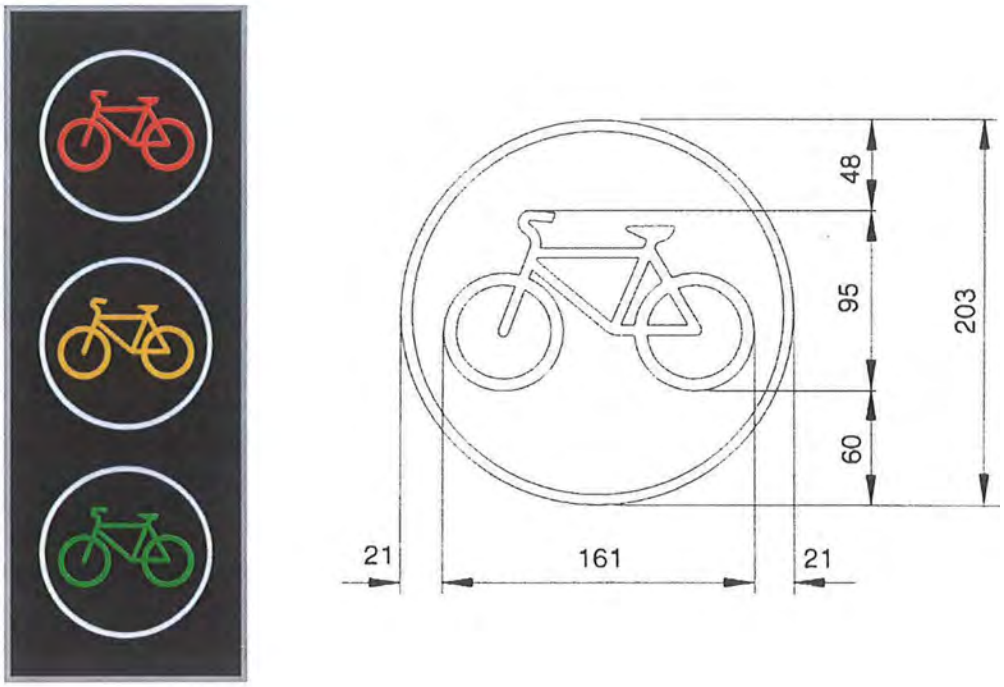


FIGURE G-74 // BICYCLE TRAFFIC SIGNAL HEAD DISPLAY[2]

***Note: All dimensions are in mm*

2 2014 TAC Traffic Signal Guidelines for Bicycle, Chapter 3, Figure 3.1, Page 9 (Original Source: Ministère des Transports du Quebec)

Use of Different Types of Signal Heads for Bicycle Users

Movements through intersections for people cycling are most commonly controlled by the vehicular signal head. Where it is necessary or desirable to control a bicycle movement separately from motor vehicle traffic, people cycling can be controlled by a traffic signal head designated for bicycle use with a custom supplementary Bicycle Signal sign, a bicycle signal head, or a pedestrian signal head with supplemental signs that indicate that people cycling should use the pedestrian signal. Each of these three options are described below. Along a corridor, it is recommended that traffic signal indications for bicycle users are consistent and as uniform as possible. Design professionals are reminded, however, that traffic signals with a bicycle signal head are not currently recognized as a traffic control device in the *B.C. MVA* and, as such, have no legal meaning under current legislation. In addition, traffic signals with a bicycle signal head cannot currently be used for facilities on roadways under provincial jurisdiction.

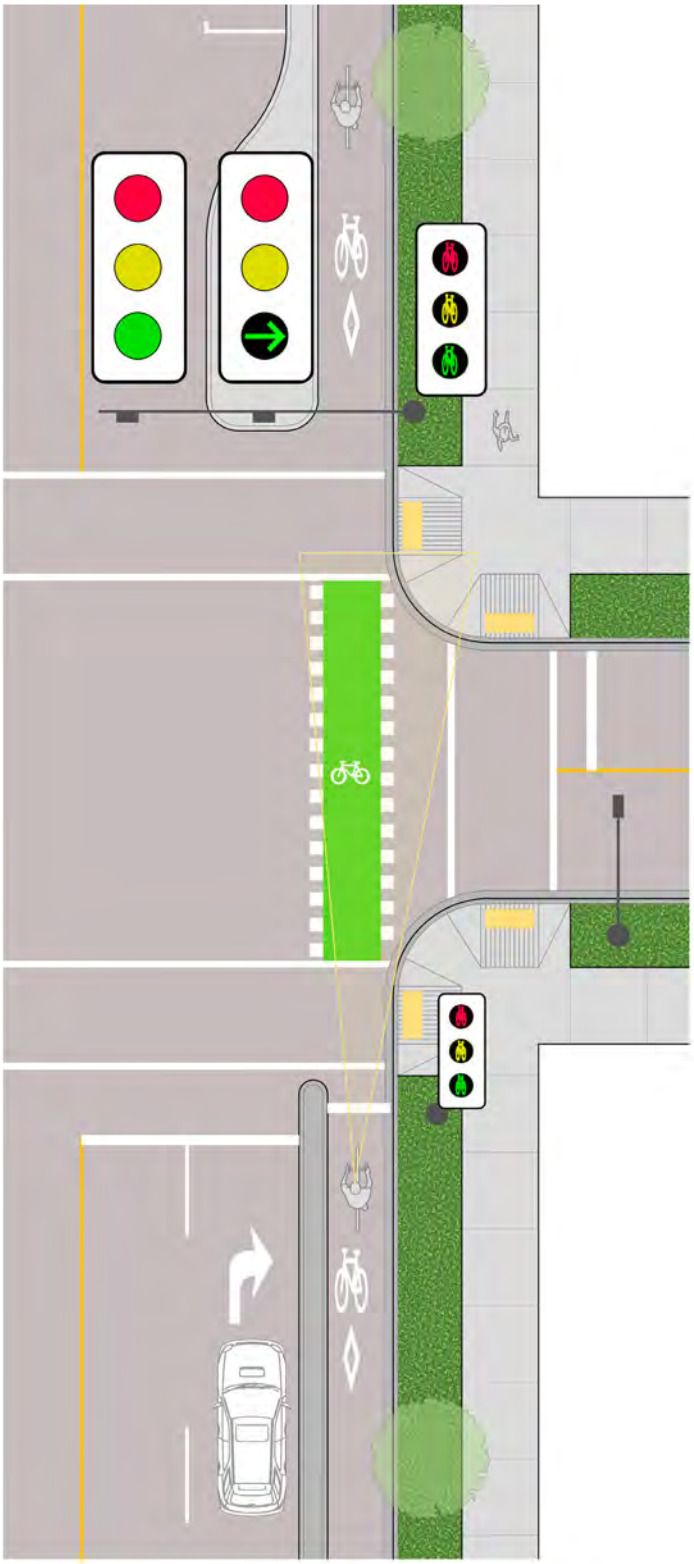


Figure G-75 // Bicycle Signal Placement

Standard Traffic Signal Head Designated for Bicycle Use

A vehicular traffic signal head may be designated for bicycle users by mounting a Bicycle Signal sign (CUSTOM) adjacent to the traffic signal. This may be beneficial at locations where:

- It is necessary to add a signal head where people cycling cannot see existing vehicle signal faces;
- Bicycle users have a separate directional movement, phase, or interval; and
- It is desired to maximize the time a bicycle user may legally enter a crosswalk.

In situations where motorists and bicycle users are on the same parallel approach and on different phases, design professionals should minimize confusion of similar traffic signal displays for approaching road users. Using geometrically programmed louvers can be useful in this regard. Additionally, visual variation in signal head housing for the vehicular signal head designated for bicycle users can increase contrast and awareness and reduce confusion.

Traffic signal heads or bicycle signal heads must be visible to approaching bicycle users. At least one signal head should be visible for a minimum of 30 metres before the stop line based on stopping sight distance for a bicycle traveling at 25 km/h. Where cycling approach speeds are higher, the approach visibility should be lengthened to match the minimum stopping sight distance required for the higher bicycle approach speed. Where bicycle users do not have a continuous view of the signal for the minimum sight distance, a Signal Ahead sign (MUTCDC WB-4; B.C. W-012 Series) should be installed warning of the approaching signal. Where existing vehicle traffic signal heads are anticipated to be the sole source of guidance for people cycling, design professionals should check that the signal faces are located within the cone of vision measured from the bicycle stop line as described in the MUTCDC. If the vehicle signal heads fall outside the cone of vision, supplementary vehicular or bicycle signal faces should be provided. The cone of vision from the bicycle facility is especially important to consider in locations where contraflow or bi-directional bicycle facilities operate on one-way roads. It may be necessary to install new signal faces that are visible to approaching bicycle users

Bicycle Signal Heads

A bicycle signal head can include bicycle symbols on the lenses. However, as noted above, traffic signals with a bicycle signal head are not currently recognized as a traffic control device in the *B.C. MVA* and, as such, have no legal meaning under current legislation. Traffic signals with a bicycle signal head cannot currently be used on roadways under provincial jurisdiction. Local and regional governments should only consider the installation of bicycle signals based on sound engineering and legislative review. Guidelines for application of bicycle signal heads are the same as described above for standard vehicular traffic signal heads with a supplementary Bicycle Signal sign (CUSTOM).

In the B.C. context, common applications of bicycle signals are the use of 200 millimetre and 300 millimetre signal lenses, with the most common being the use of 300 millimetre signal lenses. The recommendation is to provide 300 millimetre signal lenses on the far side of intersections and 100 millimetre signal lenses on the near side of intersections.

Traffic signal mounting heights are based on the type and location of poles and the size of traffic signal heads chosen. Bicycle signal heads should ideally be mounted in line with the bicycle facility. However, there are cases where the conspicuity of the bicycle signal is better mounted adjacent to the bicycle lane. Bicycle signal heads must be mounted so that they do not result in obstructions in the right-of-way for people cycling or walking.

If a 100 millimetre bicycle signal lens is used as a near side supplemental signal, the bottom of the signal housing should be between 1.2 metres and 2.5 metres above the ground. The bicycle signal head should be oriented to maximize visibility to approaching bicycle traffic.

Pedestrian Signal Heads

The use of pedestrian signal heads with a supplemental Bicycles Use Pedestrian Signal sign (CUSTOM) that indicates that people cycling should use the pedestrian signal can be an acceptable alternative for controlling bicycle traffic depending on the local bylaws and regulations associated with bicycle travel. However, due to the inherent conflict in the rights and responsibilities of people walking and cycling in crosswalks, bicycle signal heads are considered the preferred treatment where possible. Bicycle users who operate on multi-use pathways with pedestrians and other active users may be allowed to operate on sidewalks. It should be noted that the *B.C. MVA* indicates that cyclists may not ride on a sidewalk unless authorized by a bylaw made under *B.C. MVA* Section 124 or unless otherwise directed by a sign. In these scenarios, people cycling must follow the indications of pedestrian signal heads where they are crossing in crosswalks unless a traffic signal head or bicycle signal head is located for people cycling.

People cycling can be directed to follow pedestrian signal heads in the following situations:

- Where people cycling are operating in a protected bicycle lane within the roadway and bicycle users cannot see motor vehicle signal heads; or
- Where bicycle users have a separate directional movement, phase, or interval from vehicle movement; To do this, the Bicycles Use Pedestrian Signal sign (CUSTOM) should be mounted adjacent to the pedestrian signal head. Care should be taken to ensure the pedestrian indication is visible to people cycling.

Where people cycling are directed to follow a pedestrian signal, they are only legally allowed to ride in the crosswalk if authorized to do so by local or regional government bylaw. In such cases, they may enter the crosswalk during the walk indication, as the *B.C. MVA* restricts users from entering an intersection

Near side bicycle signal with 100 millimetre lens, Portland, OR during a Flashing "Don't Walk" interval. However, research has found that some bicycle users that see a Flashing "Don't Walk" may still be likely to use this interval to enter the intersection during this indication because it is timed for pedestrians who move much more slowly than people cycling Caution should be exercised when using pedestrian signals to provide guidance to people cycling at locations with long crossings or unique signal timing phases.

Signal Phasing

Traffic signal phasing represents the method by which a traffic signal divides the overall signal cycle to accommodate the turning movements of various users at an intersection. The signal phasing establishes the movements and users that are allowed to operate together at intersections. A phase consists of the necessary intervals of green, yellow, red, Walk, and Don't Walk assigned to a particular traffic movement or combination of movements (i.e. pedestrian crossing, left turn movement, combined left turn and through movements). Evaluating signal phasing options requires an assessment of the benefits of a separate phase and the resulting trade-offs that a protected phase has on efficiency. There are also the other factors that must be considered, including:

- Turning versus opposing through volumes;
- Number of opposing lanes (through or adjacent/turning);
- Cycle length and resulting delay;
- Speed of opposing traffic;
- Sight distance;
- Collision history or potential for future collisions;
- Conflicts (turning paths) between motorists and people cycling; and
- Continuity of bicycle system and proximity to schools, parks for all users and abilities.

Thresholds for Separate Phases

The decision to provide a separate bicycle phase should be based on a need to eliminate conflicts and improve safety at an intersection. **Table G-32 and G-33** provide recommended traffic thresholds in terms of motor vehicles per hour turning across a protected bicycle lane for lower speed and higher speed streets, respectively. These thresholds determine when a time-separated bicycle movement should be considered. At locations where bicycle volume varies and may not meet the minimum required levels whereby bicycle users may not be present each cycle, detection should be used to skip a bicycle phase if not already designed to do so as part of full signal timing plans for fully actuated signals. It should be noted that the volume thresholds for permissive conflicts are lower if a vehicle is crossing a bi-directional protected bicycle lane compared to a uni-directional protected bicycle lane. For left turns on two-way roads, the thresholds vary depending on the number of opposing through lanes. Research shows that as the workload increases for motorists to look for gaps in approaching traffic, they are less likely to be looking towards the crosswalk or left side of the roadway for approaching cyclists or pedestrians.

TABLE G-32 // CONSIDERATIONS FOR TIME-SEPARATED BICYCLE MOVEMENTS - LOW SPEED STREETS (50KM/HR AND BELOW)

PROTECTED BICYCLE LANE OPERATION	MOTOR VEHICLES PER HOUR TURNING ACROSS PROTECTED BICYCLE LANE			
	Two-Way Motor Vehicle Road			One-Way Motor Vehicle Road
	Right Turn	Left Turn Across One Lane	Left Turn Across Two Lanes	Right of Left Turn
Uni-Directional	250	150	50	250
Bi-Directional	150	100	0	150

TABLE G-33 // CONSIDERATIONS FOR TIME-SEPARATED BICYCLE MOVEMENTS – HIGH SPEED STREETS (>50 KM/HR)

PROTECTED BICYCLE LANE OPERATION	MOTOR VEHICLES PER HOUR TURNING ACROSS PROTECTED BICYCLE LANE			
	Two-Way Motor Vehicle Road			One-Way Motor Vehicle Road
	Right Turn	Left Turn Across One Lane	Left Turn Across Two Lanes	Right of Left Turn
Uni-Directional	100	100	0	100
Bi-Directional	50	50	0	0

Bicycle signal with separated phase, Victoria, B.C.

MANAGING TURN CONFLICTS

Signal phasing is a critical element of intersection design to mitigate conflicts between users through separation in time. When considering signal operations, trade-offs between comfort and convenience need to be considered. Design professionals need to consider the various factors and trade-offs when determining how to best manage turn conflicts, including an analysis of corridor and signal timing, review of existing risks and issues at the intersection, and an understanding of how people using the street will respond to the signal phasing.

This section describes various signal phasing schemes that can be considered for reducing conflicts.

Where vehicle movements need to be managed and separate phases are not provided for turning movements, various geometric treatments can be considered to reduce motor vehicle speeds and increase sight distance. Turn conflicts can also be mitigated by time of day restrictions for movements. At locations where conflicts are high and the provision of a separate phase is not feasible or desirable, the following should be considered:

- Install regulatory signs, such as the Turning Vehicles Yield To (or Stop For) Cyclists (or Pedestrians) sign (MUTCDC RB-37, RB-38);
- Install crossing islands, medians, or hardened centrelines to slow vehicle left turn speeds;
- Offset the bicycle crossing to create space for yielding (such as bend out elements of protected intersections and multi-use pathways as discussed in **Chapters G.4** and **G.5**); and
- Prohibit turns by time of day or when gaps are unavailable (through signal detection).

Signal Phasing Schemes for Reducing Conflicts

A bicycle signal phase at a signalized intersection can reduce conflicts between bicycle users and motor vehicles. Comparison of the operational and safety impacts of signal phasing changes are necessary in concert with necessary geometric modifications. Separated movements often require longer signal cycle lengths which may result in reduced user compliance with signal indications.

Case Study

Bicycle Countdown-to-Green Timers

Traffic signal countdown timers (TSCTs) are technologies to assist users in decision-making at signalized intersections with real-time signal duration information. These are commonplace in The Netherlands and Portland, Oregon has installed one in the United States. Traffic signals with countdown to green phase time or a 'WAIT' (WACHT) signal with a countdown circles have been used in the Netherlands with bicycle signals to allow people cycling the ability to make an informed decision on their approach speed and on whether to proceed.[1]

Bicycle signal with countdown timer, Amsterdam, NL

Bicycle signal with WAIT (WACHT) circle countdown to green, Amsterdam, NL
Source: Peter Koonce

1 Mohammad R.Islama, David S.Hurwitza , Kristen L.Macugab, "Improved driver responses at intersections with red signal countdown timers", Transportation Research Part C: Emerging Technologies, Volume 63, February 2016, Pages 207-221.

Exclusive Bicycle Phase

This phasing scheme represents a time-separated bicycle movement. All vehicle movements, including conflicting vehicle turns across the bicycle facility, are restricted during an exclusive bicycle phase (see **Figure G-76**). Exclusive turn lanes for the conflicting motor vehicle turns are not required since all motor vehicle movements are stopped. Some pedestrian movements may be allowed during the split bicycle phase. If bicycle users move independently of pedestrians, this phasing requires the use of a standard traffic signal head designated for bicycle use or a bicycle signal head that is separate from the motor vehicle signal. Alternatively, bicycle users may be directed to follow pedestrian signals during a shared protected bicycle and pedestrian phase. In this case a Bicycles Use Pedestrian Signal sign (CUSTOM) should be used. Right turn on red must be prohibited during the protected bicycle phase. The use of a blanket No Turn on Red (NTOR) sign (MUTCDC RB-17R) should be considered.

Depending on turning volumes, this phasing scheme is more likely to have an impact on motor vehicle operations. To accommodate queues due to an increase in overall inter-green time or cycle length, design professionals may consider the extension of turn lane storage lengths.

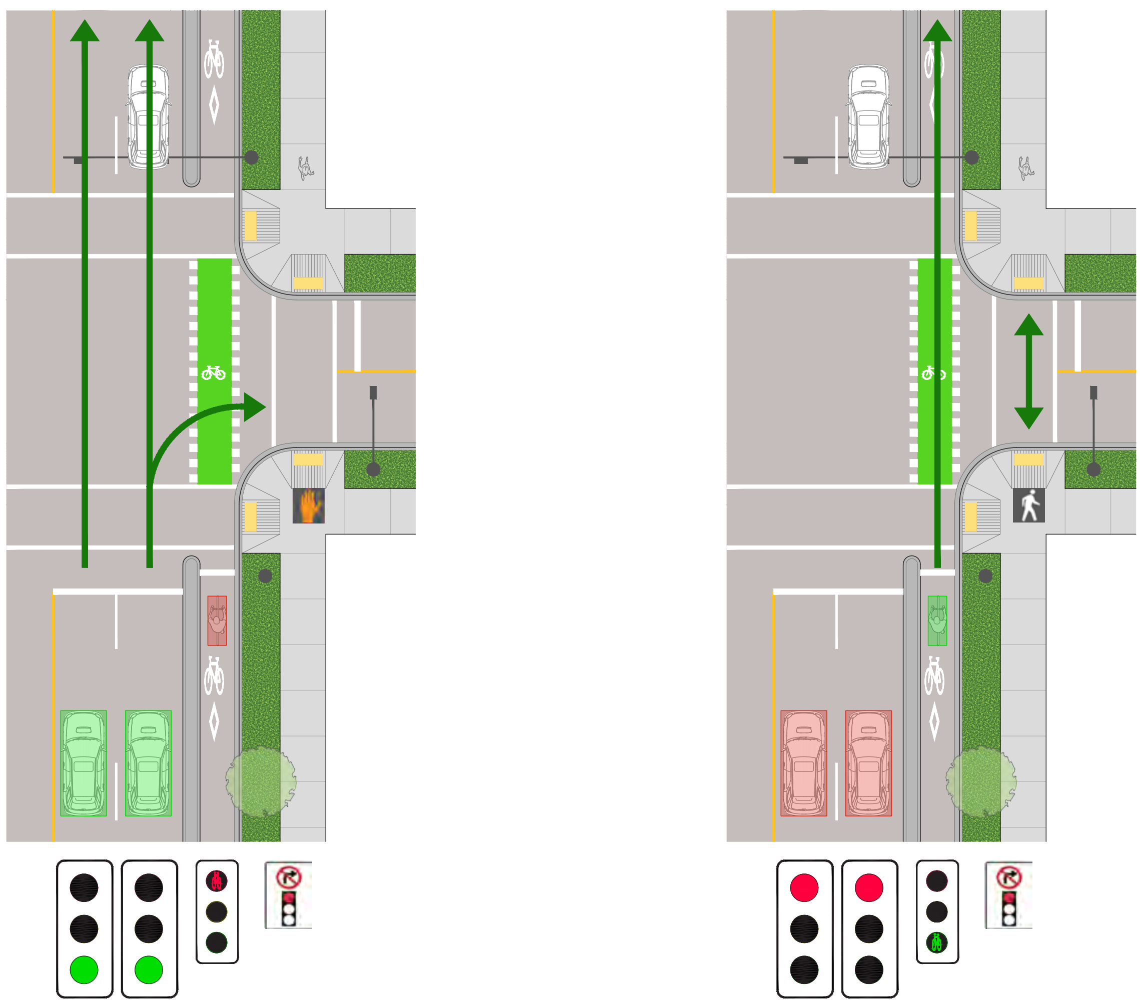
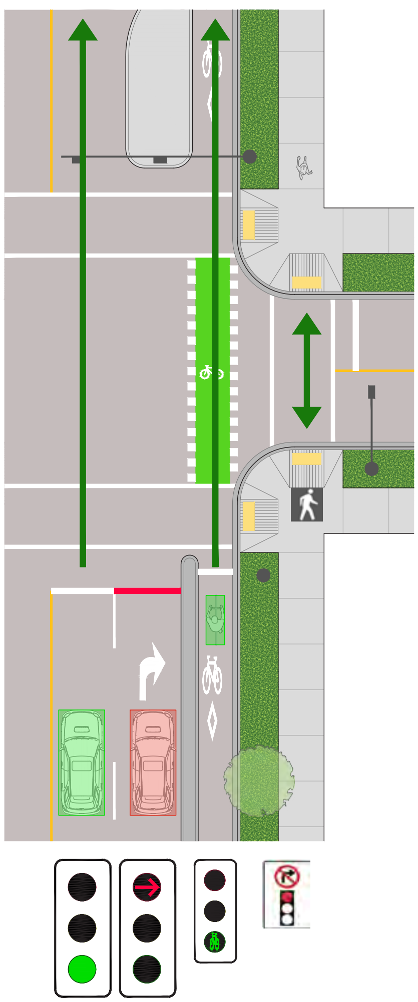


FIGURE G-76 // EXCLUSIVE BICYCLE PHASE (NO DEDICATED RIGHT TURN LANE)

Concurrent Protected Bicycle Phase

This phasing scheme also represents a protected bicycle movement. The bicycle phase runs concurrently with parallel through vehicle phases, but conflicting vehicle turns across the bicycle facility are restricted (see **Figure G-77**). Turn movements across the bicycle facility operate under a protected only phase. The provision of exclusive turn lanes for the conflicting motor vehicle turns are desirable for the adjacent through movement while the turning movements are held. In this phasing scheme, a bicycle needs to be controlled by a signal head that is separate from the motor vehicle signal. Right (or left) turns on red should be prohibited during the protected bicycle phase. The use of a blanket No Turn on Red sign (MUTCDC RB-17R) should be considered. The reduction of split times for other phases may require an increase in the signal cycle length. This phasing scheme can be effective for bicycle facilities along roadways with high through movement volumes and low turning volumes.



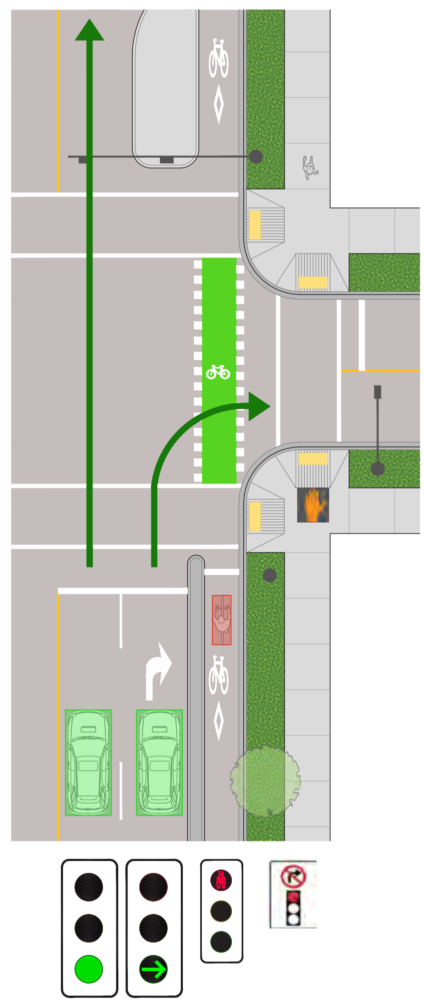


Figure G-77 // Concurrent Protected Bicycle Phase (With Dedicated Right Turn Lane)

Leading Bicycle Interval

At locations where bicycle volumes and/or motorist turning volumes are lower than the threshold to provide a protected phase, or at locations where provision of a protected phase is not feasible, leading bicycle intervals may be considered (see **Figure G-78**). This scheme represents a partially separated bicycle movement. Leading intervals are typically between 3 and 8 seconds long and occur in advance of the green indication for turning motor vehicles. A leading bicycle interval allows a bicycle user to enter the conflict area prior to a turning motorist, improving motorist visibility of the bicycle users A parallel leading pedestrian interval should also be considered where there is a parallel pedestrian crossing (see further details below). In this phasing scheme, a bicycle needs to be controlled by either the pedestrian WALK indication or via a separate signal head from the vehicle signal. Each of the three options outlined previously could be used. Right (or Left) Turn on Red must be prohibited during the leading bicycle phase8

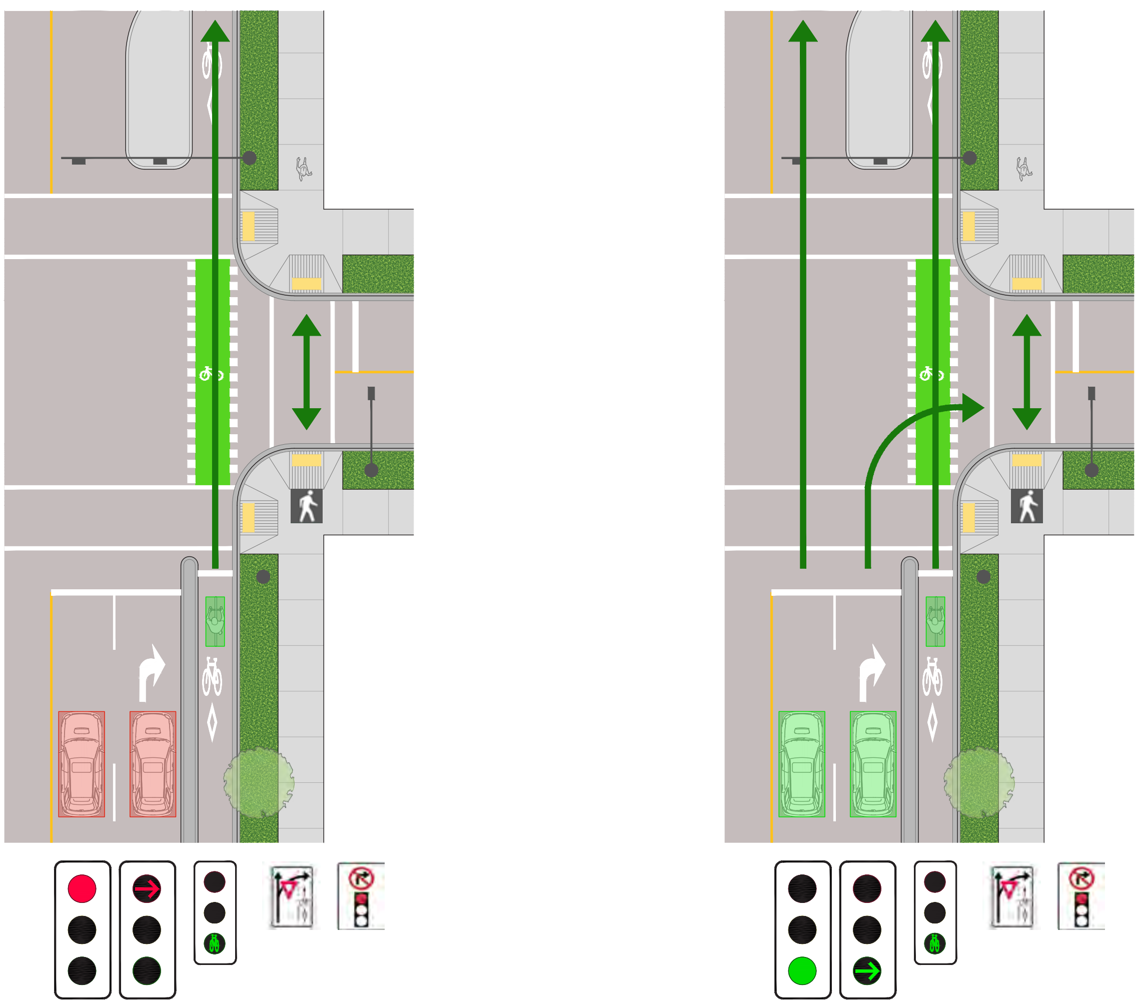


Figure G-78 // Leading Bicycle Interval (With Dedicated Right Turn Lane)

Concurrent Bicycle Phase with Permissive Vehicle Turns

This phasing scheme represents a common scenario at most intersections where bicycle users are not provided any exclusive time in the intersection. In this case, bicycle users are crossing the intersection concurrently with parallel through vehicles, and motorists can make permissive turns (see **Figure G-79**). This phasing scheme has the least impact on motor vehicle operations, but does not enhance bicycle users safety, although the conflict between turning motorists and through moving bicycle users is addressed with the yield requirement. Geometric and signing treatments should be considered with this phasing scheme to improve safety.

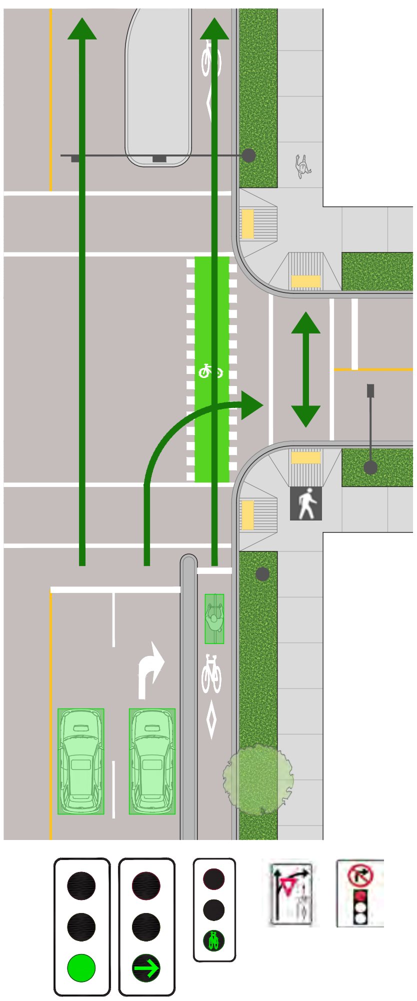


Figure G-79 // Concurrent Bicycle Phase with Permissive Vehicle Turns

No right turn on red, Burrard Street, Vancouver, B.C.

An example of a pedestrian countdown timer

COUNTDOWN TIMERS

Pedestrian Countdown Timers

Pedestrian countdown timers provide information for pedestrians to cross within the allotted green time by informing them of the time until the green phase terminates. With pedestrian countdown timers, people crossing are aware of how much time they have to cross the road. Research has shown that fewer people are in the crosswalk once the countdown timer expires. The added information that pedestrian countdown timers provide to pedestrians can also be used by approaching drivers. Before and after case studies on the effects have been inconsistent among studies, with some studies claiming that timers increase pedestrian compliance,,,[3][4][5] and others reporting increased pedestrian erratic behaviour in the presence of countdown timers,[6] and a decrease in pedestrian compliance[7]. In addition, drivers may behave differently when pedestrian countdown timers are installed compared to when pedestrian countdown timers are not installed.

3 Arhin, S. A., & Noel, E. C. (2007). Impact of countdown pedestrian signals on pedestrian behavior and perception of intersection safety in the District of Columbia. Intelligent Transportation Systems Conference, 337-342.

4 Eccles, K. A., Tao, R., & Mangum, B. C. (2003). Evaluation of Pedestrian Countdown Signals in Montgomery County, Maryland. Transportation Research Board.

5 Schattler, K., Wakim, J., Datta, T., & McAvoy, D. (2007). Evaluation of pedestrian and driver behaviors at countdown pedestrian signals in Peoria, Illinois. Transportation Research Record, 2002(98), 106.

6 Huang, H., & Zegeer, C. (2000). The effects of pedestrian countdown signals in Lake Buena Vista. Florida Department of Transportation.

7 Botha, J., Zabyshny, A., Day, J., Northouse, R., Rodriguez, J., & Nix, T. (2002, May). Pedestrian Countdown Signals: An Experimental Evaluation. San Jose State University & City of San Jose Department of Transportation Final Report to the California Traffic Control Devices Committee.

Green Time, Change Interval and Clearance Intervals for Cyclists

Traffic signal timing must consider and accommodate all users of the intersection: people walking, cycling, driving, or using transit. Bicycle operating characteristics are significantly different than pedestrians and motor vehicles and design professionals should incorporate those unique operating characteristics. Important factors to consider are the speeds and behaviours of people on bicycles. Some bicycle users, especially children, may use crosswalks and pedestrian push buttons to cross, especially at locations where low-stress bicycle facilities are not provided. At these locations, sidewalk facilities should be accessible to all users. The users and their behaviours have an impact on the selection of signal indication equipment, signal timing parametres, design characteristics, and ultimately the operational performance of the intersection.

Where multi-use pathways are present, the needs of pedestrians should be considered, and in some cases pedestrians should be the design user profile. In the case when a pedestrian is not present, the traffic signal can resort to using timing explicitly for bicycle users. This allows design professionals to use less green time than the pedestrian clearance times would require. This section includes a discussion of the traffic signal options for bicycle users and guidance on green times, yellow change intervals, and red clearance for bicycles. At multi-use pathway crossings, bicycle timing may operate in parallel with pedestrian timing. For this reason, design professionals should consider the operating characteristics for people cycling when calculating minimum green, yellow change, and red clearance interval design. A design speed of 13 km/h and acceleration of 0.76 m/s^2, which is the speed and acceleration of a slow-moving bicycle user, is recommended. In locations where slower moving bicycle users (such as children and seniors) are expected or in locations with relatively steep terrain, design professionals should consider whether alternate design speed and acceleration values are appropriate.

Bicycle Minimum Green

When an approach receives a green indication, a bicycle user waiting at the stop bar needs enough time to cross the intersection before the beginning of the yellow indication. Vehicle minimum green times ranging between 10 and 15 seconds may be based primarily on driver expectancy and queue clearances. It is recommended that the minimum green for a bicycle user is long enough for a person cycling to completely clear the intersection before the signal turns yellow. At some wider crossings, the minimum green time must be longer. When bicycle signals (either a standard traffic signal head designated for bicycle use or a bicycle signal head) are used for bicycle movements that are concurrent with motor vehicle movements, the larger minimum green value should be used for both signals unless the controller and detection can provide a separate bicycle minimum green.

Yellow Change Interval

The yellow change interval is intended to warn approaching vehicles of the end of their right-of-way before the onset of the red interval. The vehicular clearance period is split between yellow and all-red for each phase. Design Professionals should refer to Section 400 of the MOTI Electrical and Traffic Engineering Manual for further detail. If the vehicle yellow change interval is calculated based on the kinematic equation (assuming a higher speed than most cyclists travel), the vehicle yellow change interval will always be sufficient to warn bicycle users and allow them time to stop. The MUTCDC states that vehicle yellow change intervals should have a minimum value of 3 seconds. When bicycle signals are used for bicycle movements that are concurrent with motor vehicle movements, the vehicle yellow change interval calculated for motor vehicles should be used. When bicycle signals are used exclusively for bicycle phases, the minimum yellow change interval should consider the needs of the bicycle user in concert with the red clearance interval discussion below. Based on the kinematic equation, typically a value of 3 seconds is considered sufficient.

Red Clearance Interval

The red clearance interval is the 'all-red' time and is combined with the yellow time. Road users are not permitted to enter an intersection on a yellow indication unless they are unable to stop. The all-red phase provides a buffer to help protect against collisions due to human error, distraction, and poor judgement. The 'all-red' time is calculated based on the vehicle clearance speed (posted speed limit of 10 km/h less for conflicting movements), clearance distance, and conflict distance.

Design professionals should consider where a bicycle user would be positioned and the level of risk at the beginning of green for conflicting traffic. Large or complicated intersections may reduce how visible bicycle users are to drivers, thus making it harder for a driver to appropriately recognize the bicycle user's right of way. These situations may include:

- Intersections with wide medians;
- Unconventional or complex intersections (skews, extra legs);
- Intersections with horizontal or vertical curvature;
- Intersections with poor lighting; and
- Intersections with other sight distance issues.

Bicycle Green Extension

On bicycle facilities that have detection, there is more flexibility with respect to signal timing. Minimum green times should be provided to ensure that a waiting bicycle user can completely clear the intersection. In locations where bicycle volumes are heavy during a particular time of day, additional green time may be needed. In this case, the approach can include a detector in advance of the stop line to extend the green interval to allow the bicycle traffic to move through the intersection. The length of the extension should be determined by the speed of bicycle users, the distance the detector is from the stop line, and the amount of extension time that can be provided. Once the phase has begun, each bicycle user will extend the green time for each bicycle detected up to the maximum green.

SCRAMBLES AND DIAGONAL CROSSINGS

Pedestrian Scrambles

An exclusive pedestrian phase or "scramble" is a type of traffic signal phasing where pedestrians are allowed to use the intersection before or after motor vehicle traffic on all approaches is stopped. Pedestrians can make diagonal crossings (hence the term "scramble") as well as conventional crossings without coming into conflict with turning vehicles. Table G-5 summarizes the advantages and disadvantages of pedestrian scrambles. Limited published evaluations of scramble phasing show the potential for increased pedestrian safety as long as vehicles and pedestrians are compliant with the signals. However, mention of bicycle users in these studies is limited. As both pedestrians and vehicles experience increased delays since the cycle length is increased this may reduce compliance, which may negate the expected safety benefits of scramble phasing.

Bicycle Scrambles and Diagonal Bicycle Crossings

Bicycle scrambles are intersections where traffic signals stop vehicles in all four directions, allowing people cycling to cross laterally or diagonally. Motor vehicles should not be permitted to make right turns on red during scramble phases. Many cities around the world use scrambles to provide safe and accessible crossings in pedestrian-heavy areas, but few countries use them strictly for bicycle traffic. Installing these scrambles can impact vehicle, transit, and pedestrian travel times, but are also expected to improve safety and convenience for people cycling. The United States FHWA explicitly prohibited their use with bicycle signals in their

December 2013 Interim Approval[8], but they can be found in the Netherlands. Bicycle scrambles are not recommended for application in B.C. at this time.

Table G-34 // Advantages and Disadvantages of Pedestrian Scrambles

ADVANTAGES	DISADVANTAGES
▪ Eliminates concurrent pedestrian phases, allowing motor vehicle traffic to make left or right turns without any impedance by pedestrians in the crosswalk. ▪ Provides opportunities for people to walk diagonally which may reduce out of direction and compliance issues.	▪ Requires a longer cycle length to accommodate all movements. ▪ Requires compliance of turn restrictions for vehicles during red. ▪ Increases delay for most users depending on situation.

Bicycle Signal Activation

Traffic signals should passively detect bicycles or allow bicycle users to manually call a phase with a push button. Bicycle users should not have to dismount to use a push button. One of the primary purposes of detectors is to call the signal phase. If detection is used on an intersection approach where bicycle users are expected, it should be designed to sense bicycles whether they are mixed with vehicle traffic or in their own lane. Various technologies are available for passively detecting bicycles, including: inductive loops, microwave, video, and magnetometres. To provide a backup to passive detection devices, a bicycle push button may be used. The detection layout and design should be based on intersection geometry and the intended use and operation of the detectors. The design must reliably and accurately detect bicycle traffic, and should provide guidance on how to actuate detection. Each type of detection should be monitored to evaluate effectiveness and field calibrated as needed to ensure the detection systems are working as intended.5

Bicycle Detection Loop

In-ground induction loops can be used to detect the presence of bicycles to actuate the bicycle traffic signal phase where the intersection is signalized and shared with motor vehicles. In locations where induction loops for motor vehicles are in place, additional induction loops for bicycles may not need to be installed, reducing the cost of installation. However, the sensitivity of the loop must be carefully considered. Additionally, some loops may have difficulty detecting vehicles with limited metal in them (such as carbon fiber bicycle frames). If existing loop systems do not provide enough sensitivity to detect a bicycle, existing loop systems may still need to be updated.

Push Button

Call or push buttons should be used at signalized bicycle crossings of major roads, where the minor road traffic is stopped, and where loop detectors cannot be installed. Compliance at the signals may be greater when push buttons are present as compared to passive detection due to the physical and visual presence of the device and the understanding that the device is intended to be used to change the traffic signal phase. When selecting where to install a push button, consideration should be made so that people cycling do not need to dismount. Consideration should also be made so that the push button can be activated by all bicycle users (including recumbent and hand bicycles without dismounting. Where bicycle push buttons are not intended for the use of pedestrians, push buttons do not have to meet accessibility guidelines for placement. Bicycle push buttons should have a supplemental sign explaining their purpose and use, and the sign should be mounted immediately above or incorporated into the push button. The push button should be oriented in the same direction as the bicycle crossing. Push buttons may also include a detection confirmation light to provide positive feedback to the

8 Lindley, Jeffrey. "MUTCDC – Interim Approval for Optional Use of a Bicycle Signal Face (IA-16)", Federal Highway Administration, December 24, 2013.

user and potentially improve compliance with the traffic signal (see below).

Other Forms of Detection

Infrared, microwave (radar), ultrasonic, video and/or motion detectors can also be used for detection at signalized bicycle crossings of major roads. By lengthening the detection zone, the traffic signal may provide a quicker response time to waiting bicycle users. There are situations where their use may present accuracy problems particularly during periods of poor weather conditions. In other cases, these types of detectors – such as loop detectors – can be susceptible to false detections, so while they can be used, there should be a plan to ensure that accuracy is assured where loops or push button detection is undesirable or not available.

Indicator Light

Indicator lights can be considered with the bicycle signal head. Indicator lights indicate that the person cycling has been detected by the sensor. These lights are relatively small and are mounted at or near the traffic signal face controlling the approach. The purpose of the confirmation light is to reduce concern for users that they have not been detected. This can be particularly helpful at locations with long signal cycle lengths where bicycle users may be required to wait 60 seconds or more for a green signal. Compliance may increase for people riding bicycles when they know that they have been detected. Detector confirmation indications are currently experimental in the United States, but used widely in The Netherlands.

Traffic Signal Control (Actuated and/or Coordinated) and Effects

The use of coordination between traffic signals has primarily been used to move cars through a series of signalized intersections. The effect of coordination on people walking and cycling can be to decrease the respective user's delay. There is limited research on the impacts of operating the signal in free mode compared to traditional coordination.

Cycle length in signal timing refers to the time taken for a complete sequence of signal indications. Research has shown that shorter cycle lengths benefit pedestrians by providing less delay. Guides such as the NACTO *Urban Street Design Guide* recommend the provision of shorter cycle lengths to increase efficiency of multimodal operations and reduce pedestrian delay[9].

Progression Speed for Bicycles (Green Wave)

A corridor traffic signal progression speed may be based on a desired travel speed, the posted speed limit, or an agency policy. In most cases, the signal progression is set at a higher speed than what a person cycling can achieve. As a result, people cycling on the coordinated corridor may not benefit from the progression and will experience delays that motorists do not. The use of a lower progression speed is appropriate to support and encourage bicycle traffic. Signal progression focused on people cycling is referred to as "Green Wave" progression and they allow people cycling to operate at a consistent speed, reduce stopping, and improve compliance. The speed of motor vehicle traffic can also be considered in the design of signal timing that accommodates both users. A bicycle "Green Wave" results in slower travel speeds for motor vehicles which improves safety for all roadway users. The speed for a "Green Wave" depends on the extent of grade and is often in the range of 15 km/hr to 25 km/hr.

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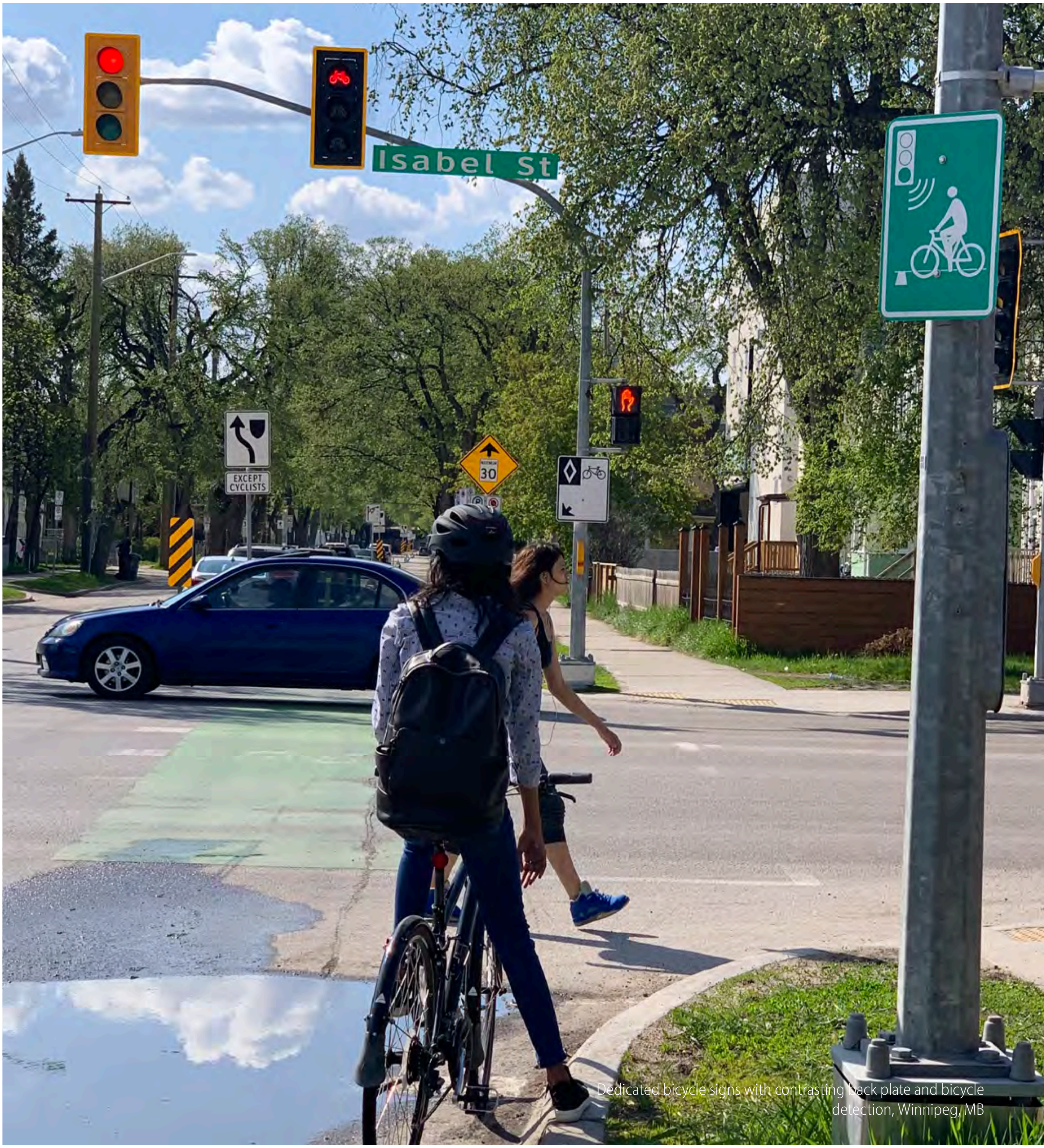
9 NACTO, National Association of City Transportation Officials. 2013. Urban Road Design Guide, New York.

Case Study

Several cities, including Calgary, Edmonton, and Portland have used small blue confirmation lights to provide confirmation to bicycle users that they have been detected at actuated approaches to traffic signals. The intent of the installation is to provide feedback to help reduce the level of stress for waiting bicycle users. Given the relatively low cost of installation, the intent is that these could be tools for creating infrastructure that promotes mobility and efficiency for people cycling. Research is limited on the effect of the confirmation devices, accompanying informational signs, and countdown timers on the behavioural and psychological effects for bicycle users. One recent study has shown positive impacts of using a blue light feedback confirmation device along with an informational sign at signalized intersections to aid bicycle detection, with a significant decrease in the number of bicycle users getting off their bicycle to use the pedestrian push button for detection. [1]

Bicycle detection light, Calgary, Alta
Source: Shea Friesen

1 Boudart, J., Liu, R., Koonce, P., and L. Okimoto. An Assessment of Cyclist Behavior at Traffic Signals with a Detector Confirmation Device. Transportation Research Record, Journal of the Transportation Research Board, No. 2520, Transportation Research Board of the National Academies, Washington D.C., 2015, pp.21-26.



Dedicated bicycle signs with contrasting back plate and bicycle detection, Winnipeg, MB

Surrey, B.C.

G.3

PEDESTRIAN CROSSINGS

The provision of safe and accessible pedestrian crossings is crucial to ensuring that people of all ages and abilities are able to navigate the active transportation network and reach their destinations. When crossing the road, pedestrians are exposed to potential conflicts with motor vehicles, bicycle users, and other road users. Geometric design elements, signals, signage, and pavement markings can all be used to prioritize pedestrians and mitigate conflicts.

A number of reference documents provide important context for pedestrian crossing design in B.C. and have been referenced throughout this chapter. These documents include the TAC *Pedestrian Crossing Control Guide*, TAC *Manual of Uniform Traffic Control Devices*, *B.C. Manual of Standard Traffic Signs & Pavement Markings*, and the *Pedestrian Crossing Control Manual for British Columbia*.

This chapter provides design guidance for on-street intersection and mid-block pedestrian crossings, introducing geometric crossing enhancements such as curb ramps, curb extensions, pedestrian refuge islands, and other elements. Off-road crossings and additional conflict areas are discussed in **Chapters G.5** and **G.6**, respectively. **Chapter B.3** provides an overview of universal access design considerations, while **Chapter B.4** provides more detail on the operational and behavioural characteristics of pedestrians, including walking speed.

CURB RAMPS

A curb ramp is a smooth, graded transition from the sidewalk to the road. Curb ramps are an essential universal design element – they are required for people using wheelchairs, power scooters, and other mobility devices, but also benefit people with strollers, baggage, and delivery carts, and they are used as a navigational tool by people with visual impairments. Curb ramp characteristics and design guidance are provided below. Additional information can be found in the MOTI *B.C. Supplement to TAC Geometric Design Guide*.

Curb Ramp Components

Curb ramps consist of several components that combine to create a universally accessible crossing, (see **Figure G-80**). These include a ramp 1, top landing area 2, bottom landing area 3, flares 4, and approach 5. The shape and positioning of each element can vary according to geometric constraints and curb ramp type. Directional score lines 6 may be included on the ramp and oriented to direct pedestrians in the correct crossing. Tactile attention indicators can also be provided for universal accessibility 7.

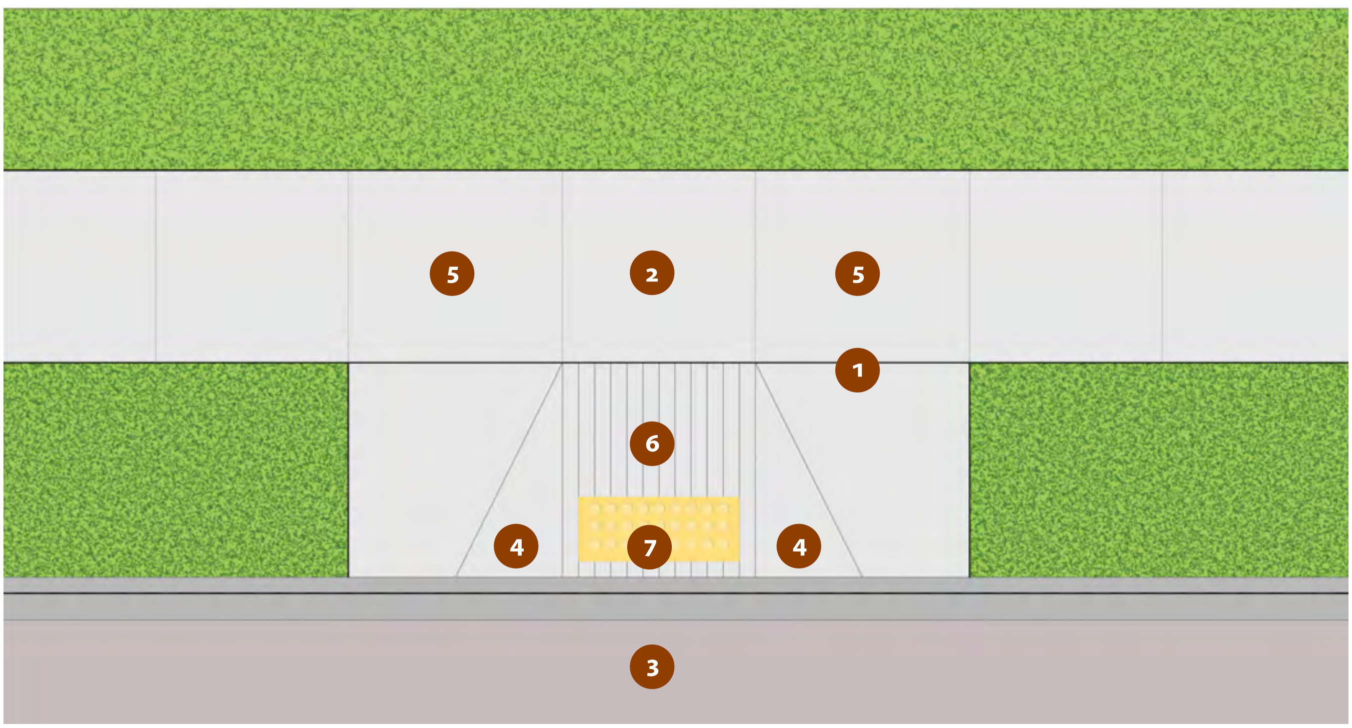


Figure G-80 // Curb Ramp Components

1 Ramp
2 Top Landing Area
3 Bottom Landing Area
4 Flares
5 Approach
6 Directional Score Lines
7 Tactile Attention Indicator

1 Ramp

The ramp is the transitional surface between the sidewalk and road. The surface of the curb ramp should be firm, stable, and slip resistant. The desired curb ramp width (exclusive of flared sides) is 1.8 metres, with a constrained limit width of 1.5 metres. The absolute minimum curb ramp width is 1.2 metres.

The maximum running slope of a curb ramp is 1:12 (8.3%). A running slope of 1:10 (10%) is acceptable in existing locations. The cross slope should be no steeper than 1:50 (2%) at intersections. At mid-block locations, the cross slope may match the road gradient.

Directional score lines may be included on the ramp and oriented to direct pedestrians in the correct crossing directions, **(**see **Chapter B.3**) for details on score lines). Additionally, in order to provide full universal access, tactile attention indicators (a type of TSWI) may be installed at the base of curb ramps to alert pedestrians that they are entering a conflict zone and to assist with wayfinding. When used, tactile attention indicators should extend the full width of the curb ramp and should start between 300 and 350 millimetres from the road face of the curb. See **Chapter B.3** for more details on tactile attention indicators. Directional score lines and tactile attention indicators may be used together to provide full universal access.

2 Top Landing Area

The top landing area is a level surface at the top of the curb ramp that provides space for manoeuvring and refuge. In constrained conditions, it may not be possible to provide a landing area. The top landing area should be as wide as the ramp portion and a minimum of 1.2 metres long. At constrained corners where the ramps land on an area where a pedestrian must change direction, a landing of at least 1.5 metres long should be provided. Larger top landing areas are preferred wherever feasible. A turning space of at least 1.35 metres by 1.35 metres should be provided, although this space can overlap with other clear spaces.

3 Bottom Landing Area

The bottom landing area is the receiving space in the road at the base of a curb ramp. While it is actually part of the crossing and not the ramp itself, the bottom landing area has important slope and drainage considerations. Counter slope is the grade change where the down slope of the curb ramp meets the up cross slope of the gutter or road. Steep counter slopes can be difficult to navigate for wheelchair users, as the counter slope may catch footrests or cause a loss in wheel traction. The maximum recommended counter slope is 1:20 (5%).

The bottom landing area should be prioritized for maintenance to ensure that the surface remains in good condition and to prevent the accumulation of debris such as gravel, leaves, and snow. Curb ramps should provide appropriate drainage to prevent water and ice from accumulating in the bottom landing area. No catch basins should be located within the bottom landing area unless they meet accessible standards (see **Chapter I3**).

4 Flares

The flares are the sloped edges that connect the ramp to the adjacent sidewalk. They should be slip resistant and have a maximum slope of 1:10 (10%). Flares provided a flexible side access to the ramp, although they may not be easily navigable for people with mobility devices users. This underlines the importance of providing an accessible top landing area.

5 Approach

The approach is the portion of the sidewalk leading up to the top landing area. The grade and slope of the approach is the same as the Pedestrian Through Zone and top landing area. 2.

Curb Ramp Placement

Curb ramp design and placement is influenced by geometric elements such as the corner radius and the width and alignment of the Pedestrian Through Zone and Furnishing Zone. Where feasible, the recommended approach is to provide **double curb ramps**, which provides a dedicated curb ramp for each individual crosswalk), as shown in **Figure G-81.** Double curb ramps help to provide full universal access by landing pedestrians directly in the crossing area and in the desired direction of travel, rather than entering the road at an angle and having to reorient themselves. This is especially important for pedestrians using mobility devices and who are visually impaired.

Wherever feasible, double curb ramps should be aligned with the Pedestrian Through Zone and centred in the crosswalk, creating a direct pedestrian path. Double curb ramps also help to reduce crowding by separating pedestrians by direction of travel. This in turn makes it easier for motorists to determine the pedestrians' desired crossing direction

A minimum of 1.2 metres of level clear space must be provided behind the ramps to allow pedestrians to bypass the curb ramps without having to enter the ramp itself. A full height curb should be provided at the corner between the two curb ramps. This prevents motor vehicle incursion into the corner. In order to form this full height curb, the two curb ramps must be separated by a minimum of 1.0 metre of full height curb, measured along the arc of the curb.

Where there is insufficient space for a double curb ramp due to larger corner radii, obstructions such as utility poles, and/or narrow Pedestrian Through Zones and Furnishing Zones, a **combined curb ramp** may be used (**Figure G-82**). Combined curb ramps still allow people using wheelchairs to enter the crosswalk along a straight trajectory, unlike a single curb ramp that is located at an angle to the road. However, combined curb ramps do not provide the benefit of separating directions of pedestrian travel, and they are at risk of motor vehicle encroachment due to the lack of full height curb.

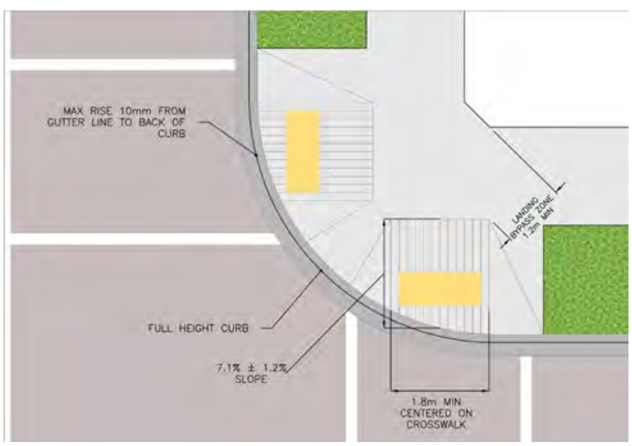


Figure G-81 // Double Curb Ramp

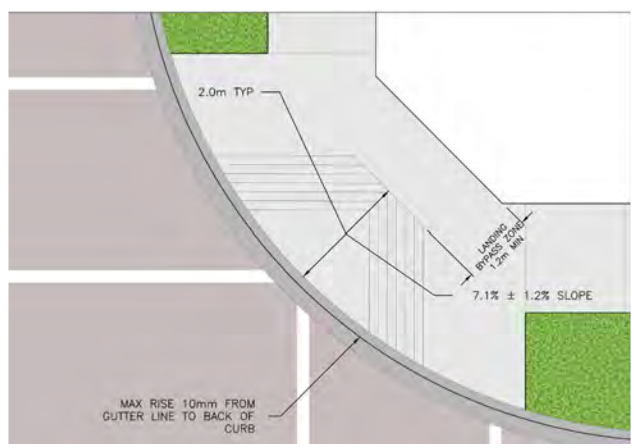


Figure G-82 // Combined Curb Ramp

INTERSECTION CROSSINGS

Unmarked Crossings

According to the B.C. MVA, at the intersection of any two roads with pedestrian facilities, all legs of the intersection are legally considered to contain crosswalks, regardless of whether or not they are marked with signage or pavement markings. Unmarked crosswalks are typically defined by connecting the Pedestrian Through Zones on either side of the road. Where there is no sidewalk, the unmarked crosswalk is measured from the edge of the road.

Marked Crossings

Providing crosswalk signage and pavement markings makes a crosswalk more visible to all road users, increasing motorist yielding behaviour and helping to guide pedestrians across the road in the safest and most direct location. All crosswalks at signalized intersections should be marked. At unsignalized intersections, a range of crosswalk markings may be considered, based on the context. The TAC *Pedestrian Crossing Control Guide* and the *Pedestrian Crossing Control Manual for British Columbia* contains warrants for when different levels of crosswalk are required, based on a number of criteria including road classification and motor vehicle speeds and volumes. As described in **Chapter G.1**, warrants should be applied alongside qualitative engineering judgement to assess the best design for each individual context.

Certain types of intersections may require crosswalk markings even if otherwise unwarranted based on road classification and motor vehicle speeds and volumes. For example, intersections with visibility constraints due to topography, road curvature, or obstructions such as buildings or road trees may require signage and markings to increase visibility. Offset and complex intersections should also be marked in order to guide pedestrians through the intersection along the most direct path. Finally, all intersections and crossings within school zones deserve special consideration.

Crosswalk Signage and Pavement Markings

The TAC *Pedestrian Crossing Control Guide,* TAC *MUTCDC, B.C. Manual of Standard Traffic Signs & Pavement Markings,* and MOTI *Pedestrian Crossing Control Manual for British Columbia* provide detailed descriptions and installation instructions for pedestrian crosswalk signage and pavement markings. These signs and pavement markings are also shown in **Appendix B**. Basic crosswalk signage includes the Pedestrian Crosswalk sign (MUTCDC RA-4; B.C. PS-003 Series), the Pedestrian Crosswalk Ahead sign (MUTCDC WC-2; B.C. PS-002 Series), the Special Crosswalk Overhead sign (MUTCDC RA-5), and the Yield Here to Pedestrians sign (not currently part of the MUTCDC).

The standard pedestrian crosswalk pavement marking is the **twin parallel line crosswalk** marking, which simply consists of two parallel while lines delineating the crossing. The twin parallel line crosswalk is suitable at intersections that are stop or signal controlled, including pedestrian signals.

Zebra crossings feature wide white parallel lines and offer enhanced visibility over the twin parallel line crosswalk. Zebra crossings should be used at mid-block crossings, school zone or school route crosswalks, and special crosswalks. They are also recommended anywhere that there are higher volumes of children, older pedestrians, or visually impaired pedestrians. According to the MOTI *Pedestrian Crossing Control Manual for British Columbia,* zebra crossings should be used for all crosswalks installed at unsignalized intersections on roadways under provincial jurisdiction. Local governments may use the twin parallel line crosswalk on roads under their jurisdiction. While zebra crossings offer enhanced visibility, consideration should be given to not overusing them as this may reduce their overall effectiveness.

Yield lines, also known as 'shark's teeth,' may also be used in advance of a marked and signed crosswalk to discourage motor vehicle incursion into the crosswalk and may be accompanied by the Yield Here to Pedestrians sign (not included in MUTCDC). Yield lines are not currently defined in the B.C. MVA and cannot be used on roadways under provincial jurisdiction. See **Chapter G.4** for more details on yield lines.

Pedestrian crossing pavement markings should be used in combination with another traffic control device, such as signage or signals. The pavement markings should use durable, skid-resistant materials and should be well maintained to ensure they remain visible.

Decorative Crosswalks

Many communities across B.C. have installed decorative crosswalk pavement markings. Decorative crosswalks can enhance the visibility of a crosswalk, can be used as branding and wayfinding along an active transportation route, and can add to the aesthetic appeal of the road. A common type of decorative crosswalk is the rainbow crosswalk, which supports the LGBTQ2S+ community while adding vibrant colour to the streetscape. Additionally, many communities have taken artistic approaches to crosswalk design that relate to local culture.

The use of decorative crosswalks is not currently covered under TAC or provincial policy. As such, careful consideration should be given to the context and design prior to installing a decorative crosswalk. Designs should include unobstructed twin parallel line crosswalk markings to ensure that they are considered a legal crosswalk. Decorative elements may be added in between the twin parallel lines but should not interfere with or obscure the standard crosswalk pavement markings.

Decorative Sidewalk, Gibsons, B.C.

Decorative Sidewalk, London, UK

School Zone Crossings

Crossings in school zones and along school routes require special attention to increase the safety of children that are travelling along the road. In addition to marking and enhancing crosswalks, motor vehicle speeds and volumes should be managed within the school zone. The TAC *School and Playground Areas: Guidelines for Application and Implementation* provides guidance for setting reduced speed school zones in both rural and urban contexts.

The TAC *Pedestrian Crossing Control Guide* and the MOTI *Pedestrian Crossing Control Manual for British Columbia* recommend that all crosswalks within a school zone be marked with a zebra crosswalk, as opposed to a standard twin parallel line crosswalk. School zones also require special signage, including the School Crosswalk sign (MUTCDC RA-3; B.C. PS-005 Series) and the School Crosswalk Ahead sign (MUTCDC WC-16; B.C. PS-004 Series) (see **Appendix B**). The In-Road School Crosswalk sign (MUTCDC RA-8) may also be placed in the middle of the road to increase visibility. It is typically used on a temporary basis during busy pick up and drop off periods.

Crosswalks within school zones may also use crossing guards, who are paid or volunteer supervisors that help children cross the road at particularly busy or hazardous crossings. The *B.C. MVA* states that all road users must obey the instructions of all authorized school crossing guards, including students acting as volunteer traffic patrol members. The MOTI *Pedestrian Crossing Control Manual for British Columbia* outlines the suite of School Crossing Programs in B.C., including the Safe Route to School Program, the School Patrol Program, and the Adult Crossing Guard Program.

School Administrator assisting as a crossing guard in Surrey, B.C.

Signalized Crossings

In addition to signage and pavement markings, pedestrian crosswalks may be signalized to further enhance visibility and motorist yielding behaviour. Signalization can include full signals, pedestrian and cycling activated signals, overhead pedestrian flashers, and side mount pedestrian flashers . **Chapter G2** provides an overview of each type of signalized crossing, including how these signals are activated. The TAC *Pedestrian Crossing Control Guide* and the MOTI *Pedestrian Crossing Control Manual for British Columbia* provide further details on each type of signalization.

Mid-Block Pedestrian Crossings

Mid-block crosswalks can enhance the connectivity of the pedestrian network, especially where intersections are spaced at least 100 to 200 metres apart and there are destinations on both sides of the road. They are useful where major pedestrian generators such as transit stops, parks, and businesses are located mid-block. Transportation professionals should consider pedestrian desire lines. Where a substantial amount of jaywalking is occurring, mid-block crossings may help to consolidate and formalize these crossings, improving safety for all road users.

Transportation professionals should consider a number of factors when assessing the feasibility of a mid-block crosswalk, including: road width, number of travel lanes, topography, sightlines, pedestrian volumes, motor vehicle speeds and volumes, turning conflicts, and distance to the nearest intersection. The TAC *Pedestrian Crossing Control Guide* and the MOTI *Pedestrian Crossing Control Manual for British Columbia* provide detail for conducting an engineering study that assesses the feasibility of a mid-block crossing and the type of traffic control required.

Mid-block crossings should be marked with basic crosswalk signage and pavement markings at minimum. Enhanced markings, signalization, and geometric crossing enhancements such as curb extensions and median refuge islands can be useful for increasing the visibility of mid-block crosswalks, especially since motorists may not expect mid-block crossings. These enhanced crosswalk elements are described below.

Mid-block crosswalks are often associated with off-road pathways. Refer to **Chapter G5** for design guidance on mid-block crosswalks for off-road pathways.

Mid-block Crosswalks

Offset mid-block crosswalks can be used on two-way roads with median refuge islands. The crosswalk is offset on either side of the median as shown in **Figure G-83.** A barrier, fencing, or curbs may be used to encourage compliance, guide pedestrians to the next stage of the crossing, and provide an enhanced pedestrian refuge. Offset mid-block crosswalks encourages eye contact between pedestrians and motorists, as it causes the pedestrian to turn towards oncoming traffic. The median refuge area should be at least 3.0 metres wide.

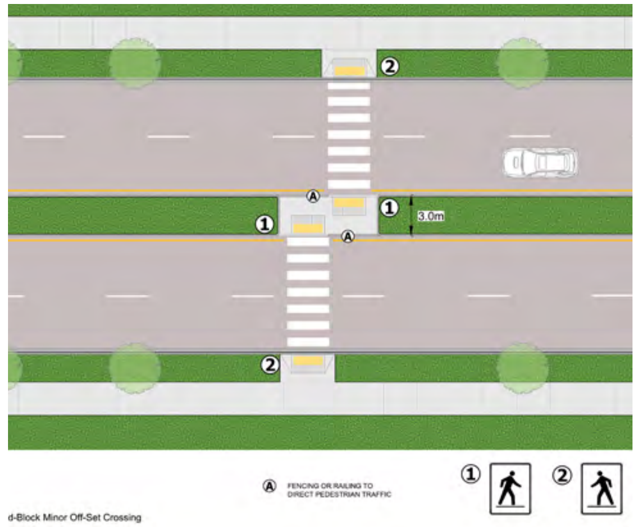


Figure G-83 // Offset Midblock Crossing

Mid-block crosswalk in Gibsons, B.C.

Geometric Crossing Enhancements

A number of geometric design elements can be used to enhance crosswalks. In general, the approach is to provide the shortest, safest, and most accessible crossing possible. Creating safer crossings involves increasing sightlines and providing physical protection wherever possible, minimizing the amount of time that pedestrians are exposed to motor vehicle traffic. The following elements can help to achieve these objectives.

Daylighting and Advanced Stop Lines

Sightlines at intersections and mid-block crossings can be enhanced by 'daylighting' in advance of the mid-block crossing. Daylighting refers to bringing pedestrians further out into the motorists' line of vision and/or removing obstructions. This can be accomplished by installing curb extensions and removing on-street parking on both sides of the road. Advance stop lines can be used at signalized intersections to ensure that motor vehicles do not encroach into the crosswalk. At signal or stop controlled mid-block crosswalks, advance stop lines or Yield Here to Pedestrians signage can help ensure that the crossing pedestrian is visible, especially on multi-lane roads. Stop lines are only used where a control device is used. See **Chapter G5** for more guidance on daylighting at mid-block crossings.

Curb Extensions

Curb extensions shorten the crossing distance, reducing the time that people are in mixed traffic conditions. They also increase visibility by bringing people waiting to cross further into the intersection, ensuring that they can be seen by motorists. Curb extensions can change the corner radii as well, as described on page G51. Finally, curb extensions create extra space at the corner that can be used for pedestrian queuing, street furniture, and landscaping.

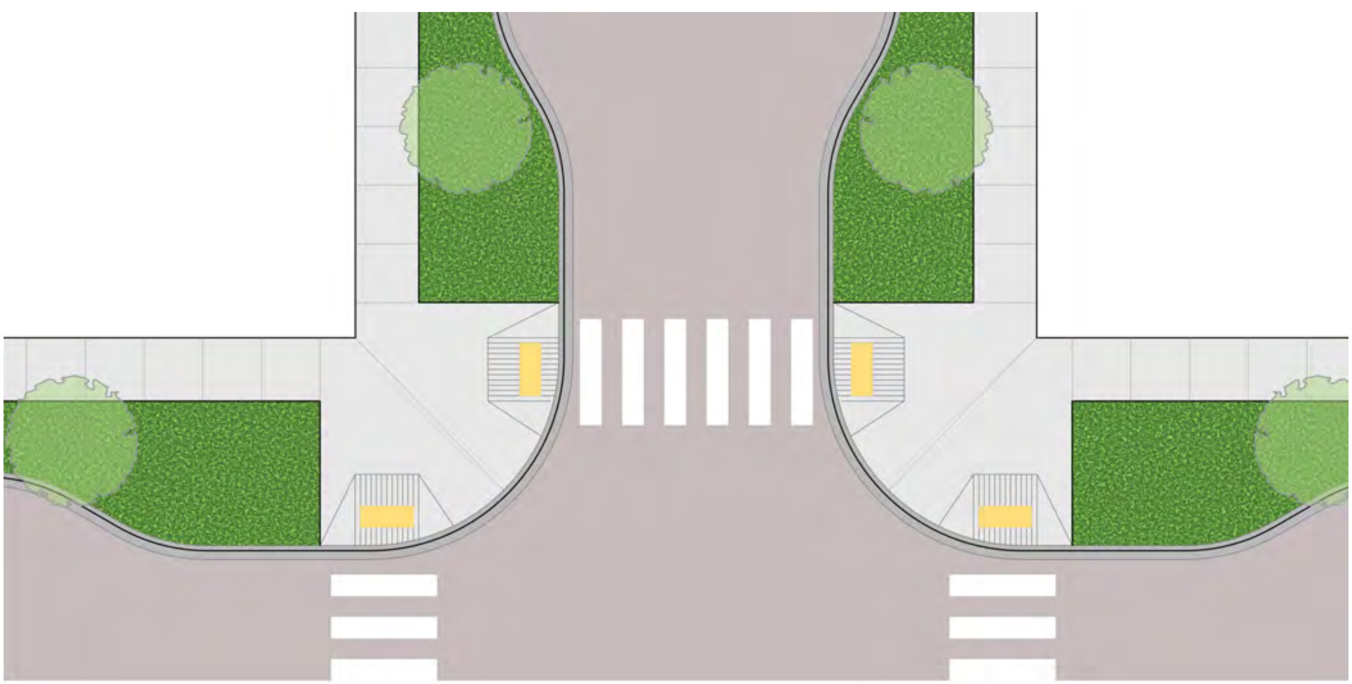
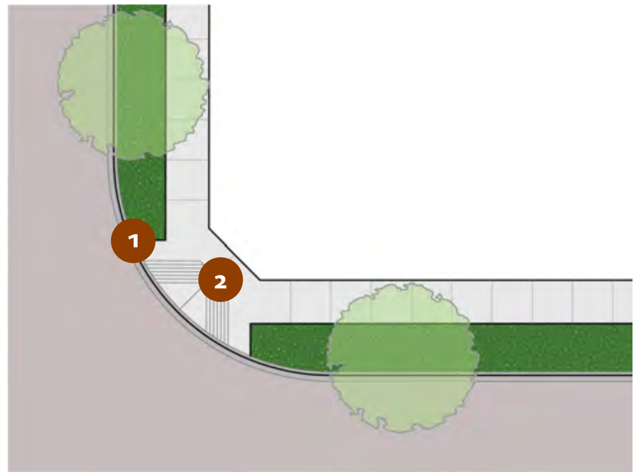


FIGURE G-84 // CURB EXTENSIONS AT CORNER

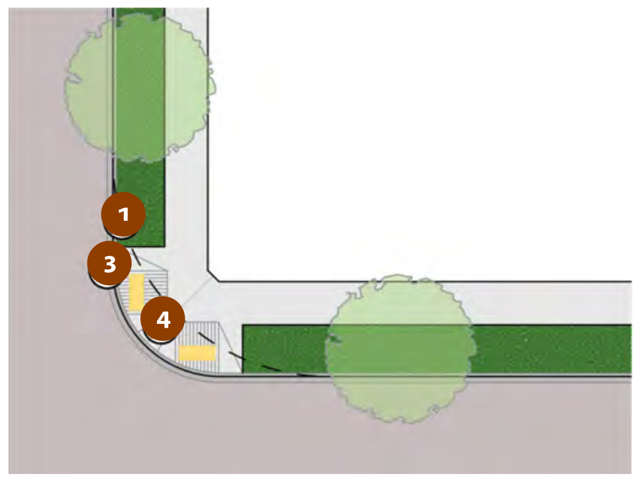
Reducing Corner Radii

As described in above and in **Chapter G.1**, corner radius has a direct impact on pedestrian visibility as well as the length and directness of a pedestrian crossing. **Figure G-85** demonstrates the impact of reduced corner radius on pedestrian positioning, curb ramp type, curb ramp alignment, and crossing distance. A smaller radius allows the application of a double curb ramp, provides increased pedestrian queuing space, and allows the curb ramp to be better aligned with the Pedestrian Through Zone. As noted in **Chapter G.1**, it is important to ensure that the design vehicle is accommodated when determining the corner radius.

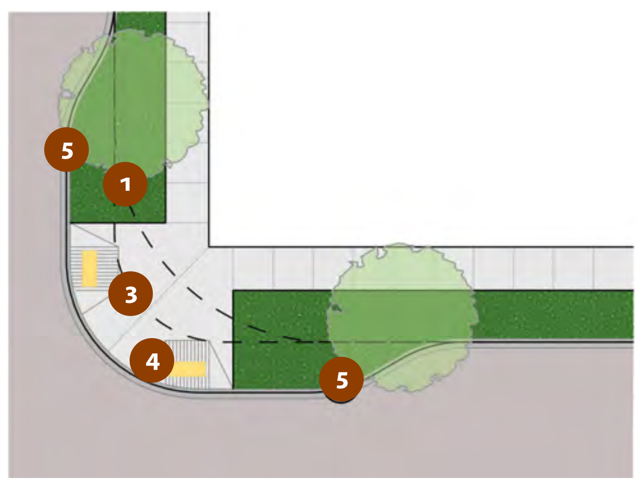
1. *Original 9 Metre Curb Radius*
2. *Combined Curb Letdown*
3. *4.5 Metre Curb Radii Reduction*
4. *Double Curb Letdowns*
5. *Curb Extensions*



1. Original Curb Radius with Combined Curb Letdown



2. Reduced Curb Radius with Double Curb Letdown



3. Reduced Curb Radius with Double Curb Letdown and Curb Extensions

Figure G-85 // Hierarchy of Crossing Enhancements Based on Reduced Corner Radius

Pedestrian Refuge Islands and Medians

Pedestrian refuge islands allow pedestrians to cross only one direction of traffic at a time and provide physical protection for waiting pedestrians. The pedestrian crossing may either be cut through a median island as shown in **Figure G-86,** or raised with curb ramps on either side of the refuge island. The refuge should have a constrained width of 2.4 metres to accommodate a range of pedestrians, bicycles, and mobility devices. The absolute minimum depth of a pedestrian refuge island is 1.8 metres. The refuge island should be at least 4.0 metres long in order to be perceived as a significant barrier by motorists. A refuge island may be cut out as part of an existing median or it may be added specifically for use by crossing pedestrians.

Pedestrian refuge islands are desirable in complex intersections with irregular crossing routes, as they break the crossing into smaller segments and allow pedestrians to rest. Pedestrian refuge islands are also recommended in areas with higher volumes of children, older pedestrians, and pedestrians with mobility challenges, such as in school zones and near healthcare facilities.

Raised Crosswalks

Raised crosswalks elevate the crossing to or close to curb level, improving pedestrian visibility and reducing motor vehicle speeds along the corridor. Raised crosswalks can also improve accessibility for people using mobility devices. Detectable edges such as tactile attention indicators can be provided at the entrance to the raised crosswalk so that visually impaired pedestrians are aware that they are entering the road. **Figure G-87** shows the dimensions of a raised crosswalk.

Raised crosswalks are applicable on local and collector roads with posted motor vehicle speeds of 50 km/h or less, as well as school zones. They can pose challenges for long vehicles, so they should typically not be used along dedicated emergency routes or within 25 metres of a bus stop serviced by articulated buses. They are not appropriate on grades over 8%, in areas with limited sight distances, curves with small turning radii, or within 75 metres of traffic signals.

Note that raised crosswalks and other forms of vertical deflection are not permitted on roadways under provincial jurisdiction.

Figure G-86 // Pedestrian Refuge Island

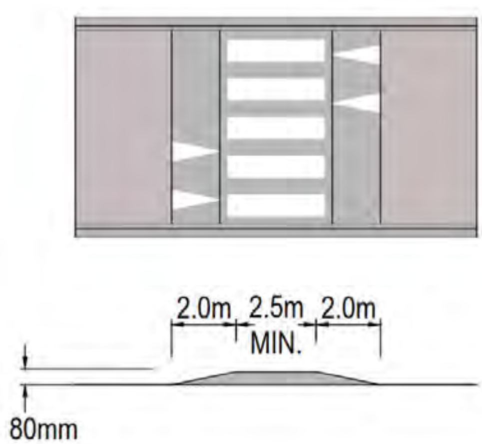


Figure G-87 // Raised Crosswalk Specs

Raised Intersections

Raised intersections apply the same principles and design as raised crosswalks, with the key difference that they are spread across an entire intersection (see **Figure G-88)**. This design gives pedestrians elevated priority and visibility throughout the intersection, while indicating to motor vehicle drivers that they have entered a different type of space where increased caution is required. As shown in **Figure G-88,** raised intersections may be constructed with alternate pavement materials to add further visual and tactile differentiation to the road.

Channelized right turn lane crossings

Channelized right turn lanes are often used at intersections along roads with high motor vehicle volumes and are used to facilitate right turn motor vehicle movements. Channelized right turn lanes can be challenging and inconvenient for pedestrians to cross due to the higher speed of the turning vehicles and the yield controlled (unsignalized) nature of the turn. Additionally, the triangular refuge island (sometimes referred to as 'pork chop island') may contain limited refuge and queuing space for pedestrians. Consideration should be made to normalizing the intersection by removing the channelized right turn lane (see **Figure G-89**). Converting the intersection into protected corners is recommended where feasible (see **Chapter G.4**).

Where removal of the channelized right turn lane is not feasible, a second option is to redesign the channel as a 'high entry angle' or 'smart channel'. The difference between a conventional channelized right turn lane and a high entry angle right turn lane. High entry angle channels increase the entry angle to the cross road and decreases the turning speed to be more consistent with a yield condition. The high entry angle reduces the motorist viewing requirement and requires less neck rotation for motorists. High entry angle approaches also make pedestrians and bicycle users more visible at the crossing. Refer to Section 700 of the MOTI *B.C. Supplement to TAC Geometric Design Guide* and Section 9.15.2 of the TAC *Geometric Design Guide for Canadian Roads* for more guidance on high entry angle approaches. Refer to **Chapter G.4** for design guidance on high entry angle crossings for both people walking and people cycling.

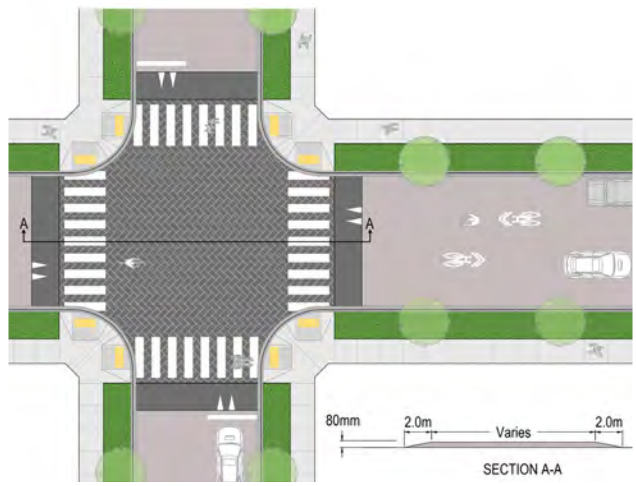


Figure G-88 // Reconfigured Channelized Intersection

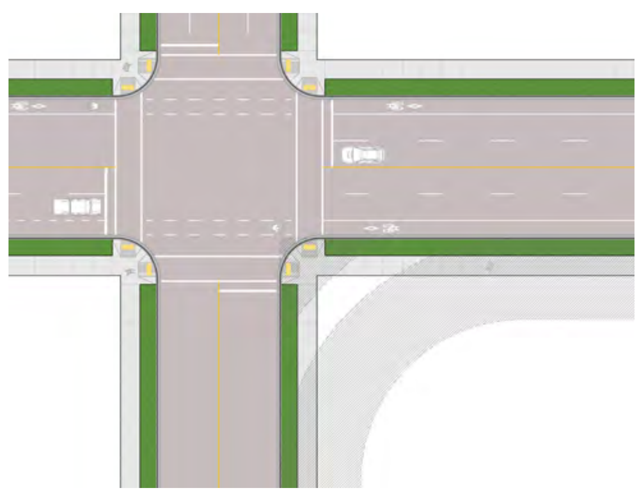
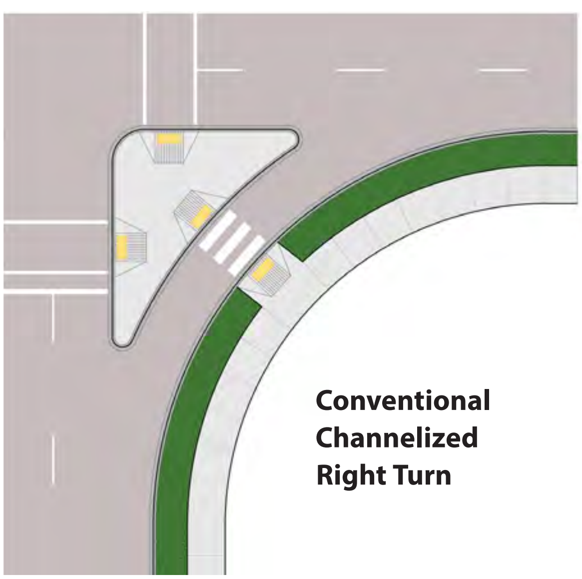


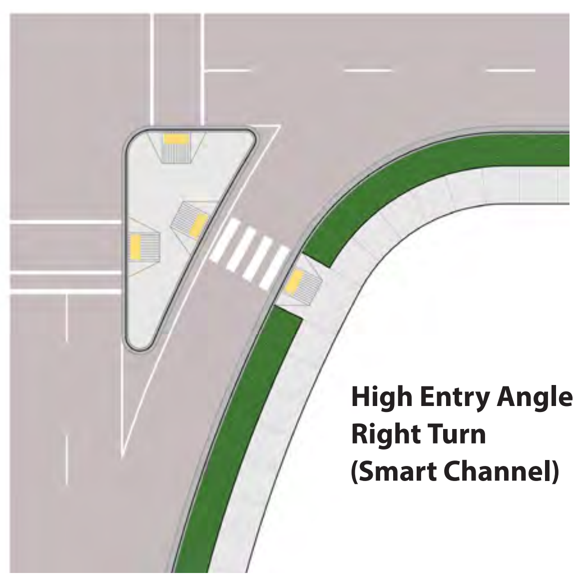
Figure G-89 // Conventional Channelized Right Turn Lane vs. High Entry Angle Right Turn Lane (Smart Channel)

Where channelized right turn lanes cannot be removed or redesigned, there are a number of considerations concerning crosswalk placement. When installing pedestrian crossings at channelized right-turns near traffic signals, transportation professionals should consider driver workload, expectations, and sightlines. The crosswalk can be installed in one of three locations: the upstream (entering) side of the turn lane, the midpoint, or the downstream (exiting) side. The midpoint location is typically the preferred option, as described below:

- **Upstream crosswalk** locations require pedestrians to discriminate between through motor vehicles travelling straight and motor vehicles turning into the right turn lane, which can be challenging. Additionally, where there is no dedicated right turn lane in advance of the crossing, queues from vehicles yielding to pedestrians may encroach into the through travel lanes.
- **Midpoint crosswalk** locations minimize the crossing distance and are likely to coincide with the location of slowest motor vehicle speeds. This design provides more vehicle storage space than crossings at the upstream location.
- **Downstream crosswalk** locations provide the most vehicle storage capacity. However, motorists in the turn lane are more likely to be looking to their left at vehicles approaching on the major road and may not see pedestrians waiting to cross. Motor vehicles may also accelerate as they approach the downstream exit, making it less likely that they will yield to pedestrians.

Raised crosswalks may also be used at channelized islands to slow motor vehicle speeds and increase the visibility of pedestrians and cyclists at the crossing. Raised crosswalks may include yield line placement markings ('shark's teeth') on their approach. Note that neither raised crosswalks nor yield lines may be used on roadways under provincial jurisdiction. In addition, RFBs may be considered at crosswalk and cross-ride to further raise awareness of the presence of people walking and cycling. Raised crosswalks may include yield line pavement markings ('shark teeth') on their approach. Note that neither raised crosswalks or yield lines are used on MOTI facilities. In addition, RFBs may be considered at the crosswalk and cross-ride to further raise awareness of the presence of pedestrians and cyclists.





Burrard and Pacific Protected Intersection, City of Vancouver, B.C.
Source: Rod Preston

G.4

ON-STREET BIKEWAY CROSSINGS

Intersection design is a critical component of overall bicycle facility design, as intersections tend to be high conflict areas along bicycle routes. Careful consideration must be taken to ensure people cycling can navigate intersections in a safe and comfortable manner. This chapter provides design guidance for intersections and for crossings with on-street bicycle facilities, including signage and pavement markings and geometric design guidance for protected intersections, dedicated major intersections, shared major intersections, minor intersections, and transitions between bicycle facility types. Off-street crossings and additional conflict areas are discussed in **Chapters G.5** and **G.6**, respectively.

SIGNAGE AND PAVEMENT MARKING CONSIDERATIONS

Signage and pavement markings can be used at intersections to help communicate right-of-way and warn all modes of conflict areas.

Signage

There are a number of signs at or approaching intersections that are important for on-street bicycle facility crossings. Relevant signage as it pertains specifically to bicycle facility design is shown in figures throughout **Section G**, and a full list of signage is provided in **Appendix B**. However, two key signs warrant introduction, as they are particularly relevant for crossings with on-street bicycle facilities and are present in a number of the designs discussed throughout this chapter.

- The **Right Turn on Traffic Signal Prohibited sign** (MUTCDC RB-17R; B.C. R-117-R Series) is used at intersections where signal priority is given to bicycle users, allowing them to complete a protected through movement without risk of collision with right turning motor vehicles. Protected signal phasing is discussed in **Chapter G.2**.
- The **Turning Vehicles Yield to Bicycles sign** (MUTCDC RB-37 with customized versions) is used where motor vehicles turning across a bicycle facility are required to yield to bicycle users. It provides through-moving bicycle users with the right-of-way over turning vehicles and is important for alerting motorists of the potential conflict. Another supplementary sign that may be used is the Turning Vehicles Yield to Bicycles and Pedestrians sign (MUTCDC RB-38; B.C. ZR-056 Series).

Cross-Ride Markings

Cross-rides, also known as elephant's feet and cross-bikes, are the bicycle equivalent of a crosswalk. They are intended to alert all road users of a bicycle crossing. Cross-rides consist of a series of white squares laid out in parallel lines across a road. They can be enhanced by adding bicycle symbols and/or applying a green surface treatment. On crossings of two-way facilities, bicycle symbol markings should indicate that there is two-way bicycle traffic by marking bicycle symbols in opposite directions in the two lanes. Placement of the bicycle symbol should be positioned in the middle of the motor vehicle travel lanes to reduce wear on the marking. **Appendix B** provides detailed pavement marking dimensions.

Cross-rides are not currently defined in the *B.C. MVA*, meaning that they have no legal status and have limited application on roadways under provincial jurisdiction. Cross-rides are only used on roadways under provincial jurisdiction where motor vehicles have a stop condition. Cross-rides that are used in combination with crosswalk markings are not currently permitted on roadways under provincial jurisdiction.

However, municipalities may enact bylaws that define cross-rides and permit them on municipal roads, as several cities across the province have done. Cross-ride markings typically do not provide legal right-of-way on their own – signage such as the Turning Vehicles Yield to Bicycles sign (MUTCDC RB-37) is also usually required. However, cross-ride markings help to reinforce the right-of-way of bicycle through movements over turning motor vehicles.

Cross-ride markings are typically used for bicycle facility crossings where bicycle users have the right-of-way over the person on the cross road. The extent of the marking will depend on site-specific conditions such as the type of traffic control for crossing motor vehicle traffic, the type of bicycle facility, and the volume of bicycle traffic. Cross-ride markings are recommended in the following circumstances:

- At bicycle crossings with appropriate signage and motorist sightlines, where motorist yielding behaviour can be expected; and
- At crossings where motor vehicle traffic is stop or signal controlled, or legally required to stop before entering the road (i.e. driveways, lanes, accesses, etc.). Yield Lines, also known as 'Shark's Teeth', may be used for approaching motor vehicles when crossing driveways and laneways to mark the edge of the bicycle facility.

Cross-ride markings should not be used:

- Where bicycle users are expected to yield priority;
- When there are not adequate decision sightlines between bicycle users and the motorists as they approach the crossing; and
- To demarcate conflict zones across high speed ramps, as the high-speed differential between bicycle users and motorists introduces a significant conflict potential where motorists do not expect to yield to people cycling.

Cross-rides may be installed parallel to the pedestrian crosswalk, or the two may be combined. A combined cross-ride and crosswalk is typically reserved for multi-use pathway crossings (see **Chapter G.5**). The combined cross-ride and crosswalk application is not permitted on roadways under provincial jurisdiction. Separate crossings for bicycles and pedestrians should be provided wherever possible. When enacting bylaws that permit cross-rides, local governments should include wording that requires people cycling, skateboarding, in-line skating, and other faster active modes to yield right-of-way to pedestrians when using a combined cross-ride and crosswalk.

Cross-ride pavement marking, Vancouver, B.C.

Cross-ride pavement marking with bicycle stencils and green coloured pavement markings. A turning Vehicles Yield to Bicycles sign is also visible, Vancouver, B.C.

Conflict Zone Markings

Conflict zone markings raise awareness and visibility of people cycling, make cycling movements more predictable, guide bicycle users and motorists through conflict zones or complex intersections, and provide clarity of right-of-way (through cycling over driveway or cross road traffic). Coloured pavement markings can be used to indicate conflict zones.

The TAC *MUTCDC* has reserved the on-street application of the colour green to be used to denote bicycle facilities. The application of green pavement marking does not legally indicate right-of-way. However, it can help to alert all road users of conflict zones and draw attention to the area.

Combined cross-ride and crosswalk on the Spirit Trail, North Vancouver, B.C.

The application of green pavement markings should be considered on a case-by-case basis. In general, green pavement markings should be reserved for the specific area where a conflict may occur, rather than being applied across an entire corridor, as overuse may reduce their effectiveness. Green pavement markings can generally be applied in the following circumstances:

- On cross-rides (see section above), especially where bicycle facilities cross major driveways and laneways, intersections with permissive left- and right-turn motor vehicle conflicts, or where there is poor compliance with turn restrictions;
- To increase the visibility of sharrow markings in areas with high bicycle traffic or significant crossing conflicts, such as merging and mixing zones. Green-backed sharrows are sometimes referred to as 'super sharrows';
- Where bicycle lanes approach an intersection away from the curb, either due to a bicycle-only turn lane or where a dedicated right turn or bus lane is located to the right of a bicycle lane; and
- In bike boxes and two-stage turn boxes.

Green pavement marking treatments are not recommended in the following circumstances:

- Along bicycle lanes approaching intersections against the curb where motor vehicles are expected to merge into the bicycle lane to turn right;
- At multi-use crossings with a combined cross-ride and crosswalk, as green should be reserved for bicycle-only applications instead of multi-use applications; and
- At bicycle crossings with no conflicts, such as where signal phasing exists and compliance is high (note that a cross-ride may still be used, but green surface treatment is not necessary).

Guideline Pavement Markings

Guideline pavement markings are used to guide bicycle users though an intersection, connecting two bicycle facilities. These are useful across complex intersections, two-stage turn boxes, and bicycle facility transitions to direct people cycling to the safest and most direct path (see **Appendix B**).

Yield Lines ('Shark's Teeth')

Yield lines, also known as 'shark's teeth', feature a line of solid white isosceles triangles pointing in the upstream direction (towards oncoming traffic). Yield lines are intended to provide a visual cue that motorists or bicycle users should yield. They may be used 6 to 15 metres in advance of a marked and signed crosswalk that crosses multiple travel lanes as a means of discouraging motorists from stopping too close to the crosswalk when yielding to pedestrians. They may also be used prior to on-street merging zones and on bicycle facilities to encourage people cycling to yield at pedestrian crosswalks.

Yield lines should not be used at crosswalk locations that are stop or signal controlled. They also should not be used in advance of crosswalks that cross an approach to or departure from a roundabout. On-street parking should be prohibited in the area between the Advance Yield to Pedestrians Line and the crosswalk.

Yield lines are not a common pavement marking in North America, so users may not readily interpret their meaning. However, the intent is that they provide 'visual friction' on the roadway that causes motorists and people cycling to intuitively take note and proceed with caution. Yield lines are not currently defined in the *B.C. MVA* and are thus not used on roadways under provincial jurisdiction.

Figure G-90 // Protected intersection Key Features

PROTECTED INTERSECTIONS

Protected intersections are intersections that use a number of enhanced design elements, to provide increased protection for people walking and cycling as shown in **Figure G-90**:

1. Corner refuge islands
2. Forward bicycle queuing areas
3. Setback of bicycle and pedestrian crossings
4. Pedestrian refuge islands
5. Bicycle-friendly signal phasing.

Protected intersections provide a high level of safety and comfort for people cycling by clearly indicating right-of-way, promoting predictable movements, reducing the distance and time during which people on bicycles are exposed to conflicts, and adding protected design elements to the intersection. These design elements result in intuitive, low-stress movements in all directions. Conflicts between right turning vehicles and through bicycle users approaching an intersection are eliminated, while conflicts at the intersection itself are mitigated by adding physical protection for bicycle users and reorienting motor vehicles to increase visibility and encourage eye contact between users. Signal phasing may be used to completely eliminate all conflicting movements (see **Chapter G.2**).

Protected intersections are the preferred intersection treatment for people of all ages and abilities.

Typical Application

Protected intersections can be applied on any road where enhanced comfort for people of all ages and abilities is desirable. Protected intersections may be suitable at both large intersections with multi-lane roads and complex signal phasing, and at smaller, simpler intersections, including stop-controlled intersections. Many existing standard intersections can be turned into protected intersections by installing protected crossing elements, although additional right-of-way may be required. A signal analysis should be conducted prior to implementing a protected intersection in order to identify any impacts on signal operations and user delay.

Protected intersections are used predominantly where protected bicycle lanes reach an intersection. Protected intersections may also be used at multi-use pathway intersections, although this is less common. Neighbourhood bikeways, shared streets, buffered bicycle lanes, and bicycle lanes may be transitioned into short protected bicycle lane segments prior to the intersection and then directed into a protected intersection (see **Figure G-90**).

Where insufficient space exists for a fully protected intersection, they may be partially implemented by adding key protected intersection elements at one or more corners, typically in the dominant direction of bicycle travel. This can be effective in constrained environments, when bicycle facilities are not located on all sides of the road, and where there is a desire to transition unprotected facilities into protected facilities and protected intersections. See the Transitions subsection below.

Protected intersections can also be implemented using interim materials, even when building a refuge and corner island may not be possible. Paint markings along with flexible delineators and modular speed humps are examples of interim materials that can be considered.

Vancouver, B.C.

Design Guidance

Figure G-91 shows a protected intersection with uni-directional protected bicycle lanes. Design elements have been numbered to correspond with the descriptions below:

- **Corner Refuge Island:**
  The corner refuge island is a physical element that defines the protected queuing space for bicycle users waiting to proceed through the intersection. A vertical curb should be used on the island to prevent motor vehicle encroachment. The transitional zone between the corner refuge island and the sidewalk should be at least 3 metres wide to allow bicycles to maneuver.

  The corner refuge island can be used to create a smaller corner radius, helping to slow the speed of turning motor vehicles. A maximum turning radius of 14 metres is recommended where permissive right turns across the through bicycle facility are permitted. To accommodate larger motor vehicles with wide turning radii, a mountable truck apron may be added as part of the corner refuge island.

In environments with a high volume of people cycling, high capacity protected intersections can be created by using a thinner corner refuge island, which maximizes the available queuing and maneuvering space. The outside of the corner refuge island remains the same, but the thinner island allows more people to wait side-by-side and depart at the same time.

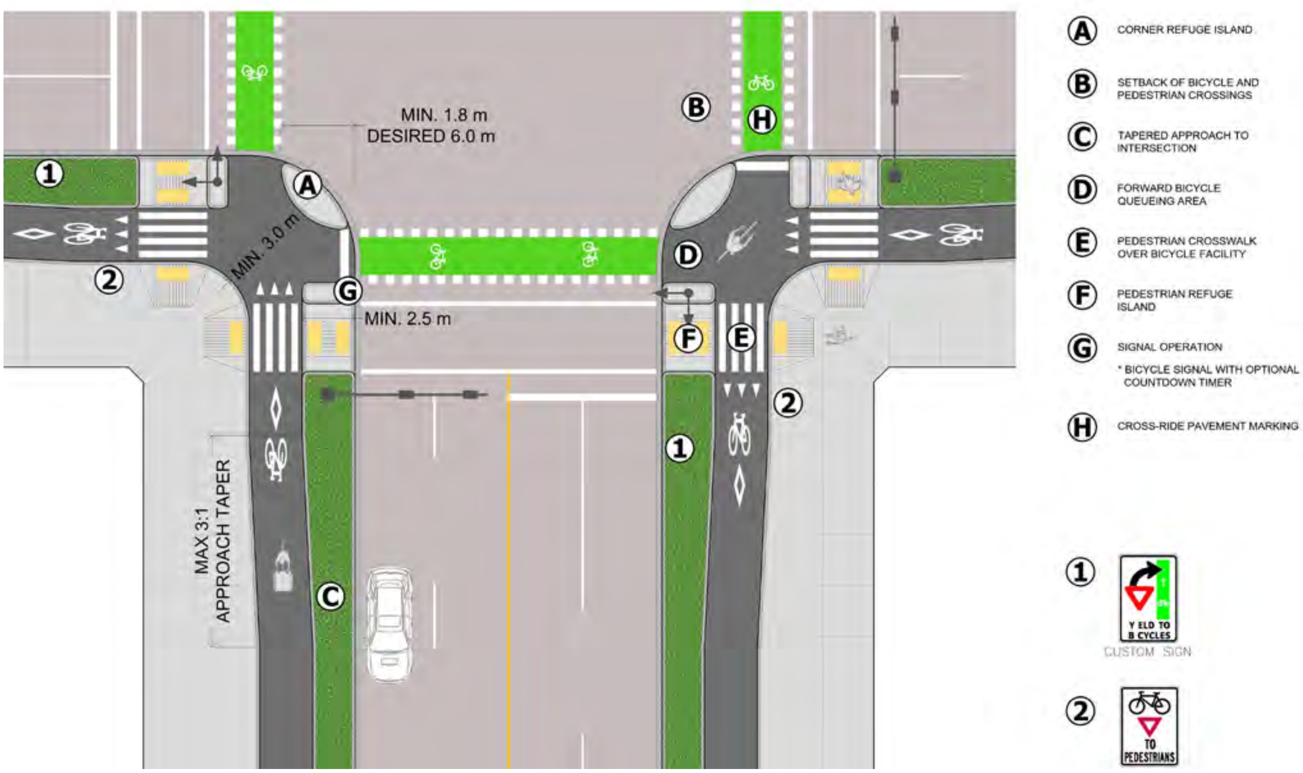


Figure G-91 // Protected Intersection with Uni-Directional Protected Bicycle Lanes

- **Setback Bicycle and Pedestrian Crossings:** Setback bicycle and pedestrian crossings create queuing space for right turning motor vehicles, which significantly improves motorist sightlines. Motor vehicles are able to turn almost 90 degrees to face people walking and cycling before crossing their paths, enabling better eye contact between users. The setback also increases the time and space that all users have to react to potential conflicts

  The recommended setback between the bicycle crossing and the motor vehicle travel lane is 6 metres, as this provides space for a single motor vehicle to queue outside of the path of through bicycle and motor vehicles. A minimum setback of 1.8 metres is required to ensure that queuing motor vehicles do not impeded through traffic.

- **Tapered Approach to Intersection:** The protected bicycle facility may be required to move away from the motor vehicle travel lane when approaching the intersection in order to align cyclists with the setback crossing and provide larger queuing areas for bicycles and motor vehicles. This alignment shift should occur gradually at a taper rate of no greater than 3:1, assuming a cycling speed of 20 km/h.

- **Forward Bicycle Queuing Area:** This is the area where people cycling wait before proceeding through the intersection. The forward bicycle queuing area shortens the crossing distance and enables people cycling to enter the intersection before motor vehicles, making them more visible to motorists. The bicycle queuing area should be 1.8 metres deep (between the road and the and the bicycle) and 1.8 metres wide for a uni-directional facility, or 3.0 metres wide for a bi-directional facility. A stop bar for bicycle users should be painted to minimize bicycle overhang into the motor vehicle travel lane.

- **Pedestrian Crosswalk over Bicycle Facility:** Bicycle users must yield to pedestrians who are crossing the bicycle facility to wait in the pedestrian refuge area. This crosswalk must be marked and a Bicycle Yield To Pedestrian sign (MUTCDC RB-39) may also need to be provided. Additional yield lines (i.e. 'shark's teeth') may be placed in advance of the crosswalk to encourage people cycling to slow down and yield to pedestrians. Tactile attention indicators should be installed on either side of the crosswalk to alert visually impaired pedestrians that they are crossing a bicycle facility.

- **Pedestrian Refuge Island:** The pedestrian refuge area provides a protected waiting area for pedestrians and shortens the crossing distance. The constrained minimum dimensions of the pedestrian refuge island are 2.5 metres deep (between the road and the bicycle lane) and 1.8 metres wide. Protected intersections can be challenging for visually impaired people to navigate. Tactile attention indicators should be installed on either side of the pedestrian refuge island to alert visually impaired people that they are crossing a bicycle facility or road.

- **Signal Operation:** Protected bicycle signal phases may be used to further reduce conflicts between people walking, cycling, and driving. **Chapter G.2** provides guidance on the placement and operation of protected bicycle signal phasing.

- **Cross-Ride Markings:** Cross-rides should be painted across the intersection to guide bicycle users and raise awareness of people cycling. Cross-ride guidance is provided earlier in this chapter, with dimensions in **Appendix B**.

People waiting in forward bicycle queuing area and pedestrian refuge island, respectively. Pacific Street/ Burrard Street intersection, Vancouver, B.C.

Maintenance Considerations

Protected intersection maintenance requirements should be considered early in the design process to ensure that there is sufficient space between vertical curb elements to facilitate road sweeping and snow removal. These requirements are similar to those of protected bicycle lanes – the same equipment should be able to clear both facilities. The radius, width, and vertical curb height of the corner refuge islands must all be considered. Smaller curbs may collect less debris and snow. Signs or vertical delineators may be installed on curbs to ensure that they are visible in winter conditions, as long as the signage or vertical delineators do not obstruct sightlines for queuing or approaching users. See **Chapter I.3** for more guidance on cycling facility maintenance.

DEDICATED MAJOR INTERSECTIONS

If protected intersections cannot be provided, dedicated bicycle facilities can be provided to direct people on bicycles through the intersection. The following subsections provide design guidance for dedicated intersection approaches and crossing points, and are organized based on the bicycle's movement, the motorist's movement, the available right-of-way, and whether there is a dedicated right-tun lane for motor vehicles.

Bicycle Through Movements with Right Turning Vehicles

Careful consideration must be given to ensure that all road users are aware of upcoming intersections and potential conflict points. One of the most common types of collisions between motor vehicles and bicycle users is the 'right hook' collision, where right turning motor vehicles hit or cut across the path of a through-moving bicycle user. A number of signage, pavement marking, and geometric design treatments can be used to improve motorists' awareness of bicycle users, clarify right-of-way, and allow people cycling to position themselves in advance of the intersection in order to reduce conflicts at the intersection.

Design treatments vary depending on the type of bicycle facility and the number and type of adjacent motor vehicle lanes. Bicycle lanes can expose people cycling to conflicts where motor vehicles must merge into or weave through the bicycle lane on the intersection approach. Protected bicycle lanes provide more security for bicycle users along the corridor, but at intersections the separation can change depending on the intersection design and transition in the facility type. Considerations for each type of facility are discussed below.

The following design recommendations apply to both painted and protected bicycle lanes at all intersection configurations:

- Cross-rides, conflict zone markings, and green pavement markings should be applied as per the guidance earlier in this chapter ;
- Sightlines at intersections and crossings should be maintained by limiting and/or restricting on-street parking and vertical barriers (see **Chapter G1**);
- At signalized intersections, bicycle signal detection should be configured to detect bicycles in the through bicycle lane (see **Chapter G.2**);
- At signalized intersections, a protected bicycle signal phase may be considered wherever feasible to mitigate the conflicts between people walking, cycling, or driving (see **Chapter G2**); and
- Where permissive left or right turns are allowed, and where motor vehicles may merge across bicycle lanes, the Turning Vehicles Yield to Bicycles sign (MUTCDC RB-37) should be used to reinforce bicycle through movement right-of-way over turning motor vehicles. The decision to implement this signage should also consider other contextual factors related to the operating environment and other signage in the area.

The subsections below provide detailed guidance on the following road layouts:

- Combined through lane and right turn motor vehicle lane;
- Dedicated right turn motor vehicle lane with continuous bicycle lane; and
- Channelized right turn lane.

These configurations are ordered based on how much right-of-way is required, from least amount of space (combined through and turn motor vehicle lane) to greatest amount of space (channelized right turn lane). Within each of these layouts, there are a hierarchy of treatments that may be considered.

Combined Through and Right Turn Motor Vehicle Lane

Figure G-92 shows a protected bicycle lane that bends-out at the intersection to improve the sightlines and provides additional yielding space for right turning motor vehicles. This design is preferred whenever the width of the Furnishing Zone provides sufficient space to shift the bicycle alignment. The protected bicycle lane can be narrowed on the approach to maximize the lateral shift away from the intersection.

Figures G-93 and **G-94** show a protected bicycle lane and painted bicycle lane, respectively, adjacent to a combined through and right turn motor vehicle lane. At signalized intersections, providing bicycle-friendly signal phasing (see **Chapter G.2**) and an advanced stop line for bicycle users is recommended. Where this is not possible, it is important to provide appropriate signage and sightlines, as outlined above and in **Chapter G.1**. At unsignalized intersections where sightlines are not achieved, a Yield or Stop sign for the bicycle users should be installed.

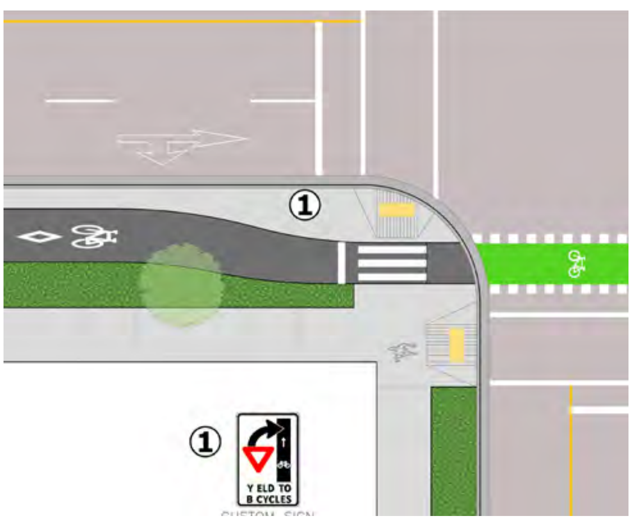


Figure G-92 // Bend-Out Protected Bicycle Lane

Figure G-93 // Protected Bicycle Lane Adjacent to Combined Right Through Turn Lane

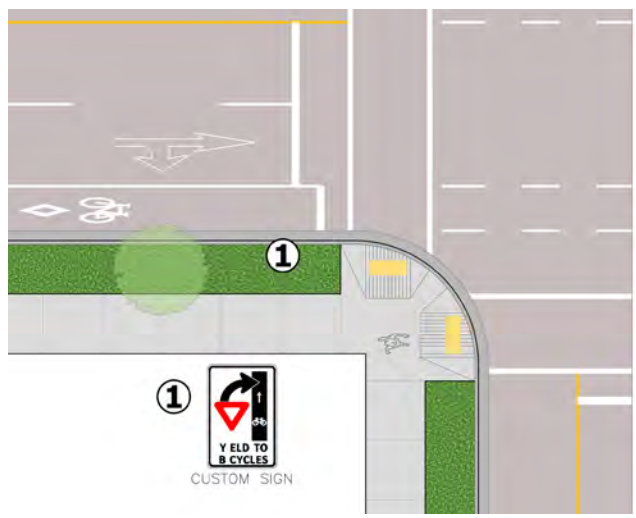


Figure G-94 // Painted Bicycle Lane Adjacent to Combined Right Through Turn Lane

Considerations should be given to eliminate motor vehicle right turns across protected bicycle lanes when the street network allows access through an alternative route. By eliminating right turning motor vehicles the physical barrier can be continued past the nearside crosswalk as seen in **Figure G-95**. This treatment can be used at one-way streets that do not accommodate traffic in that direction as well as locations where right turns are not permitted. At corners where right turns are not permitted a tighter corner radius can be used to improve the pedestrian crossing.

For bicycle lanes at unsignalized intersections, or where a protected bicycle signal phase cannot be implemented, the bicycle lane should become dashed approaching the intersection to allow motor vehicles to merge and turn right from the lane closest to the curb (see **Figure G-96**). This design will result in a higher workload for motorists and bicycle users, as it does not separate the modes in the conflict area. This configuration is the least preferred and is not considered comfortable for people of all ages and abilities.

The dashed segment of the bicycle lane should be a minimum of 18 metres in length and follow a minimum length to width ratio of 10:1. In locations with more than 4,000 vehicles per day, the dashed lane lines should be at least 30 metres in length to provide greater time and flexibility for motorists to complete the weave. See **Appendix B** for dashed bicycle lane marking dimensions.

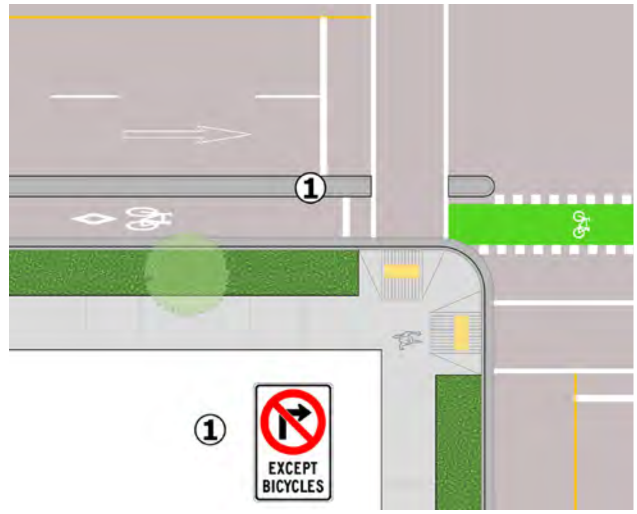


Figure G-95 // Protected Bicycle Lane, No Right Turns

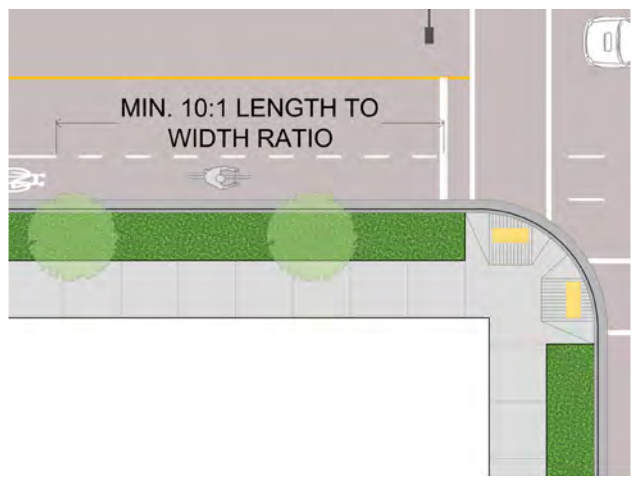


Figure G-96 // Bicycle Lane Without Right Turn Lane - Dashed Approach

Protected bicycle lane adjacent to dedicated right turn lane narrowing upon intersection approach in City of Vancouver, B.C. Custom bicycle lane narrows sign is visible (left).

Protected bicycle lane adjacent to dedicated right turn lane narrowing upon intersection approach in City of Vancouver, B.C.

Dedicated Right Turn Lane with Continuous Bicycle Lane

The presence of a dedicated right turn only motor vehicle lane implies that the right turning motor vehicle volume is high and will warrant more protection for people cycling. Motor vehicle volumes should be verified to confirm whether the right turn lane is in fact warranted before proceeding with designing the bicycle facility.

Figure G-97 shows a protected bicycle lane adjacent to a dedicated right turn lane. The protected bicycle lane should remain to the right of the dedicated right turn lane. Bicycle-friendly signal phasing may be used to mitigate conflicts between through moving bicycle users and right turning motor vehicles (see Chapter G2). Where signal phasing is not feasible, the Turning Vehicles Yield to Bicycles sign (MUTCDC RB-37) should be used.

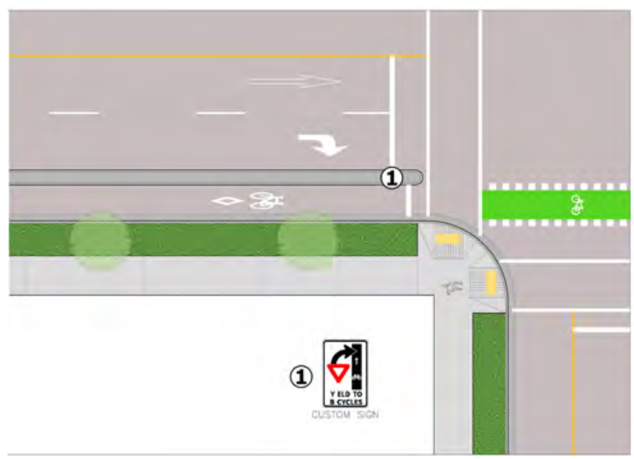


FIGURE G-97 // PROTECTED BICYCLE LANE ADJACENT TO DEDICATED RIGHT TURN LANE

In constrained rights-of-way, the protected bicycle lane may need to narrow upon approaching the intersection. This maintains the protection for people cycling right up to the intersection and is preferred over the mixing zone approach discussed below. See **Chapter D.3** for guidance on constrained protected bicycle lane widths. The Bicycle Lane Narrows sign (CUSTOM) can be used on the intersection approach to alert people cycling of the change in facility width.

Bicycle lanes along roads with dedicated right turn lanes require a different approach than protected bicycle lanes. Bicycle lanes with green conflict zone pavement markings should be placed to the left of any dedicated right turn lane and to the right of any left turn lanes at intersections.

Figure G-98 shows a constrained protected bicycle lane next to a dedicated right turn lane. This design transitions the on-street protected bicycle lane to a constrained raised bicycle lane to maintain some physical separation between the bicycle lane and the right turning vehicles. The bicycle lane should be dashed approaching the intersection to allow motor vehicles to weave across the bicycle lane into the dedicated right turn lane.

Figures G-99 shows a continuous bicycle lane with dedicated turn lane for motor vehicles and on-street motor vehicle parking. Right turn only lanes should be designed to ensure adequate motor vehicle storage so that motor vehicles are not stopping in the bicycle lane. These lanes should not be longer than necessary, as having moving motor vehicles on both sides can be uncomfortable for people cycling.

The dashed segment of the bicycle lane should be a minimum of 18 metres in length and follow a minimum 10:1 length to width ratio. In locations with more than 4,000 vehicles per day, the dashed lane lines should be at least 30 metres in length to provide greater time and flexibility for motorists to complete the weave. The width of a dashed bicycle transition lane and through bicycle lane should match the width of the bicycle lane on the approach (see **Chapter D.4**). Dashed lane line transition areas for through bicycle lanes should not be used on roads with double right turn lanes. Double right turn lanes are extremely difficult for bicycle users to negotiate. An alternative off-street bicycle pathway with perpendicular crossing should be considered.

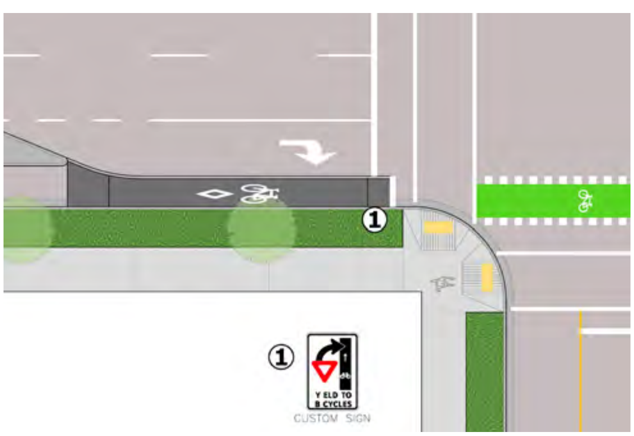


Figure G-98 // Constrained Protected Bicycle Lane Adjacent to Right Turn Bay

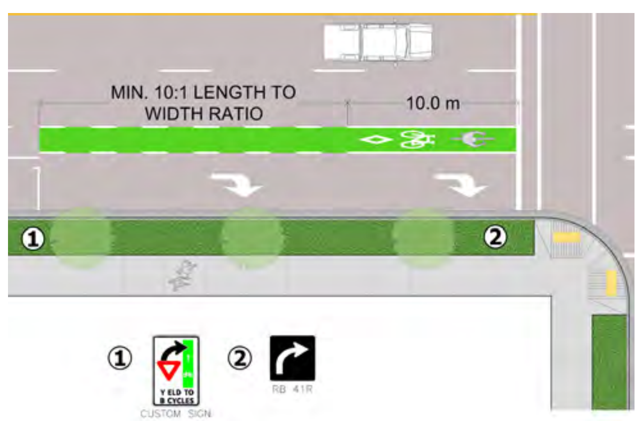


Figure G-99 // Continuous Bicycle Lane with Dedicated Turn Lane

Green conflict zone pavement markings should be used in the bicycle lane to bring awareness to the conflict area. Additionally, the bicycle symbol and diamond markings should be used to denote the reserved bicycle lanes and can be supplemented with directional arrows. However, bicycle symbols and diamond markings should not be used through transition areas. The Turning Vehicles Yield to Bicycles sign (*MUTCDC* RB-37) should be used on the intersection approach where motor vehicles will be merging across the bicycle lane, but is not required at the intersection because of the dedicated right-tun lane.

When a through motor vehicle travel lane drops into a right turn only lane, it is recommended that the through bicycle lane remain to the right of the travel lane, and that the bicycle lane transition to a protected facility or off-street pathway in advance of the intersection. In conjunction with this, a protected bicycle signal phase may be considered to minimize the conflict with the right turning motor vehicle volume.

Channelized Right Turn Lane

As described in **Chapter G.3**, channelized right turn lanes can be found at intersections along roads with high motor vehicle volumes and are used to facilitate right turn motor vehicle movements. They can be challenging and inconvenient for people walking and cycling to cross due to the higher speed of the turning vehicles and the yield controlled (unsignalized) nature of the turn. Additionally, the triangular refuge island may contain limited refuge and queuing space for people walking and cycling.

Design guidance for bicycle facilities in this context is dependent on the right turning motor vehicle volume and speed, sightlines, and whether or not the intersection can be redesigned. Consideration should be made to normalizing the intersection by removing the channelized right turn lane (see **Chapter G.3**). Converting the intersection into protected corners is recommended where feasible (see protected intersection section above).

It may not be possible to remove channelized turn lanes due to roadway geometry, traffic operations, costs, and other considerations. Where removal is not feasible, a second option is to transition the bicycle lane off-street in advance of the intersection **(**see **Figure G-100**). This option minimizes the amount of exposure bicycle users have to motor vehicle traffic. In this configuration, people walking and cycling cross onto the right turn island and then have to cross the road again. This application should only be applied where adequate sightlines are achieved for all road users, and in lower speed applications where motorists would be expected to yield to people walking and cycling.

Along with transitioning the bicycle facility, the channelized island may be geometrically adjusted to reduce motor vehicle speeds. Redesigning the channelized island as a 'high entry angle' or 'smart channel' increases the entry angle to the cross road and decreases the turning speed to be more consistent with a yield condition. See **Chapter G.3** for further details on the benefits of the high entry angle design.

Cross-ride pavement markings may be considered to increase motorist awareness of people cycling and their anticipated path of travel approaching the intersection. The Pedestrian and Bicycle Crossing Ahead sign (WC-46R) and Right Turning Vehicles Yield to Pedestrians and Bicycles sign (MUTCDC RB-38) can be installed to bring additional awareness to motorists (see **Appendix B**). A Stop sign should also be provided for bicycle users to ensure they only proceed through the channelized right turn after stopping and proceeding only when safe to do so.

As mentioned in **Chapter G.3**, raised crosswalks may also be used at channelized islands to slow motor vehicle speeds and increase the visibility of people walking and cycling at the crossing. Raised crosswalks also provide smoother transitions for pathway users, which may result in higher approach and crossing

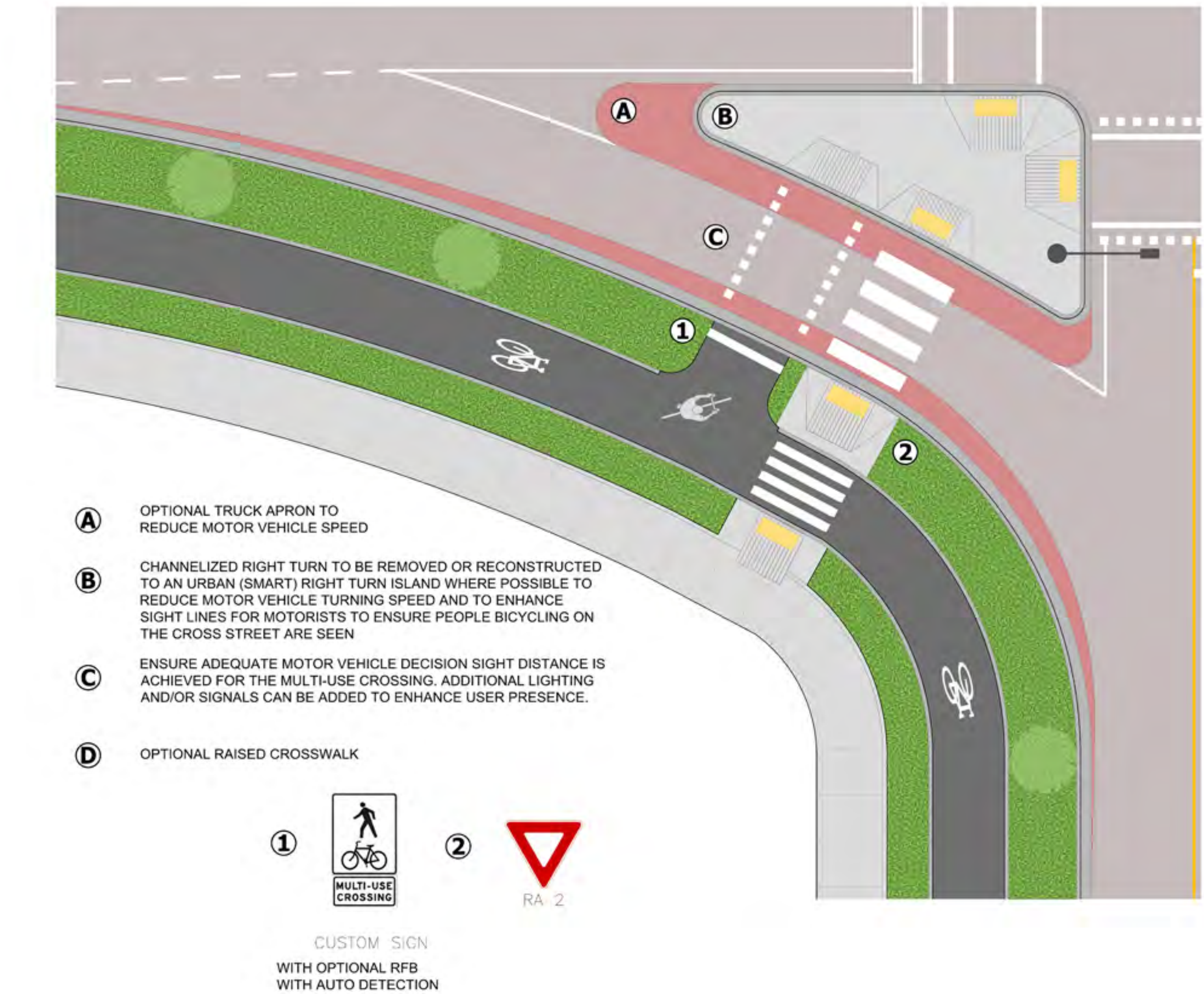


Figure G-100 // Protected Bicycle Lane Crossing at Channelized Right Turn Island

speeds of bicycle users. Raised crosswalks may include yield line pavement markings ('shark's teeth') on their approach. Note that raised crosswalks and other forms of vertical deflection are not permitted on roadways under provincial jurisdiction.

Where channelized right turn lanes cannot be removed or redesigned, a third option is to carry the bicycle lane straight through to the intersection, similar to the dedicated right turn lane configuration discussed above. **Figure G-101** shows an example of this configuration. This option is less desirable from a safety standpoint because it creates a long conflict area where motorists and bicycle users are mixing. However, it has the benefit of providing the most direct alignment for bicycle users through the intersection.

Coloured conflict zone pavement markings should be applied through the bicycle lane conflict area. At the right turn island, the bicycle lane can be denoted with white solid lane lines, the bicycle symbol, and a diamond marking. To provide a more protected facility, a physical barrier may be installed between the bicycle lane and the motor vehicle lane.

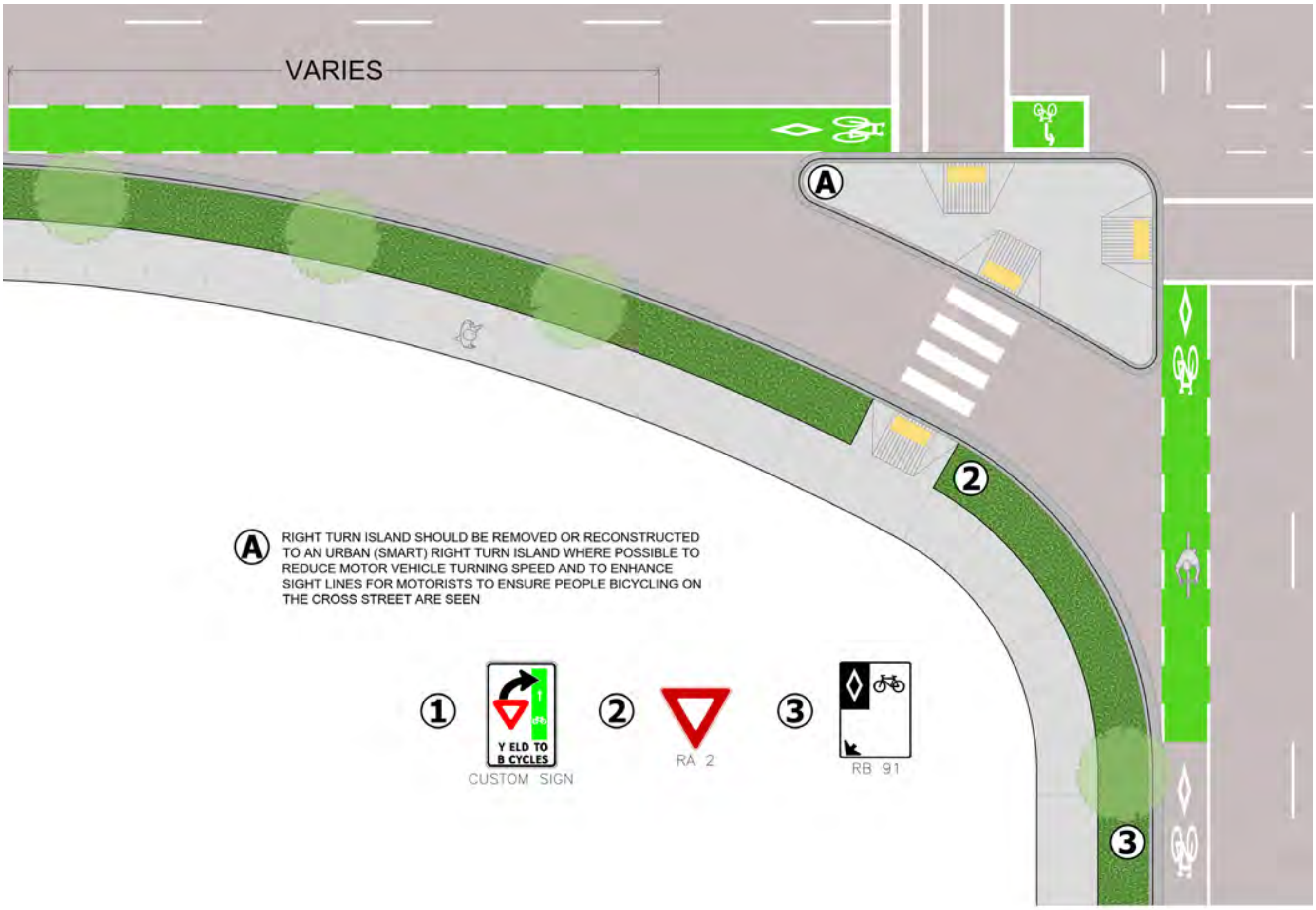


FIGURE G-101 // BICYCLE LANE WITH CHANNELIZED RIGHT TURN ISLAND - THROUGH BICYCLE LANE OPTION

Bicycle Left Turning Movements

Completing a left turn movement can be challenging for people cycling, as it can expose them to conflicts with motor vehicles travelling in multiple directions. There are a number of left turn options for bicycle users, each with varying levels of directness and exposure to potential conflicts. People cycling may choose different left turn options depending on the number of travel lanes and motor vehicle speeds and volumes.

A person's approach to left turns may also differ based on comfort levels. For example, in the absence of dedicated bicycle facilities, a confident bicycle user may choose to take the lane and make a vehicular left turn, whereas less confident bicycle users often do a two-stage left turn, crossing one direction of motor vehicle traffic at a time. There are a number of design solutions to help make left turns more comfortable for people of all ages and abilities.

Bicycle Left Turn Lane

On bicycle facilities with low motor vehicle speeds and volumes, there are likely sufficient gaps in motor vehicle traffic to allow people cycling to merge to the left and make a left turn either from a combined through and turning lane or a dedicated left turn lane if one exists. A dedicated bicycle left turn lane adjacent to the motor vehicle left turn lane may be provided, as shown in **Figure G-102.**

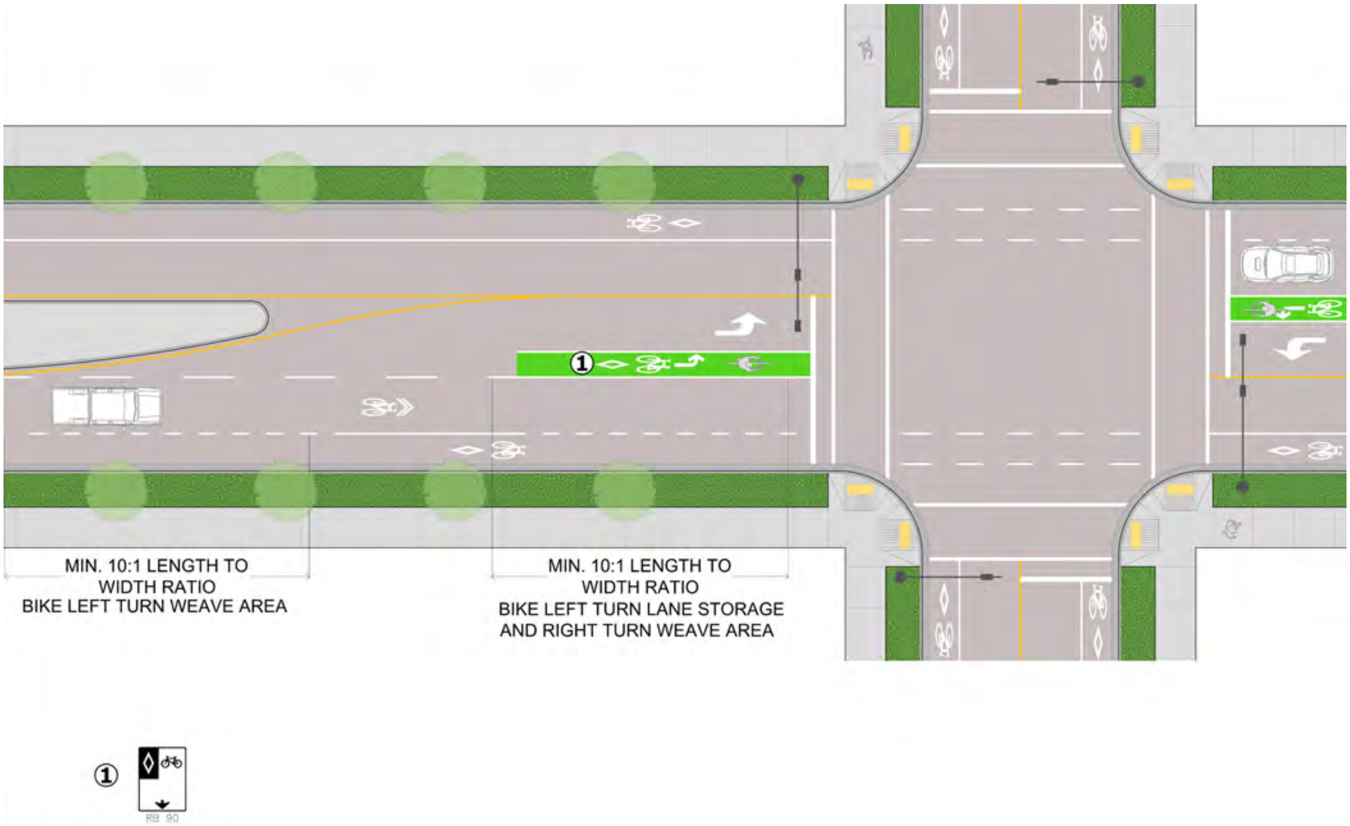


Figure G-102 // Painted Bicycle Left Turn Lane

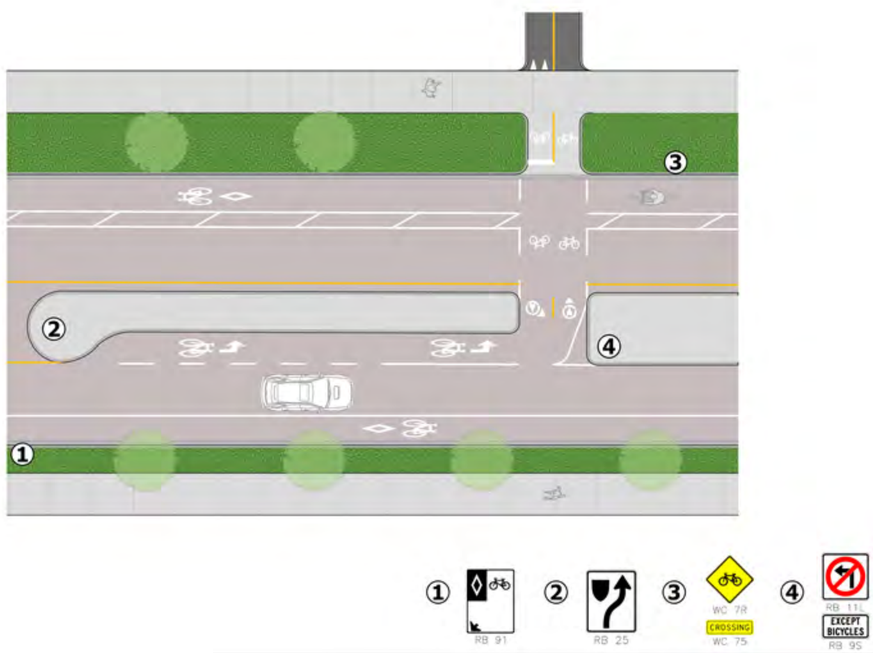


Figure G-103 // Protected Bicycle Left Turn Lane

This treatment should not be implemented on roads with multiple motor vehicle through lanes per direction of travel. Dedicated bicycle left turn lanes are not considered an all ages and abilities facility, as they require people cycling to weave across traffic and wait between two motor vehicle travel lanes when traffic is stopped.

Protected bicycle left turn lanes can provide people cycling with a safer crossing facility with less exposure to motor vehicle traffic (**Figure G-103**). These are only appropriate on neighbourhood bikeways, on low volume two-lane roads where the weaving maneuver is shorter, or where there is a T-intersection.

Bike Boxes

A bike box is a designated area located at the front of motor vehicle lanes at signalized intersections where people cycling can wait for a green signal phase (see **Figure G-104**). Bike boxes help to position bicycle users ahead of waiting motor vehicles, increasing their visibility and allowing people cycling to enter the intersection ahead of motor vehicles. This added visibility means that bike boxes can be beneficial in preventing 'right-hook' conflicts at the start of the green signal phase.

Motor vehicles cannot stop within the bike box when waiting at a light but may pass through it when the light turns green. This means that bike boxes are only effective when the people cycling arrive at the intersection during the red signal. Bike boxes facilitate left turn movements by allowing bicycle users to safely move into the correct lane during the red signal phase. This only applies when the bike box extends across the entire travel lane(s) for that direction of travel. Bicycle users approaching a green signal phase and looking to turn left need to either perform a vehicular left turn or wait for a red signal phase before moving into the bike box.

Bike boxes can be installed in the following locations:

- In built-up areas with high cycling volumes and a relatively small speed differential between motor vehicles and bicycles;
- At signalized intersections with high volumes of left turning bicycle movements or where through bicycle users are anticipated to be waiting for a green indication;
- Where right turns on red are, or can be, prohibited; or
- Where the right turning motor vehicles and through bicycle users are separated prior to the intersection (i.e. channelized right turn, or via access ramp), as the right turning motor vehicle traffic will not be in conflict with bicycle users stopped in the bike box.

Design considerations for bike boxes include the following:

- The bike box should be at least 2.75 metres deep, with depths commonly ranging from 2.75 to 5.0 metres. The minimum width of a bike box is equal to the combined width of the motor vehicle lane and the adjacent bicycle facility.
- Bike box design should consider non-standard bicycle lengths and operating characteristics. Longer bicycles may need a larger refuge area and may require additional manoeuvring space to enter the bike box.
- Green surface treatment and a bicycle symbol should be applied to the bike box to demarcate it as dedicated bicycle facility. It is recommended that a solid green surface treatment is applied in the bicycle lane for a minimum of 15 metres in advance of the bike box.
- A 600-millimetre-wide stop line for motor vehicles should be provided in advance of the bike box, supplemented by a Stop Line sign (MUTCDC RC-4; B.C. R-025 Series) with supplemental Except Bicycles tab (MUTCDC RB-9S; B.C. R-009 Tabs). The motor vehicle stop line may be set back by up to 2 metres to limit motor vehicle encroachment into the bike box.

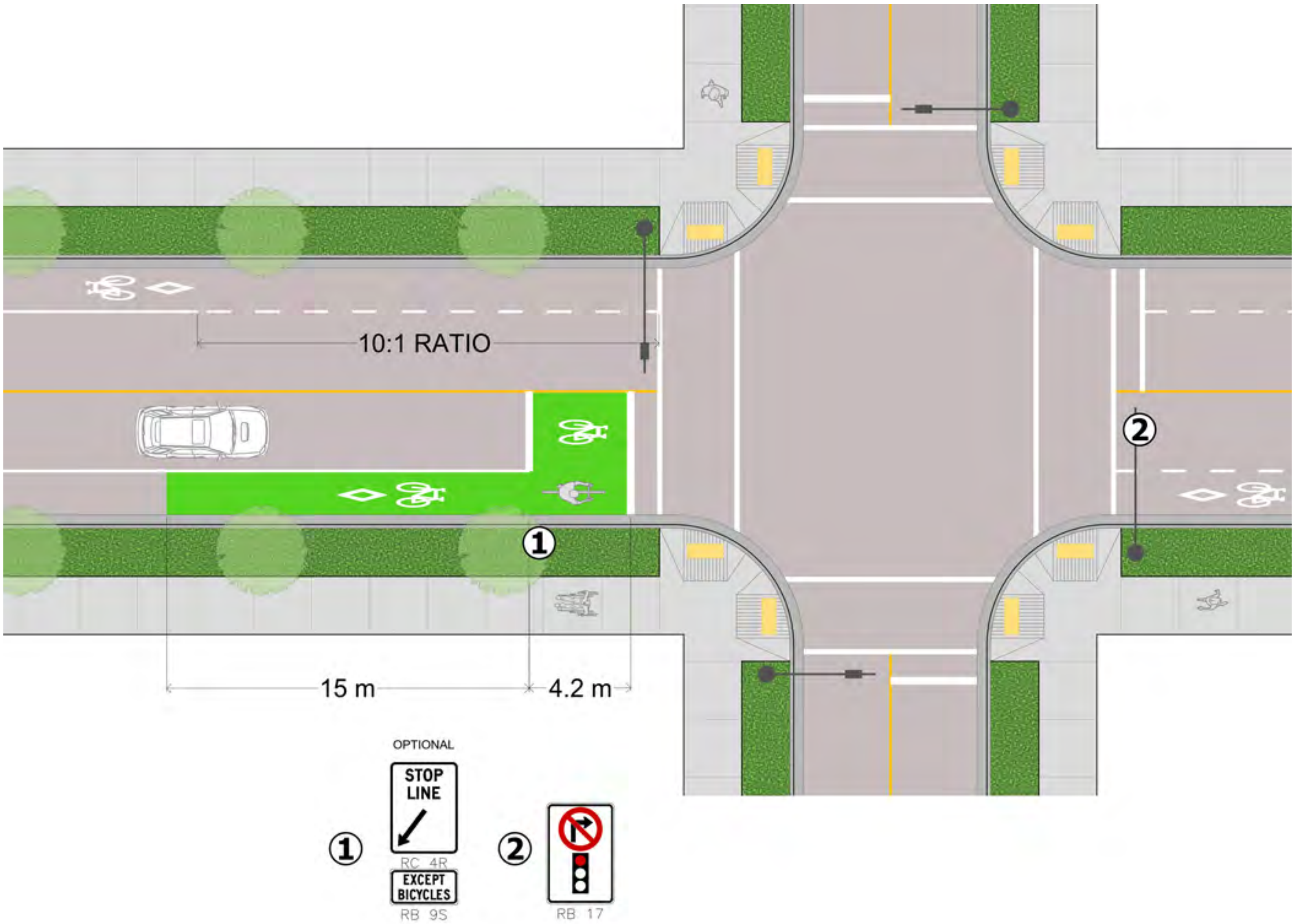


Figure G-104 // Bike Box

Optional 'Wait Here' pavement markings may be installed in areas of low compliance.

- A 600-millimetre-wide stop line should also be provided at the front of the bike box to prevent encroachment of bicycles into crosswalks. The bike box may be set back from the crosswalk to further limit bicycle encroachment.
- For actuated signals, bicycle detection should be provided with bicycle loop detectors in the bike box.
- Right Turn on Red Traffic Signal Prohibited signs (MUTCDC RB-17R; B.C. R-117-R Series) should be installed to ensure that motorists do not encroach into the bike box during the red signal phase.
- The Turning Vehicles Yield to Bicycles sign (MUTCDC RB-37) is recommended to clarify that bicycle users in the bike box have right-of-way.
- Educational signage directed at bicycle users may be required to communicate where bicycles should stop.

Two-Stage Turn Boxes

A two-stage turn is when a person cycling crosses one direction of traffic at a time. A two-stage turn box provides a designated waiting area outside of the travel lanes on the adjacent road, giving people cycling a waiting area to complete a two-stage left turn. The left turning bicycle users proceed straight to the waiting area on a green signal phase and then turn across the intersection when the crossing traffic gets a green signal phase. **Figures G-105** and **106** show two-stage turn box applications with protected and painted bicycle lanes, respectively.

Two-stage turn boxes improve safety and comfort by reducing the turning conflicts between vehicles and bicycles, and prevent conflicts resulting from bicycles queuing in the bicycle lane or on the sidewalk. This configuration typically results in increased delay for people cycling, as they must receive two separate green signal indications or wait for a safe gap at an unsignalized intersection.

Two-stage turn boxes are applicable in a number of circumstances, including:

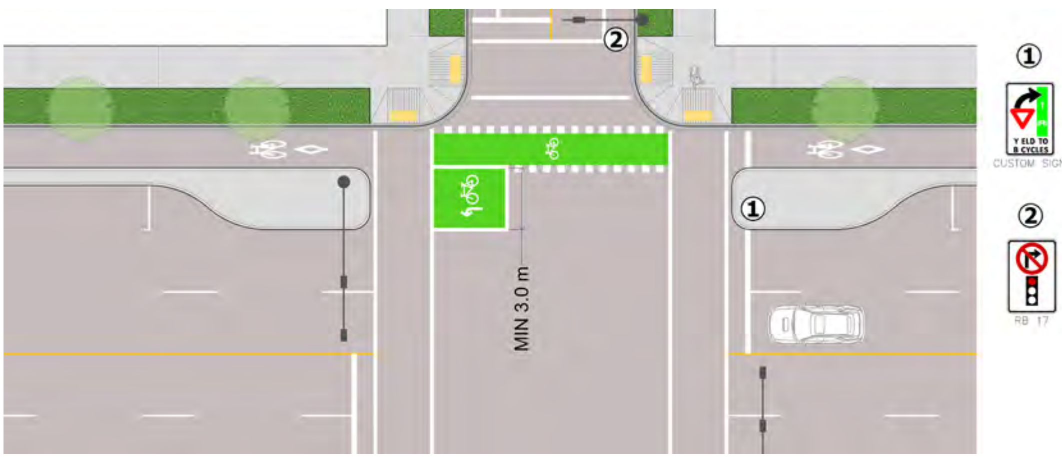


Figure G-105 // Protected Bicycle Lane with Two-Stage Left Turn Box

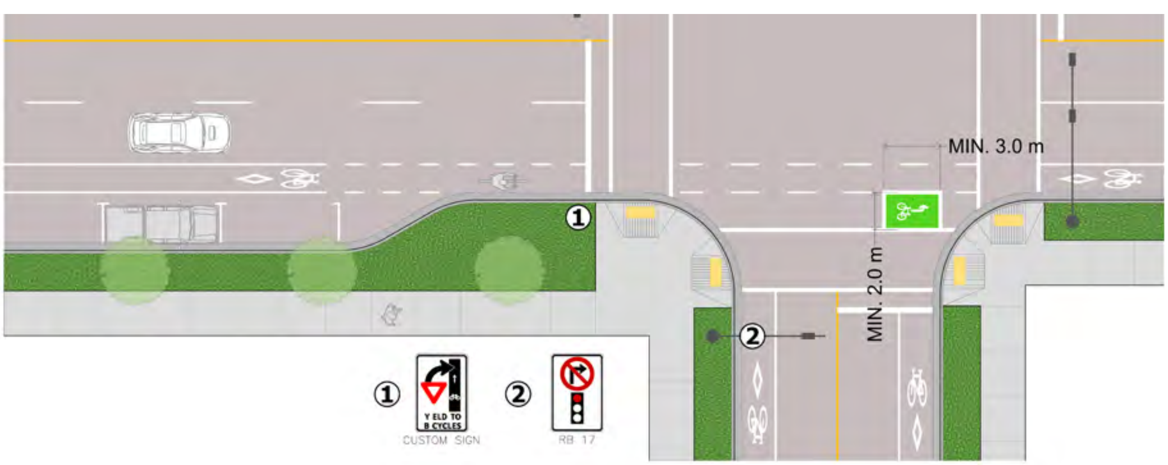


Figure G-106 // Painted Bicycle Lane with Two-Stage Left Turn Box

- At signalized intersections where there are few gaps in traffic;
- At multi-lane signalized intersections;
- Where the right turning motor vehicle traffic on the cross road is low and where right turns on red can be prohibited, or where there is a right turn lane on the cross road that can be separated from the bike box space;
- At locations where the person riding a bicycle needs to turn left from a right-side bicycle facility or right from a left-side bicycle facility;
- At mid-block crossings, to orient people cycling properly for safe crossings; and
- Where protected bicycle lanes are continued up to an intersection, but a protected intersection is not provided.

Two-stage turn boxes may also be applied at unsignalized intersections to simplify turns from a bicycle lane to another facility type, such as neighbourhood bikeways. However, challenges can occur when applying two-stage turn boxes at unsignalized intersections, as the turn box cannot be protected. As a result, motor vehicles on side roads may encroach on the turn box while waiting for a gap in traffic.

Design considerations for two-stage turn boxes include the following:

- The preferred dimensions for two-stage turn boxes are 2 metres by 3 metres, with a constrained minimum width of 1 metres.
- Two-stage turn box design should consider non-standard bicycle lengths and operating characteristics. Longer bicycles may need a larger refuge area and may require additional manoeuvring space to enter the two-stage turn box.
- Green surface treatment and a bicycle symbol should be applied to the bike box to demarcate it as a dedicated bicycle facility.
- A turn arrow should be included to clearly indicate bicycle positioning and direction.
- Right Turn on Red Traffic Signal Prohibited signs (MUTCDC RB-17R; B.C. R-117-R Series) should be installed to ensure that motorists do not encroach into the two-stage turn box during the red signal phase.
- Educational or wayfinding signage directed at bicycle users may be required to show bicycles the ideal travel path to complete their left turn, as this facility may not be intuitive.
- Guideline pavement markings may also be used to indicate the bicycle travel path.
- Placement of the two-stage turn box must be carefully considered. In order to enhance the visibility of bicycle users, the two-stage turn box should be positioned laterally in the cross road and aligned with the direction of travel of motor vehicles approaching the intersection from behind. The two-stage turn box must also be located in a protected area – typically, they are placed in line with an on-street parking lane or between a bicycle lane and a crosswalk.

In cases where a constrained geometry or right-of-way prevents placing the two-stage turn box in a protected area, the pedestrian crosswalk may be adjusted or realigned to enable space for the two-stage turn box. Alternatively, a two-stage turn box placed behind the pedestrian crossing can serve the same purpose (see **Figure G-107).** However, this configuration should only be considered if pedestrian volumes are low, as it requires people cycling to yield to pedestrians then weave across the crosswalk to enter the two-stage turnbox.

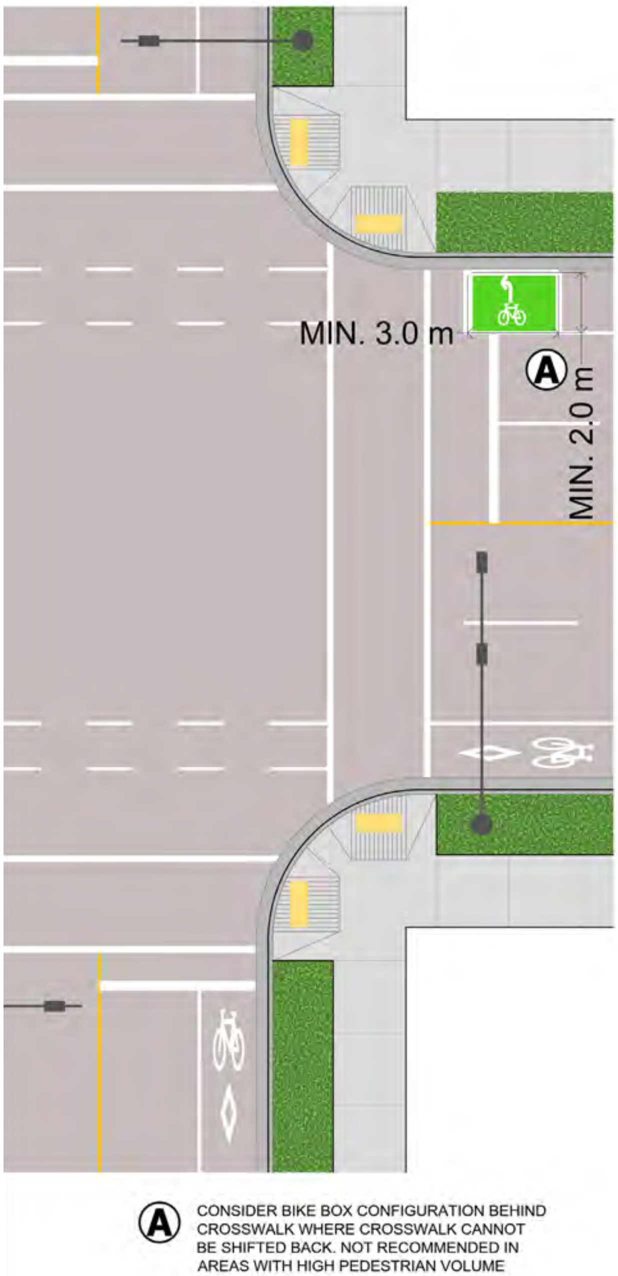


Figure G-107 // Two-Stage Left Turn Box Behind Crosswalk

Two-Stage Protected Left Turn

Bicycle left turns at T-intersections can be facilitated by redirecting the bicycle users to a waiting area behind the curb line on the right side of a road, often referred to as a jughandle. Jughandles position bicycle users to face the cross-road traffic. Designs vary depending on a number of factors, including available space, bicycle volumes, and the road's design speed. **Figure G-108** shows one example of a jughandle-style left turn. A more gradual transition to the side is more comfortable for people cycling and can provide a larger queuing area, but this requires more space than is typically available in existing environments.

Jughandles create a fourth leg to the intersection and require traffic control complementary to the other approaches. The T-intersection approach is typically a minor cross-road and would likely be stop controlled. In more developed areas where there are few gaps in traffic, traffic signals may be required in the jughandle waiting area. In these cases, bicycle signal detection should be installed in the jughandle.

At signalized intersections, conflict zone markings can be used for the conflict area with the through bicycles and the left turning motorists. Supplementary signage and pavement markings, including a bicycle symbol, directional arrows, and green pavement markings can be installed on the jughandle to indicate the space is reserved for turning bicycles.

Bicycle Right Turning Movements

At signalized intersections with a demand for right turning bicycle movements,, a free-flowing bicycle right turn can be designed to improve operations. This can be developed using a protected corner. Before the intersection, people cycling can be guided past the signal and connected to a facility on the cross road. A bicycle right turn lane with no stop bar can be provided, with directional arrow pavement markings. Signage can be used that indicates that people cycling are permitted to turn right.

Free-flowing bicycle right turns require additional right-of-way and have potential conflicts with

Figure G-108 // Jughandle-Style Left Turn

pedestrians. The right-of-way must be clearly defined for crossing pedestrian and cycling facilities. More details on protected intersections are provided below.

CONSIDERATIONS FOR BI-DIRECTIONAL BICYCLE FACILITIES

Bi-directional protected bicycle facilities require special consideration at intersections, including the following:

- A directional dividing line should be painted on the bi-directional protected bicycle lane at the approaches to the intersection for a minimum of 5 metres;
- Bicycle symbols, and the reserved diamond should be marked on the entrance of the bicycle facility for each direction;
- Bicycle signals with protected bicycle signal phasing should be considered where possible. Where permissive turns are allowed, Turning Vehicles Yield to Bicycles signs(MUTCDC RB-37) should be installed both approaching the intersection and at the intersection;
- The Contraflow Bicycle Lane Crossing sign (MUTCDC WC-43) may also be installed for the approaching cross-road traffic to alert motorists to the presence of the bi-directional bicycle facility. This is especially important on one-way motor vehicle roads.
- Protected intersections where a bi-directional protected bicycle lane intersects with a uni- or bi-directional protected bicycle lane may see a larger relative amount of cycling traffic. These protected intersections require additional bicycle queuing and manoeuvring space to ensure that bicycle through movements are not impeded. The forward bicycle queuing area should be at least 3.0 metres wide. It is recommended that right turns on red be prohibited and short signal phases are used, allowing the bicycle queuing areas to empty more frequently.

Shared Major Intersections (Mixing Zones)

Where dedicated space is not available for a separate facilities for people cycling and turning motor vehicles, shared intersections (also known as mixing zones) may be considered. However, it should be noted that shared intersections do not address conflicts between people cycling and turning motor vehicles and are not comfortable for people of all ages and abilities. As such, these treatments should only be considered after exploring options to provided dedicated facilities as noted in the previous sections.

Dedicated Right Turn Lane with Mixing Zone

Where a dedicated right turn lane is provided but there is insufficient space to maintain the bicycle facility up to the intersection, a mixing zone may be considered. This configuration is not suitable for people of all ages and abilities – where feasible, a dedicated cycling facility should be maintained up to and through the intersection. Mixing zones are suitable where there are relatively low turning motor vehicle volumes. Mixing zones can be considered if right turning motor vehicle volumes are less than 100 vehicles during the peak hour. **Figures G-109** and **G-110** provide guidance on the transition from protected or bicycle lane to a mixing zone before the intersection. Green-back 'super sharrows' can be applied to further enhance the shared lane.

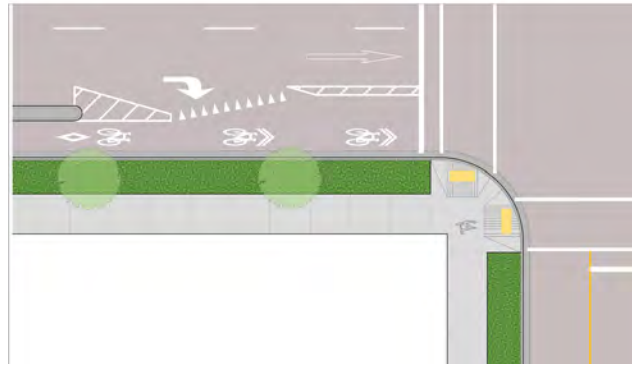


Figure G-109 // Discontinuous Protected Bicycle Lane with Mixing Zone

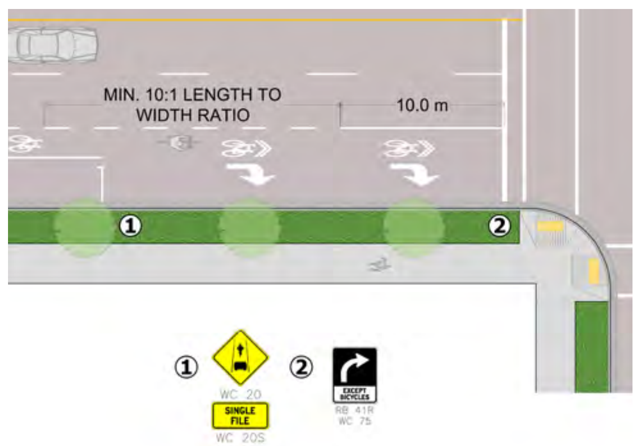


Figure G-110 // Discontinuous Painted Bicycle Lane with Mixing Zone

Minor Intersections

At minor intersections, laneways, and driveway crossings, people cycling can be assigned priority over motor vehicles as described below.

Minor Road Crossings

Treatments for minor road crossings are dependent on the intersection geometry, sightlines, and motor vehicle speeds and volumes. Transportation professionals should aim to reduce or minimize bicycle delay by limiting the number of stop signs along a bicycle route. This means that wherever, possible, bicycle through movements along bicycle facilities should have priority over local cross roads. However, a Yield or Stop sign should not be installed on the higher motor vehicle volume road unless justified by an engineering study (refer to the MUTCDC for details on the application of Yield and Stop signs).

Design professionals should consider the following when deciding which road should yield or stop where two roads with relatively equal motor vehicle volumes and/or characteristics intersect:

- Control the direction that conflicts the most with established bicycle crossings, pedestrian crossing activity, or school walking routes; and
- Control the direction that has obscured vision, dips, or bumps that already require drivers to use lower operating speeds.

Traffic calming and diversion measures such as neighbourhood traffic circles, curb extensions, and median diverters should be used in coordination with the above approaches to prevent neighbourhood bikeways from becoming attractive shortcuts for motorists (see **Chapter D2**). Where traffic calming and diversion measures are used, transportation professionals should ensure that municipal operations departments, emergency services, and transit agencies are involved in the design process to ensure winter maintenance considerations and to minimize impacts on other emergency services and transit. At road crossings, sharrow pavement markings can be used on the approach and can be carried across the intersection to enhance awareness of bicycle crossings. On higher volume roads, green-backed 'super sharrows' can further enhance the visibility of the sharrow and crossing. Additional wayfinding pavement marking symbols with directional arrows may be used where the bicycle route changes directions (see **Chapter D2**).

Laneway and Driveway Crossings

Bicycle facilities have greater potential for conflict where there are many laneway and driveway crossings along the corridor. The number of laneway and driveway crossings should be considered in the network planning and bicycle facility selection processes. Where laneway and driveway crossings exist, design considerations are necessary to mitigate potential conflicts.

Sufficient sightlines for both bicycle users and motorists must be provided. This may necessitate removing obstructions and restricting on-street parking on either side of the laneway or driveway. For high-use laneways and driveways, such as commercial and employment accesses, conflict zone markings can be used to enhance the visibility of the crossings. Signage can also be used to alert motorists both entering and exiting the laneway or driveway of the conflict. However, transportation professionals should use caution when installing signage to ensure to not result in reduced effectiveness of existing signage.

Where possible, bicycle facilities should maintain a consistent elevation through the laneway or driveway crossings. This is applicable to sidewalk level and intermediate level protected bicycle lanes. In this case, the sidewalk and bicycle facilities would remain at a consistent elevation with the laneway or driveway ramping down to road level once past the bicycle facility.

TRANSITIONS

Transitioning between different bicycle facility types requires special consideration to ensure a safe and intuitive transition for people cycling. It is important to maintain sightlines and clearly communicate right-of-way to all road users. Maintenance is particularly important in transition areas to ensure signage and pavement markings are visible and that surface conditions are safe. Minimum grades through transition areas should be confirmed to ensure no ponding or icing will be present during wet and winter conditions.

Transition designs will vary depending on site-specific conditions. For example, in some cases the available right-of-way along a corridor can vary, and the lane configuration can change to meet the demand of the motor vehicle traffic patterns on approaches to more major intersections. Design considerations for specific facility types are provided below. Each transition can also be considered in the opposite direction (i.e. vice versa).

Figure G-111 shows the signage and pavement markings required for transitioning between a bicycle lane and a neighbourhood bikeway Guideline pavement markings should be used to guide bicycle users through the intersection in the correct position in order to line up with the receiving facility. When transitioning to a bicycle lane, a dashed bicycle lane should be included for 25 metres prior to the intersection, with a Reserved Bicycle Lane sign (MUTCDC RB-90, RB-91) installed. A Reserved Bicycle Lane Ahead sign (MUTCDC WB-10) should be used to alert road users of the transition.

When transitioning to a neighbourhood bikeway the bicycle lane should carry through to the far side of the intersection and should transition from solid to dashed, with Reserved Bicycle Lane Ends sign (MUTCDC RB-92) installed. On the neighbourhood bikeway, sharrow pavement markings can be used guide bicycle users' lateral position on the road, shifting them into or out of the bicycle lane. The Shared Use Lane Single File sign (MUTCDC WC-20) may be used to alert road users of the transition.

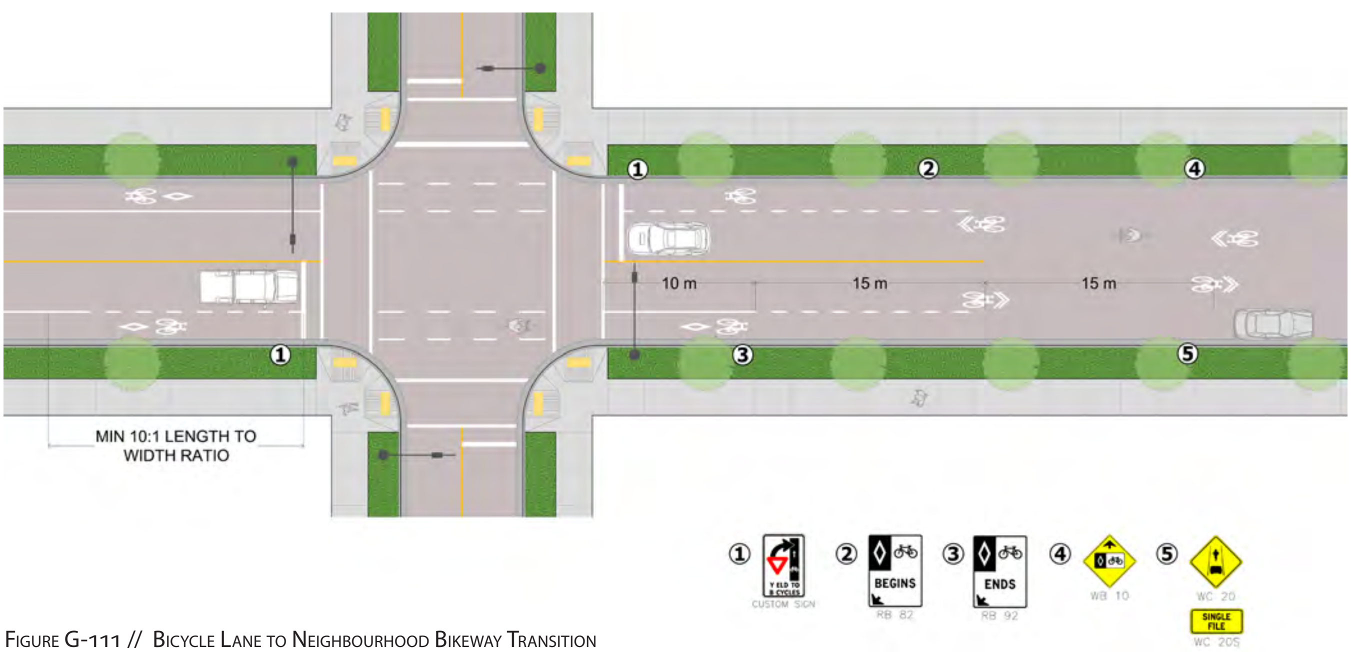


Figure G-111 // Bicycle Lane to Neighbourhood Bikeway Transition

Bicycle Lane

Transitioning to bicycle facilities with physical protection in higher conflict areas can improve safety and comfort for cyclists. **Figure G-112** shows the transition to a protected bicycle lane. Transitions to protected facilities should include Object Marker signage (MUTCDC WA-36; B.C. W-054-D Series) to identify the introduction of upcoming physical barriers for cyclists and drivers.

Transitions should cause minimal shift in travel for cyclists, with a maximum recommended taper of 3:1. The taper design should consider off-tracking for longer bicycle and bicycles with trailers. This transition bends cyclists away from the intersection – see **Chapter G5** for more details on bend out transitions. A straight segment of protected bicycle lane that is at least 5.0 metres long should be included prior to the intersection to ensure that cyclists are properly aligned for the crossing. Cross-ride markings should be included as per the guidance earlier in this Chapter.

When transitioning to a lower order bicycle facility, protection for cyclists and facility type should be carried through the intersection and then transition into a lower order bicycle facility on the other side in order to lessen the workload for all road users.

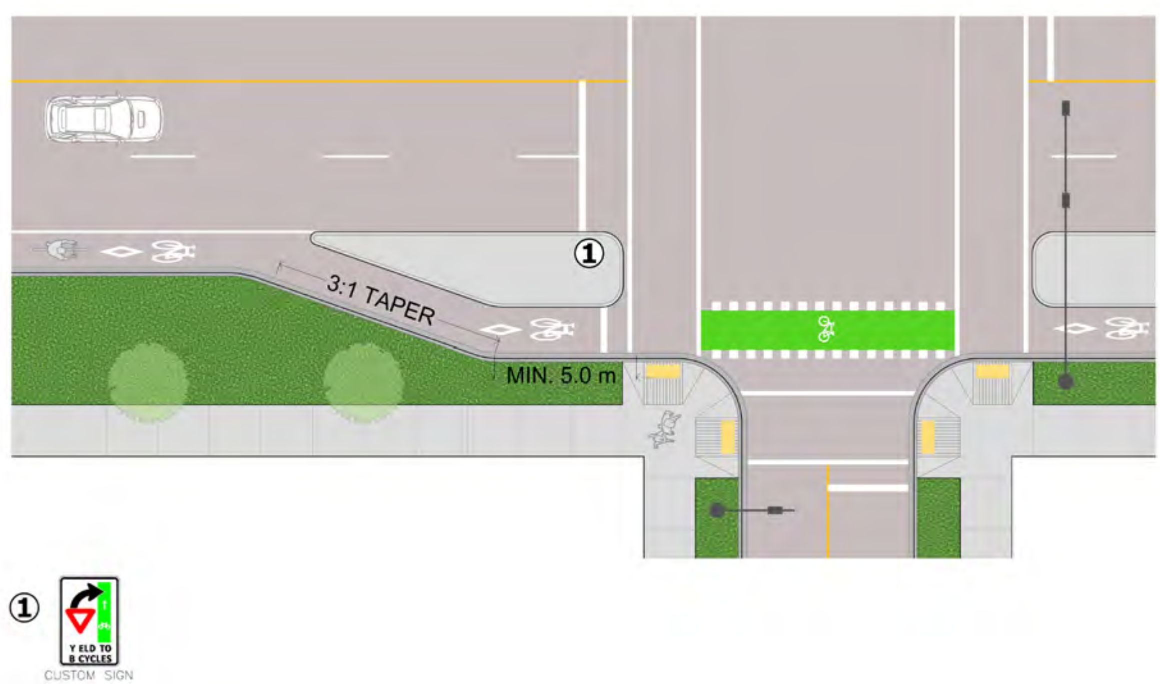


Figure G-112 // Painted Bicycle Lane to Protected Bicycle Lane Transition

Figure G-113 // Bicycle Lane Transitioning to Protected Corner

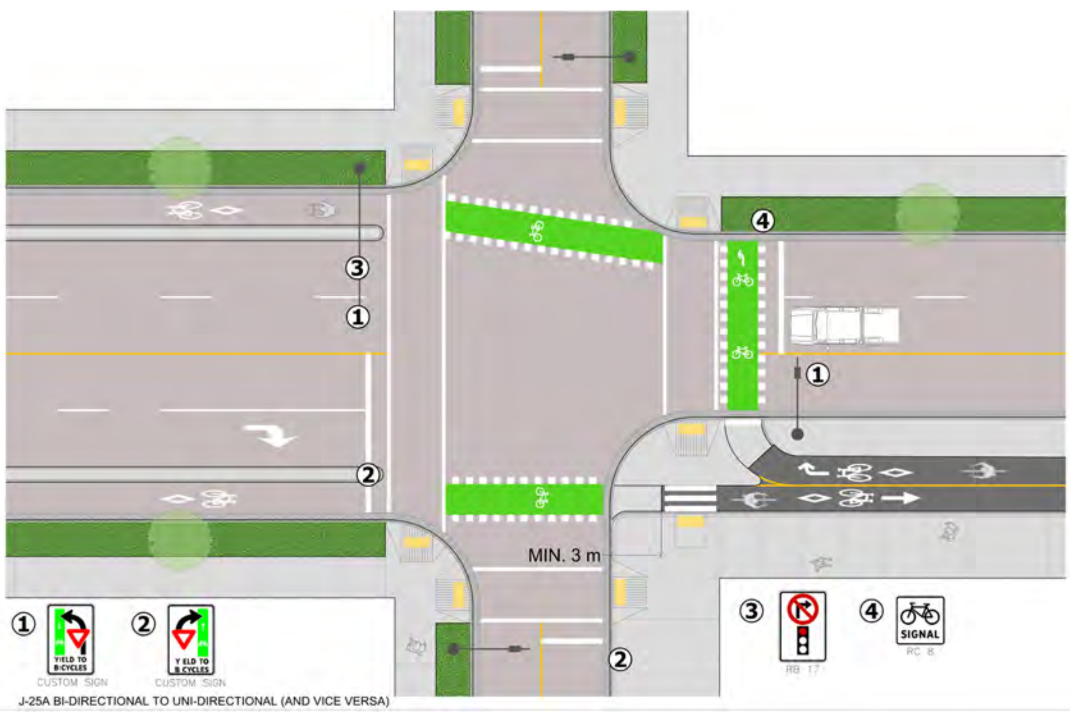


Figure G-114 // Bi-Directional to Uni-directional Protected Bicycle Lane

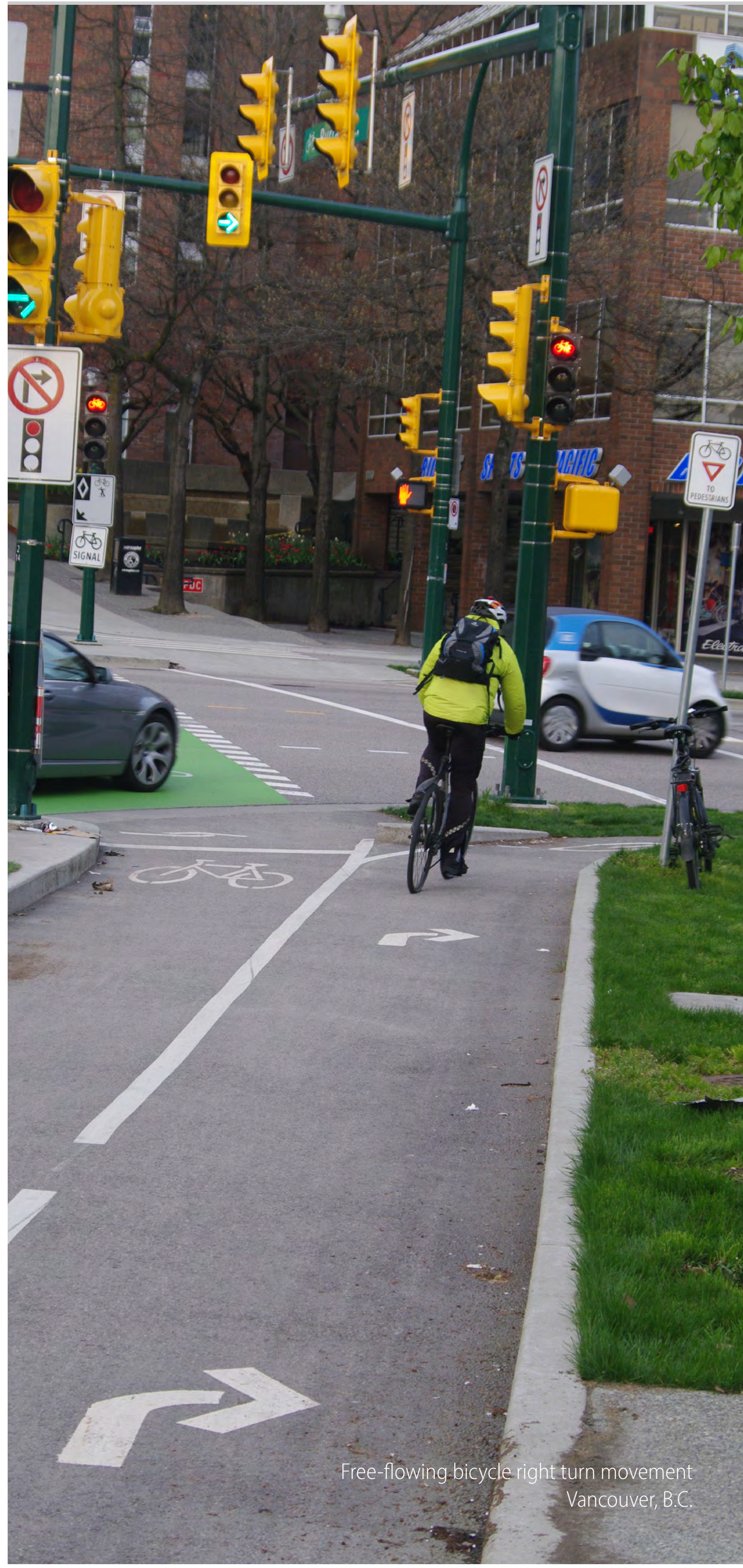
Unprotected Bicycle Facility to Protected Intersection

Neighbourhood bikeways and buffered bicycle lanes may be transitioned into short protected bicycle lane segments prior to the intersection and then directed into a protected intersection (see **Figure G-113**). This treatment can be used where the bicycle corridor intersects with a major road with higher volumes and turning conflicts. Where feasible, protected intersection elements should be provided on both sides of the intersection. Once the bicycle user has crossed through the intersection, the protected facility can then transition back to an unprotected facility if desired.

Bi-Directional to Uni-Directional Protected Bicycle Lane

Figure G-114 illustrates the transition between a bi-directional protected bicycle lane and a uni-directional bicycle lane. Transitioning between bi-directional and uni-directional facilities requires clear pavement markings and signage for the transition areas to ensure that contraflow bicycle users do not go the wrong-way down the uni-directional protected bicycle lane. Bicycle symbols with directional arrows provide visual guidance for bicycle users transitioning between the two facilities. Bicycle route and/or directional signage should also be installed at the intersection to indicate the shift in cycling facility.

Bike boxes, two-stage turn boxes, and/or protected corners can be installed to help transition between facilities by providing a protected space for bicycles to stop during a two-stage turning maneuver. Bicycle traffic signals should be provided, and protected bicycle signal phasing should be implemented (see **Chapter G2**). Near side bicycle signals may be appropriate for some facilities. Higher-level conflict zone markings should be used to provide enhanced visual guidance to all intersection users.



Free-flowing bicycle right turn movement
Vancouver, B.C.

Arbutus Greenway, Vancouver, B.C.
Source: Dylan Passmore

G.5

OFF-STREET PATHWAY CROSSINGS

An off-street pathway crossing is where an off-street bicycle facility such as a multi-use pathway or bicycle pathway crosses a road, driveway, or laneway. Crossings provide a potential conflict between people cycling, walking, and using other mobility devices and motor vehicles, and as such, require careful design considerations. These conflict points also tend to be locations where a higher number of collisions occur. Off-street pathway crossings can be located at intersections or mid-block locations, and may be at-grade or grade separated. This chapter provides design guidance for crossings of multi-use pathways and bicycle pathways.

TRAFFIC CONTROLS

Roadway Facing Controls

As noted in previous chapters, the TAC *Pedestrian Crossing Control Guide* and MOTI *B.C. Pedestrian Crossing Control Guide* provide guidance on when various types of crossings are warranted at intersections. When an off-street pathway is crossing a roadway that is currently uncontrolled, a warrant should be conducted to determine the appropriate intersection control required. Some jurisdictions may also have their own guidance and warrant process to determine the crossing control that is warranted. A summary of specific roadway facing controls is provided in **Chapter G.2**.

Off-street Pathway Facing Controls

Signage and pavement markings are the primary means of communicating to off-street pathway users when they must yield or stop before proceeding through an unsignalized or minor intersection or before crossing at a mid-block location. The off-street pathway controls required will depend on which user has the right-of-way: the motor vehicle driver on the roadway, or the pathway user. At unsignalized or minor intersections and mid-block crossings, where pathways volumes are greater than motor vehicle volumes, priority should be provided to pathway users. This involves giving the right-of-way to pathway users by requiring motorists on the roadway to stop. This also ensures consistency along the length of the entire off-street pathway facility at all unsignalized intersections. However, certain situations may require yield or stop control for pathway users, including:

- When appropriate sightlines can not be achieved between motorists and people cycling. Additional signage for bicycle users to yield or stop and watch for turning motorists should be installed. The presence of stop or yield signs on the pathway does not limit people walking from entering the crosswalk in an appropriate manner. More information about sight distance can be found in **Chapter G.1**.
- At locations where a pathway intersects with a road that has a designated bicycle facility.

DESIGN GUIDANCE

Bend-in Versus Bend-Out Crossings

When designing intersection approaches for on-street bicycle facilities and off-street pathways, there are two options for designing the alignment of the facility as it approaches an intersection to improve sightlines and visibility:. Bend-In Crossings:

1. Bend-In Crossings: Bending the facility towards the parallel road;
2. Bend-Out Crossings: Bending the facility away from the parallel road.

The taper ratio of the alignment shift for either option, should be between 3:1 and 10:1, with a 10 to 15 metre tangent. Each of these approaches are described below. Generally, the bend-out design is recommended as it can provide more benefits, but it requires more space than bending the pathway towards the road. The benefits and drawbacks of each treatment are discussed below.

Bend-In Crossings

Bend-in crossing designs allow for improved sightlines for motorists on the parallel roadway as they approach the intersection to see bicycle users as the facility is brought closer to the road. This design also requires less space and generally does not require any change to the width of the right-of-way. As the crossing is brought closer to the parallel roadway, there is an intuitive sharing of traffic signals (when present) between users. As the crossing location is closer to the parallel roadway, the stop line on the side road is also brought closer to the intersection, allowing for improved efficiency and throughput for motor vehicles.

The drawbacks of the bend-in crossing include a reduction in user queuing spaces at the intersection. As the crossing is close to the intersection, there is little room for turning vehicles from the parallel road to stop before entering the crossing. This situation may be compounded by the creation of a blind spot that does not allow turning motorists stopped at the stop line on the parallel roadway to see bicycles approaching from behind. Design considerations to alleviate this conflict may include separate signal phasing of movements and/or signage for motorists to yield to bicycles.

Bend-Out Crossings

Bend-out crossing designs are generally recommended as they provide more space and time for motorists to react as they turn from the parallel road onto the side road. This additional queuing space allows motorists from the parallel road to orient their motor vehicles perpendicular to the bicycle facility before crossing it, facilitating two-way sightlines between bicycle users and motorists. The queuing space is also located outside of the through traffic path on the parallel road, improving vehicle throughput. Design considerations include ensuring clear sightlines for turning motor vehicles to the setback bicycle facility

Bend-out crossing designs also allow for more room at the intersection to provide queuing space for pedestrians between the pathway and curb ramp when crossing the parallel road. Where there are high volumes of pedestrians crossing the parallel road, this design is preferred. The additional room at the intersection may also allow for bicycle box placement to facilitate bicycle turning movements onto the perpendicular road from the pathway.

The drawbacks of bend-out designs include the additional space required at the intersection. In constrained rights-of-way, this design may not fit. There may be reduced sight lines for motorists approaching the intersection on the perpendicular road, as the stop bar is set back. It may also cause some motorists to queue onto the crosswalk as they advance towards the intersection for better sight lines. At signalized intersections, this may be alleviated by restricting right turn movements on red.

Speed Reducing Elements at Crossings

When off-street pathways intersect roads at unsignalized crossings, several design options may be considered to slow motor vehicle traffic, as well as people cycling, to ensure that all users are aware of the crossing. Approaches to reduce speeds for both roads and pathways are discussed below.

Road Approach

Narrowing of the road through the introduction of geometric design elements such as median islands and/or curb extensions can slow motor vehicle traffic prior to approaching pathway crossing. Median islands provide an additional benefit to pathway users as a refuge while crossing the road. Median islands are desirable on roads with multiple motor vehicle lanes in each direction and/or higher speed roads. Median islands should be a minimum of 3.0 metres wide in order to provide adequate protection for all types of bicycles (such as bicycles with trailer), and should include curb ramps or cut-throughs with tactile warning strips.

Curb extensions reduce the distance for pathway users to cross as well as provide enhanced visibility of people walking and cycling waiting to cross. Curb extensions are particularly valuable on roads with high volumes of on-street parking that may limit motorist sightlines of the pathway. Design considerations with curb extensions may include whether there are any on-street bicycle facilities or existing bicycle use of the project into the Bicycle Through Zone, pushing bicycles into adjacent motor vehicle lanes.

Median islands and curb extensions can provide opportunities for enhanced landscaping, including rainwater management as well as snow storage.

However, landscaping elements, public art, and vegetation should be placed and managed so that sightlines are maintained. Median islands and curb extensions can also be used for snow storage in the winter, provided sightlines are maintained and the pathway remains clear. Additional visual cues such as signage may also be installed on median islands and curb extensions to alert motorists and maintenance staff of the curb locations in winter conditions.

In addition to median islands and curb extensions, a raised crossings may be used. Raised crossings increase crossing visibility and yielding behaviour with the use of vertical deflections on the roadway. Raised crossings are most appropriate in areas with high volumes of pathway users, such as near parks, schools, and other major destinations. Raised crossings should be used where the posted speeds are 30 km/h or less. The use of raised crossings should include consideration for snow clearing.

Pathway Approach

Geometric design may be used to reduce user speed on bicycle pathways and multi-use pathways as they approach crossings. This can include adding horizontal and vertical curvature to the pathway or an uphill grade in advance of the crossing.

Additional speed-reducing elements that can be applied to the pathway approach include textural surface contrast, transverse paint lines, yield markings, and warning signage along the pathway.

Separating Users

Intersections can also be a location for conflicts between various pathway users. There are a wide range of users and existing facility types approaching intersections, including separated pedestrian and cycling facilities and multi-use facilities that need to be considered when designing intersections. Separating people walking from people cycling at intersections is the best practice at all crossings regardless of the pathway configuration of the approach. At locations where a multi-use facility approaches an intersection, there are conditions were a multi-use crossing is preferred, such as at locations with low volumes of pathway users and challenging geometry that restricts sightlines of both pathway and roadway users.

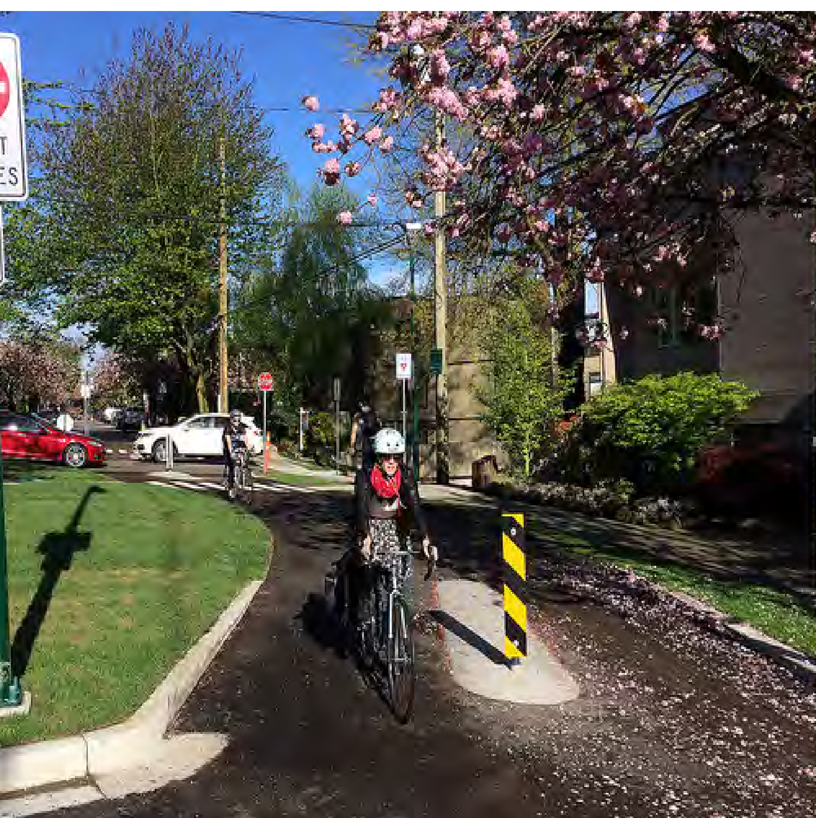
Speed reducing transverse pavement markings for bicycle pathway, North Vancouver, B.C.

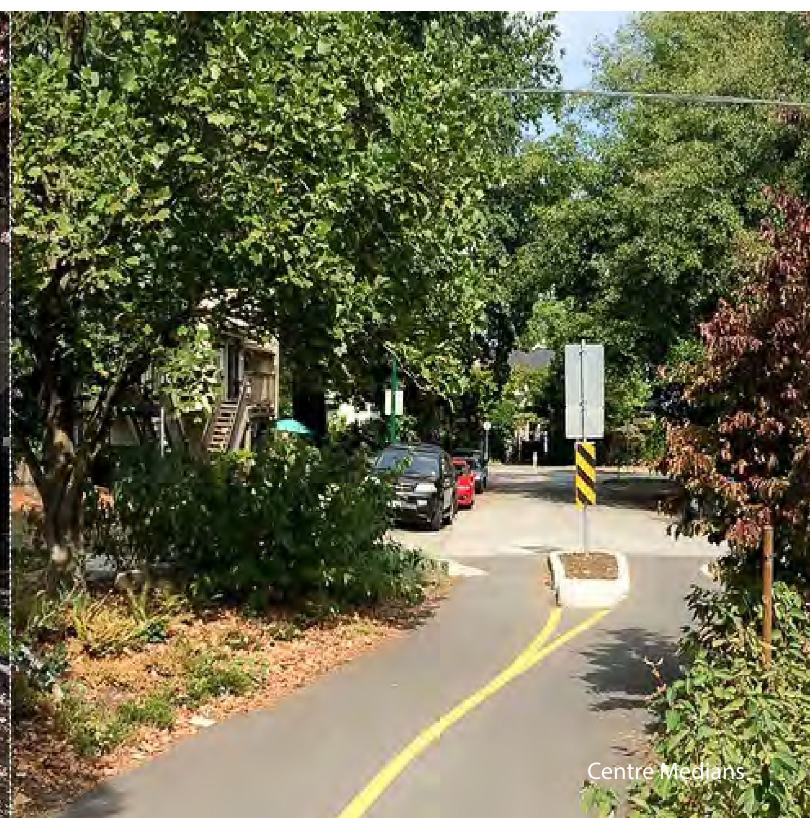
Access Restrictions

Access restrictions for off-street pathways have often historically occurred through the installation of access control devices such as bollards, maze gates (offset gates), flexible delineators, raised medians, and/or signage to restrict access by motor vehicles to the pathway. As noted in **Chapter D.1**. It is recommended to avoid the use of rigid bollards, maze gates, or other solid impediments in the pathway at points of entry unless there is a demonstrated history of motor vehicle encroachment, and/or a collision history.

The use of rigid bollards or maze gates for bicycle speed control is also not appropriate, as its slowing effect is by creation of a potential safety hazard to the bicycle users. Bollards and other obstructions placed within the operating space of a bicycle facility create a confined operating space for all pathway users, increasing the likelihood of conflicts and collisions. Speed control of bicycle users is better obtained through geometric controls. Where physical elements are required, flexible bollards should be considered instead.

Bollard with Painted Diamond





Centre Medians

The physical design of the pathway point of entry should clearly indicate that it is not intended as a motor vehicle access. One method of restricting motor vehicle entry is the use of a centre island that splits the point of entry into two pathways separated by low landscaping and/or signage. The low landscaping allows maintenance and emergency vehicles to straddle the island to access the pathway when needed. The pathway-side approach to the island should include solid lane markings leading to and around the island to guide pathway users around the centre island. The width of the pathway on either side of the island should be no more than 1.8 metres to emphasize the non-motorized use of the pathway, but no less than 1.2 metres. The pathway entry design also needs to consider winter maintenance and snow clearing equipment.

MAJOR INTERSECTIONS

This section provides guidance on the treatment of off-street pathway crossings at major intersections, which are typically signalized.

At major intersections, design treatments such as dedicated phasing, pavement markings, and signage are required to provide safe and comfortable crossings for all pathway users. These treatments highlight the pathway user's presence and inform motorists that the crossing is not only for people walking, but for all forms of active transportation.

At signalized intersections with high volumes of turning motor vehicles or with complex intersection geometry, it is recommended that a separate signal phase is provided to allow pathway users to cross the intersection separate from turning motor vehicles (see **Chapter G2**). At larger intersections where there are channelized turn lanes, where feasible, it is recommended that channelized right turn lanes be removed from all major intersections and replaced with dedicated or shared right turn lanes.

Multi-use pathway crossings through a signalized intersections are shown for both **bend-in designs** (see **Figure G-115** for multi-use crossing and **Figure G-116** for separated bicycle and pedestrian crossing) and **bend-out designs** (See **Figure G-117** for multi-use crossing and **Figure G-118** for separated bicycle and pedestrian crossing).

For both bend-in and bend-out designs, the corner radii should be reduced to as small as possible for the design vehicle and circumstance (see **Chapter G.1**). Both designs must ensure adequate sightlines are provided for pathway users. Sightline obstructions can include trees, guideway columns, signals, and utility poles.

For bend-in designs, intuitive sharing of existing traffic signals at signalized intersections can be achieved. For bend-out designs, the pathway crossing should be set back a minimum of 6 metres to provide space for one vehicle to stop in advance of the crossing. This provides additional reaction time to motorists turning across the path.

Bending pathways away from the parallel roadway is generally recommended as it yields more benefits; however, bending the pathway towards the roadway tends to require less space. Both bend-in and bend-out intersections can be configured with separated or combined crossings for pedestrians and cyclists. Separated crossings are preferred, when space permits, and should include separated ramps or contrasting pavement for people walking and people cycling.

MINOR INTERSECTION, LANEWAY, AND DRIVEWAY CROSSINGS

Minor intersections are locations where off-street pathways intersect minor roadways with lower traffic volumes. Typically, these intersections are controlled by stop signs on at least two of the four legs, with a preference to stop control the roadway that crosses the pathway, which then assigns the right-of-way to the off-street pathway user. As these intersections are typically unsignalized, they often rely on both motorists and pathways users to yield the right-of-way depending on the context of the intersection.

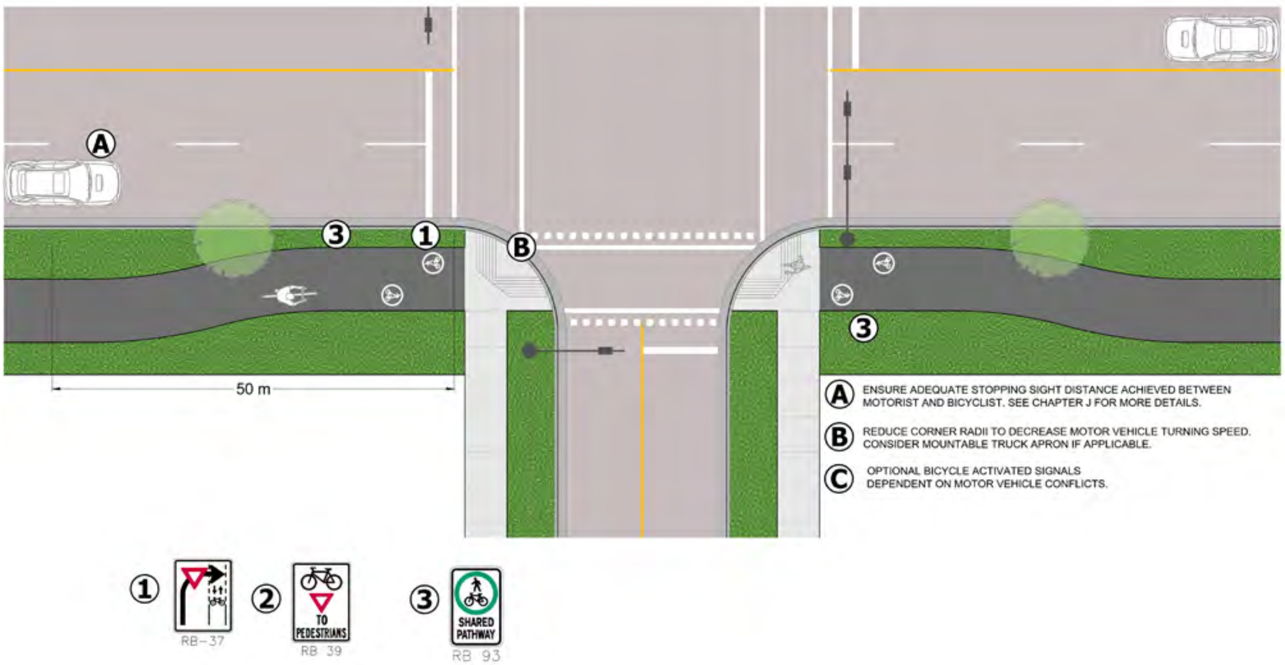


Figure G-115 // Multi-Use Bend-In Crossing

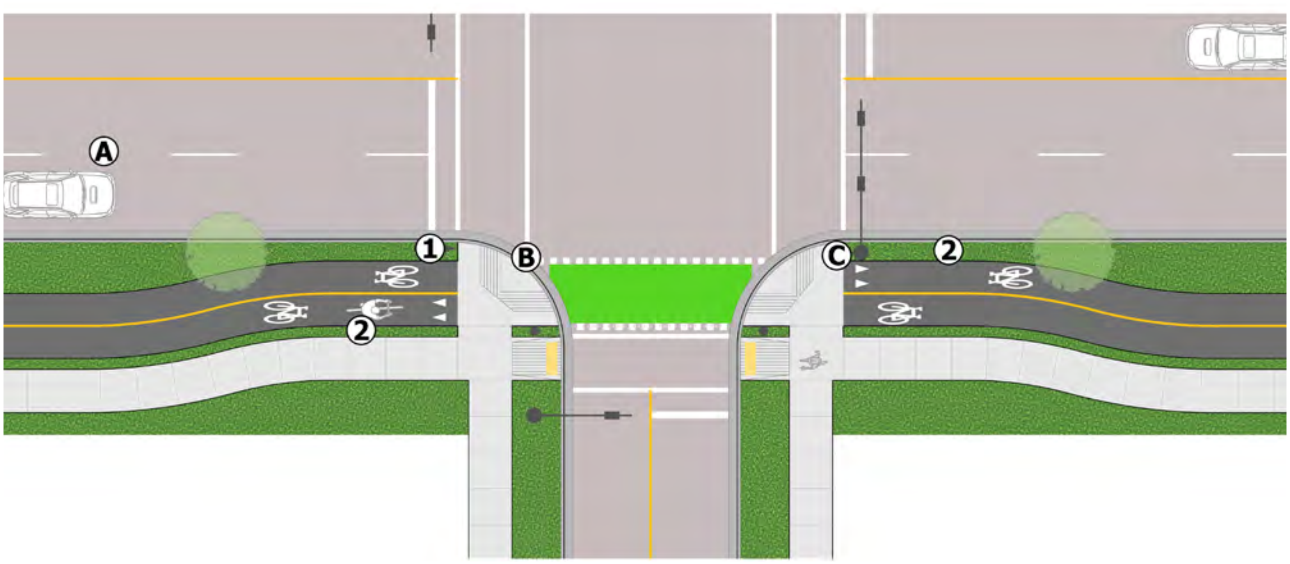


Figure G-116 // Separated Bicycle and Pedestrian Bend-In Crossing

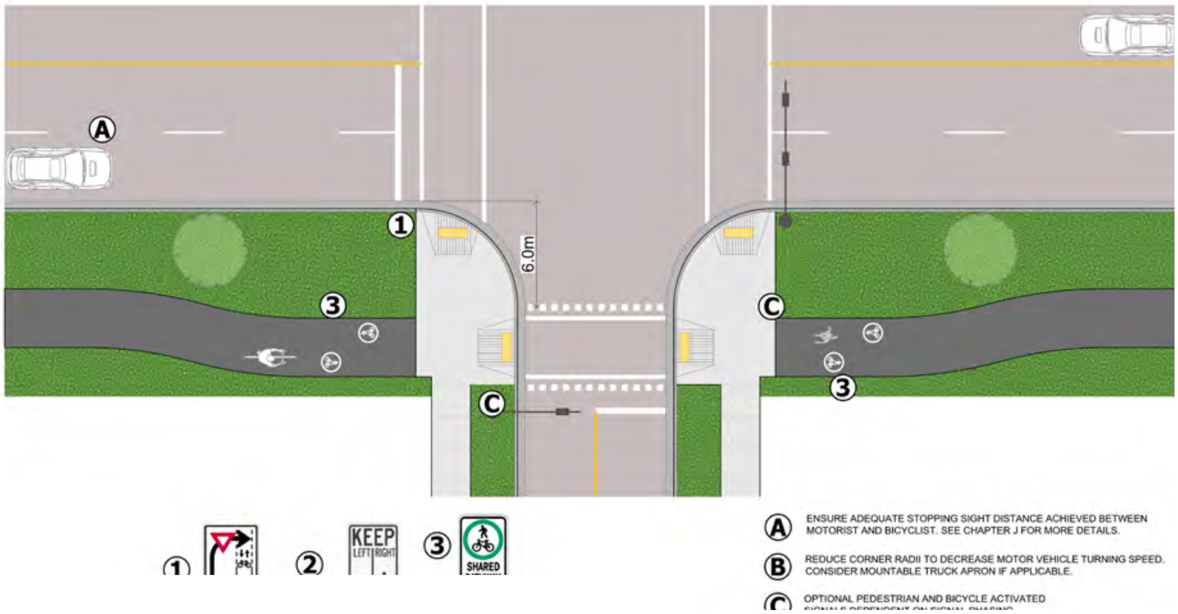


Figure G-117 // Multi-Use Bend-Out Crossing

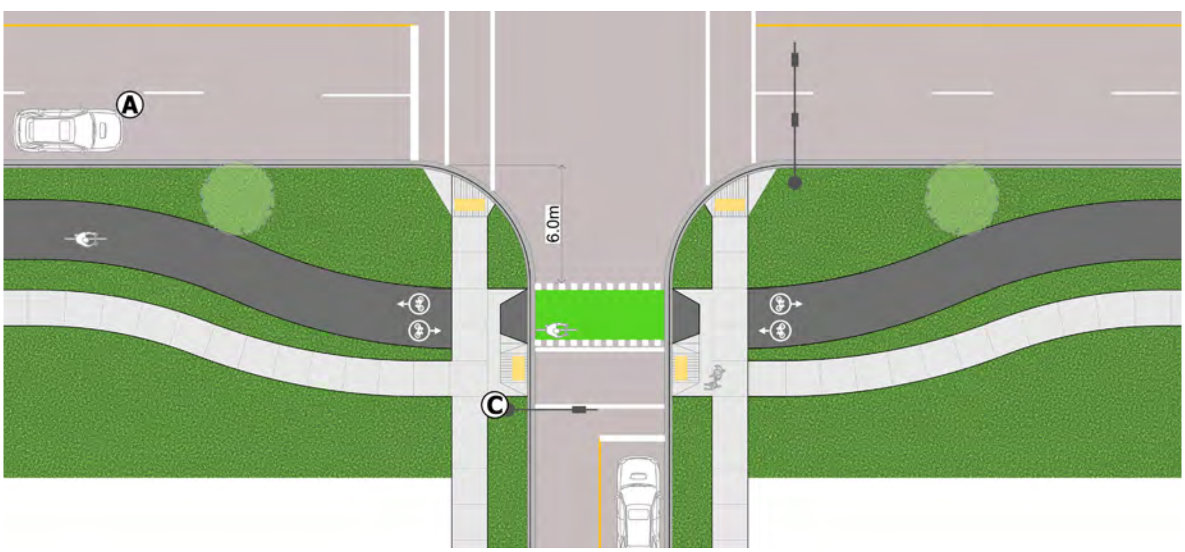


Figure G-118 // Separated Bicycle and Pedestrian Bend-Out Crossing

At unsignalized intersections, pathway users may be given right-of-way through stop control for the side road. Where this is the case, no intersection controls are required for the pathway user, although signage, pavement markings, and geometric design may be used to alert pathway users of the upcoming intersection. Other types of roadway facing controls that can be installed at minor intersections include RRFBs or special crosswalks (see **Chapter G2**).

Laneways and driveways are locations where motor vehicles cross off-street pathways to access local access roadways or parking lots.

In both of these locations, motorists might not be expecting pathway users, which highlights the importance of design features to highlight and/or control the conflict point. Additionally, considerations should be made at minor intersections and driveways to restrict certain movements to improve the safety and comfort of the pathway users.

Consistent use of traffic control for pathway users and motorists is essential to ensure pathway users safety and compliance. Pathway user compliance at intersections with pathway stop control and should only be used when geometric or sightline issues increase the risk of a conflict.

Minor Intersection Crossings

Figure G-119 illustrates an example of a multi-use pathway crossing a minor, unsignalized road. **Figure G-120** illustrates an example of where people walking and cycling are separated throughout the crossing through the use of a separate crosswalk and cross-ride pavement markings. Separated crosswalks and cross-rides are preferred when space is available.

These examples include reduced corner radii (preferably 5 metres) that helps to slow motor vehicle turning speeds. The pathway bends out, away from the parallel roadway. A minimum of 6 metres of space should be provided between the face of the curb and the start of the crosswalk and cross-ride to provide stacking space for turning motor vehicles so that they are out of the through traffic path when waiting for people crossing.

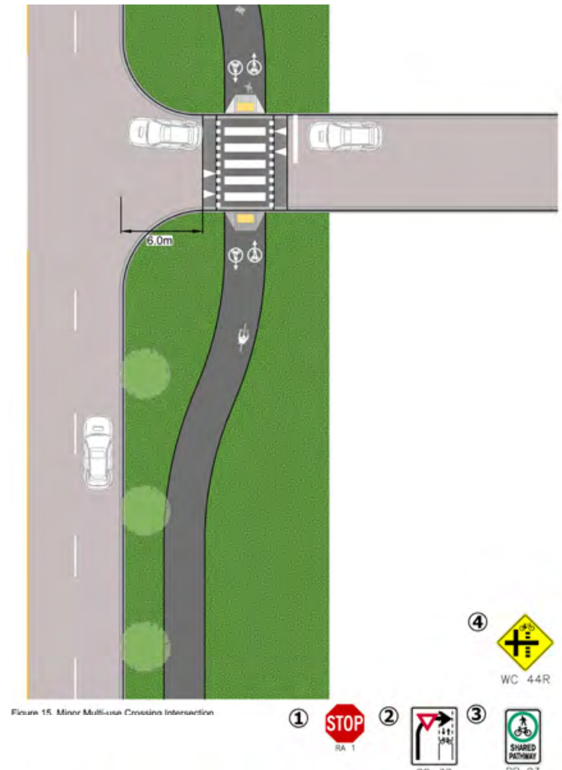


Figure G-119 // Multi-Use Crossing of A Minor Street

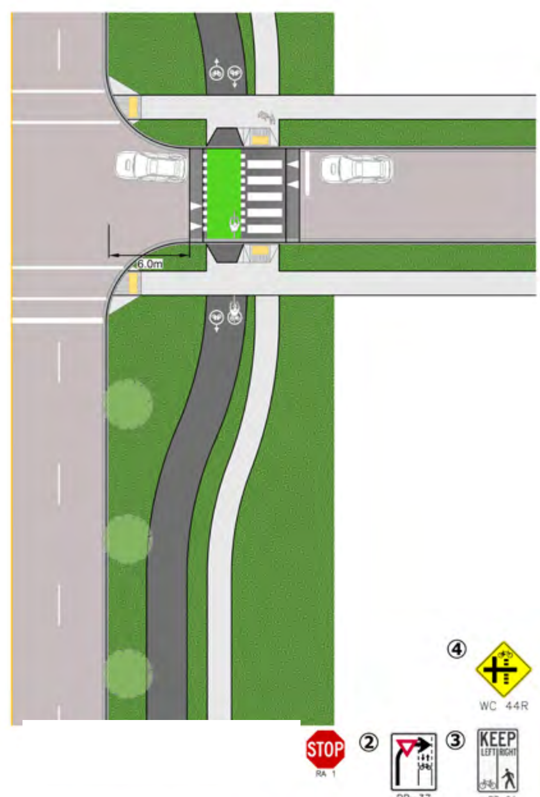


Figure G-120 // Separated Crossing of A Minor Street

Where sightlines are not achieved between motorists and off-street pathway users, signage for pathway users to yield or stop and watch for turning motorists should be installed. Stop signs should be installed on the pathway and oriented to indicate to pathway users riding bicycles that they must stop before proceeding across the crossing. The presence of stop signs on the pathway does not limit people walking from entering the crosswalk in an appropriate manner, nor does it relieve motorists of the responsibility to yield to people in the crosswalk. An additional measure to bring awareness of the crossing to motorists is to install enhanced crossing treatments such RRFBs or special crosswalks (see **Chapter G.2**).

Raised crosswalks or fully raised intersections are the preferred design treatments at unsignalized intersections and driveways to help define right-of-way, slow approaching vehicles, and create a comfortable level crossing for pathway users. Raised crosswalks increase crossing visibility and yielding behaviour with vertical deflection. Raised crosswalks are most appropriate in areas with high volumes of pathway users, such as near parks, schools, transit stations and other major destinations.

Raised intersections are full intersections that are constructed at a higher elevation than the adjacent approach roads. The purpose of a raised intersection is to reduce motor vehicle speeds and reduce conflicts, as they often are provided in conjunction with a stop control on one or both intersecting roads. A raised intersection should be raised by the same amount as any adjacent raised sidewalks (typically 80 millimetres). When raised crossings or intersections are not possible, pathway users are crossing at road grade, . In such cases, separate ramps for people walking and cycling are preferred contrasting pavement can also be used to define the space for constrained locations.

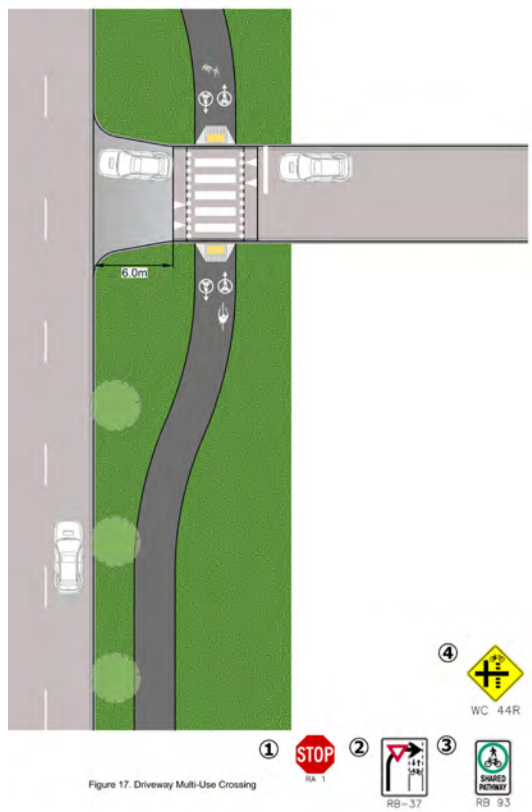


FIGURE G-121 // MULTI-USE CROSSING OF A DRIVEWAY

Laneways and Driveway Crossings

Off-street pathways have potential for conflicts where there are many laneway and driveway crossings present. The number of laneway and driveway crossings should be considered in the network planning and facility selection processes. Where laneway and driveway crossings exist, design considerations are necessary to mitigate potential conflicts. Speed reduction considerations for pathway users, as discussed above, may be considered.

Figure G-121 Illustrates an example of a multi-use pathway crosswalks a driveway. Similar to minor intersections, raised crossings are preferred. This ensures that pathway users have priority, as this provides continuity of pathway material across the laneway or driveway to highlight to motorists that they are crossing a pathway.

Motorists entering the roadway from driveways, laneways, and accesses are legally required to stop prior to entering the roadway. However, additional traffic control signage can be installed to reinforce this in locations where motorists encroachment on the sidewalk and/or pathway is an issue. For high-use laneways and driveways (such as commercial or employment access), enhanced cross-ride markings or different surface treatment such as textured or coloured concrete can be applied to increase visibility of crossing areas. Signage may also be provided to alert motorists both entering and exiting the laneway or driveway to the presence of people walking and on bicycles and the direction(s) they are approaching from.

Traffic Control and Signage

This section provides guidance on pathways crossing side roads depending on the type traffic control signage for of intersection traffic control.

Signalized crossings

- Install Bicycle Trail Crossing Side Road sign (MUTCDC WC-44) on the major street for both directions of the road in advance of the intersection.
- Install Turning Vehicles Yield to Bicycle signs (MUTCDC RB-37) for the motor vehicle left and right turn movement on the major street at the intersection
- Additional measures to reduce conflict can include adding a protected signal phase to the intersection crossing, adding a leading bicycle/walk phase, or adding a restricted right/left turn phase. These measures will eliminate many potential conflicts between users.

Unsignalized crossings

- Install appropriate Pedestrian and/or Bicycle Crossing Ahead sign (MUTCDC WC-46; B.C. W-129-2 Series) on the cross road approach in advance of the crossing.
- Install Bicycle Trail Crossing Side Road sign (MUTCDC WC-44) on the major street for both directions of the road in advance of the intersection. The Bicycle Trail Crossing Side Road sign (MUTCDC WC-44) and complementary Trail Crossing tab sign (MUTCDC WC-44T) is used to indicate that a bicycle pathway runs parallel and in close proximity to the cross road.
- Install Turning Vehicles Yield to Bicycle signs (MUTCDC RB-37) for the motor vehicle left and right turn movement on the major street at the intersection.
- An additional measure to bring awareness of the crossing to motorists, is to install RRFBs.
- Where sightlines are not achieved between motorists and people riding bicycles, additional signage for bicycle users to yield and/or stop and watch for turning motorists should be installed. Stop or yield signs may include a supplementary tab indicating ‘cyclists only’ and should be installed on the pathway and oriented to indicate to people cycling that they must stop/yield before proceeding across the crossing. The presence of stop or yield signs on the pathway does not limit people walking from entering the crosswalk in an appropriate manner, nor does it relieve motorists of the responsibility to yield to people in the cross-ride.

Pavement Markings

Pavement markings for pathways crossing side roads help provide guidance to delineate spaces for all modes, guide the travel path, raise awareness of potential conflict points, and indicate who has right-of-way Cross-ride pavement markings along with crosswalks should be installed at pathway crossings (see **Chapter G.1**).

MID-BLOCK CROSSINGS

This section provides guidance on the treatment of off-streets pathways at mid-block crossings. Mid-block crossings are not at intersections and need to be designed appropriately to consider motorists' expectations to yield to users at the crossing, or they can create a safety issue.

Typically, mid-block crossings are preferred when the nearest intersection is more than 75 metres from an existing crossing location. When an intersection is less than 75 metres from an existing crossing location, design professionals should consider rerouting the pathway crossing to the nearest intersection.

Mid-block crossings are not desirable on multi-lane roads, as motor vehicle shadowing can obscure sight lines to people crossing.

Pathway Alignment

At mid-block crossings, the off-street pathway should be as close to perpendicular as possible to the road that is being crossed. The pathways on each end of the crossing should be aligned with one another. Therefore, pathway alignments may need to shift before crossing the road. Additionally, as noted previously, prior to crossing the road, the pathway alignment should be adjusted geometrically to slow the pathway users' approach speeds to the crossing.

Adequate Sightlines of Cyclists and Motorists

Mid-block crossings should be installed only where adequate sight distance for both motorists and pathway users is available. **Figure G-122** and **Table G-33** show the calculation required for determining the appropriate sightlines required for mid-block crossings and resulting values for some road widths and speeds. For any widths or speeds not shown in **Table G-33,** the formula shown in the figure may be used to calculate the required sight distance. Sightlines can be enhanced by 'daylighting' in advance of the mid-block crossing, which refers to improving sightlines of the crossing by removing obstructions and/or bringing pathway users further out into the motorists' line of vision. This can be accomplished by installing a curb extension, bringing pathway users out into the view of motorists, and/or by removing on-street parking on both sides of the road in advance of the crossing. The extent of parking removal will be dependent on the design speed of the pathway and the road, and the location and width of the crossing. An additional advantage of curb extensions is that they shorten the crossing distance while creating a break in on-street parking that impedes motorists from driving down the parking lane.

TABLE G-35 // MINIMUM SIGHT DISTANCE FOR MULTI-USE PATHWAY CROSSING

Source: TAC Geometric Design Guide for Canadian Roads, Chapter 5, Section 5.6.3.2, Table 5.6.1

MINIMUM SIGHT DISTANCE (D) TO APPROACHING VEHICLE (M)				
Width of Street - W (m)	Street Design Speed (km/h)			
	50	60	70	80
7.0	130	150	180	200
10.5	170	200	230	270
14.0	210	250	290	330
17.5	250	300	350	400
21.0	290	350	410	460

Unsignalized Mid-Block Crossings

Figure G-122 shows an example of an unsignalized mid-block multi-use pathway crossing at a minor road where pathway users are prioritized and have the right-of-way. In this example, motor vehicle traffic is stop controlled.

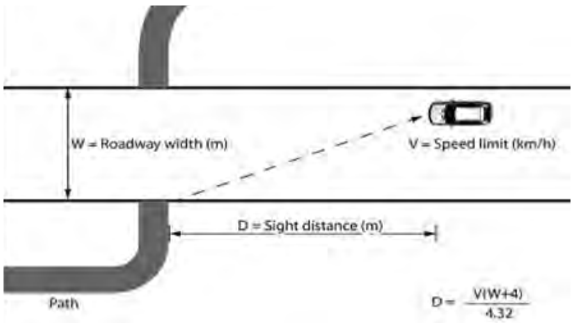


Figure G-122 // Minimum Sight Distance for Mid-Block Crossing

Source: TAC Geometric Design Guide for Canadian Roads, Chapter 5, Section 5.6.3.2, Figure 5.6.12

Stop lines should be set back 6 to 15 metres from the mid-block crossing either on the roadway when pathway users have right-of-way, or in advance of the road when motorists have the right-of-way. Along minor roads, another measure to bring awareness of the crossing to motorists is to install enhanced crossing treatments such as RRFBs (see **Chapter G.2**).

The example in **Figure G-123** also shows the use of curb extensions to narrow the crossing. An alternate treatment to narrow the crossing is to install a raised median island to provide refuge for crossing pathway users. Median islands should have a desired width of 3 metres (minimum 1.5 metres) while leaving a minimum travel lane width of 3.5 metres on either side of the island.

There may be some locations where yield or stop control may be used to control the movements of pathway users:

- Where sightlines are not achieved between motorists and people riding bicycles, additional signage for cyclists to yield or stop and watch for turning motorists should be installed. The presence of stop or yield signs on the pathway does not limit people walking from entering the crosswalk in an appropriate manner.
- At locations where a pathway intersects with a roadway that has a designated bicycle facility yield or stop control for pathway users can be installed.

Signalized Mid-Block Crossings

Where mid-block crossings cross higher volume roads and/or multi-lane roads, traffic signalization may be warranted. **Figure G-124** shows an example of a signalized mid-block multi-use pathway crossing at a major road. At signalized mid-block crossings, pedestrian and bicycle signals should be provided for pathway users. This example shows separate crosswalk and cross-ride pavement markings.

Signage

Signage on the road leading up to a mid-block crossing depends on the type of pathway user that will be crossing.

- The Pedestrian and Bicycle Crossing Ahead sign (MUTCDC WC-46; B.C. W-129-2 Series) indicates that the motorist is approaching a multi-use pathway crossing.
- For multi-use pathways, crossings must include the Shared Pathway sign (MUTCDC RB-93) on the pathway leading up to the mid-block crossing.
- For a bicycle-only off-street pathway with no crosswalk, the Bicycle Crossing Ahead sign (MUTCDC WC-7; B.C. W-129-1 Series) and supplementary Crossing tab sign (MUTCDC WC-7S; B.C. W-129 Tab) should be used.
- For separate bicycle pathways, crossings must include the Pathway Organization sign (MUTCDC RB-94) on the pathway leading up to the mid-block crossing, instructing users to stay either left or right when crossing.

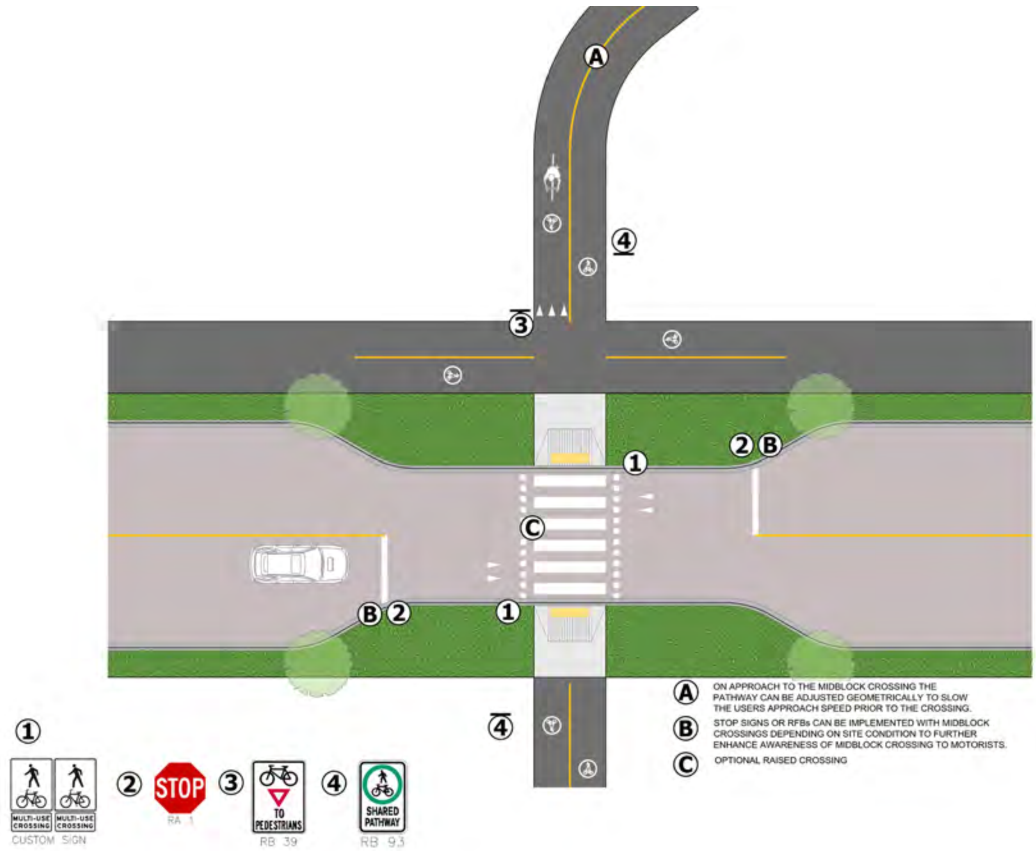


Figure G-123 // Mid-Block Crossing with Curb Extensions

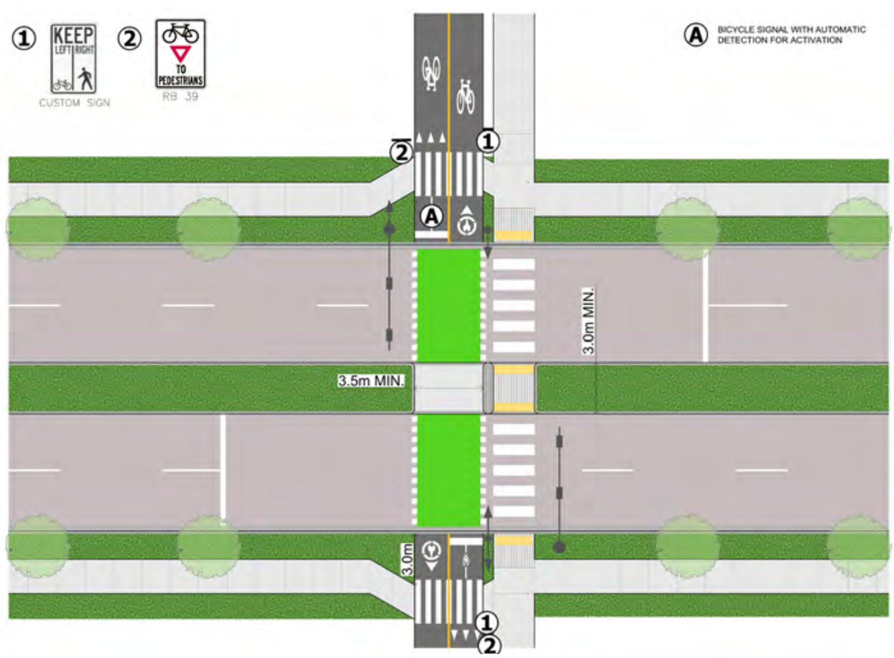


Figure G-124 // Signalied Mid-Block Separated Crossing

- Bicycle Yield to Pedestrian signs (MUTCDC RB-39) should be placed in advance of where a bicycle pathway crosses a pedestrian facility.
- Advanced warning signs with flashers installed on the road facing motor vehicles may be appropriate to increase awareness of people at major crossings or crossings with marginal sight distance. If these measures are insufficient, the crossing should be signal controlled.
- For all ages and abilities facilities, the motor vehicle traffic should be stop controlled when the pathway is crossing minor roads and signalized when crossing major roads.

Pavement Markings

Pavement markings at mid-block intersections are important design elements that increase awareness of the crossing point for approaching motorists, further enabling them to react to potential conflicts. The MOTI *Manual of Standard Traffic Signs & Pavement Markings* provides guidance on signage and pavement markings. The following are recommended pavement markings at mid-block pathway crossings.

- Where clear sightlines exist for motorists to see approaching people riding bicycles on the pathway, cross-rides should be used at the mid-block crossings. Cross-rides alert road users to the presence and right-of-way of crossing persons cycling and walking. For multi-use pathways, a combined crosswalk and cross-ride should be used (see **Figure G-125).** Zebra style crosswalks are recommended to enhance the visibility of the crossing. It should be noted that cannot be implemented on roadways under provincial jurisdiction. On roadways under provincial jurisdiction, cross-ride markings can only be implemented where pathway users have a stop control.
- Combined crosswalk and cross-ride markings,
- For off-street pathways with separate pedestrian and bicycle pathways, the cross-ride and crosswalk should be separated (see **Figure G-126).** Zebra style crosswalks are recommended to enhance the visibility of the crossing.
- Yield lines or markings may be placed in advance of the crossing, either on the road or on the pathways, to indicate to users who has priority at these crossings, and should be accompanied by a yield sign.
- Stop lines should be set back 6 to 15 metres from the mid-block crossing either on the road when pathway users have right-of-way, or in advance of the road when motorists have right-of-way. Stop lines should only be used when signalized or stop sign controlled.

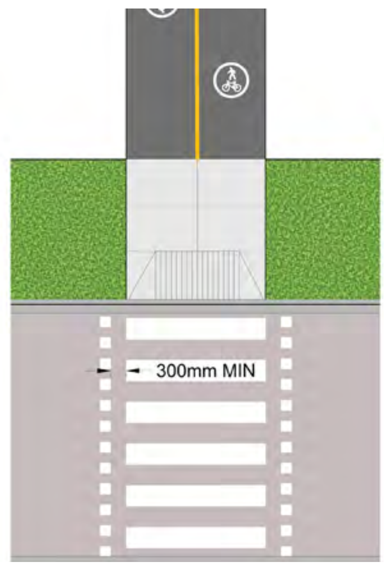


Figure G-125 // Combined Crossing Pavement Markings

Figure G-126 // Separated Crossing Pavement Markings

Salton Road Pedestrian and Bicycle Bridge, Abbotsford, B.C.

Source: City of Abbotsford

G.6

ADDITIONAL CROSSINGS + CONFLICT AREAS

This chapter covers additional crossings and conflict areas that are relevant to pedestrian facilities, bicycle facilities, and off-road pathways. This includes cut-through pathways, rail crossings, and grade separated crossings.

CUT-THROUGH PATHWAYS

Cut-through pathways run between two properties to connect two segments of a pedestrian facility, bicycle route, or off-road pathway that are separated by development or open space. They are typically paved or a hard surface. Cut-through pathways make neighbourhoods more walkable and bikeable by shortening distances and providing important connections to destinations. They are especially useful where there are long blocks or in suburban developments with non-grid layouts. Cut-through pathways can be an important tool to prioritize active transportation by making destinations more direct for people walking and cycling than they are for motorists.

Cut-through pathways are intended for active transportation use only. They have often historically been designed with access restriction devices such as maze gates and bollards. However, maze gates and bollards can make them difficult for people cycling to use, particularly for a wide range of types of bicycles. To ensure cut-through pathways are accessible for people of all ages and abilities, maze gates and bollards are not recommended unless there is a demonstrated history of motor vehicle encroachment, and/or a collision history (see **Chapter G.5**). Pedestrians are typically the primary users of cut-through pathways; however, cut-through pathways can provide valuable cycling connections as well, so bicycle access should be considered. As such, cut-through pathways should be designed consistent with design guidance for off-road pathways (see **Chapter E.3**). Appropriate wayfinding signage and pavement markings should be used to help guide users (see **Chapter H.3**).

Cut-through pathways require that adequate horizontal clearances and widths are provided for all users (see **Chapter C.2**). Cut-through pathway entrances should be well lit with adequate sightlines. Pedestrian scale lighting may be considered for longer pathway sections to ensure adequate lighting of the facility and intersections, while considering the impact to adjacent properties. Straight pathways where both entrances are visible at all times are preferred from a Crime Prevention Through Environmental Design (CPTED) perspective and can help to discourage undesirable activities within the cut-through.

Year-round maintenance is important to ensure that cut-through pathways are functional in all seasons. They may collect debris, garbage, and snow, making them less desirable for active transportation users. Cut-through pathways should have appropriate drainage for the longitudinal grades and the cross-sectional grades. Installation of a concrete swale or gutter can help direct drainage. See **Chapter I.3** for more details regarding maintenance.

Chapter G.5 provides guidance on the end treatment considerations when intersecting a road or laneway.

RAIL CROSSINGS

Rail crossings are particularly relevant for bicycle facilities. If bicycle facilities are desired in the same corridor as rail lines, careful consideration and caution must be taken to ensure adequate separation between the rail line and the bicycle facility. Refer to Transport Canada's *Grade Crossing Regulations and Grade Crossing Standards* for detailed design guidance on rail crossings. Additional design guidance can be found in Section 8.8 of the TAC ***Bikeway Traffic Control Guidelines*** and the MOTI *B.C. Supplement to TAC*. A summary of important design considerations is provided below.

The crossing design should ensure that people cycling are given adequate advance warning of the rail crossing. Adequate sightlines along the tracks should be provided, and appropriate warning systems should be installed. If warning systems with gate arms are used, the gate arms should span the bicycle facility as well as the road. Where rail tracks run parallel to a bicycle lane, two-stage turn boxes should be used to facilitate left turns from the bicycle facility.

Where rail tracks run parallel to a pathway and perpendicular to the road, traffic signals can be installed in combination with the warning systems. Bicycle and pedestrian signal activation may be installed with the traffic signals. Gate arms should be installed on the side of the pathway adjacent to the railway to deter pathway users from crossing the tracks when the warning systems are activated.

The rail tracks themselves can also present a hazard to people cycling, as bicycle wheels can get caught in or alongside the track. Freight rail tracks have higher risks of bicycle wheels getting caught than streetcar tracks which are typically more flush with the road and have a narrower flange. To prevent this issue, rail crossings should be perpendicular (at right angle) to the tracks (see **Figure G-127**) Where tracks cannot be crossed at right angles, widening the road or adding a curve at the rail crossing approach can allow bicycle users to achieve a better crossing, enabling them to maneuver without interfering with motor vehicle traffic. See section 5.6.9 of the TAC *Geometric Design Guide for Canadian Roads* for more details.

Flangeway gaps and track height should be designed to minimize variation in surface grade to allow for a smoother surface. This is critical for pedestrian rail crossings as well. Installation of barriers to slow people cycling and walking at the crossings is not recommended as these may be more hazardous to users manoeuvring around the barriers while trying to cross.

GRADE SEPARATED CROSSINGS

Grade separated crossings improve safety and allow for the uninterrupted flow of active transportation users and motorists or trains. However, grade separation requires additional space, makes active transportation facilities less direct, and can require significantly higher construction and maintenance costs. At-grade crossings are preferred where feasible. A traffic flow and safety assessment of an at-grade crossing should be completed as part of the consideration for whether or not to construct a grade separated crossing, taking into account the expected volume of active transportation users and the potential delay for active transportation users if crossing at-grade.

Generally, grade separated crossings should only be considered over rail lines, natural features, and roads with high motor vehicles volumes or speeds (70 km/h or greater) where at-grade crossings cannot be achieved safely and comfortably. Such locations include high speed on/off ramps, interchanges, highways, and locations with other geographic barriers. Grade separated crossings can be used where high volumes of people walking and cycling exist or are planned (such as at a crossing for a regionally significant pathway).

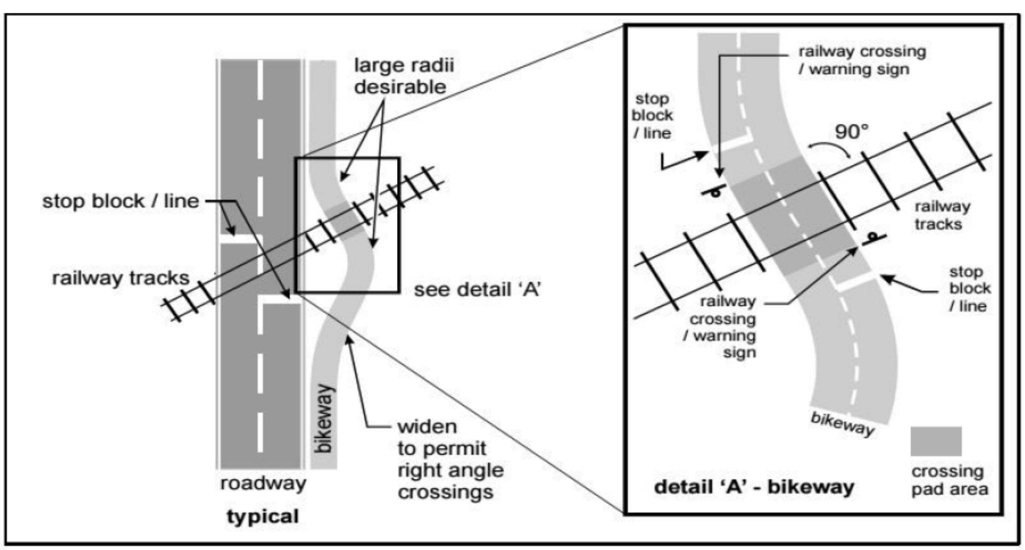


Figure G-127 // Bicycle Facility Crossing of Railway

Source: TAC Geometric Design Guide for Canadian Roads, Figure 5.6.19

Design Guidance

Grade separated crossings should be accessible for people of all ages and abilities whenever possible. In order to provide full universal access, accessible ramps and/or elevators should be provided. Ramps should be designed so that they are not too steep for wheelchair users or a deterrent for people on bicycles, with enough space at curves to allow people cycling to maneuver. Refer to **Chapters C.2** and **D.1** for guidance regarding accessible grades for people walking and people cycling.

In situations where large grade differences exist and stairs are unavoidable, bicycle channels should be installed on stairs. Guidance for bicycle channels is provided below. Entrances and exits to grade separated crossings should be clearly visible and accessible, and they should connect to existing at-grade transportation facilities.

In order to encourage use of the grade separated pathway, the crossing distance should be minimized. If the existing (but undesired) at-grade crossing distance is significantly shorter, the grade separated crossing may be used less often. For grade separated crossings where bicycle users are expected, longitudinal grades of less than 4% are recommended, with a maximum grade of 6%. Grades of 6 to 8% can be considered for short sections. Grade breaks of flat sections (less than 3%) should be provided every 100 metres for steep sections. Where pedestrians are expected, level resting spots should be provided even more frequently: where the longitudinal grade is greater than 4%, a flat landing area should also be provided every 50 metres.

The width of the grade separated crossing should remain consistent, other than at entrances and exits where additional widths can better facilitate movements between different users. Minimum lateral clearance to obstacles should be provided, including 0.2 metres to obstructions that are 100 millimetres to 750 millimetres high, and 0.5 metres to obstructions that are greater than 750 millimetres high. The minimum radii for the pathway need to factor in stopping sight distance, superelevation, bicycle speed, turning radii for larger bicycles (i.e. cargo, tandem, trailers), and coefficient of friction.

There are two types of grade separated crossings – bridges and overpasses, and underpasses. Each have different costs and unique design considerations.

Bridges + Overpasses

Bridges, including pedestrian and cycling overpasses, are most applicable where the topography allows for a structure that has little grade change for active transportation users, such as when the road is lower than the pathway. Bridges have a greater visual impact on the landscape but can be designed as an architectural feature. They can include multi-modal bridge structures or dedicated active transportation overpasses.

Protective railings should be installed on the outside of the bridge in all instances where an active transportation facility is located on the outside of the road. Protected railings of at least 1.4 metres should be provided on the outside of the bridge.

Barriers and railings should also be considered on the motor vehicle side when there is a vertical difference between the bicycle facility and the road of greater than 0.20 metres, where the active transportation facility does not have the desirable width, or when the motor vehicle speed is greater than 60 km/h. Protective barriers and railings should be a minimum of 600 millimetres tall, with a desired height of 1.4 metres, and should meet applicable barrier design standards for bridge structures. See *section 7.6.4* of the TAC *Geometric Design Guide for Canadian Roads* for more detailed design guidance.

The active transportation portion of an overpass should have a desired width of 5.0 metres and a constrained limit width of 3.5 metres to accommodate two-way travel with lateral clearance. On multi-modal bridges, bicycle facilities should typically be situated between the pedestrian facility and the motor vehicle travel lanes. Bicycle and pedestrian facilities should be provided on both sides of bridges where possible. Facilities that require active transportation users to shift from one side of the road to the other in order to use the bridge are unlikely to be embraced.

Continuity of the facility is important – wherever feasible, the same bicycle facility type should be continued across the bridge. In constrained locations, it may be necessary to transition to a shared use facility across the bridge. This may be viable depending on the motor vehicle speed and volume, but this design is not appropriate for all ages and abilities. If a shared facility is required, additional pavement markings and advanced warning signs for all road users should be used to indicate the upcoming shared lane. Additional Advanced Warning of Bicycle on Bridge sign (MUTCDC WC-49) can be installed on the approaches to the bridge for additional awareness. The shared lane should only be considered as an interim measure until a more appropriate and dedicated facility can be designed and developed for all users.

If the existing width of the bridge is insufficient to accommodate active transportation facilities, modifications to the structure may be required. Structural modifications are costly and will require specific analysis to determine their feasibility. Where accommodating active transportation users on an existing bridge is not feasible, alternative routes should be considered and wayfinding should be provided for active transportation users.

Underpasses

Perceived safety is an important consideration for design and use of underpasses or tunnels, as they can be dark, confined spaces that are less visible to passersby if not well designed. Underpasses provide shelter from the elements, but this shelter may also lead to loitering. Underpasses are most suitable when the design allows for an open and accessible crossing that is well lit 24 hours a day, to allow a feeling of safety and security for users. Lighting should also be provided outside of the underpass entrances at night so that the contrast between the interior of the underpass and the exterior does not cause visibility challenges. Refer to **Chapter H4** for more lighting design guidance.

Underpass design may not be appropriate in areas where there is high groundwater, as drainage can be an issue. Snow clearance is another challenge, as regular maintenance is required to ensure that underpasses remain functional in all seasons.

The constrained limit width for underpasses that accommodate two-way active transportation travel with lateral clearance is 3.5 metres, with a desired width of 5.0 metres. If the underpass is longer than 20 metres, consideration should be given to increasing the facility width to improve sightlines and allow for more passing opportunities.

The minimum vertical clearance of an underpass or tunnel is 2.5 metres, with a desirable clearance of 3.5 metres. This allows for small services motor vehicles and equestrians to use the underpass. The clearance is measured from the surface of the active transportation facility to the underside of the structure.

Where an underpass is also used for motor vehicle traffic, both walking and cycling facilities should be separated from the motor vehicle travel lane. The underpass should also be well lit, and additional Advanced Warning of Bicycle in Tunnel sign (MUTCDC WC-48) can be installed on the approaches to the tunnel for additional awareness.

RAMPS AND STAIRCASES

Pedestrian Ramps

Accessible pedestrian ramps allow people using mobility devices, pushing strollers, or rolling any type of bag or device to safely and comfortably access grade separated facilities and crossings. In order to provide full universal access, pedestrian ramps should have a maximum longitudinal grade of 1:12 (8.3%) and a maximum cross slope of 1:50 (2%). Longitudinal grades between 1:20 (5%) and 1:15 (6.7%) are recommended. Handrails are required on both sides of all accessible pedestrian ramps.

Ramps should have a desired width of at least1 .8 metres wide with a minimum width of at least 1.5 metres between any obstruction or handrail. Where space is required for two wheelchairs to pass, ramps of at least 1.8 metres should be provided. Level landing spots at least 1.5 metres long should be provided at the top of each ramp and anywhere that the ramp changes direction. Landings of 1.8 metres are recommended, as this accommodates most manual wheelchairs and certain electric wheelchairs. Landings of 2.25 metres will accommodate most types of wheelchair and mobility scooter.

Detailed guidance regarding exterior ramps is provided in CSA Standard B651-18: *Accessible Design for the Built Environment*.

Bicycle Ramps

Bicycle ramps enable bicycle users to transition between bicycle facilities that are at different grades without dismounting. They are commonly used between on-street and off-road facilities and when connecting to overpasses. Smooth transitions on and off the ramp should be provided. Grade changes greater than 13% should be avoided when transitioning between the ramp and the road or gutter. This considers a maximum ramp slope of 8% and a maximum counter cross slope of 5% in the gutter and/ or road. The preference is to have a ramp that has a portion flush with the pavement and curb and gutter. However, a flush ramp needs to take into consideration a line of drainage to follow and a detectable edge for pedestrians with visual challenges.

Bicycle ramps at an intersection should be constructed at 90 degrees to the road and should function as an extension of the bicycle facility. When transitioning between off-road and on-street facilities, ramps should be constructed at an angle of 30 degrees or less to the curb line along the corridor. Custom ramps that accommodate both people cycling and people walking can be used for multi-use crossings. The top of the ramp widths should be as wide as the combined crossing.

Ramps should have a maximum longitudinal grade of 1:12 (8.3%) and a maximum cross slope of 1:50 (2%). Similar to a pedestrian curb ramp, flares should be provided to avoid abrupt grade changes and tripping hazards (see **Chapter G.3**). Bicycle ramps should be located downhill from catch basins or drainage inlets where possible in order to reduce the risk of water pooling and ice buildup.

Stairways

Stairways are not universally accessible, as they are inaccessible for people using wheelchairs, pushing strollers, and using other mobility devices. However, where at-grade crossings and pedestrian ramps are not feasible, stairways are effective in traversing significant vertical distances in a limited horizontal distance, making them a space-efficient means of accessing grade separated facilities.

Staircase components include a flight of stairs, handrails, and landings. There are a number of design considerations for making stairs accessible to the largest possible percentage of the population. These include stairway width, stair rise and run, handrails, and the provision of landing areas. Detailed guidance regarding staircases is provided in CSA Standard B651-18: *Accessible Design for the Built Environment* and section 6.5.2.2 of the TAC *Geometric Design Guide for Canadian Communities*.

Bicycle Channels and Stroller Push Ramps

Bicycle channels and stroller push ramps can be provided along stairways to make them accessible for strollers and dismounted bicycle users. Stroller push ramps require two flat ramps with stairs between them, allowing the stroller pusher to walk between the ramps. Dismounted bicycle users may also use these ramps. Alternatively, bicycle channels can be provided along the edge of a stairway. These ramps are inaccessible to stroller users.

Bicycle channels allow for transitioning between facilities, accessing services, and bicycle access at intersections where there is a large vertical grade difference and grades do not allow for development of a gradual approach or ramps. Bicycle channels should be provided on both sides of the stairs, to facilitate up and down movement. Channels can be concrete, metal, or wood. Maintenance of the channels is important during all seasons to ensure clearing of any debris or snow build-up.

Placement of channels should be away from handrails or have handrails set closer to the wall to prevent handlebars from hitting the rail. In general, providing channels on all stairs allows for better accessibility for people cycling. The top of the channel should be flush with the top of the steps. For weather-controlled environments with high cycling demand, a bicycle escalator could also be considered, but would need to be evaluated for feasibility.

Section 6.5.2.2 of the TAC Geometric Design Guide for Canadian Roads provides further design guidance for both bicycle channels and stroller push ramps.

Bicycle channel on stairway leading to bicycle parking facility, University of Victoria, Victoria, B.C.

H.

AMENITIES + INTEGRATION

Public bike share docking station at Olympic Village Canada Line Station, Vancouver, B.C.

H.1

MULTI-MODAL INTEGRATION

Effectively integrating active transportation with other modes of transportation facilitates multi-modal trip making and provides an attractive alternative to motor vehicle travel. This is particularly important for regional travel or longer distance trips where walking, cycling, and other forms of active transportation may not be practical for the entire trip distance, but offer a means to get to and from public transit, ferries, and airports as the primary means of completing the trip. Successfully integrating active transportation to complete the 'first and last mile' as part of a longer distance trip increases the attractiveness of multi-modal trips as an alternative to motor vehicle travel.

The opportunities for multi-modal integration that are the focus of this chapter include:

- Active transportation and public transit;
- Transit stops and exchanges;
- Bicycles on transit vehicles;
- Ferries and ferry terminals;
- Airports; and
- New mobility.

ACTIVE TRANSPORTATION AND PUBLIC TRANSIT

Public transit extends the range of travel for people walking or cycling, making longer or time-constrained trips more feasible. Walking and cycling also extend the reach of transit trips by providing 'first- and last-mile' opportunities to complete the trip by active transportation by and increasing the number of destinations easily accessible by bus or train. Connecting active transportation networks to transit routes – with a focus on high frequency transit – extends the reach of both modes. These 'first- and last-mile' opportunities and ability to make longer trips can be further enhanced by electric bicycles and bike sharing programs, as discussed in **Chapter H.5**.

An important consideration when planning and designing active transportation facilities is the opportunity for integration with transit and ensuring that continuous, seamless connections to transit are created. This can help to ensure that walking, cycling, and transit are mutually supportive. This includes considerations such as planning and designing pedestrian and cycling facilities so they connect directly to transit stops and ensuring that most residents have access to a bus stop desirably within a five-minute (400 metre) walking distance.

TransLink bike parkade at King George Station, Surrey, B.C.

TRANSIT STOPS AND EXCHANGES

This section discusses opportunities to integrate cycling at transit stops and exchanges.

Bicycle Parking at Transit Stops and Exchanges

Adequate bicycle parking at transit stops and exchanges is required to make cycling an effective 'first- and last-mile' solution for public transit and to facilitate multi-modal trips. Bicycle parking at transit stops and exchanges typically takes one of three forms:

1. **Short-term bicycle parking** may be provided at the transit stop or exchange through the use of bicycle racks to allow bicycle parking for short durations. These facilities should include shelter, lighting, and adhere to the design guidance contained in **Chapter H.2.**
2. **Long-term bicycle parking lockers** may be provided at the transit stop or exchange to facilitate long-term bicycle parking. These facilities are typically offered on a subscription basis.
3. **Long-term bicycle parking rooms or bicycle parkades** may be provided at transit stops or exchanges with a high volume of bicycles, and typically include a secured bicycle parking area and supporting amenities.

Bicycle parking should be considered at all high activity bus stops as well as transit exchanges, park-and-rides, and rapid transit stations. Bicycle parking should be highly visible and provided at convenient locations close to the bus stop or close to the entrance to the transit station to ensure seamless integration with public transit. Bicycle parkades have recently been provided at several SkyTrain stations in Metro Vancouver (refer to the case study on page H6).

Bicycle Integration at Transit Stops and Exchanges

In addition to providing bicycle parking and supporting amenities, consideration should be given to designing transit stops and exchanges in such a way that the transition between nearby cycling infrastructure and the transit stop or exchange is direct, intuitive, and easily navigated. The following should be considered in the design of transit stops and exchanges:

Grade

Conventional staircases and escalators are not an effective means for bicycle users to navigate grade or travel from floor-to-floor of a transit station, and therefore other means are necessary. The following options can be considered:

1. **Elevators** provide the opportunity for a person cycling to travel from floor-to-floor. Although they can introduce friction between pedestrians and bicycles – particularly where there is a high volume of either group – proper planning and design of the elevator boarding and alighting areas and the elevator itself can ensure that sufficient space is provided for both user groups. Consideration should be given to the size and operating characteristics of a bicycle (refer to **Chapter B.2**), with allowances for additional space where particularly high volumes of pedestrians and/or bicycles are anticipated.
2. **Staircases with a bicycle ramp** to enable bicycle circulation up and down the staircase. This is typically a flat or grooved area at the edge or centre of the staircase, with paint markings and/or signage indicating the space is intended for bicycle circulation.
3. An **inclined escalator** is similar to a conventional escalator except for the absence of built-in steps which allows a bicycle to be walked up or down the device. An inclined escalator typically benefits from a longer span as compared to a conventional escalator to allow for a gentler grade.

Doorways

Ineffectively designed doorways impede bicycle travel. Where possible, doorways should be designed to include a sensor, push-button, or FOB strike in advance of the doorway to allow a person cycling to travel through with minimal disruption and without dismounting their bicycle. Consideration should be given to providing sufficient doorway width to accommodate a range of users and types of bicycles, particularly where high volumes of pedestrians and bicycles are anticipated, and/or if two bicycles are intended to pass in opposing directions. Based on the dimensions and operating characteristics of bicycles and other active modes (see **Chapter B.4**), the doorway width should have a desirable width of 1.6 metres and a minimum width of 1.2 metres.

Design and dimensions for doorways must also adhere to the *B.C. Building Code* and *B.C. Fire Code*.

Wayfinding

Effective wayfinding is important to ensure continuity between bicycle infrastructure and transit vehicles, particularly where transit stops or exchanges are being retrofitted to better accommodate bicycles. Consideration should be given to reflecting the wayfinding/graphic standards of both the transit agency and local or regional government, and ensuring the signs and pavement markings used are as continuous as possible between the two.

Wayfinding, signage, and pavement markings are explored in detail in **Chapter H.4**.

Case Study

TransLink Bicycle Parkades, Metro Vancouver, B.C.

TransLink is the regional transportation agency for Metro Vancouver, operating an extensive bus system throughout the region, SkyTrain rapid transit, SeaBus passenger ferries, West Coast Express commuter rail, and HandyDART for passengers who are unable to use conventional transit. TransLink also has a multi-modal mandate that includes funding and delivering the Major Road Network and a network of walking and cycling facilities. As part of this mandate, TransLink offers three different types of bicycle parking at SkyTrain stations, bus exchanges, and West Coast Express stations throughout Metro Vancouver, including bicycle racks, bicycle lockers, and, most recently, bicycle parkades.

TransLink's bicycle parkades are located at the Main street–Science World, King Edward, Commercial–Broadway, and Joyce–Collingwood SkyTrain stations. The facilities are glass-walled, lit 24-hours per day, and are equipped with video cameras for additional security. Access is provided seven days a week. Space is first-come, first-serve and parking costs $1/day, with fees capped at $8/month. Only customers who enroll to use the bicycle parkades can access the facilities. Enrollment is completed for free on-line – customers must first register for a Compass Card (TransLink's reloadable transit pass) if they do not already have one. Once registered, the Compass Card can be used to unlock the bicycle parkade entrance using the same technology as the SkyTrain and bus onboarding process.

TransLink has produced a short video explaining how to register for, gain access to, and park bicycles in the bicycle parkade using the high-density two-tiered racks. Each bicycle parkade also has informative posters showing how to use the racks.

BICYCLES ON TRANSIT VEHICLES

Bicycles are an effective 'first- and last-mile' solution when effectively integrated with public transit. Some bicycle users may prefer to lock their bicycle at a bus stop or transit exchange and complete the remainder of their trip by transit or walking, while others may prefer to bring their bicycle on transit so that it may be used for the subsequent portions of the trip. This requires dedicated, well-designed bicycle parking on transit vehicles.

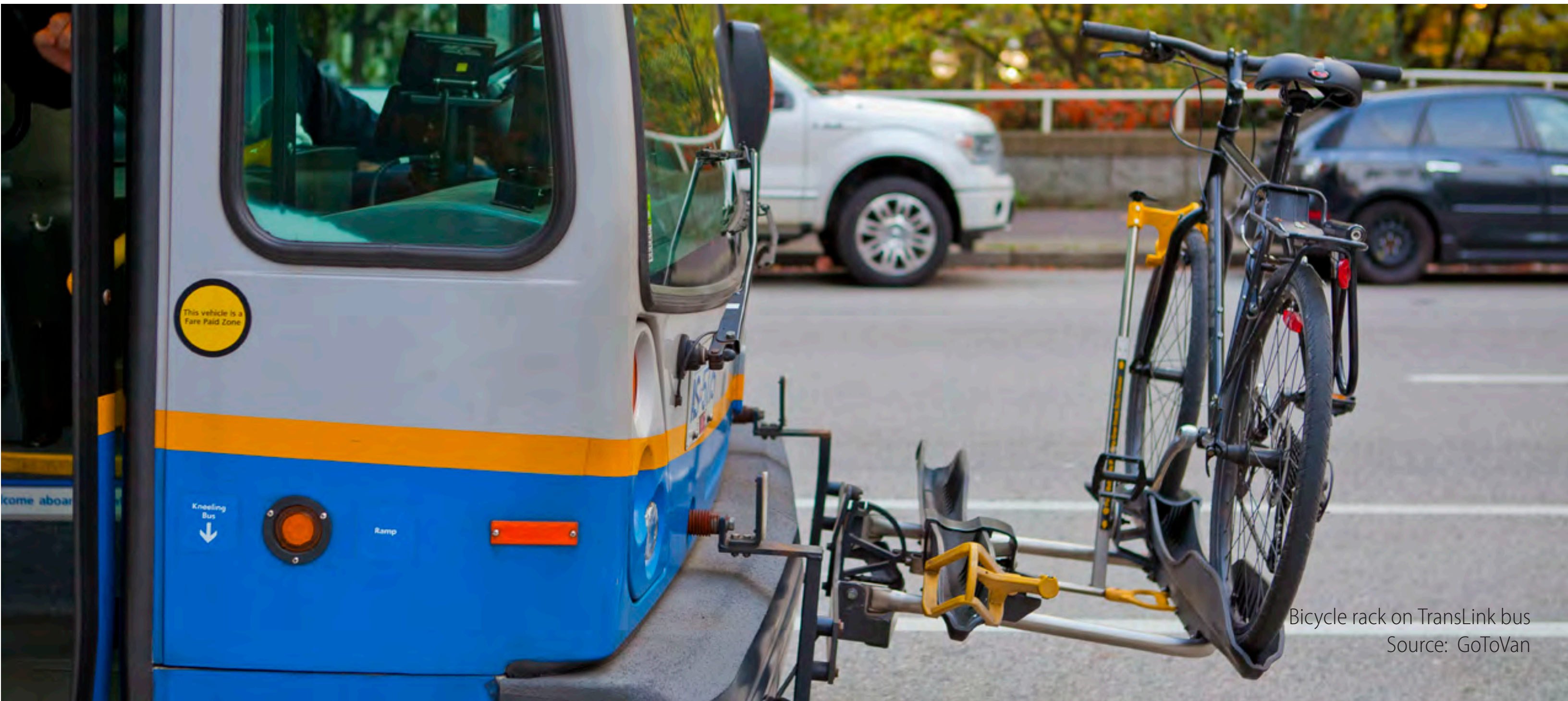
Buses

The most prevalent means of accommodating bicycles on buses in B.C. are front-mounted bicycle racks. These devices most commonly have capacity for two bicycles and are external to the bus, thereby not impacting passenger capacity. They require that the bicycle user fold down the rack, place the bicycle, and secure it with an attachment. This process is relatively simple, but can result in a short delay to the bus service. This type of bicycle rack is typically sized for conventional bicycles and cannot accommodate larger bicycles such as cargo bicycles and tricycles. The capacity is typically limited to two bicycles, and may therefore result in prospective riders being 'passed up' when the rack is full.

The majority of the buses in the B.C. Transit and TransLink systems already have front-mounted bicycle racks with capacity for two bicycles. The practice of outfitting buses with front-mounted bicycle racks should be continued to aid in multi-modal trip making. Both B.C. Transit and TransLink also allow folding bicycles inside a transit vehicle, provided they are in a folded position and in a protective case.

While bicycle racks on buses is an effective means of encouraging multi-modal trips, the following are opportunities to address some of the current limitations and further expand the appeal and uptake:

- **Capacity:** The majority of bus-mounted bicycle racks in B.C. are limited to no more than two bicycles. While this is typically sufficient, there are noted 'pass ups' of prospective transit riders that are required to wait for the next bus when the front-mounted rack is at capacity. As cycling increases in future, consideration may be given to increasing on-board bicycle capacity to address this issue. Other jurisdictions have implemented bus-mounted bicycle racks with capacity for more than 2 bicycles.



Bicycle rack on TransLink bus
Source: GoToVan

- **Large Bicycles:** Currently, bicycles in excess of 50-pounds, with tires larger than 40 centimetres in diametre, and cargo bicycles or tricycles with an atypical wheelbase cannot utilize bicycle racks on B.C. Transit or TransLink vehicles. Consideration may be given to altering bicycle rack type to better accommodate larger bicycles as the proportion of atypical bicycles – such as cargo bicycles and tricycles – continues to increase.
- **E-Bikes:** Electric bicycles (e-bikes) are becoming more prevalent as bicycle infrastructure improves and the cost of e-bikes decreases. TransLink does not currently allow e-bikes on front-mounted bicycle racks, and B.C. Transit only allows them if the battery is removed. Consideration may be given to eliminating this barrier to facilitate use of e-bikes for multi-modal trips.

It should be noted that public transit vehicles in B.C. are typically part of the B.C. Transit or TransLink fleets. While local or regional governments may have influence, transit vehicles are typically the responsibility of B.C. Transit or TransLink and the local operators.

Rapid Transit and Commuter Rail

Bicycles are currently permitted on the SkyTrain, West Coast Express, and SeaBus services at no additional cost. Some of these vehicles / vessels include dedicated bicycle parking areas, while others simply allow bicycles to be brought on-board. This is an effective means of increasing the geographic catchment area of potential transit riders and facilitating multi-modal trips.

The following are opportunities to address some of the current limitations of accommodating bicycles on rapid transit and commuter rail to further expand the appeal and uptake:

- **Time / Capacity Restrictions:** Time-of-day and capacity restrictions introduce a level of uncertainty for individuals seeking to bring a bicycle on public transit. In Metro Vancouver, bicycles are currently permitted at all times of day on the Canada Line, SeaBus, and West Coast Express, but are restricted on the Expo and Millennium Lines during specified peak periods. Capacity is also limited to one bicycle per car on the Canada Line, and two bicycles per car on the Expo and Millennium Lines and the West Coast Express, and may be limited during rush hour when passenger capacity is limited.
- **On-Board Storage:** The provision of on-board bicycle storage varies between vehicles and services. Consideration should be given to ensuring all new rapid transit vehicles have dedicated bicycle storage that is functional, attractive, and represents an effective use of space. Effective bicycle parking types and dimensions are explored in detail in **Chapter B.2**.
- **Large Bicycles:** Large bicycles such as cargo bicycles, bicycles with trailers, and tricycles are not effectively accommodated on rapid transit or commuter rail services due to their large size and impact on passenger capacity. On SkyTrain, as an example, bicycles are limited to no more than 183 centimetres in length and bicycle trailers of any kind are not permitted. Consideration may be given to altering operating procedures to better accommodate larger bicycles and/or selecting future commuter rail vehicle types that better accommodate larger bicycles.
- **At-Grade Boarding:** Vehicles that accommodate at-grade boarding are strongly preferred where bicycles are intended to be accommodated on-board. At-grade boarding is also preferred to better accommodate strollers, mobility scooters, and other mobility aids.

Roll on bicycle racks, such as those provided on the Canada Line, can accommodate a wide range of bicycle types and do not require as much physical ability to use, since the bicycle can be rolled into place and does not have to be lifted. Roll on bicycle racks are best suited to multi-car trains with level boarding. However, roll on racks take up passenger standing space, which can be an issue on crowded vehicles.

Although not implemented yet in B.C., some transit agencies in other jurisdictions have used vertical or hanging bicycle racks installed inside the vehicle to accommodate bicycles on transit. Though able to fit more types of bicycles and not delay the transit vehicle while securing the bicycle, vertical racks can still be a challenge for some people to use and does not accommodate some bicycle types. Vertical racks also take up some passenger standing room, which can be an issue if the vehicle is near capacity on its run.

Roll on racks are generally recommended instead of hanging onboard bicycle racks due to concerns of equity and ease of use.

SkyTrain on-board bicycle area with roll on bicycle rack

TRANSIT STOP DESIGN

Transit stop design must include a variety of considerations and design strategies, including:

- **Pedestrians and Universal Accessibility**
  - *When considering floating transit stops (as discussed in further detail below), the preferred transit stop design requires bicycle facilities to be shifted to directly adjacent to the Pedestrian Through Zone at sidewalk grade. The lack of grade separation and close proximity of people cycling through the transit stop creates an increased potential for a conflict. Specialized design treatments are required to ensure that all people, including those with visual and mobility impairments, can safely and comfortably access the transit stop.*
- **People cycling**
  - *In some cases, providing bicycle facilities on the left side of a one-way road can be a strategy to eliminate conflicts between bicycle users and transit vehicles.*
  - *Conflicts between all modes on a multi-modal corridor can be minimized by exploring opportunities to remove, consolidate, or relocate transit stops.*
  - *When transit conflicts cannot be eliminated or minimized, design options that separate people cycling from the transit stop should be explored.*
  - *Carefully designed transit stops on multi-modal corridors can provide people cycling with a safe bypass of the transit stop by considering floating transit stops (as discussed in further detail below).*
- **Efficient Transit Flow**
  - *Transit stop design that separates cycling facilities from the curbside boarding and alighting area improves bus travel speeds by reducing conflicts between people walking and cycling with buses. By separating cycling*

facilities from the motor vehicle lane, the 'leap-frogging' effect of buses and people cycling constantly passing each other as the bus stops is eliminated, improving both safety and bus travel speeds.

- **Road Design**
  - *The motor vehicle travel lanes adjacent to the transit stop should be of sufficient width to accommodate transit vehicles. In general, 3.3 metres is considered the desirable with for vehicle lanes to accommodate buses, although 3.0 metres can be considered in constrained circumstances. The local transit agency should be consulted during the design process to confirm acceptable lane widths.*
- **Improved Pedestrian and Cycling Connections to Transit**
  - *To enable people to travel greater distances and in all weather conditions by active transportation requires integration of cycling and walking facilities with transit stops. Considerations are needed to ensure proper placement and amenities exist to make multi-modal travel desirable and efficient.*

Defining Context Zones

The various context zones for transit are shown in **Figure H-134** and described below.

1 **Pedestrian Through Zone**: As introduced in **Chapter C.2**, this is the area intended for pedestrian movement, where people walk, interact with each other, and access destinations along the corridor. The Pedestrian Through Zone should be kept clear of obstructions at all times, with the minimum width maintained the length of the corridor and through all crosswalks.

2 **Furnishing Zone**: As introduced in **Chapter C.3**, this area provides space for utilities, street furniture, bicycle racks, landscaping, street trees, transit shelters, and snow storage. This zone is flexible and can be eliminated at floating transit stops if adequate right-of-way width does not exist.

3 **Bicycle Through Zone:** As introduced in **Chapter D.1**, this area is reserved for the bicycle facility. In the case of a floating transit stop, the bicycle facility in this zone is re-routed behind the transit stop to bypass the transit boarding and alighting area. In this application, this zone is located between the Furnishing Zone and the Floating Transit Stop Zone and is recommended to be elevated to sidewalk grade.

Floating transit stop, Burrard Road, Vancouver, B.C.

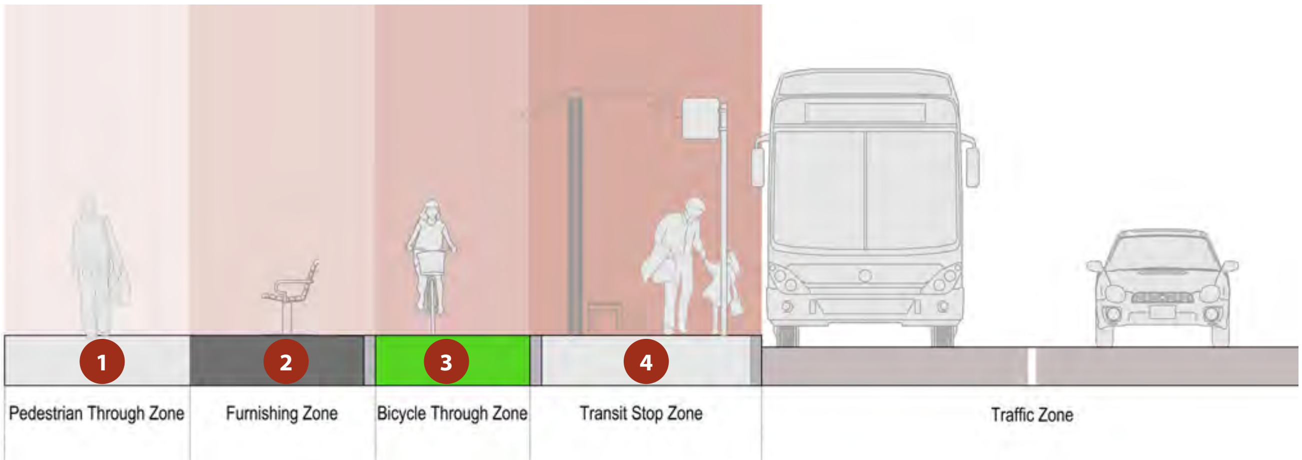


FIGURE H-134 // TRANSIT STOP ZONE

4 **Transit Stop Zone**: This is the zone where transit passengers wait for transit vehicles and also serves as a dedicated space for passengers boarding and alighting. The Transit Stop Zone must maintain a clear space large enough to accommodate bus ramps and lifts, as well as sufficient space for people with mobility aids to navigate boarding and alighting.

Transit Stop Design Principles

This section provides an overview of key principles related to transit stop design. Further details are provided in the following documents:

- TransLink *Bus Infrastructure Design Guidelines*
- BC Transit *Infrastructure Design Guidelines*
- MOTI *B.C. Supplement to TAC Geometric Design Guide (*Section 960)

Stop Location and Placement

Transit stops can be placed in one of three typical locations along a road in relation to intersections (See **Figure H-135**):

- **Far-side stops** are located directly after an intersection;
- **Near-side stops** are located in advance of an intersection; and
- **Mid-block stops** are located between intersections.

The specific location and placement of the transit stop should be coordinated with the local transit agency.

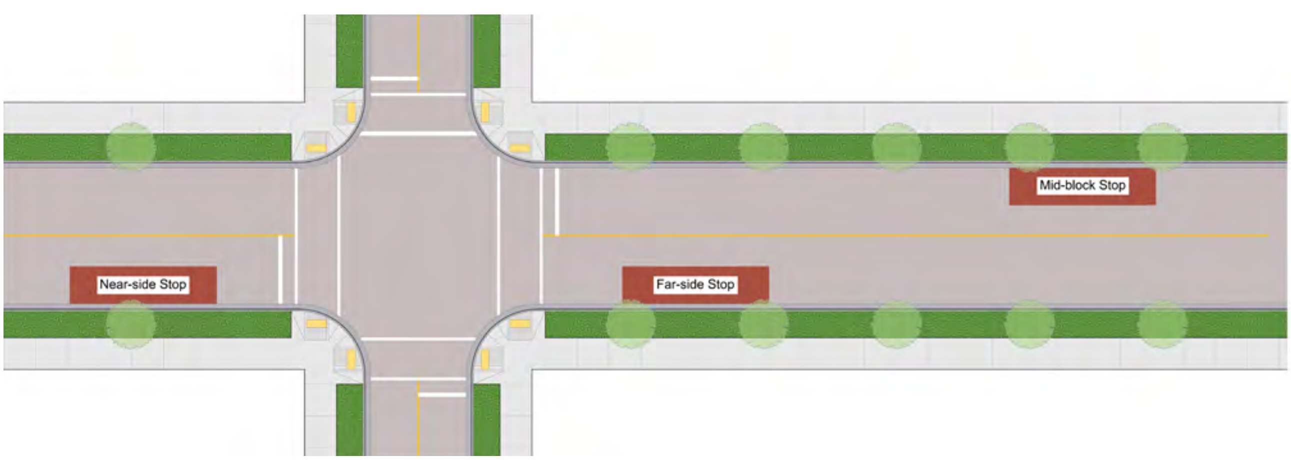


FIGURE H-135 // TRANSIT STOP LOCATIONS

Far-side transit stops are typically preferred both from an active transportation and traffic flow perspective. Far-side transit stops allow transit vehicles to move more efficiently along a corridor, prevent stopped buses from obstructing sightlines, and encourage pedestrians to cross at the rear of the bus.

Occasionally, transit stops are needed to be located at the near-side or mid-block along a corridor to accommodate physical and transit route constraints. Near-side stops are generally used when far-side stops are impractical or unsafe, or if the stop serves multiple routes that change directions at the intersection.

Mid-block stops are used in locations with long blocks and should include a crosswalk at the rear of the stop when designed.

Stop Layout

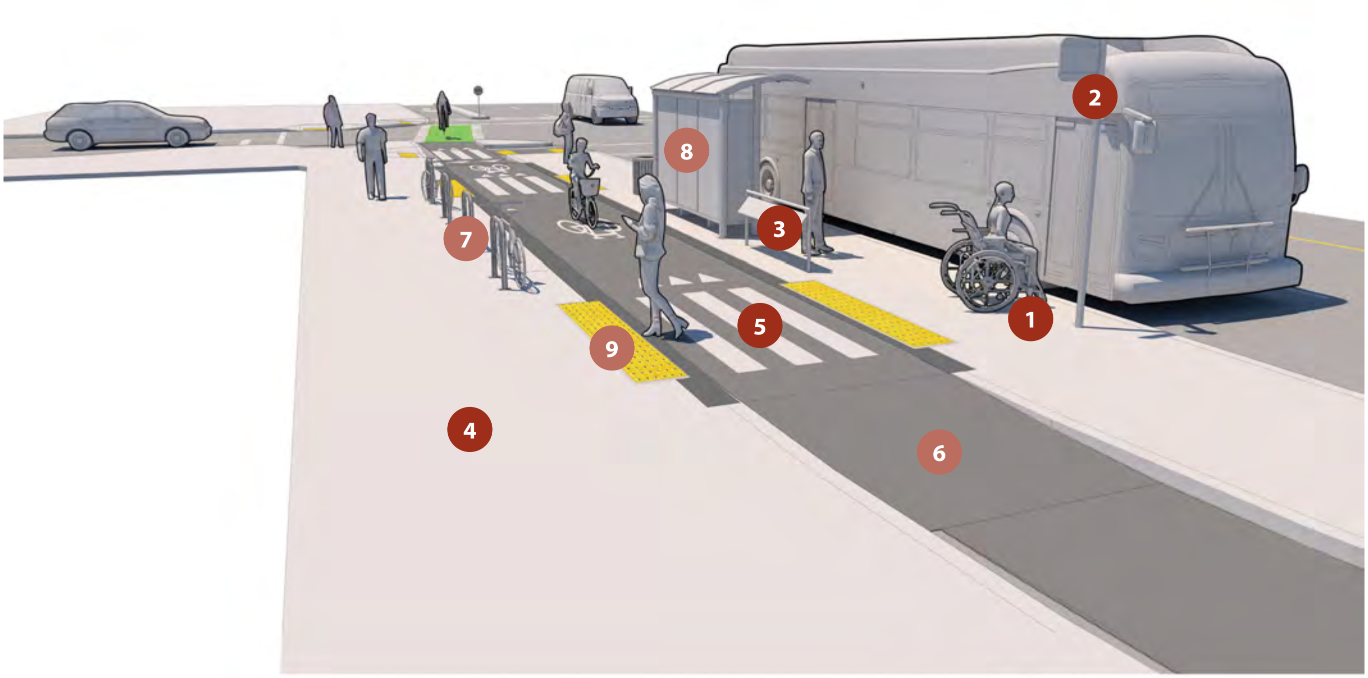
Transit stop layout is determined by the type of vehicles that will be using the stop and the facility type provided. Consideration is needed for the location of both the front and rear doors of any transit vehicles that will be using the stop, to ensure clear zones are maintained for boarding and alighting as well as the wheelchair lift or ramp. B.C. Transit and TransLink both provide guidance on their fleet of vehicles including dimensions to both the front and rear doors. The local transit agency should be consulted in the design process to confirm the design vehicles to be used for the design.

Four general sizes of buses currently operate on B.C. roads, including conventional buses, articulated buses, double-decker buses, and community shuttles. The following layout considerations are needed to accommodate each vehicle type.

- **Conventional bus**
  - *12.4 metre vehicle*
  - *Minimum 9 metre bus stop length*
  - *Greater than 0.45 metre clearance for the route identification pole*
  - *Preferred 3 metre long by 3 metre wide (2.5 metre minimum) clear zone at the front door to accommodate the wheelchair ramp/lift*
- **Articulated bus**
  - *Minimum 15 metre bus stop length*
  - *Greater than 0.51 metre clearance for the route identification pole*
  - *Preferred 3 metre long by 3 metre wide (2.5 metre minimum) clear zone at the front door to accommodate the wheelchair ramp/lift*
- **Double-decker bus**
  - *Minimum 9 metre bus stop length*
  - *Greater than 0.45 metre clearance for the route identification pole*
  - *Preferred 3 metre long by 3 metre wide (2.5 metre minimum) clear zone at the front door to accommodate the wheelchair ramp/lift*
  - *Overhead clearance of 4.8 metres or greater plus a minimum of 0.25 metre lateral clearance for the entire 4,8 metre height*
- **Community Shuttle**
  - *Minimum 8 metre bus stop length*
  - *A minimum 3 metre long by a preferred 3 metre wide clear zone is required at the rear of the bus stop*

Transit Stop Elements

All transit stops should be designed to consider the comfort and safety of all transit passengers as well as all other modes travelling past the stop. This section outlines the design elements that can be used, the zone where they should be sited, and classifies them as minimum, desired, or optional (see **Figure H-136**). Minimum transit stop elements are the typical treatments required to accommodate transit passengers, people walking, and people cycling. Desired transit stop elements will create a higher level of service and comfort for all modes. Optional design elements are context specific and should be reviewed with the transit agency prior to installation.



Minimum Design Elements

1. Accessible Landing Pad
2. Transit Route Identification Pole
3. Rear Clear Zone
4. Pedestrian Connection
5. Crosswalk

Desired Design Elements

6. Ramp Grade
7. Bicycle Parking
8. Shelters, Benches, and Garbage Receptacles
9. Tactile Walking Surface Indicators

Figure H-136 // Transit Stop Elements

Minimum Design Elements

1 Accessible Landing Pad

Located in the Furnishing Zone or in the Floating Transit Stop Zone

Accessible landing pads are required at all transit stops to allow passengers using mobility devices to board and alight the bus via the mechanical ramp or lift that is deployed from one of the bus doors. A concrete 3 metre by 3 metre space with no more than a 2% slope is preferred to allow people using mobility devices to navigate around the deployed ramp or lift. The accessible landing pad must be free of all obstructions and amenities.

2 Transit Stop Route Identification Pole

Located in the Floating Transit Stop Zone or the Furnishing Zone

A route identification pole is required to mark the stop location and communicate to riders the routes that use the stop. The route identification pole should be located a minimum of 0.5 metres from the face of the curb to ensure buses have adequate clear space when leaving the stop.

3 Rear Clear Zone

Located in the Floating Transit Stop Zone or the Furnishing Zone

This area is where the rear doors of the bus unload passengers and additionally serves as the loading area for community shuttle buses wheelchair lifts. The clear zone is required to be 4.5 metres long and 1.5 metres wide for standard, articulated, and double-decker buses and 3.0 metres wide for mini buses or community shuttles.

4 Pedestrian Connection To / From the Bus Stop

The Pedestrian Through Zone

Transit users need a pedestrian connection between the bus stop to their origin and destination. An effective transit system is served by a robust pedestrian network that allows transit users easily navigate the vital first and last legs of their journeys on foot.

5 Crosswalks to Cross the Bicycle Zone (required for Floating Bus Stops only)

Located in the Bicycle Through Zone

Crosswalks direct people walking to cross the Bicycle Through Zone at a designated point, helping to ensure yielding of right-of-way by people cycling past the transit stop. Crosswalks should be located at points that provide clear sightlines for people walking, cycling, and driving to prevent collisions. At least two crosswalks are preferred to minimize congestion from people boarding and alighting through both the front and rear doors. When adequate width of a floating transit stop exists, additional amenities such as a shelter, or bench can be sited between the two crossings to direct pedestrians to the preferred crossing locations. An additional crosswalk is desirable at all mid-block transit stops to improve connectivity for pedestrians walking on the other side of the road.

Desired Design Elements

Bicycle Lane Elements

Located in the Bicycle Lane Zone

- **Bypass zone:** A bypass zone shifts the bicycle facility behind a floating transit stop. Careful design considerations are required to ensure the bypass is safe and comfortable for people cycling that minimizes any potential conflicts with pedestrians. The bypass zone can constrict the bicycle lane width to a minimum of 1.5 metres. Design professionals should consider visually and physically narrowing the bicycle facility at locations where people cycling might be travelling at high speeds, to encourage people cycling to slow down. Additional signage or pavement markings may be effective at managing the speed and yielding behaviour of people cycling.

6 **Ramp grade:** The bicycle lane should transition to sidewalk grade for the length

of the floating transit stop to provide a level crossing for people accessing the transit stop. To create a comfortable transition from a street level bicycle lane to a sidewalk level bicycle lane that bypasses the floating transit stop, the maximum ramp grade slope should be 1:12. Drainage considerations are required to ensure water does not pool in the bicycle lanes in transition points.

- **Taper:** To create a comfortable transition from a curbside bicycle lane or protected bicycle lane to a bicycle lane that bypasses the floating transit stop, the desired taper should be 1:12 with a maximum taper of 1:5 in constrained environments.
- **Surface treatment:** The bicycle lane surface treatment should create a visual contrast from the adjacent floating transit stop and sidewalk. The asphalt surface treatment should continue from the curbside or protected bicycle lane through the floating transit stop, with optional green pavement markings to create additional contrast. A detectable edge treatment should be applied along the length of the sidewalk grade bicycle lane that bypasses the floating transit stop to provide tactile warning for people who are visually impaired. Consider installing yield pavement markings in advance of the crosswalk locations.

8 Benches

Located in the Furnishing Zone or the Floating Transit Stop Zone

Benches are preferred at all transit stops to provide a comfortable place for passengers to wait for the bus. Benches should be located in the Furnishing Zone, while maintaining a Pedestrian Through Zone of 1.8 metres. Benches can also be located in the Floating Transit Stop Zone when adequate width exists to maintain 1.5 metres clear from the leading edge of the bench to the curb. Benches can be sited under transit shelters or free standing when no shelter exists.

7 Bicycle Parking

Located in the Furnishing Zone or the Floating Transit Stop Zone

Bicycle parking should be installed at transit stops to encourage multi-modal trips. Bicycle parking at transit stops allows passengers additional choices for their 'first- and last-mile' connections. All bicycle racks should ensure that a minimum 1.8 metre Pedestrian Through Zone is maintained as well as a minimum 0.5 metre clear space between the bicycle lane and the rack. Further bicycle parking guidance can be found in **Chapter H.2**. Bicycle parking at transit stops should consider both the needs of people using bike share and traditional individually owned bicycles. Refer to **Chapter H.2** for further guidance on bicycle and scooter share parking considerations.

8 Shelters

Located in the Furnishing Zone or the Floating Transit Stop Zone

Transit shelters are a preferred design element at all transit stops to provide waiting passengers a safe, comfortable and dry space to wait. Transit shelters should be sited so they do not impede pedestrian circulation and are a maximum of 9 metres from the route ID post to ensure efficient boarding. Shelters should provide both seating and a 1 metre wide clear space for a person in a wheelchair. Lighting should be provided to illuminate the interior of the shelter either through its own light source or adjacent road lights. Shelter design should be simple to allow easy maintenance and maintain clear sightlines to create a safe environment for waiting passengers.

9 Tactile Walking Surface Indicators

Located in the Furnishing Zone and the Floating Transit Stop Zone

Tactile walking surface indicators (TWSIs), as discussed in **Chapter B.3**, are used to alert passengers that they are approaching an area that is used by a different mode. TWSIs are desired to delineate either side of the bicycle lane where pedestrians are directed to cross the cycling facility. Additionally, longitudinal tactile warning strips can be used to direct passengers to the front door of the bus.

Lighting

Located in the Furnishing Zone or the Floating Transit Stop Zone

Lighting is important to create a safe and secure environment for passengers waiting for transit during night time operation. Lighting ensures visibility is maintained for all modes. Adequate lighting can be achieved with installation of pedestrian-scale lighting on or around the shelter or through road lights in close proximity to the transit stop.

8 Garbage Receptacles

Located in the Furnishing Zone or in the Floating Transit Stop Zone

To keep transit stops clean and comfortable, garbage receptacles are desired at stops with higher ridership, stops with shelters, and in commercial areas. Garbage receptacles can be used to direct passengers boarding and alighting to the crosswalks across the bicycle lane.

Optional Design Elements

Advertisement Board

Located in the Furnishing Zone or in the Floating Transit Stop Zone

Many communities have advertising agreements that require transit shelters to display advertisement panels. The placement and orientation of these panels is important as the opaque panel will block people's sightlines as they are boarding and alighting the bus. When the transit shelter is sited in the Floating Transit Stop Zone, it is preferred for the advertisement panel to be separated from the shelter to maintain sightlines of both people walking and cycling through the bus stop area.

Railings or Lean Bars

Located in the Floating Transit Stop Zone

Railings or lean bars can be used to provide a place for waiting passengers to rest and to direct passengers towards the preferred crossing locations of bicycle lane. Similar to all other amenities located in the Floating Transit Stop Zone, a minimum of 0.5 metres clear space is required from edge of the bicycle lane to the railing or lean bar.

Street Trees

Located in the Furnishing Zone

When properly sited, street trees can create a more desirable waiting area at the transit stop. Street trees need to be located so they do not impact the sightlines of any modes of transportation and do not infringe into the required clear operating space for all transit vehicles.

TRANSIT STOP TYPES

Floating Transit Stop

Floating transit stops are the preferred treatment at transit stops along corridors with bicycle facilities. Various floating transit stop configurations can be considered depending on the bicycle facility type along the corridor, but many design elements are consistent across all floating transit stops. The consistent elements include: the dimensions of the floating transit stop island, the bicycle lane ramp and taper, required and desired amenities, and accessibility requirements that ensure the stop is safe and comfortable for all modes and users.

Description

Figures H-137 to **H-139** show different configurations of far-side floating transit stops transitioning from a protected bicycle lane, curbside bicycle lane, and parking protected bicycle lane. These are the preferred treatments for corridors with each of these facility types. The back of the transit stop must be located a minimum of six metres from the crosswalk at the nearest intersection.

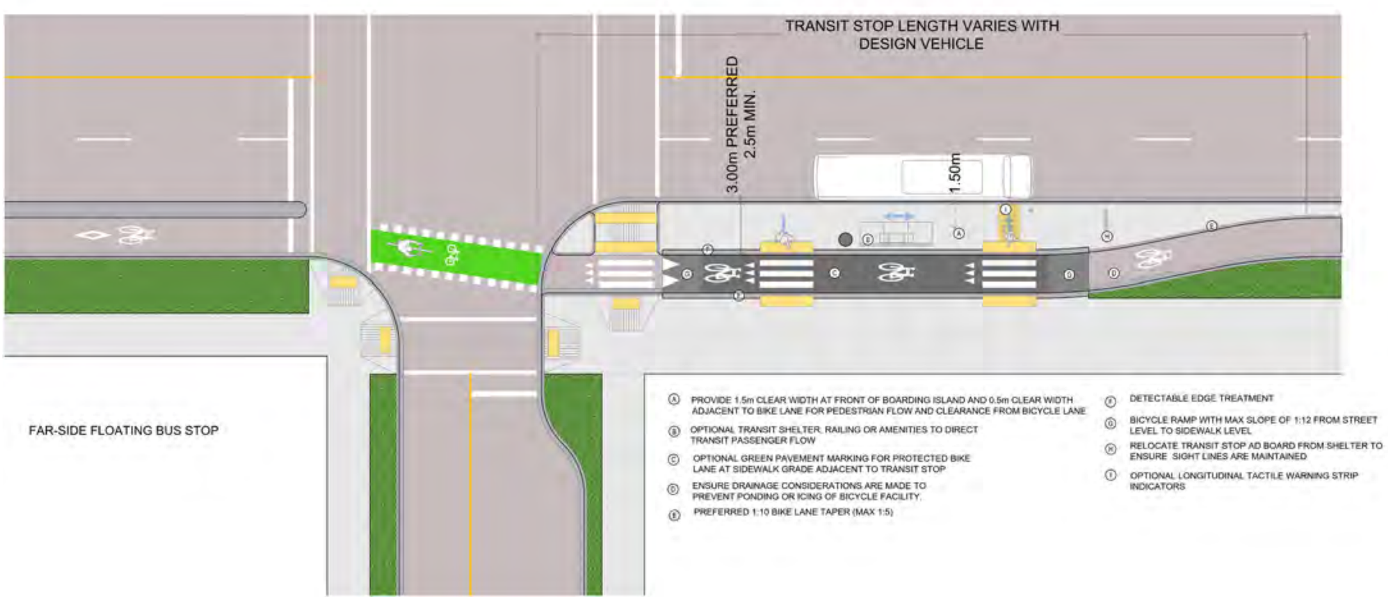


Figure H-137 // Protected Bicycle Lane Floating Transit Stop

FIGURE H-138 // CURBSIDE PAINTED BICYCLE LANE FLOATING TRANSIT STOP

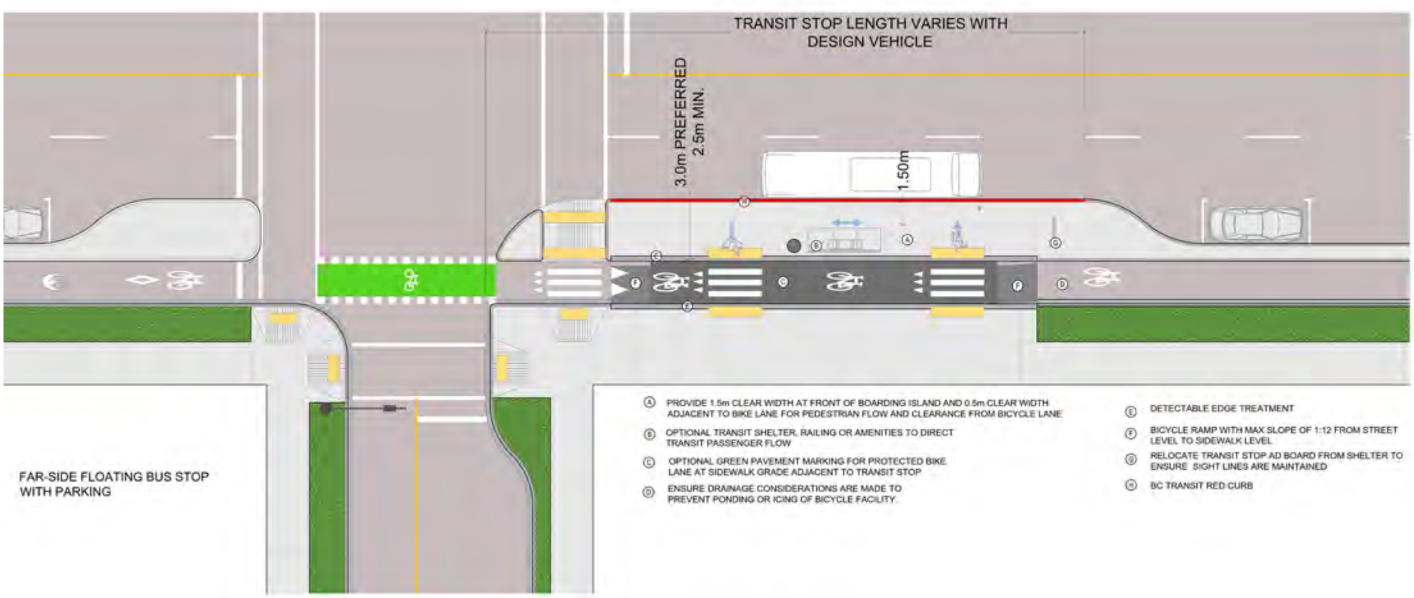


FIGURE H-139 // PARKING PROTECTED PAINTED BICYCLE LANE FLOATING TRANSIT STOP

Mid-Block Floating Transit Stop

Figure H-140 shows a mid-block floating transit stop where a bicycle lane transitions to the bicycle bypass to separate people cycling from the motor vehicle lane.

Application

- Not preferred on high speed roadways (>60km/h)
- Low frequency transit stops

Design Guidance

- Dimensions
  - *Floating transit stop island dimensions – 3 metres wide preferred, 2.5 metres minimum; length determined by stop usage.*
  - *Transit stop dimensions – 6 metre minimum clearance from the nearest crosswalk*
  - *Bicycle lane dimensions:*
    - *Unidirectional bicycle facility:*
      - *Width - 2.5 metres preferred, 1.2 metres minimum*
      - *Taper – 1:10 preferred, 1:5 minimum*
      - *Ramp grade – 1:12 slope maximum*
    - *Bi-directional bicycle facility:*
      - *Width - 4 metres preferred, 2.4 metres minimum*
      - *Taper – 1:10 preferred 1:5 minimum*
      - *Ramp grade – 1:12 slope maximum*
- Additional signage:
  - *Add Yield to Pedestrians sign (MUTCDC RB-39) for people cycling approaching the floating transit stop.*

Curbside Transit Stop (With Bicycle Facility)

Curbside transit stops along corridors with bicycle lanes are less desirable from both a comfort and safety standpoint for people cycling as well as from a transit speed and operation perspective. All others options including stop relocation, constrained floating transit stop, and stop consolidation should be considered before designing a curbside transit stop adjacent to a bicycle lane.

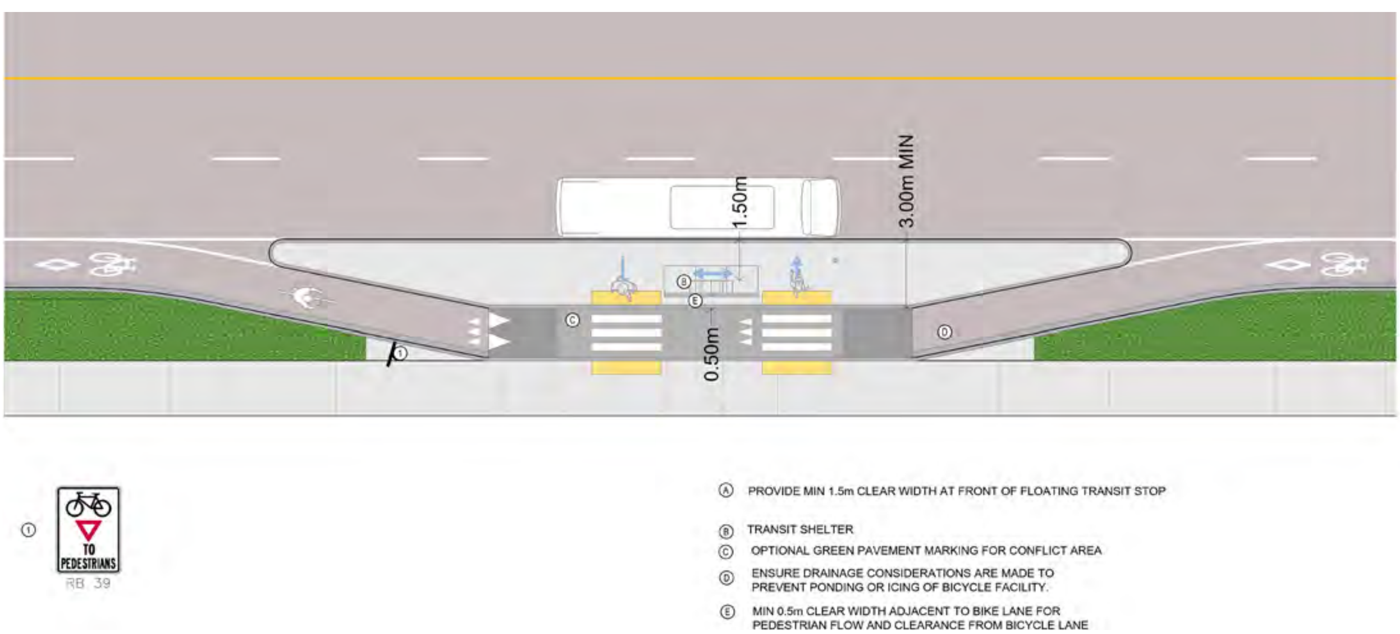


Figure H-140 // Mid-block Floating Transit Stop

Description

Curbside transit stops require transit vehicles to stop to board or alight within the bicycle lane, requiring people cycling to either stop and wait or to pass the transit vehicle in the motor vehicle lane. The increased interactions between people cycling and the transit vehicles can have a negative impact on the operation of the transit route due to the 'leap-frogging' effect of people cycling passing the stopped transit vehicle when boarding and alighting and getting passed by the transit vehicle between stops. This operation additionally increases the risk of collisions with motor vehicles for bicycle users passing stopped transit vehicles.

Application

- Roads with posted speed limits of 50 km/h or less.
- Low frequency transit stops that do not serve as timing points for the route.
- Consider for locations with constrained space and limited available funding.

Design Guidance

- All minimum design elements required.
- Transition the solid bicycle lane line to a dashed line treatment throughout the length of the transit stop. The dashed line treatment should be a minimum of 30 metres in length and should allow the required bus pull-in/pull-out taper without crossing the solid line. The local transit agency should be consulted regarding the transit vehicles operating on the route when designing the start and end points of the dashed line treatment.
- A minimum width of 5.8 metres is required for the combined width of the bicycle lane and adjacent motor vehicle lane for a two-lane bidirectional road. This minimum width ensures that motor vehicles are able to pass on the left side of stopped transit vehicles.
- Optional sharrow pavement markings can be placed in the bicycle lane in the transit zone.

Curbside Transit Stop (Without Cycling Facility)

Curbside transit stops are the typical transit stop design for roads that do not have bicycle facilities. At these stops, transit passengers board and alight at stops identified by stop identification poles. All transit stop amenities are located within the Furnishing Zone. When designing a curbside transit stop, design professionals should consider the speed limit and laning configuration of the road of interest.

Description

Three curbside transit stop configurations can be selected from when designing transit stops along corridors without bicycle facilities. The options to consider include:

- **Bus Bulge**: where the transit stop is located on a widened section of the sidewalk that protrudes into the parking lane;
- **Bus Bay**: where the transit stop is located within a pull-over zone that removes the stopped transit vehicle from the adjacent motor vehicle lane; and
- **Basic Curbside**: where the transit stop is located on the curb of the motor vehicle lane.

Application

Urban Application

- **Bus Bulge**
  - *Preferred design to provide increased visibility for transit passengers.*
  - *Limits the amount of on-street parking removal required.*
  - *Provides additional space for transit stop amenities.*
  - *Reduces transit route delays since the bus does not need to re-enter the motor vehicle travel lane.*

- **Bus Bay**
  - *Preferred design on highways or arterials with a posted speed limit of 60 km/h or greater.*
  - *Recessed bus bay allows transit vehicles to wait at a stop location out of the motor vehicle travel lane, which makes bus bays desirable at timing points along a route*
  - *May increase transit delays since the bus is required to pull-off and re-enter the motor vehicle travel lane.*
- **Basic Curbside (see Figure H-141):**
  - *Constrained locations where space does not exist to provide a bus bulge or bay.*

Rural Application

- **Rural Transit Stop (see Figure H-142):**
  - *Rural transit stops are located along rural roadways and highways that typically do not have sidewalks. For rural transit stops to be wheelchair accessible and allow the deployment of a transit ramp or lift, a waiting area that is elevated 150 millimetres is required. The transit stop pad is typically built within the existing shoulder, with curb letdowns at either end.*

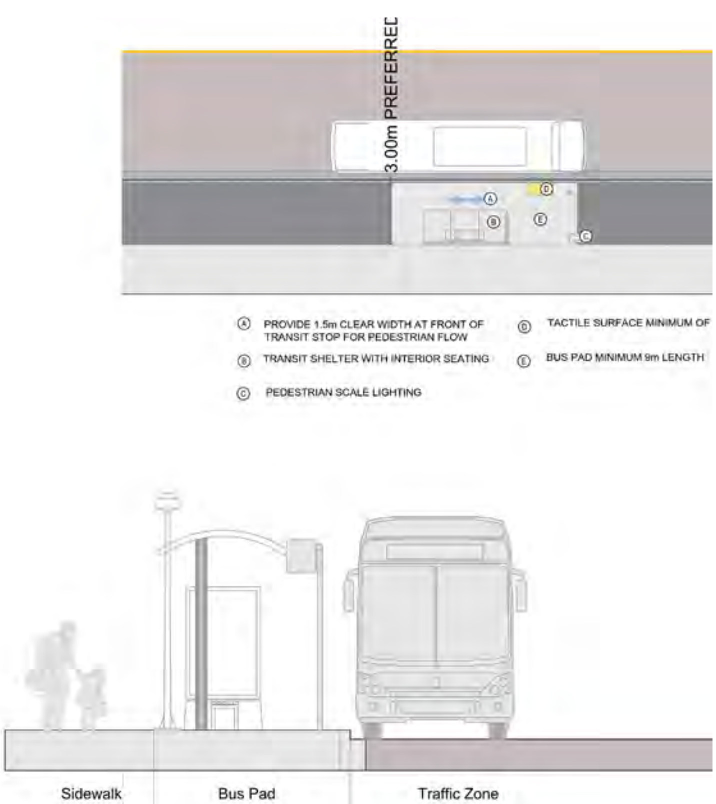


FIGURE H-141 // URBAN BASIC CURBSIDE ACCESSIBLE TRANSIT STOP

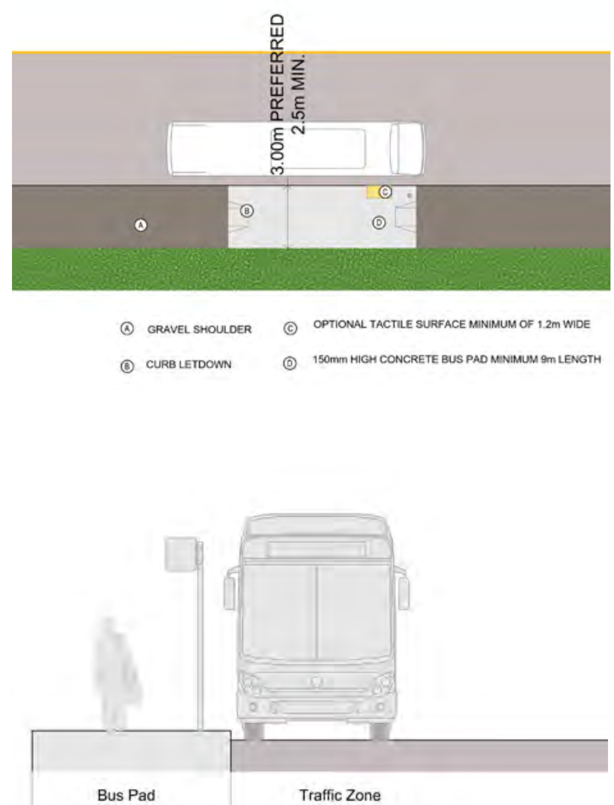


FIGURE H-142 // RURAL ACCESSIBLE TRANSIT STOP

FERRIES AND FERRY TERMINALS

Ferry services provide an important link for regional travel between many B.C. communities, both coastal and inland. These services facilitate commute and errand/service trips as well as bicycle tourism, which is a significant economic driver in a number of B.C. communities. Better accommodation of active transportation at ferry terminals and on ferry vessels helps support local economies, while facilitating active and sustainable transportation throughout the province.

This section identifies opportunities to better accommodate walking, cycling, and other active transportation modes in the planning and design of ferry terminals and on ferry vessels.

Ferry Terminals, On-Site

Ferry terminals are the interface between ferries themselves and the surrounding transportation networks. Effectively planned and designed active transportation facilities that connect points of arrival and departure with off-site active transportation facilities ensures that walking, cycling, and other forms of active transportation are desirable options to travel to and from ferry terminals. The most common opportunities to facilitate active travel to and from ferries include:

1. Walk to and from ferry terminal, and walk on and off the ferry;
2. Bicycle to the ferry terminal, park the bicycle at the ferry terminal, and walk on the ferry; and
3. Bicycle to the ferry terminal and board the ferry with the bicycle.

All terminal planning and development is undertaken by the organization with jurisdiction over the terminal, most commonly with provincial and local or regional governments involved in the process as a stakeholder. While the ultimate responsibility for terminal design lies with the ferry jurisdiction, the following guidance is provided to better understand how to plan and design effective ferry terminals that encourage walking, cycling, and other forms of active transportation to travel to and from ferry terminals.

- Provide bicycle and pedestrian facilities that provide a direct, intuitive connection between active transportation facilities outside the terminal area and the points of arrival and departure within the terminal.
- Mark crossings and conflict zones with appropriate pedestrian crossing control markings and/or bicycle conflict zone markings. Refer to **Section G** for further guidance on crossing treatments.
- Consider adding physical protection where a pedestrian and/or bicycle facility is adjacent an area of high motor vehicle speed.
- Consider measures to prevent motor vehicles from blocking or temporarily impeding walking and/or bicycle facilities where motor vehicle parking or queuing is near an active transportation facility. Conversely, pedestrian management measures (such as signals or gates) may be required to manage conflicts with vehicles during loading / unloading periods.
- Utilize wayfinding to strengthen the connection between on- and off-site active transportation facilities, which may include signs, surface markings and other visual queues.

Ferry Terminals, Off-Site

The provision of safe and comfortable active transportation facilities leading to and from ferry terminals facilitates walking, cycling, and other forms of active transportation, thereby broadening the travel options available to individuals completing regional trips and further supporting trip making via healthy, sustainable travel modes.

The following guidance is provided to ensure active transportation facilities nearby ferry terminals are appropriately designed and provide strong connectivity to the ferry terminal. Guidance is directed at the organization with jurisdiction over transportation corridors – commonly the provincial government or the respective local or regional government – but may also be referenced by BC Ferries or other ferry operators to understand how ferry terminals may integrate with off-site networks.

- Provide a direct, intuitive connection between nearby active transportation facilities and the arrival / departure areas, vehicle drop-off / pick-up areas, and bus stops.
- Reference and consider reflecting the ferry service provider's sign and pavement marking standards for active transportation routes to and from ferry terminals to create a consistent treatment and aid in pedestrian and cycling wayfinding.
- Consider providing an information kiosk oriented at bicycle users exiting the ferry terminal that includes maps and supporting information directing bicycle users on preferred routes to destinations in the region. This is particularly important for bicycle tourists.
- Active transportation facility planning and design nearby ferry terminals should include BC Ferries or other ferry operators as a stakeholder to ensure integration of active transportation facilities in ferry terminals with nearby facilities

Ferry Vessels

The type, model, and design of ferry vessels is the responsibility of the ferry operator. There is therefore limited ability for local or regional governments or the provincial government to influence the provision of active transportation facilities on ferry vessels.

Given that encouraging active transportation is a province-wide objective, it is important that existing ferries are retrofitted to the extent possible and that the procurement of new ferries include provision of basic facilities that facilitate active transportation.

Pedestrian travel is generally well accommodated on ferries by way of clear corridors, elevators as an alternative to stairways to accommodate mobility devices, and directional and wayfinding signs to on-board amenities.

Bicycle lane to access Duke Point Ferry Terminal
Source: Brian Burger

The level of bicycle accommodation on ferries varies based on the type, age, and route of the vessel. While bicycles are well accommodated on some vessels they are not as well-accommodated on others. The following bicycle accommodation measures should be considered:

- Bicycle parking areas should be provided that include bicycle-specific racks or locking areas. The number of bicycle parking spaces should accommodate summer months when demand for bicycle parking is highest. Consideration may be given to 'fold away' bicycle parking racks that can be collapsed while not in use.
- Bicycle parking should be well designed to address concerns over bicycle damage and bicycle / bicycle parts theft during sailings. The design / layout guidance for bicycle parking provided in **Chapter H.2** should apply. Design related to bicycle stability is particularly important given the potential for movement during ferry sailings.
- Hooks and/or lockers may be provided adjacent to bicycle parking so that bicycle users can store helmets, bags and/or clothing.
- Wayfinding signs should be provided that direct people cycling where to park.

AIRPORTS

There are upwards of 40 airports in B.C. that are significant generators of travel in communities throughout the province. Generally, airports are located in outlying areas due to the need for large areas of land to accommodate airport activities. Some are in major urban centres with access to a variety of travel options (such as Vancouver, Victoria, and Kelowna), while most provide access to very remote communities with limited travel options, such as Masset and Texada/Gilles Bay.

While the bulk of trips to and from airports are made by motor vehicles, as well as taxis, shuttles and public transit at larger airports, there can be a role for active transportation for a portion of trips to and from airports to further support community-wide active transportation uptake and to help reduce the demand for motor vehicle parking and drop-off/pick-up space for taxis and shuttles on airport sites. The following are opportunities to integrate active transportation facilities at airports:

- **Network Integration**: Where sidewalks, bicycle facilities, or other active transportation infrastructure is present nearby an airport, ensure that those facilities provide a continuous connection to the airport site and terminal building. Jurisdiction over airports in B.C. may be federal, provincial, municipal or private, and the ability and/or interest in building bicycle infrastructure on airports lands may vary from site to site.
- **Bicycle Station**: Create an on-site bicycle station to encourage both travellers and airport employees to travel to and from the airport by bicycle. The bicycle station may include short-term bicycle parking (e.g. bicycle racks), long-term bicycle parking (e.g. lockers or bicycle room), and end-point amenities such as a repair stands, tools, and maps and related information.
- **Pedestrian Integration**: Enhance pedestrian facilities between the terminal building and on-site travel options such as taxis and shuttles to prioritize these modes over private motor vehicle use.

Case Study

Airport Bicycle Parking, Victoria, B.C.

To facilitate cycling to/from the airport and consistent with Victoria's status as the 'cycling capital of Canada', the Victoria International Airport (YYJ) has created a bicycle station in the short-term parking area immediately adjacent the terminal arrivals area. The bicycle station includes secure bicycle parking available at $2 per day (as opposed to $16 to per day to park a vehicle), short-term bicycle parking racks, and a repair stand and tools for basic bicycle maintenance.

NEW MOBILITY

New mobility refers to new or emerging travel modes, typically made possible by advances in technology and/or telecommunication. Relevant new mobility forms include active travel modes such electric bicycles, electric scooters and bikeshare that are explored in detail in **Chapter H.5**, as well as other new mobility forms such as electric vehicles, carshare and ride-hailing.

The following are opportunities to encourage integration between active transportation facilities and the various new and emerging new mobility options:

- **Short-term bicycle parking** may be located adjacent to carshare vehicle parking locations to allow carshare users with bicycles to access the carshare vehicle;
- **Carshare vehicles** may be mounted with a bicycle rack that allows carshare users to bicycle to/from the carshare parking location to access the vehicle, as well as use a carshare vehicle to transport a bicycle to a recreational cycling location; and
- **Establish ride-hailing pick-up points at** key trip origins to facilitate passenger pick-up once ride-hailing becomes widespread in B.C.

Bicycle parking along Fort Street protected bicycle lane, Victoria, B.C.

H.2

END-POINT FACILITIES

In order for active transportation to be an attractive and competitive transportation option, it needs to be as convenient as possible. Providing end-point facilities such as short-term and long-term bicycle parking, showers, change rooms, repair facilities, and parking for other active modes is an important way to accommodate active modes of travel for everyday trips.

BICYCLE PARKING OVERVIEW

Providing convenient, safe, and secure bicycle parking is key to encouraging cycling as a mode of transportation. Design professionals must consider a number of factors when providing bicycle parking, including the bicycle parking type, placement, quantity, and installation method. There are two main categories of bicycle parking: short-term and long-term bicycle parking. Each of these categories of bicycle parking are described in further detail below.

Bicycle Parking Programs and Policies

Local governments play a key role in ensuring that ample and high-quality bicycle parking is available in their communities. Insufficient, inefficiently located, and/or low-quality bicycle parking may result in bicycle theft, sidewalk clutter, as well as damage to street furniture and property.

To mitigate these issues and encourage cycling as an active and sustainable form of transportation, local governments should develop bicycle parking programs that support the provision of bicycle parking in public places such as sidewalks, on-street parking stalls, and at parks and other civic spaces. Local governments can also introduce short- and long-term bicycle parking requirements for private developers and employers, covering both new developments and retrofits. In B.C., municipalities can regulate the provision of bicycle parking for new developments and retrofits in their development regulations. Municipalities should establish bicycle parking regulations that designate both the quantity and design / layout of bicycle parking, providing clear standards for bicycle rack configuration, design, placement, and installation.

Bicycle parking regulations should be context-specific, with local jurisdictions outlining the minimum number of required bicycle parking spaces for both short-term and long-term use. Factors that influence the number of bicycle parking spaces include land use, number of residents or employees, floor area, site planning requirements, and/or bicycle parking design specifications. Land uses that typically generate shorter visits such as commercial, retail, dining, recreational, and civic uses should provide sufficient short-term bicycle parking. Likewise, long-term bicycle parking should be required for high activity transit stops, workplaces, and multi-family residential developments.

Similar to parking requirements for motor vehicles, a certain amount of bicycle parking can be required based on the number of units or the floor space of a development. In both short-term and off-road, long-term bicycle parking facilities, it is recommended that 10% of all bicycle parking spaces be able to accommodate larger, non-standard bicycles such as cargo bicycles. Additionally, a number of electric bicycle charging spots should be provided. It is recommended that 50% of long-term and 10% of short-term bicycle parking be designed to accommodate e-bikes by providing an electrical outlet.

Aesthetically designed short-term bicycle racks, Vancouver, B.C.
Source: VIVA Vancouver

Case Study

Bicycle Parking Requirements and Strategy, Victoria, B.C.

The City of Victoria has regulations and guidelines in place to ensure that high-quality bicycle parking is provided both on- and off-road throughout the city. These guidelines ensure that all new development includes adequate and appropriately designed bicycle parking and continues to contribute to making Victoria one of the most bicycle-friendly communities in Canada. Schedule C of the City of Victoria's Zoning Bylaw sets out the minimum number of required short-term and long-term bicycle parking spaces for a range of residential, commercial, institutional, and industrial land uses. Generally, the recommendations are based on the number of dwelling units for residential buildings and the total floor area for other land use classes.

The bylaw also sets out bicycle parking installation requirements for both short-term and long-term bicycle parking. For example, it indicates how far away short-term bicycle parking can be located from the destination building, as well as the proper spacing between bicycle racks to ensure they can meet their capacity without impeding pedestrians or building entrances. For long-term bicycle parking, the bylaw set outs minimum bicycle room dimensions, rack specifications, and access requirements.

Victoria's Zoning Bylaw is supported and informed by the City of Victoria's 2011 Bicycle Parking Strategy, which presented the importance of proving bicycle parking and provided design guidance for on-street and off-road bicycle parking facilities. The Bicycle Parking Strategy also provides guidance on end-of-trip facilities, maintenance, management, advertising potential, and emerging bicycle parking technologies. Documents such as this strategy and the Zoning Bylaw clearly define expectations and guidelines for both government planners and private developers to provide excellent bicycle parking in all developments.

BICYCLE PARKING GUIDING PRINCIPLES

The following guiding principles apply to both short- and long-term bicycle parking. These guiding principles help to select the appropriate type and location of bicycle parking and are key to ensuring that bicycle parking is convenient, accessible, and secure for all types of bicycle and for people of all ages and abilities.

- **Convenience:** Bicycle parking should be located in convenient and intuitive locations, near building entrances (no more than 15 metres away), and at common destinations such as parks and sport fields. Bicycle racks should be easily visible from adjacent bicycle routes or, in the case of off-road parking especially, have signage and wayfinding that helps people cycling locate the bicycle parking. Bicycle parking should also be plentiful enough that people cycling can be confident of finding a parking spot in close proximity to their destination, as this will reduce the number of bicycles locked to street furniture such as parking metres, railings, and sign posts. Weather protection should be provided wherever possible to help encourage all-season cycling.
- **Safety and Secure:** Bicycle parking should be located in a well-lit and highly-visible location with passive surveillance from pedestrians, retail activity, and/or building windows; otherwise, other security measures should be taken. Passive and active surveillance help to discourage theft and vandalism and also make people cycling feel safer. Bicycle parking should be built to resist being cut or detached using bolt cutters, piper cutters, or other devices. Bicycle racks should be firmly anchored to the ground or building structures.
- **Functional:** Bicycle parking designs should be intuitive and functional for a wide range of bicycle types, including longer, taller, and wider models (e.g. recumbent bicycles, cargo bicycles, bicycles with child trailers, etc.). Bicycle parking should also accommodate bicycles with attachments such as baskets and other accessories. Bicycle parking should also be designed so that people of all ages and abilities can safely and easily park a bicycle without having to lift the bicycle onto a rack. Proper bicycle parking placement is crucial to ensuring functionality. Clearance from buildings and other features is a significant component of functionality. Even if bicycle racks are well designed, they become less functional if they are installed with insufficient clearance from buildings, street furniture, vegetation, and other bicycle racks. Finally, proper maintenance, especially in winter climates where snow clearing is necessary, is crucial to ensuring that on-street bicycle racks remain accessible and functional in all seasons.
- **Accessible:** Bicycle parking should not conflict with other transportation modes, including motor vehicles and pedestrians. On-street bicycle parking should not be placed in a way that results in either bicycle racks or parked bicycles impeding transit vehicles or users, people opening the door of a parked car, or pedestrians in the Pedestrian Through Zone of the sidewalk. Bicycle racks must be easily detectable by a visually impaired person using a cane to navigate. Bicycle racks should not present a tripping hazard or have sharp edges, and protrusions above 0.7 metres tall should not overhang by more than 0.3 metres.
- **Aesthetics:** Bicycle parking design can be coordinated to match or enhance the surrounding streetscape and other street furniture using certain designs, colours, branding, and even custom shapes. However,

design functionality must be prioritized over aesthetic appeal. Both on- and off-street bicycle parking should receive ongoing maintenance to check for unsecured racks and keep the parking free of debris, vandalism, and abandoned bicycles or locks.

SHORT-TERM BICYCLE PARKING

Short-term bicycle parking is generally intended for people stopping for two to four hours or less to run errands, shop, have a meal, or partake in any other short-term activity. Short-term bicycle parking is generally appropriate for commercial and retail areas, office buildings, health care and recreational facilities, and institutional developments such as libraries and universities. Short-term bicycle parking typically consists of on-street bicycle racks, bicycle corrals, or covered bicycle parking in commercial, institutional, and recreational areas and at key community destinations. Key considerations for short-term bicycle parking include proximity to destination, ease of use, and winter maintenance.

Bicycle Racks

Bicycle Rack Selection

Bicycle racks are the most common and versatile type of short-term bicycle parking. Bicycle racks come in a variety of styles that vary greatly in functionality. This section outlines some of the most common types of bicycle racks, although this list is not exhaustive. Bicycle rack selection and installation should be consistent with local design standards, using tested and approved rack types, attachments, and mounting surfaces. All bicycle racks should meet the following performance criteria:

- **Supportive**: Supports the bicycle in an upright position, providing at least two points of contact with the bicycle frame. In order to support a wide range of bicycle types, bicycle racks should be a minimum of 80 centimetres tall and 45 centimetres wide.

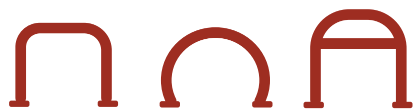
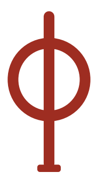
Well used short-term bicycle parking, Tofino, B.C.

- **Lockable**: Allows the frame and at least one wheel to be securely locked to the rack using a U-lock.
- **Flexible**: Accommodates a variety of bicycle types and attachments by providing appropriate clearances and avoiding rack designs that restrict the length, height, or width of bicycles or attachments.
- **Intuitive**: Is simple and intuitive to use and is recognizable as a bicycle rack. The user should not have to lift the bicycle or move another bicycle to use the bicycle rack.
- **Secure**: Is both secure and durable due to context-appropriate materials and installation methods.

Bicycle Racks for All Applications:

The bicycle rack designs in **Table H-36** meet the performance criteria and are generally appropriate for all applications:

TABLE H-36 // BICYCLE RACKS FOR ALL APPLICATIONS

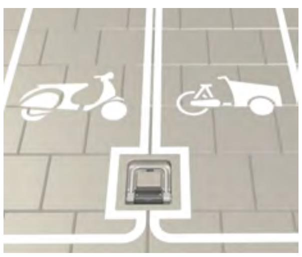
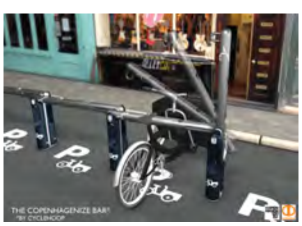
RACK TYPE		NOTES
Inverted U (Also called loop or staple rack)		• Can support two bicycles per rack. • Can be installed alone or in a series on rails. • Many variations are available. • Can be efficiently located within the Furnishing Zone of a public right-of-way.
Post and Ring		• Can support two bicycles per rack. • Products exist to retrofit certain parking metres to create custom post and ring racks. • Can be efficiently located within the Furnishing Zone of a public right-of-way.

Bicycle Racks for Non-Standard Bicycles:

Many non-standard bicycles are longer, wider, and heavier than a typical bicycle, making them challenging to park using conventional bicycle racks. However, these bicycles are typically self-standing (such as tricycle) or have a stand (such as cargo bicycles), meaning that they may not require a rack that supports the frame of the bicycle in two places. Special bicycle racks designed for non-standard bicycles can both make it easier to lock up non-standard bicycles and dissuade standard bicycles from taking up designated spaces. Users of non-standard bicycles may be more likely to use large chain locks rather than u-locks, which allows greater flexibility in the bicycle rack design.

Bicycle racks for non-standard bicycles are shown in **Table H-37**. Bicycle racks for non-standard bicycle are not recommended for on-street installation along sidewalks. They may be suitable in short-term applications in covered bicycle shelters, parks, or outside community facilities such as recreation centres. They are also suitable for off-street locations such as parkades, bicycle rooms, and bicycle stations (described later in this chapter. These special racks may not be recognizable as bicycle racks and should be marked as such using signage and/or pavement markings. They should be located at grade or accessible via a ramp so that users do not need to lift their bicycles.

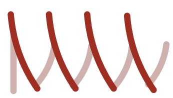
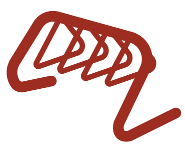
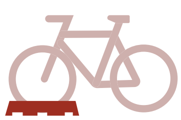
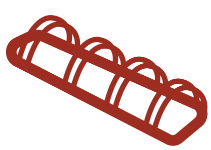
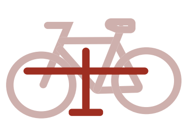
Table H-37 // Bicycle Racks for Non-Standard Bicycles

RACK TYPE		NOTES
Half-Height Stand	 Source: Kevin Hickman	• Low enough that it will not support a standard bicycle, helping to reserve it for non-standard bicycles. • No lower than half height (40 centimetres tall), as some users may have difficulty bending down to access the rack. • Can be a tripping hazard; therefore, racks should be clearly marked with signage and/or pavement markings and installed in groups, preferably in a well-lit and sheltered location.
Ground Fixings	  Source (both images): VelopA	• Parking bracket that can be flipped up by foot up to provide a secure place to attach a lock. • When not in use, the bracket retracts into the ground, so it is not a tripping hazard. • May not be accessible for people with limited leg or foot control or people with difficulties bending down.
Copenhagenize Bar	 Source: Mikael Colville-Anderson	• An emerging technology in Denmark; still in design phase, not in widespread use. • Consists of a movable bar that flips down to secure the bicycle; moving parts would require maintenance. • Could feature a built-in locking mechanism active through a swipe card for subscribers.

Bicycle Racks to Avoid:

It is recommended that the following bicycle rack designs be avoided due to performance concerns as shown in **Table H-38**.

Table H-38 // Bicycle Racks to Avoid

RACK TYPE	NOTES
Wave 	•Only supports frame at one location and can require lifting wheel to park bicycle. •Often fails to provide advertised capacity.
Spiral 	•Only supports frame at one location and can require lifting wheel to park bicycle. •Often fails to provide advertised capacity.
Coat Hanger 	•Top bar limits the height of bicycles that can be accommodated. •Thin 'coat hanger' loops are less durable than the thicker posts on other rack types.
Schoolyard 	•Only supports frame at one location and can lead to wheel damage. •Does not allow locking of frame to bicycle rack.
Wheelwell  	•Presents a tripping hazard when not in use. •Only supports frame at one location and can lead to wheel damage. •Does not allow locking of frame to bicycle rack.
Bollard 	•Similar to Post and Ring rack, but narrower design typically does not support bicycle at two locations
Swing arm secured 	•Only accommodates limited bicycle designs. •Moving parts create maintenance complications.

Custom Bicycle Racks

Bicycle racks can be custom-made to include branding, colour, and custom shapes that serve as public art and enhance the aesthetic quality of the streetscape. Custom bicycle racks can be designed with the help of community members through contests such as the City of Vancouver's Bike Rack Design Contest. However, local governments should be cautious when considering custom bicycle racks and must ensure that all custom bicycle racks meet the performance standards listed above.

Bicycle Rack Materials and Installation

Bicycle racks are typically constructed of carbon steel or stainless steel. There are a range of coatings and finishes that can be applied, with varying costs and maintenance requirements. Local conditions and preference should be considered when choosing the material. Square tubing is typically more theft-resistant than round tubing, which can more easily be cut with a hand-held pipe cutter.

Bicycle rack installation methods vary depending on the surface material. The ideal installation surface is concrete, which allows the rack to be securely fastened using concrete spikes or wedge anchors. Concrete spikes are tamper proof but can damage the surface upon removal, whereas concrete wedge anchors allow for removal but require security nuts to make them theft resistant. If pouring a new concrete pad, bicycle racks can be embedded directly into the concrete, although the rack material, location, placement, and quantity should be carefully considered as removal is costly and complicated. Surfaces such as asphalt, pavers, earth, and mulch are too soft to hold concrete spikes or wedges. In this case, bicycle racks should be embedded into the ground or installed as a free-standing on rails, which can then be secured with landscape nails.

Custom bicycle rack in Tofino, B.C.

Custom bicycle rack in Tofino, B.C.

Custom bicycle rack in Tofino, B.C.

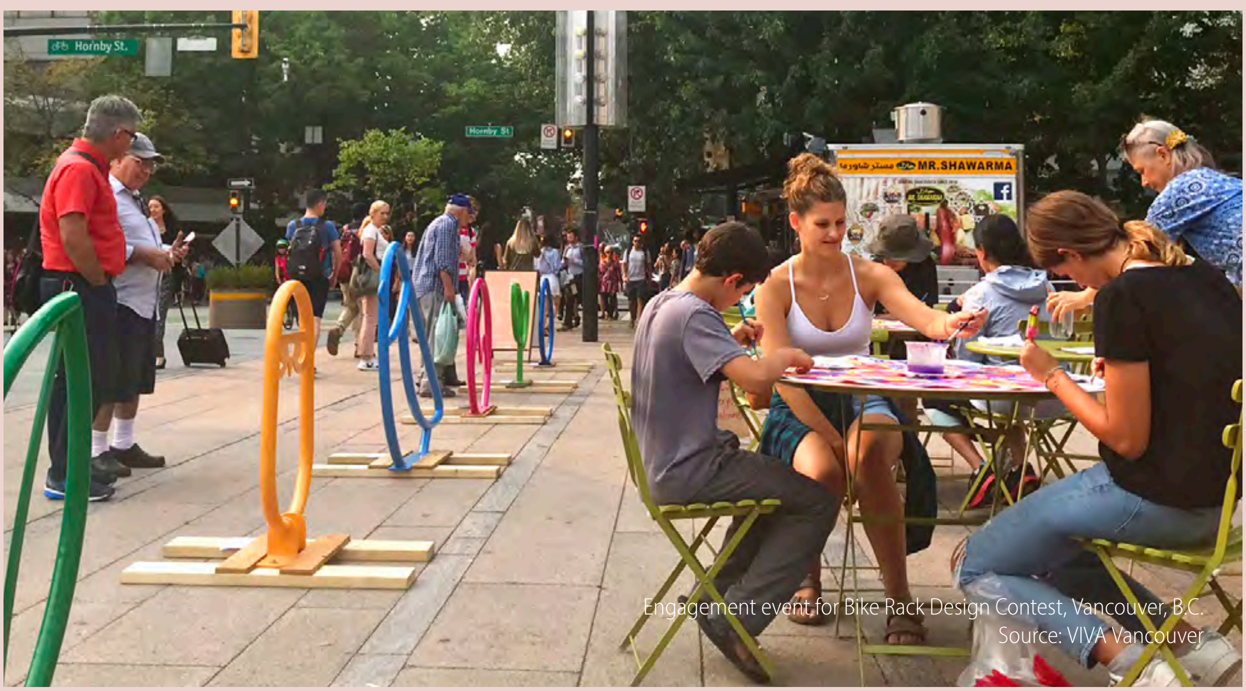
Case Study

Bike Rack Design Contest, Vancouver, B.C.

In the spring and summer of 2018, the City of Vancouver held a Bike Rack Design Contest, encouraging anyone living, working, or going to school in Vancouver to submit fun and functional bicycle rack designs. The basic requirements were that the bicycle rack should hold two bicycles, could be fabricated and installed by the City in a cost-effective way, and would reflect Vancouver in a creative and original way. The objective was to end up with one or more new bicycle rack designs that could be added to the City's existing inventory, with winning entries installed around Vancouver wherever new bicycle parking is needed.

To guide the contest, City staff conducted best practice research and created a visual and easy to read design guide for contestants, covering key rack design criteria such as functionality, security, durability, cost, and accessibility. The contest was promoted primarily via social media, in additional to posters distributed to community centres, libraries, bike shops, schools, and cafes. The City also held two 'Design Jams' where participants were encouraged to design a bicycle rack with support from city staff.

In total, the City received over 450 submissions, which were then shortlisted to 30 designs by an independent jury comprising cycling advocates, artists, and transportation professionals. The design concepts were displayed to the public at an event in the summer, where community members could vote for the 'People's Choice Award.'



Engagement event for Bike Rack Design Contest, Vancouver, B.C.
Source: VIVA Vancouver

The designs were also assessed internally by the City's Equipment Services team for affordable constructibility, reviewing aspects such as the amount of material, number of welds, and complexity of the bends, with the goal of finding fun but feasible designs. The Equipment Services team then built six designs that met their feasibility criteria.

These six designs were showcased at another series of events, where people were able to test them out and vote for a second 'People's Choice Award.' The jury ultimately selected four winning designs based on the competition design criteria as well as aesthetics, safety, and fabrication cost. Each winning designer received a $2,000 prize, as did the designer of the 'People's Choice Award' bicycle rack. Ten to 20 of each winning design will be built and installed throughout Vancouver. After installation, the City will review the designs for final cost and functionality. The contest was very well received by the public, and the resulting bicycle racks will add local flair to Vancouver's streetscape.

Prototype bicycle racks
Source: VIVA Vancouver

Bicycle Rack Placement

When installed within the public right-of-way adjacent to a sidewalk, bicycle racks should be placed in the Furnishing Zone alongside other street furniture such as street trees and parking metres. If there is insufficient width in the Furnishing Zone, bicycle racks can be installed in other areas where additional space is available, such as curb extensions. The Pedestrian Through Zone must remain unimpeded by bicycle racks and parked bicycles. In some contexts, where sufficient width exists, bicycle racks may also be installed in the Frontage Zone and on private property adjacent to building entrances, as long as building entrances are not impeded. A certain number of bicycle racks should be weather protected. This may be achieved simply by locating bicycle racks under existing awnings.

Inverted U and Post and Ring racks are two of the most common and functional bicycle racks to be placed in the public right-of-way adjacent to sidewalks. **Figure H-143** shows the minimum rack dimensions and the space required to park a bicycle.

Table H-39 and **Figure H-144** show the minimum clearance required between bicycle racks and from other sidewalk elements such as the curb, the Pedestrian Through Zone, and sidewalk furniture. Bicycle racks should be oriented so that bicycles are positioned parallel to the curb. They should not be placed in fire zones, loading zones, bus zones, taxi zones, adjacent to accessible on-street parking spaces, or in any other area where pedestrians will require frequent access. When placed next to on-street motor vehicle parking, bicycle racks should be located between stalls in order to avoid obstructing the door zone. Bicycle racks should be a minimum of 1.5 metres from fire hydrants and bus stops.

Table H-39 // Bicycle Rack Placement Dimensions

CLEAR SPACE REQUIRED BETWEEN:	DESIRABLE WIDTH (M)	CONSTRAINED LIMIT WIDTH (M)
Bicycle racks in series (parallel to curb)	1.8	1.8
Bicycle racks in series (perpendicular to curb)	1.2	0.9
Bicycle racks in series (angled)	0.7	0.7
Bicycle rack and face of curb	0.9	0.6
Bicycle rack and street furniture and utilities*	1.2	0.9
Bicycle rack and multi-modal conflicts (curb ramps, driveways, crosswalks, loading zone, bus stops)*	1.2	1.2

*1.5 metres required from fire hydrants and bus stops. 1.5 metres recommended for crosswalks.

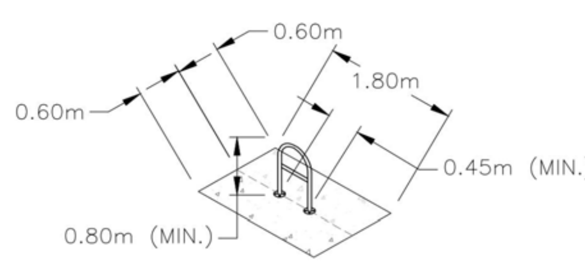


Figure H-143 // Bicycle Rack Dimensions

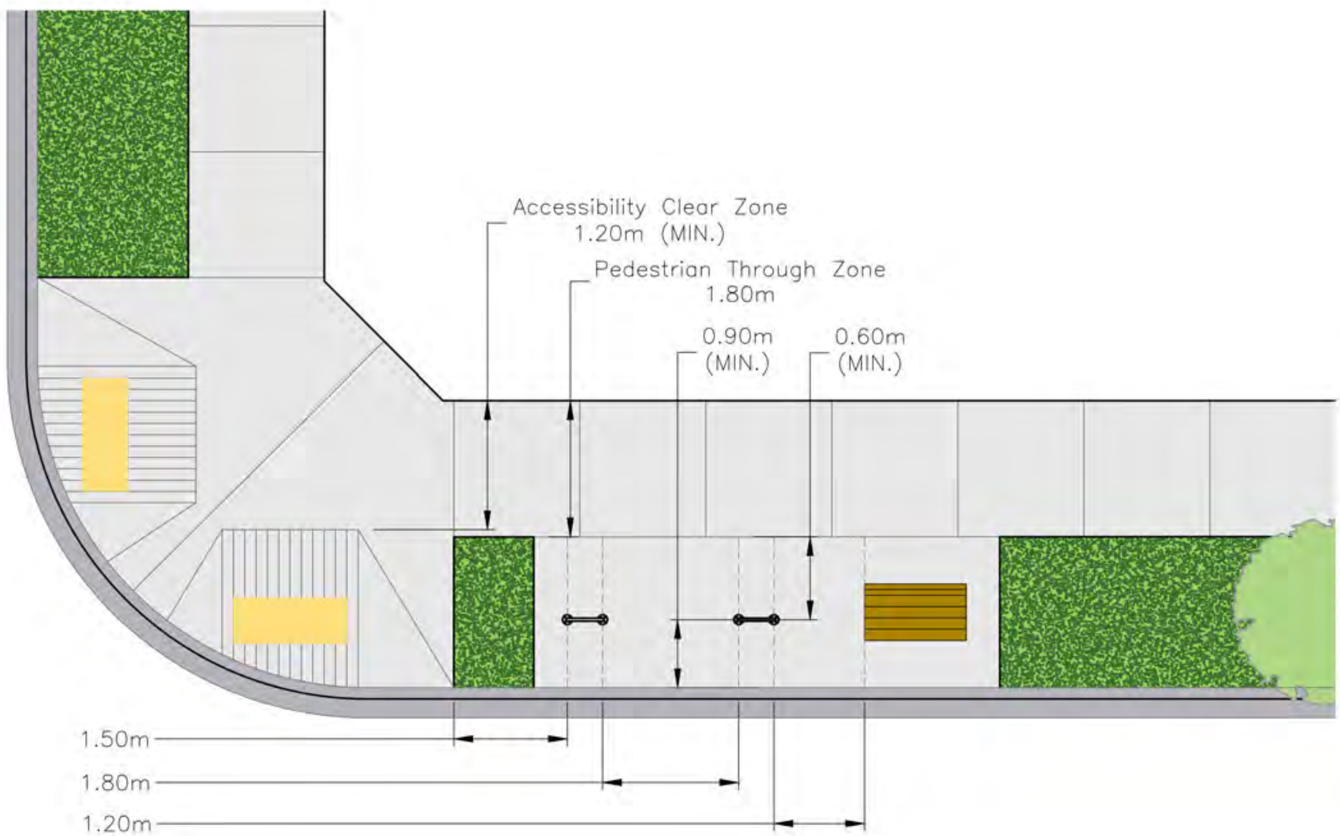


FIGURE H-144 // BICYCLE RACK PLACEMENT ON SIDEWALKS

Bicycle Corrals

Bicycle corrals (also known as in-road bicycle parking) consist of bicycle racks grouped together in a common area on-street within the public right-of-way traditionally used for motor vehicle parking, providing relatively inexpensive high-volume bicycle parking. Typically, one or two on-street motor vehicle parking spaces are converted into bicycle corrals, with each motor vehicle parking space providing capacity for approximately six to 10 bicycle parking spaces. Both parallel and angle parking spaces can be converted. This treatment is beneficial as it moves bicycle storage off the sidewalk, leaving more space for pedestrians and sidewalk furniture. It may be possible to locate bicycle corrals in 'no parking' zones close to intersections or crosswalks. However, when selecting a bicycle corral location, safety of all road users must be considered. This includes considering the visibility needs of motorists and motorist expectations at intersections.

Bicycle corrals are applicable where there is moderate to high demand for short-term bicycle parking, in areas with high pedestrian demand and where there is limited space in the Furnishing Zone for bicycle racks, and where there is ample on-street motor vehicle parking. They are suitable in major commercial and retail areas and may be requested by the business community where demand is high, such as in front of coffee shops and restaurants. Maintenance is an important consideration when planning bicycle corrals, as they can present challenges in terms of road sweeping and snow removal. In some cases, local governments have established maintenance agreements with nearby businesses who requested the bicycle corral.

Figure H-145 shows a typical bicycle corral configuration. Bicycle corrals installed in the road can be protected from motor vehicles with physical barriers such as curbs, curb stops, bollards, planters, or by applying other unique surface treatments. A 1.5 metre maneuvering area is recommended on either end of the bicycle corral to allow people cycling to enter and exit the parking area. Adjacent motor vehicle parking can provide an additional buffer for the bicycle corral. Parking stalls next to curb extensions provide excellent locations, as the curb extension serves as protection for one side of the corral. Bicycle corrals can also be installed adjacent to protected bicycle lanes, with the protected bicycle lane buffer offering protection to parked bicycles. Bicycle corrals can be visually enhanced using planters and vegetation as buffers. Signage should be provided to inform users that the corral is for bicycle use only.


Bicycle corral, Victoria, B.C.

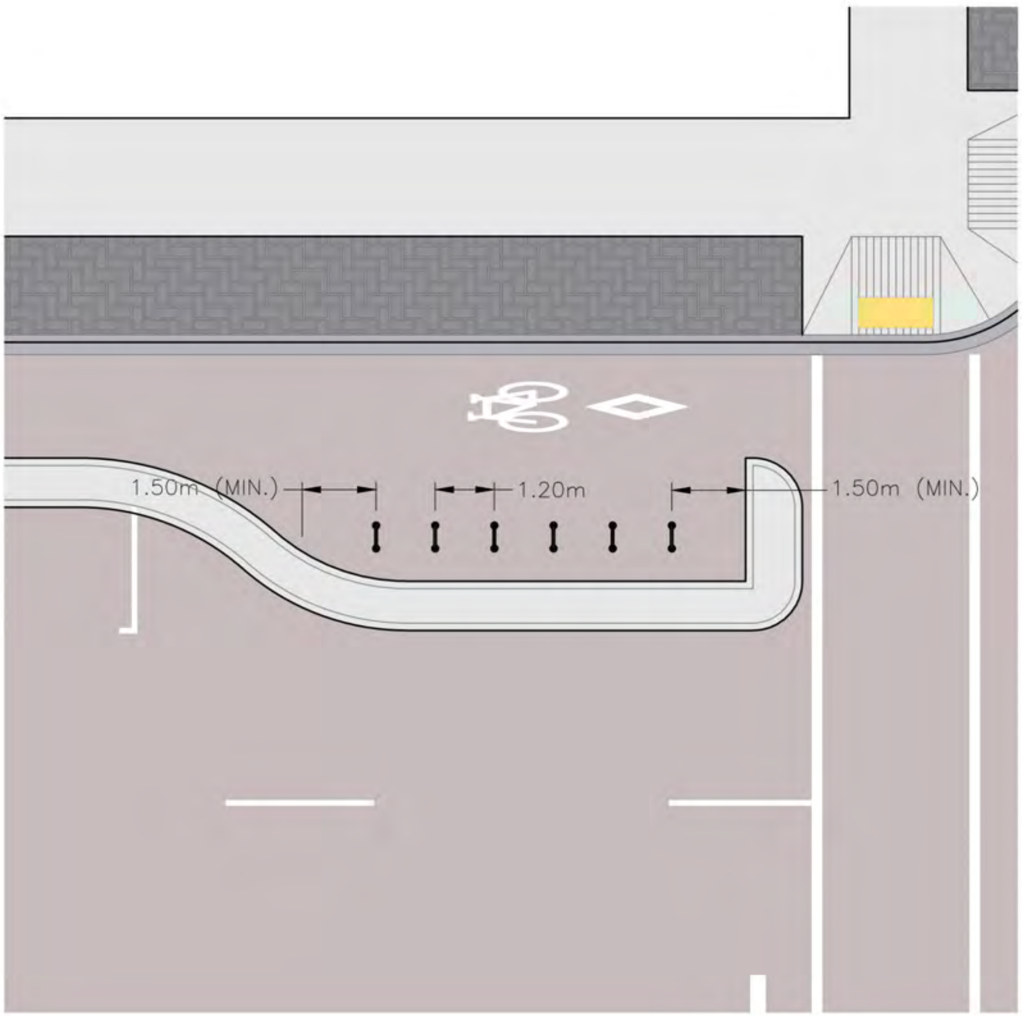


FIGURE H-145 // BICYCLE CORRAL ADJACENT TO PROTECTED BICYCLE LANE

Covered Bicycle Parking

Where space permits, providing covered short-term bicycle parking can improve the experience for bicycle users and encourage all-weather cycling by providing shelter from rain, snow, and sun. Covered bicycle parking is warranted anywhere that bicycle racks may be located, but is most appropriate in a variety of locations, including major commercial centres, areas with sufficient space on the sidewalk or in plazas, and where there is demand for longer-term bicycle parking, such as at schools, universities, recreation centres, community centres, and heavily used transit stops or stations.

There are a variety of designs for covered or freestanding covered bicycle parking structures. Components such as shelters, racks, and roofs may be enhanced with different shapes, colours, and materials. The space needed is dependent on the shelter design and the amount of bicycle parking provided; typically, it is similar to other short-term bicycle parking types, with additional considerations for shelter walls or posts and access aisles if required. The recommended shelter height is 2.5 to 3.5 metres, with a roof area of 3.5 to 4.5 metres to provide adequate weather protection.

Temporary Bicycle Parking at Events

A unique type of short-term bicycle parking is temporary event parking, often called a 'bike valet' service. Bike Valets provide temporary secure, supervised bicycle parking at concerts, sporting events, festivals, and other community events which would normally overwhelm existing short-term bicycle parking supplies. This enables event-goers to travel by bicycle, helping to reduce event-related road and transit congestion. Bike Valet services are often provided by non-profit or community organizations with support from local governments and/or event organizers. The service is typically free for people to use or may accept payment by donation.

Bike Valet organizers coordinate with event organizers to choose a visible site near the event entrance that is large enough to accommodate the estimated number of Bike Valet users. They will then set up a secure enclosure using temporary fencing and fill the enclosure with temporary 'triathlon-style' valet racks. Upon arriving at the Bike Valet, event-goers trade in their bicycle for a numbered ticket and Bike Valet staff or volunteers park the bicycle, similar to a coat check. The numbered ticket must be redeemed after the event to recover the bicycle. Bicycles do not need to be locked to the temporary bicycle racks as they are inside a supervised enclosure, facilitating a faster drop off and return process. Bike Valets may also accept bicycle accessories and personal bags, which are often prohibited inside large events.

Covered bicycle parking, University of Victoria, Victoria, B.C.

Temporary event parking, Vancouver, B.C.
Source: Mike Zipf

LONG-TERM BICYCLE PARKING

Long-term bicycle parking is generally intended for destinations where people cycling will be stopping for two to four hours or longer, including schools and workplaces, multi-family residences, high activity transit stops, and other areas of high cycling activity. Long-term bicycle parking is designed to offer increased security, weather protection, and often higher bicycle parking capacity, but may be less convenient than short-term bicycle parking. On-street long-term bicycle parking can include bicycle lockers and bicycle cages, while off-street long-term bicycle parking can include bicycle cages, bicycle rooms, bicycle shelters, and full-service bicycle stations. Some long-term bicycle parking is public, such as at transit stations, whereas some is located on private property and is only available for residents, employees, or other defined user groups.

Bicycle Lockers

Bicycle lockers are large metal or plastic stand-alone boxes that offer high-security, weather-protected bicycle parking. They are suitable for daily and overnight long-term bicycle parking at locations such as universities and transit stations. In addition to providing secure bicycle parking, bicycle lockers can also securely store gear and other accessories along with the bicycle, giving people cycling more flexibility in their travel arrangements. A flat, level surface is required for installation. They should be installed close to building entrances or on the first level of a parking garage.

Bicycle lockers take up more space than short-term bicycle parking. Bicycle lockers should be a minimum of 1.2 metres tall and 1.9 metres deep, with a minimum opening of 0.8 metres. One bicycle locker typically provides storage space for two bicycles, with a separating partition and separate doors to maintain security. Bicycle lockers are designed to allow the user to roll their bicycle into the locker. Models exist that require bicycles to be hung vertically, which may not be appropriate for people of all ages and abilities. Bicycle lockers do not typically accommodate larger, non-standard bicycles, so additional bicycle parking should be provided.

When planning the layout for bicycle lockers, access to front and back of the lockers must be maintained since they are designed to be accessed from both sides. A minimum clearance of 1.8 metres is recommended between the bicycle locker entrance and any walls or barriers, and a minimum of 2.4 metres is recommended between the entrance and pedestrian flow. Where bicycle lockers are installed facing one another, a minimum of 2.1 metres of clearance is recommended between the two sets of lockers.

Bicycle locker, Kelowna, B.C.

Traditionally, bicycle lockers have been available on a sign-up basis, where a single user is given a key or a code to access a particular locker. Newer computerized on-demand systems offer increased flexibility by allowing subscribers to check for available lockers or sign up on-line. Some models allow keyless access to the locker with the use of a cell phone or SmartCard. Though not required for their use, bicycle locker use can be monitored remotely using the internet. These programs typically have fewer administrative costs because they simplify or eliminate key management, inspection, and locker assignment. Lockers that are available on-demand for one-time use have the advantage of serving multiple riders a week. Monthly rentals, by contrast, provide assurance to renters that their own personal locker will always be available and allows the flexibility of using the space for transitory items required on various days.

Bicycle Rooms, Cages, and Parkades

Unlike bicycle lockers, which only accommodate one or two bicycles, there are several options for secure, high capacity bicycle parking. Bicycle rooms, cages, and parkades are types of off-road, long-term, higher capacity bicycle parking designed for increased security, weather protection, and capacity. They can be built as standalone structures or added to existing buildings or motor vehicle parkades. These facilities are suitable at post-secondary educational institutions, transit stations, and dense commercial or residential buildings. Each of these facilities consist of enclosed structures containing bicycle racks and secured with a locked door. These facilities vary by enclosure type, capacity, level of security, means of access, and other features. Some bicycle rooms and parkades also include other end-of-trip amenities. The following design considerations can be applied to bicycle rooms, cages, and parkades.

Safety and Security

Bicycle theft is one of the most significant deterrents to bicycle use, particularly for bicycles that are parked for an extended period of time. Long-term use of bicycle parking facilities requires a high level of safety and security both for parked bicycles and for the bicycle users themselves. It is recommended that bicycle rooms and parkades have solid opaque exterior walls from floor to ceiling, while bicycle cages should have an exterior structure made of expanded metal mesh from floor to ceiling. The door and frame should be constructed of steel and have tamper proof hinges.

Off-street bicycle parking facilities should be well lit, and a window may be provided in the door to provide permanent visual access. Additionally, an emergency help button can be installed in bicycle rooms and parkades. Surveillance is key for ensuring both user and bicycle safety, so parking facilities should be located in

Bicycle room, Victoria, B.C.

a monitored area. If the bicycle parking is located in an attended parking facility such as a parking garage, the bicycle parking should be located within 30 metres of an attendant or a security guard, or alternatively, the bicycle parking must be visible by other users of the parking facility.

Access and Convenience

Often, high capacity facilities can be located in parkades or basements, which can present access challenges. Bicycle parking facilities should be located no lower than the first level below grade to ensure that the facility is easily accessible, convenient, and that there are fewer potential conflicts between bicycles and motor vehicles. Access to the bicycle facilities should either be directly from the road or via an approach that people cycling can access without having to dismount. If the bicycle parking is located on a separate level, access should be provided by installing a ramp, elevator, or stairway with bicycle channels to avoid requiring people to carry bicycles up or down stairs. Ideally, the ramp access should be separated from motor vehicles.

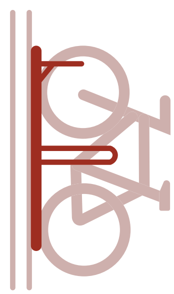
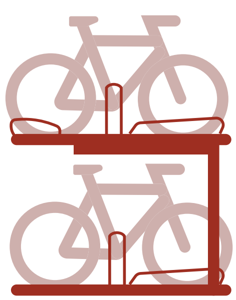
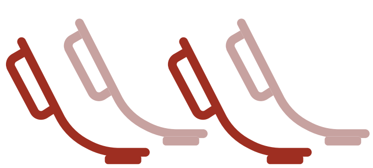
Access to the bicycle room, cage, or parkade can be provided through security cards, non-duplicable keys, transit cards, or pass code access. Where there is a high demand for bicycle parking, several small compounds or rooms provide more security than one larger room, as the number of people who have access to each compound or room is reduced. Requiring a key or a code in order to access the bicycle parking facilities is a barrier to incidental use, and this method of access is most suitable to facilities that are for designated user groups, such as employees.

Access to Translink bicycle parkade

High Density Bicycle Racks

The bicycles racks described in **Table H-40** can be used inside an enclosure to provide suitable off-road, long-term bicycle parking. However, in applications where parking density is a top priority, alternative bicycle racks may be considered **(Table H-40**). High density bicycle racks often fail to meet the full set of bicycle parking performance criteria, such as universal accessibility. A minimum of 50% of all bicycle parking spots in any off-street, long-term bicycle parking facility should be basic, on-ground bicycle racks that serve all ages of abilities, with high density bicycle racks providing additional capacity as needed.

Table H-40 // High Density Bicycle Racks

RACK TYPE	NOTES
Vertical 	• Space-efficient and often used for indoor, high-density bicycle parking. • Must allow bicycle frame to be securely locked using a u-lock. • These racks may not accommodate non-standard bicycles and are not accessible to users of all ages and abilities, as they require lifting the bicycle into place. • Additionally, they can cause safety concerns if bicycles are not secured properly. If used to increase bicycle parking density, they should be combined with accessible on-ground parking.
Two-Tier 	• Space-efficient and often used for indoor, high-density bicycle parking. • Must allow bicycle frame to be securely locked using a u-lock. • These racks may not accommodate non-standard bicycles, they require additional maintenance of moving parts, and they may cause safety concerns if bicycles are not secured properly. • In order to increase their accessibility, two-tier bicycle racks should include pneumatic or mechanical lift assist for the upper rack. Two-tier racks should be tested before application as their performance varies significantly between manufacturers.
Staggered Wheelwell-secure 	• A variation of the wheelwell-secure rack that is designed to stagger handlebars to mitigate handlebar conflict and increase parking density. • As with wheelwell-secure racks, they may accommodate fewer bicycle types than Inverted U or Post and Ring racks.

Bicycle Parking Layout

Figure H-146 shows key dimensions for bicycle rooms, cages, and parkades. The entrance to a bicycle room, cage, or parkade must be at least 1.6 metres wide to allow a variety of bicycle sizes to gain access. Consideration should be given to including an automated doorway opening system, similar to an accessible push button, to facilitate convenient entry/exit by bicycle users. Sufficient width should be provided along any hallways or access points to the bicycle parking facility. The enclosure itself must be designed to allow a person to walk beside their bicycle and maneuver the facility to find an available bicycle rack.

If standard on-ground bicycle racks are used and are located perpendicular to a wall, at least 0.6 metres clearance should be provided if the rack has single-side access, or 2.5 metres clearance for a rack with double-sided access. If the bicycle rack is located parallel to a wall, at least 0.6 metres clearance should be provided. Bicycle racks should have at least 1.2 metres of space between them. A clear aisle of at least 1.8 metres should be maintained between bicycle racks holding two bicycles.

Off-street bicycle facilities should have a set percentage of spaces that are required to accommodate non-standard bicycles such as cargo bicycles and bicycles with trailers. Multi-family residential buildings and schools should have the highest proportion of non-standard sizes, followed by commercial and office buildings. These spaces can be marked with a sign or pavement markings identifying their purpose as a spot for non-standard bicycles, in order to encourage compliance.

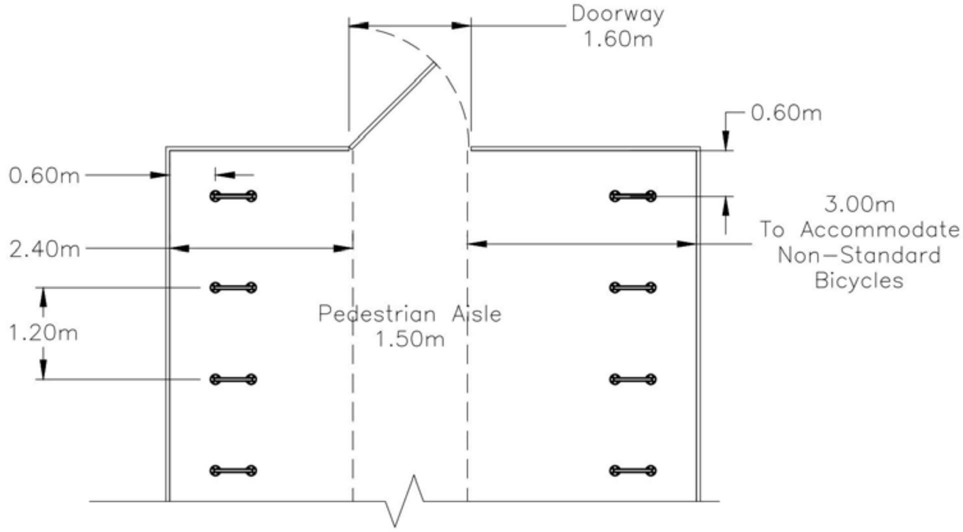


Figure H-146 // Off-Street Bicycle Parking Layout

Bicycle Parking Retrofits

In some existing multi-family and commercial buildings, demand for bicycle parking may exceed the existing supply (if any exists). In some cases, a building may not provide any secure bicycle parking.

In others, the existing bicycle parking may be insufficient, inconvenient, or insecure.

Building owners are strongly encouraged to retrofit their buildings to provide an adequate quantity and quality of bicycle parking. A bicycle room or cage may be constructed as a retrofit, using existing motor vehicle parking spots or other underutilized spaces. However, this may not always be feasible due to cost or space constraints.

In this context, it is still possible to find flexible solutions for long-term bicycle parking. In buildings with parkades, bicycle racks can be installed in private parking spots, either on the ground or in the wall, to provide private bicycle parking without removing any motor vehicle parking. This arrangement works best where parking spots are designated to set individuals and the same person or family owns both the bicycle and the motor vehicle.

The photos shown are from a condominium in downtown Vancouver that has two bicycle cages, both of which are poorly designed and at full capacity. Bicycles are banned inside the building and elevators, prohibiting residents from storing bicycles in their units. Instead, residents are able to install bicycle parking in their privately-owned parking spaces, giving them convenient access and preserving space for their motor vehicles.


Parkade with retrofit bicycle racks, Vancouver, B.C.


Parkade with retrofit bicycle racks, Vancouver, B.C.

Bicycle Stations

Bicycle stations, also known as bicycle hubs or depots, are highly-secure, high capacity, and full-service bicycle parking facilities. Bicycle stations are suitable in high density employment centres with high bicycle parking demand, ideally connected to multi-modal transit facilities. Bicycle stations are staffed, they contain a complete suite of end-of-trip amenities, and they can typically store hundreds or even thousands of bicycles. Bicycle depots or stations are common in Europe and Asia but are increasingly being implemented in North America.

Bicycle station, Potsdam, Germany

Bicycle station, Potsdam, Germany

Bicycle pump and repair stand, Tofino, B.C.

END-OF-TRIP AMENITIES

End-of-trip amenities can support both short- and long-term bicycle parking by making it more convenient to cycle. These amenities help to address challenges or concerns that bicycle users experience, such as needing a place to change or shower after a long ride, store cycling gear, inflate tires, and make minor repairs.

Bicycle Repair Stands

Bicycle repair stands typically include a stand, repair tools, and a tire pump. Anti-theft versions where the repair tools are connected to cables can be provided on-street and in other public places such as parks, transit centres, and post-secondary campuses, especially in places near high-density bicycle parking. Bicycle repair stands can be useful at multi-modal transit stations such as airports and bus terminals to allow people who are travelling with a bicycle to build/reassemble them on-site. They can also be provided off-road in bicycle rooms and bicycle stations. Worksites and other private parties can provide larger repair stations with a workbench and tools within a secured bicycle parking area, although tool theft can be an issue.

Shower and Change Room Facilities

Providing showers and change rooms is a common amenity to encourage bicycle use, particularly for commuter trips, in addition to appealing to employees at office or retail sites who exercise during the work day. Local and regional governments can require these facilities through development regulations and can encourage employers to provide showers in addition to secure bicycle parking as part of a Transportation Demand Management (TDM) program. Short-term lockers or other storage bins can be useful for storing cycling gear that may be needed on a wet or cold ride. It is recommended that lockers are full sized as this allows wet clothing to dry faster.

Shower and change room facilities can also include additional amenities to increase cycling comfort and convenience. For example, in additional to secure long-term bicycle parking, showers, and a change room, the Cycling Centre at Vancouver General Hospital includes a number of additional amenities, including: a clock, maps, bus timetables, tissues, towel service, a 'member of the month' board, a comments and suggestions box, and even a small lounge with foosball and stretching mats. Additional amenities are certainly not required in all contexts, but they can be an excellent way to encourage cycling.

PARKING FOR OTHER ACTIVE MODES

Bicycle are not the only active transportation devices that need secure parking at destinations. End-of-trip accommodation for devices such as skateboards, scooters, in-line skates, and micro-mobility devices are an important considerations. Some of these devices are small enough to be carried around upon reaching a destination, but others require unique accommodation.

One destination where the accommodation of scooters and skateboards is particularly relevant is at schools, from elementary up to secondary and post-secondary levels. Active school travel has been shown to have a number of positive benefits for students' health and learning, but there is often a lack of secure parking facilities and devices may not be allowed inside classrooms. Specialized racks are available that can securely store and lock scooters and or skateboards. These can be installed either inside or outside, although if installed outside, weather protection is encouraged. Providing secure parking of this nature can help alleviate the concerns of students, parents, and school staff about theft and clutter.

Other active modes such as cross-country skiing, snow shoeing, canoe, kayaking require larger spaces to park, but are less commonly used for regular transportation purposes. Local governments, multi-family residences, offices, institutions, and businesses should note when users have special needs and are travelling using alternative forms of active transportation. For example, some Ottawa residents enjoy skating to work along the Rideau Canal in the winter. Meanwhile, in many coastal B.C. communities, there are residents living on boats that are moored away from shore, so residents require smaller boats to travel to and from shore.

If an existing or desired user group is identified, accommodation can be made. This could include device-specific storage racks, such as canoe or kayak racks, and changing facilities to accommodate people who may be wet or need to change clothing. When proper accommodation is not provided, there can be conflict over parking spaces between modes.

Skateboard rack in a high school, City of North Vancouver, B.C.

Wayfinding signage in Gibsons, B.C.

H.3

WAYFINDING

This chapter summarizes design considerations for wayfinding for active transportation. Wayfinding is a decision-making process related to navigation and is important to provide simple, clear, and intuitive information to help people navigate spaces effectively and intuitively. This helps people identify how they can navigate a city, neighbourhood, or active transportation network effectively from their present location to their destination. Wayfinding can include signage, maps, and other trip planning tools. An important component of wayfinding specifically involves signage and pavement markings. However, the references to signage and pavement markings in this chapter speak specifically to signage and pavement markings only for the purposes of wayfinding, and not for regulatory and warning purposes.

A seamless, consistent, and easy-to-understand system of wayfinding, signage, and trip planning tools for both walking and cycling is important. It can make a community's active transportation network easier to navigate, identify the location of important destinations, and provide information about facility type. Most importantly, wayfinding helps people make decisions about how to navigate a community. Wayfinding typically refers to signage and pavement markings which help to guide users to designated facilities and key destinations, along preferred routes, without the assistance of a smartphone or other mapping tools.

It is important to consider that many residents and visitors may not be familiar with the location of existing active transportation facilities or community destinations. A wayfinding system helps provide information about routes, but also helps to identify destinations that can be accessed via a given route or within a short walking or cycling distance. Wayfinding can also help raise awareness of the distance and time that is required to travel to destinations within a community by walking or cycling.

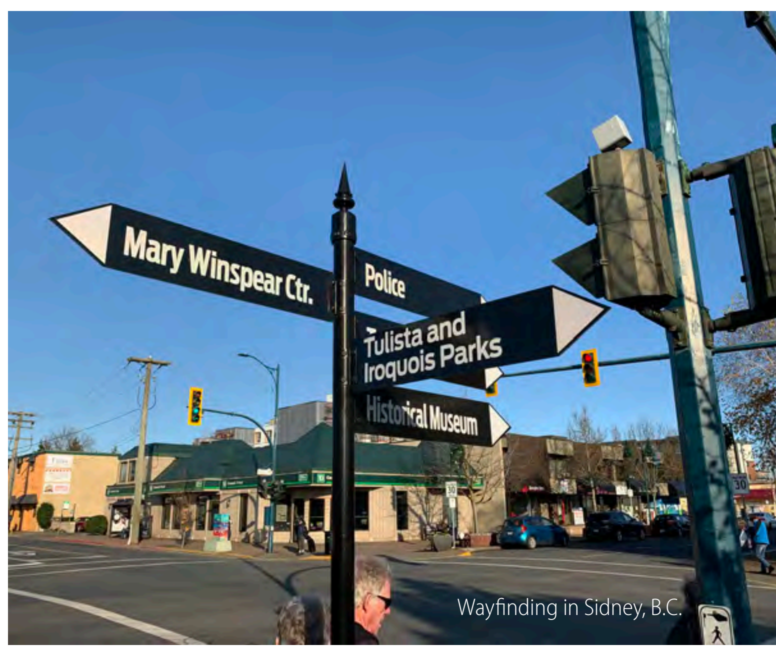
People walking and cycling have very different needs with regards to wayfinding. A person cycling can travel much further and faster than a person walking for the same effort. This produces large differences in how far away a destination might be reasonably signed from. People walking are also more willing to stop and study information, whereas maps, detailed directions and smaller text are difficult to use while cycling. As with driving, to safely manage the information load, a bicycle wayfinding system must be simple and refrain from including too much text on any one sign.

In B.C., cycling wayfinding guidelines have already been developed by both TransLink and the Capital Regional District to help municipalities prepare wayfinding signage plans specifically for cycling in Metro Vancouver *(Getting There By Bike! – Wayfinding Guidelines for Utility Cycling in Metro Vancouver)* and Greater Victoria *(Cycling Destination Wayfinding Guidelines)*, respectively. These guidelines are available on-line and provide advice and designs for bicycle wayfinding across their jurisdictions[1,2]. In addition, the province has also developed guidance for wayfinding signage and pavement markings on roadways under provincial jurisdiction, including the pedestrian and bicycle sign catalogues in the MOTI *Manual of Standard Traffic Signs and Pavement Markings*.

Guidance regarding regulatory and warning signage is provided in earlier sections and in the TAC *Bikeway Traffic Control Guidelines for Canada*. The TAC *MUTCDC* may also be referenced for wayfinding signage options in instances where signage customization is not feasible. Refer to **Appendix B** for further details regarding signage and pavement marking. This chapter also includes other forms of wayfinding, including mapping and trip planning tools.

1 TransLink, *Getting There By Bike! – Wayfinding Guidelines for Utility Cycling in Metro Vancouver,* September 2013.

2 Capital Regional District, *Cycling Destination Wayfinding Guidelines, Capital Regional District*, June 2014.



Wayfinding in Sidney, B.C.

DESIGN PRINCIPLES

Layout

The layout of information should be duplicated for each sign type and the signage should clearly identify that the information is intended for people walking and cycling. Layout features such as size, style, colours, and font choice, should be the same across the wayfinding network, even if it crosses multiple jurisdictions. This will help to make it clear which user the wayfinding is targeted to. For wayfinding on roadways under provincial jurisdiction, the MOTI *Manual of Standard Traffic Signs and Pavement Markings*.

Simple

The information that is being conveyed should be structured and presented to the intended audience in a clear and logical form. The information provided needs to be read quickly at the desired travel speeds. While people walking may have more flexibility and willingness to stop, people cycling need to be able to maintain an even pace as they take in the information and identify their desired route. For both pedestrian and cycling wayfinding, simple and easily read wayfinding signage should be provided over complex messaging, such as listing too many destinations or providing unnecessary additional text.

Predictable and Consistent

When the information that is being shared is predictable, it can be quickly recognized, understood, and used. Predictability can relate to a number of aspects of wayfinding information, from the placement of a sign to the design of its contents. Predictability also means that understanding can be recalled for use in new situations and unfamiliar areas. In addition to predictable placement and content, the consistent use of an agreed list of road and destination names and references allows for users to confidently use wayfinding signage to reach destinations and follow routes across different jurisdictions. A consistent set of references also helps users trust and learn the system and apply their knowledge to new journeys.

Branding

A consistent brand along a corridor or network that is easily tied to local context is helpful to ensure that users know they are continuing along the same network. In some communities, the municipality's logo is often used to provide local community branding. Trail-specific branding could be considered for regional, provincial, and even national facilities that serve multiple jurisdictions, such as 'The Great Trail' (formerly known as the Trans Canada Trail).

Progression

It is important to provide a manageable amount of information to people at one time, as too much information can be difficult to understand and be unnecessary. Too much information can make decision-making challenging and leave people second guessing themselves. In particular, wayfinding for cycling is similar to guide signing for drivers: information provided to riders who are moving must be provided in advance of where major changes in direction are required, repeated as necessary, and confirmed when the turning movement is complete.

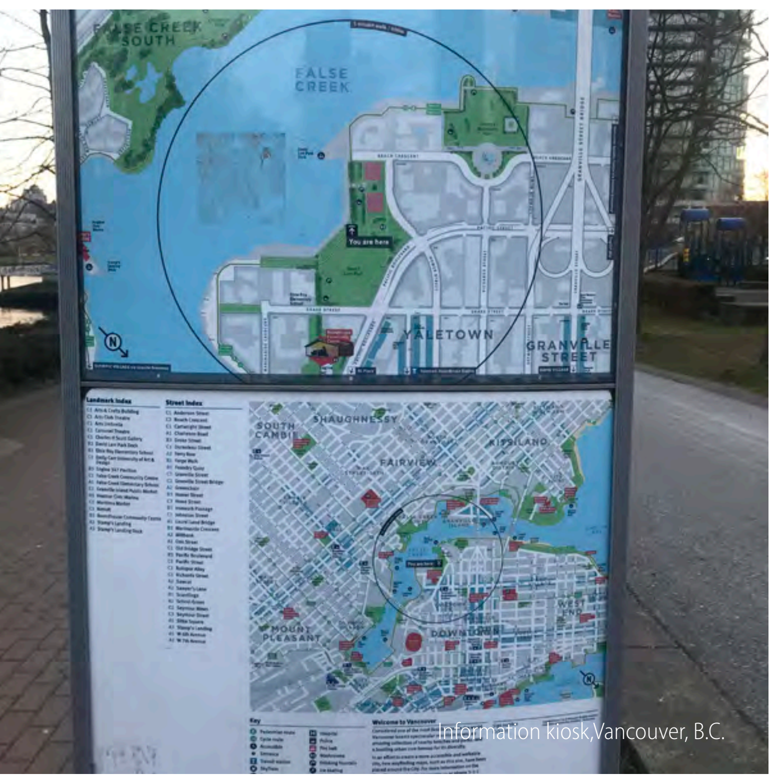
Context

The frequency and type of information that is provided on wayfinding materials will vary depending on the context in which the materials are being used. For example, there will be a difference between wayfinding that is being used along on-street facilities when compared to an off-street pathway. On-street signage, for example, will typically be required at higher frequency due to the prevalence of intersections and opportunities for decision-making. Off-road facilities may require less frequent spacing serving to remind people walking and cycling of the pathway they are on and to communicate choices at intersections or where the pathway branches.

PEDESTRIAN WAYFINDING

People walking and people cycling have very different needs when thinking about wayfinding. The size of the signage and text is an important consideration, as is the information conveyed. As a person cycling often travels at a faster speed and to a further distance when compared to someone walking, the destinations identified need to be within a reasonable travel distance based on the mode of travel. People walking are also more willing to stop and study information, whereas maps, detailed directions, and smaller text are difficult to read while cycling.

Pedestrian wayfinding systems can help residents and visitors better navigate through high activity areas of a community. This can include information kiosks with a 'finder map' that identifies key information such as transit routes, community facilities, and businesses. They often provide 'you are here' information with a five and/or ten-minute walking distance. The 'finder map' can also include building footprints, local landmarks, and 3D buildings. Wayfinding materials should be simple, easy to read, accessible to all, easy to install and allow residents and visitors to locate key amenities and facilities within a community. In addition to the detailed 'finder map', an overview map that identifies connections to the wider area can be provided., This map can also provide context of the users' location within a larger area and can help to highlight multi-modal connections if wanting to travel outside the five-minute walking distance. All elements of pedestrian wayfinding should be designed to work for a wide range people and be inclusive to people across the spectrum of cognitive, visual, and physical abilities. The height content is mounted, the colours used along with other aspects need to be considered to ensure this information can be used by all.



Information kiosk,Vancouver, B.C.

Pedestrian wayfinding should also try to include, information on the location of accessibility aids, such as ramps and elevators, as well as obstacles that may act as a barrier. As noted, the maps can also include information about connections to other active transportation facilities including cycling and transit routes as well as transit stops.

Before installing pedestrian wayfinding, it is important to develop guidelines that outline protocols for route naming and identification of destinations, as well as consistent design and application of route markings and pedestrian signage.

Information Kiosks and Signage

There are typically three main types of pedestrian wayfinding signage.

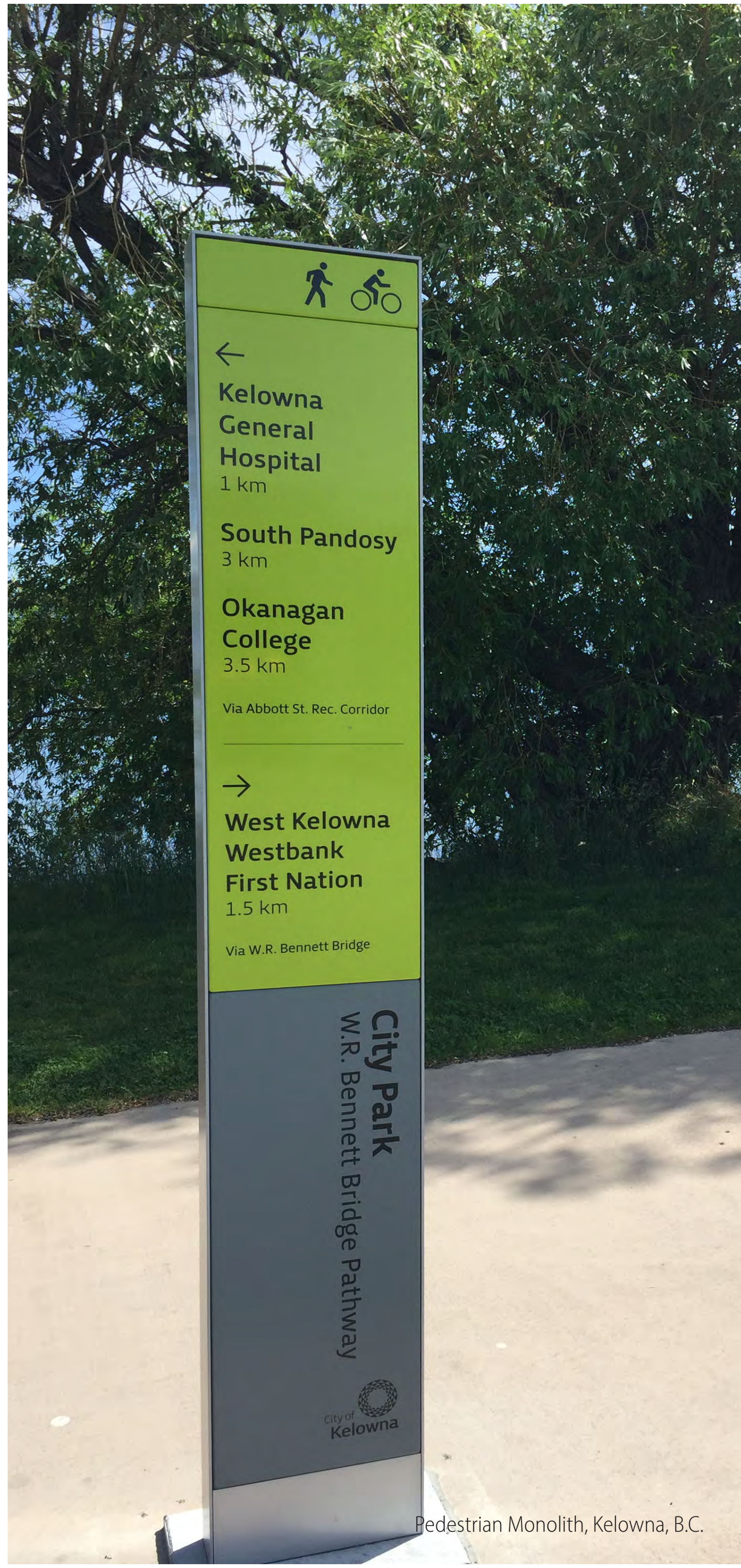
- **Pedestrian Monoliths** display a rich amount of information at dwell points and larger public spaces. They typically include the name/ address of the current location, an overview map, and/or a detailed 'finder map' (as described above). In addition to the mapping information, they can include directions to nearby destinations, any other supporting information, and community branding.

- **Pedestrian Monoliths (Small),** sometimes referred to as a monoliths, are narrower than a full-sized monolith. These signs provide support to walkers at key decision points. Similarly to full sized monoliths, they typically include the name/address of the current location, directions to nearby destinations, an overview map, a detailed 'finder map', any supporting information, and community branding.
- **Pedestrian Fingerposts** provide simple directional information to nearby destinations as a final step in a walker's journeys, or where it is simpler to point to everything in one direction rather than providing a map. Times and routing conditions can also be added. These signs should provide visibility from a distance and include recognizable brand identity.
- **Digital Hubs** can also be incorporated into the pedestrian wayfinding program that include interactive maps that can integrate transit information or provide interpretive information.

Placement and Siting

Some high-level considerations on placement and siting note that pedestrian wayfinding facilities should be located:

- Typically, on corridors with high levels of foot traffic;
- At intersections or junction points to help with route decision making;
- Where there is lighting to ensure the information is readable after dark and in winter conditions; and



Pedestrian Monolith, Kelowna, B.C.

- A minimum 0.5 metres from the curb edge and outside of the 1.8 metre clear zone (typically located in the Furnishing Zone).

CYCLING WAYFINDING

Similar to pedestrian wayfinding, cycling wayfinding should be simple, easy to read, intuitive, and provide people cycling with a level of confidence that they are travelling on the most efficient and accessible route. Like pedestrian wayfinding, bicycle wayfinding should be considered a component of a jurisdiction's overall wayfinding system, integrating information into kiosks, printed or digital routing tools, and other resources as applicable – allowing for a seamless wayfinding experience across modes. Making such information available at key community destinations such as parks, transit centres, and major bicycle parking hubs can aide a bicycle user's trip planning. This section outlines important aspects for ensuring wayfinding effectively complements bicycle facilities.

The guidance outlined in this section is consistent with TransLink's *Wayfinding Guidelines for Utility Cycling in Metro Vancouver* and the Capital Regional District's *Cycling Destination Wayfinding Guidelines*. It is recommended that communities or jurisdictions interested in implementing their own bicycle wayfinding program refer to these documents for more detailed information.

Signage is necessary at decision points within the network to guide people cycling to their destination. In most situations, two signs are recommended in each direction at an intersection. These include a decision sign before the turn and a confirmation sign after the turn and/or at regular intervals along a corridor. In some situations, it may also be useful to add turn fingerboards to provide clarity at complex intersections, or waymarkers to highlight routes. To identify their function as bicycle wayfinding signage, bicycle wayfinding signage should include a bicycle symbol, where applicable.

A comprehensive wayfinding system should consist of several types of signage and/or pavement markings to ensure a bicycle user is on the best route to their destination. The two primary categories of bicycle wayfinding signage are described below.

- **Decision Signage:** On the approach of a decision point (typically an intersection), decision signage provides direction to select destinations through the use of directional arrows. Decision signage should not repeat information provided on signs for motorists to avoid information overload. Decision signage is particularly important when people cycling require different information than motorists, such as different destinations that may be of more interest to non-motorists or bicycle route decision. Decision signage should be located at a safe stopping distance before the turn (refer to **Chapter G.1** for safe stopping distances for people cycling). On roadways under provincial jurisdiction, if there are no turn lanes present decision signs should be placed approximately 50 metres in advance of the intersection. It is important that decision signs are located so that it is clear which turn is being referred to. On routes where speed is likely to be high, decision signs can be repeated ahead of the turn. To manage the amount of information provided on one sign, decision signs will typically contain up to three destinations.
- **Confirmation Signage:** The confirmation signage is placed after decision points. These signs provide confirmation, reassure people cycling of their direction, and confirm additional destinations reached along the route. Confirmation signs will also provide information about other destinations that may be reached on the route. Confirmation signs should be located at 20–30 metres after turns and should be repeated for reassurance every 400 metres in urban areas and every 800 metres in rural areas. Because confirmation signs are located

after turns where the information load is less distracting, it is possible to include more information about destination names and distances. Typically, three to four destinations would be shown in ascending order.

- **Special Situation Signage**
    - ***Turn Fingerboard*** *– Optional turn fingerboard signs can be placed after the decision sign, at the point of the turn, to highlight unusual or easily missed turns. Fingerboards are useful for complex turns as the shape of the sign is advantageous because it clearly shows direction.*
    - ***Off-Network Waymarker*** *– Waymarkers can be used on non-designated routes to guide people cycling to the designated cycling network. They are specifically intended to indicate short linkages to designated bicycle routes from other roads or paths. They are not intended to be used to mark the route of a designated bicycle facility.*

Cycling Wayfinding on Roadways Under Provincial Jurisdiction

For wayfinding on roadways under provincial jurisdiction, the province has developed a series of bicycle route markers to identify bicycle facilities (see **Figure H-147**). These signs should be located at key decision points where people cycling can choose between routes (such as intersections), and at other locations where clarification is needed on route direction or continuity. Modification of these decisions signs to suit local conditions is recommended. For example, decision signage can include a highway shield in the lower two thirds of the sign, or this highway shield may be replaced with other relevant information such as 'City Centre' or 'Alternate Route.' If the signage directs bicycle users towards an

Turn Fingerboard, Richmond, B.C.

Confirmation Sign, New Westminster, B.C.

Off-Network Waymarker, Victoria, B.C.

overarching final destination, this information may be placed below the bicycle symbol.

Alternatively, decision tabs may be used to supplement a Bicycle Route guide sign to identify destinations or other locations of interest to cyclists. Generally, the number of destinations listed below the Bicycle Route sign should be limited to three for ease of reading and comprehension while cycling. When located on-street, or where visible to motorists, the destination tabs should always be used in conjunction with the appropriate Bicycle Route guide sign. When located on a separate bicycle facility or multi-use facility that is not visible from a roadway, the destination tabs may be used without a parent guide sign.

Whenever possible, distances should be included with the destination tabs. Typically, distances should be indicated in kilometres and the unit of measurement may be omitted. Distances in metres or minutes may also be used and are more applicable for urban areas. If distances are represented in units other than kilometres, the unit (metres or minutes) should be included on the tab.

Design Sign
Highway Shield

Design Sign with
Additional Destinations

Bicycle Route Sign with Decision Tabs

Figure H-147 // Types of Bicycle Wayfinding Signage (Roadways under Provincial Jurisdiction)

Case Study

Sea Island Cycling Wayfinding Plan, Vancouver International Airport Authority

In 2012, the Vancouver International Airport Authority developed a Cycling Plan for Sea Island, where the airport is located. One of the key actions identified in the Cycling Plan was to improve cycling wayfinding. In 2013, the Airport Authority subsequently developed and implemented a detailed bicycle wayfinding plan for Sea Island, including the identification of specific sign locations and sign content to make it easier for people cycling to navigate through the Sea Island bicycle network. This study was informed by the TransLink *Wayfinding Guidelines for Utility Cycling in Metro Vancouver* with a focus on implementing those guidelines in a manner that reflected the unique context of Sea Island. The Airport Authority has implemented the recommendations of the study throughout Sea Island to make the bicycle network easy to navigate, including decision signs, confirmation signs, and turn fingerboards. A unique component of wayfinding on Sea Island is the inclusion of both official languages on signage due to federal government sign requirements.

Placement and Siting

The frequency of signs and the provision of destination information will depend on the land use context. It is important to ensure that signage is only provided when helpful, without creating sign overload.

Destination Hierarchy

Connecting people to destinations is one of the key principles of providing wayfinding. A hierarchy of destinations allows transportation professionals to prioritize what information to include when all destinations will not fit on a sign. A destination hierarchy should be based on distance, the importance of a destination for riders in an area, and the provincial, regional, or local significance of a location. The TransLink and Capital Regional District documents provide guidance on establishing destination hierarchies. These two guides identify four levels within the hierarchy.

If a wayfinding program is being developed at a regional scale or intended to be consistent across neighbouring municipalities, then all municipalities should agree to the hierarchy.

Level 1 – Centres

These can be regional, municipal, town, or urban centres depending on the context. They are characterized as being major centres of activity that offer a range of attractions and services and provide primary geographic orientation points. Level 1 destinations can be included on signs up to 8 kilometres away.

Level 2 – Local Neighbourhoods

These represent centres of a community with sub-regional/municipal/town importance. Local neighbourhoods provide a mixture of services used by local residents and visitors and should be determined in alignment with local Community Plans. They should be suitable reference points as they are well-known and unambiguous. Level 2 destinations are included on signs up to 4 kilometres away.

Level 3 – Major Attractions

These trip attractors include transit stations and exchanges, major tourist venues, regional parks, and post-secondary education institutions. Level 3 destinations are included on signs up to 2 kilometres away.

Level 4 – Local Destinations

A community may wish to extend the wayfinding system to include local destinations. This may be useful to reflect the nature of lower density areas or to integrate bicycle wayfinding with walking wayfinding on multi-use pathways. They may also be useful if a municipality wishes to provide wayfinding signage on a route that does not connect Level 1–3 destinations. It is, however, important to consider the principles and in particular, the need to keep information simple and consistent. Overloading signs with information often has the unintended effect of making them harder to understand and use. It is not practical to list all the possible local destinations across a community, but the following represents some classifications that may be useful:

- Recreational bicycle facilities;
- Shopping centres;
- Business parks;
- Parks, open spaces and sports facilities;
- High schools;
- Landmarks;
- Healthcare facilities;
- Public washrooms;
- Bicycle repair shops; and
- Civic facilities such as community centres, or libraries.

Level 4 destinations are included on signs up to 2 kilometres away.

Accommodating Differing Audiences

Signage should be legible and useful for a broad range of riders and across different contexts.

- **Cycling Route Signage in Urban Contexts**: Due to the higher number of destinations and bicycle route intersections, signage postings should be every few blocks, or wherever decision points arise.
- **Cycling Route Signage in Recreational Contexts**: Recreational networks tend to be regional in nature, composed of off-street facilities or along less travelled roads. As such, confirmation and decision signage might be spaced at 800 metre intervals, with supportive primary level destination information. Signage intervals may differ based on the network context.
- **Cycling Route Signage on Provincial Roadways**: The province has a list of signage options and guidance on when and where each of the signs should be used (see **Figure H-148**). Decision signs should be located 50 metres in advance of intersections or before the beginning of an off-ramp or the longest turn lane taper. Confirmation signs should be installed approximately 10 metres after an intersection, and spaced approximately 1.5 to 2 kilometres between decision points. Spacing can be reduced to approximately 400 metre spacing in urban areas.

When designing a bicycle wayfinding network, it is important to provide as much information as necessary to give people cycling a detailed sense of their location, particularly on off-road facilities. Including road names on bicycle underpasses or overpasses, helps inform people cycling where they are along a given pathway and will help inform decisions as to where they should exit the pathway. More information on wayfinding for multi-use pathways and trails can be found below.

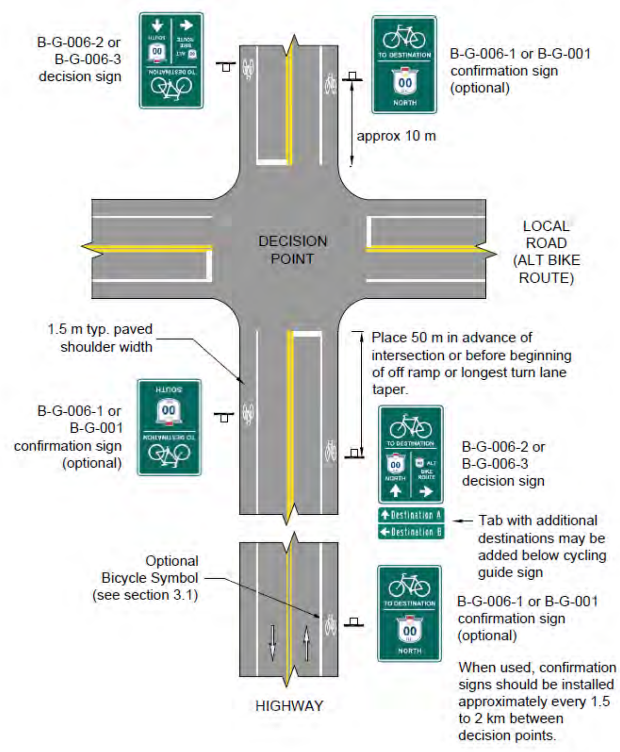


Figure H-148 // Cycling Guide Sign Layout at Decision Point

PAVEMENT MARKINGS

Some communities use pavement markings to supplement the wayfinding network. Such treatments can include coloured striping along the edge of pathways, or symbols that show distances and remind people where the route goes. Shared lane markings (sharrow) can be used on bicycle boulevards to provide confirmation information. Wayfinding pavement markings can also be used at decision points. Wayfinding pavement markings should only be used as a supplement to signage, and not in place of it. It should be noted that there will be additional maintenance costs when using pavement markings for wayfinding, and these should be factored into project life cycle costs.

MULTI-USE PATHWAY AND TRAIL WAYFINDING

Well designed wayfinding and signage allows pathway users to navigate and use off-street pathway networks with ease and efficiency. Wayfinding systems act as visual aids to help users know how to interact with the space and help to ease or prevent potential conflicts between users, the environment, or other hazards to facilitate positive experiences. Wayfinding signage can also communicate important details on the intended use and difficulty of certain pathways. It can also remind users of the etiquette they should be following so they know when to give way to more vulnerable users.

Wayfinding should be consistent with adjacent standards for signage. Many trails within communities are located on federal or provincial Crown land or private land. Parks Canada or the Province, through Recreation Sites and Trails B.C. (RSTBC)[33], have their own signage standards that are well established. Private land owners may choose to have signs that look different as well. It is important to coordinate with adjacent land owners to ensure that wayfinding systems work together. This will typically require confirming the property ownership a trail is located on and coordinating with owners. Examples of wayfinding signage types for off-street pathways and trails is provided in **Table H-41**.

3 'Signs' and 'Kiosks', Infrastructure Drawings, Recreation Sites and Trails BC, accessed June 11, 2019, *http://www.sitesandtrailsbc.ca/about/infrastructure-drawings.aspx*

WAYFINDING SUPPORT PRACTICES

There are a number of other tools and considerations that can help to support the development or maintenance of an existing wayfinding program. For example, an often-overlooked component of wayfinding systems is the internal data and management associated with wayfinding materials. There are also other tools that can help raise awareness of active transportation facilities more generally such as network maps and trip planning tools.

Network Map and Trip Planning

In addition to wayfinding and signage, there are other tools that can help increase awareness of active transportation networks and help users navigate the network. This includes features such as trip planning tools and route maps. These are typically a cost-effective approach that can make people feel safer and more comfortable walking and cycling, while encouraging increased use of active transportation facilities. Communities can individually, or in partnership with neighbouring communities, develop bicycle route maps that identify existing pedestrian and bicycle facilities as well as the level of comfort along designated bicycle routes. These maps can also provide information on the location of bicycle parking, bike share stations, transit stations, community destinations, etc. Route maps should be available on-line or as an easy to carry hard copy and updated regularly. Communities should also look for opportunities to share network information through other emerging technologies as a way of integrating available transportation information. Providing multi-modal trip planning information in one consolidated place can make planning trips by bicycle, foot, and transit convenient and effortless. There are opportunities to work with local researchers and universities/colleges to explore sharing bicycle network and other transportation infrastructure through innovative mobile applications.

TABLE H-41 // OFF-STREET PATHWAY SIGNAGE TYPES

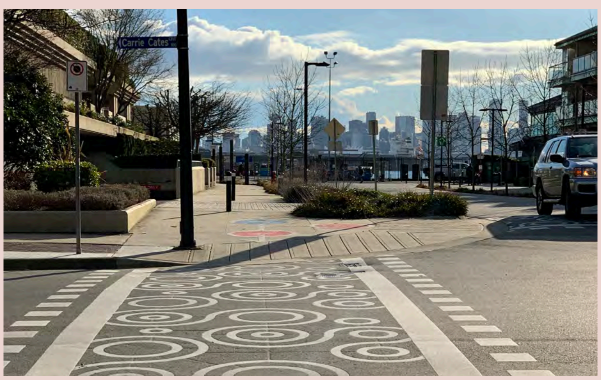
Sign Type	Placement	Components	Purpose
Trailhead Kiosk	Trailheads	• Area map • Safety information • Trail etiquette information • Environmental information	To provide an overview of the trail use area and provide information to trail users regarding safety, the environment, etiquette, and wayfinding.
Trail Direction Sign	Trail Intersections	• Direction • Trail name • Trail difficulty (if applicable) • Trail user (if applicable)	To provide direction information and indicate the difficulty level and user types permitted on a trail.
Property Sign	Where trails cross property lines	Small information sign	To alert users when they are crossing a property line.
Environmental Signage	At points of special environmental consideration	Interpretive sign	To indicate where and explain where environmentally sensitive areas are and to discourage disturbance.
Interpretive Signage	At important historical locations	Interpretive sign	To provide information on historical events or other points of interest.
Hazard Signage	At natural hazards, or busy road intersections	Warning sign	To warn trail users of potential hazards.
Etiquette Signage	At trailheads, trail intersections	Warning sign	To communicate the appropriate rights-of-way for shared trails and to communicate proper trail use.
The Great Trail Signage (formally known as the Trans Canada Trail)	Along the Great Trail	• Great Trail logo • Directional arrows	To indicate the route for the Trans Canada Trail.

Case Study

Creative Pavement Markings, North Vancouver, B.C.

The City of North Vancouver has applied the use of creative wayfinding and pavement markings at several locations along its pathway network. This includes the use of decorative pavement parkings with a distinct recognizable theme of circles along the Spirit Trail, a 35 km pathway that will ultimately extend from Horseshoe Bay to Deep Cove. These pavement markings are used along the pathway and at intersections to make the Spirit Trail a unique, highly visible, and recognizable facility for motorists as well as people walking and cycling.

The City has also applied wayfinding at major destinations such as the Lonsdale Quay to identify destinations with arrowheads and colour, and has also used creative pavement markings on several pathways to make the experience along the pathway fun and inviting for people of all ages.



Signage Inventory

Having an inventory of existing signage is helpful when municipalities are maintaining existing signage and expanding their network. Having a list and/or map that identifies the location of different types of signage can be beneficial. Additional features that could be documented include, but are not limited to, maintenance dates, material type, and any other location details.

Standardized Design Files

Standardized design files associated with the production of symbols for on the road wayfinding, as well as for posted signage, should be documented and saved in an accessible location. This will allow multiple individuals to have access as necessary. In addition, the sharing of this information through open data may allow individuals to develop apps, websites, and other tools which may be of additional use to the cycling public.

Wayfinding signage, Portland, Oregon

Lighting Along Multi-Use Pathway, New Westminster, B.C.

H.4

LIGHTING

Lighting is an important element to consider when planning and designing pedestrian and cycling facilities. Lighting is important for active transportation users because it enhances the aesthetics of the built environment, increases comfort and safety, and helps with wayfinding, navigation, and observation. Lighting also helps to enhance the visibility of road and pathway surfaces, the surrounding environment, and other roadway and pathway users. Lighting can provide significant value in enhancements to both real and perceived comfort and safety. Contextually appropriate lighting design can complement and enhance the design of pedestrian and cycling facilities.

Lighting on pedestrian and cycling facilities is important to help ensure safe, accessible, reliable, and predictable transportation choices throughout all times of day and all seasons. This is especially important for growing and maintaining existing pedestrian and cycling mode share when commuting occurs during periods of low natural light caused by short winter days.

DESIGN PRINCIPLES AND CONSIDERATIONS

Several key principles and considerations should be investigated and analyzed in the design and development of lighting systems for pedestrian and cycling facilities, including the positioning and spacing of the luminaires, local context, safety and security, location and facility type, life-cycle considerations, and all facility users.

Positioning and Spacing of Luminaires

Proper positioning of lighting components will illuminate key features of a pedestrian and cycling facility. Continuous sections of facilities may require lighting as do key features along a facility. Some of the key features that may require illumination include: wayfinding signage, conflict and decision points, and intersections. The position, placement, and angle of luminaires can maximize positive contrast and minimize glare. Consideration should be made to ensure that lighting components are positioned sufficiently away from existing lighting systems to avoid over lighting. Lighting posts and lighting fixtures should also be placed in such a way to minimize impedance to users of pedestrian and cycling facilities.

The spacing between light poles is important because it directly affects the uniformity of the lighting perceived by the user of a pedestrian and/or cycling facility. Uniformity is generally desired as it requires less effort for the user's eyes to readjust to differing lighting levels. Consistent illumination also helps minimize dark patches and shadows along the facility, which is particularly important for helping make pedestrian and cycling facilities more accessible for people with visual impairments.

Local Context

Lighting design should always consider the aesthetic, environmental, safety, security, and social contexts in which a pedestrian or cycling facility is located. The design should simultaneously provide the minimum required lighting to meet desired lighting requirements and address all relevant safety and security considerations, while respecting the local context, minimizing light pollution and trespass, and complementing the built environment.

Lighting can be used to improve the character and attractiveness of the public realm that surrounds pedestrian and cycling facilities. For example, lighting can be used to draw attention to notable buildings, landscapes, and amenities.

Excessive lighting has the potential to negatively impact the natural environment surrounding a pedestrian and/or cycling facility. Lighting that is not active through the night, such as activated lighting systems, (as discussed in further detail below), may impact animal habitat that requires no lighting. Furthermore, lighting along pedestrian and cycling facilities, particularly through large greenspace or urban parks, may further decrease available space for animal habitat and livelihood. As such, impacts to the surrounding environment should be considered in both transportation and lighting design of a pedestrian and/or cycling facility.

Lighting also has the potential to interfere in the community context surrounding a pedestrian or cycling facility. Lighting along pathways may introduce light pollution or trespass to adjacent residential properties. As such, lighting design along pedestrian and cycling facilities should consider impacts to adjacent residential properties.

Safety and Security

Lighting can be used to address safety concerns on pedestrian and cycling facilities since it improves the visibility of the roadway and pathway surfaces, surrounding environment, and other users of a facility, and enables users to anticipate potential conflicts and hazards. This is particularly important for pedestrian and cycling facilities with high variability in user operating speeds, such as multi-use pathways and bicycle facilities along roadways. Lighting should provide users with sufficient sight distance to observe, navigate around, and avoid slower facility users so as to reduce the potential for collisions and traffic-related conflicts.

Lighting can enhance security and encourage people to gather and use public spaces, including pedestrian and cycling facilities. This may, in turn, create actual security through eyes on – and in – pubic spaces. Security considerations in lighting design should always be further investigated to determine if lighting is needed and would result in actual net security benefits to security. While the installation of lighting will help to enhance the safety and security of a given pedestrian or cycling facility, it cannot eliminate or mitigate all related risks. Other urban and transportation design considerations for safety include: having an open design with clear sightlines, ensuring passive surveillance opportunities, providing access to exit routes, and ensuring the availability of emergency assistance, among others.

Location and Facility Type

Lighting design should consider the location and design of the pedestrian and cycling facility it is intended to support. The provision of lighting is often dependent on the volume of active transportation users, which can vary between urban and rural settings. Additional restrictions may be considered in areas with dark sky zones. Dark sky zones are areas designated by municipalities that have Dark Sky compliant lighting so as to minimize light pollution and preserve natural lighting within a designated portion of the community.

Lighting design should consider whether the design is new or meant to support an existing lighting system. Detailed analysis of lighting may be undertaken to investigate whether existing lighting is sufficient to support a proposed pedestrian and cycling facility.

Future Proofing Facilities for Lighting

Lighting on active transportation facilities provides a number of important benefits. However, it may not always be possible to meet the lighting recommendations set out in the Design Guide in all contexts, especially in basic rural and outer developed rural areas. Providing lighting along the length of a facility may be cost prohibitive and may require additional maintenance. Furthermore, accessing power may be challenging – some rural areas lack access to power, with communities relying on alternative sources of power in places (such as solar, wind, generators, and others). Some of these alternate sources of power may be considered for powering lighting, but this is not always feasible. The lack of power can present a large challenge towards providing lighting along an active transportation facility.

In circumstances where the provision of lighting appears to be infeasible, transportation professionals should consider future proofing the facility by installing conduits along the pathway, ensuring that lighting can be added relatively easily if and when funds and/or power become available. Future proofing the facility will prevent having to remove and reconstruct a facility in order to add lighting.

Furthermore, the implementation of lighting can be staged, with areas of highest importance such as intersections and crossings – or areas with readily available power sources – provided with lighting first, and more lighting added along other parts of the facility in the future. In this way, lighting does not have to be perceived as a barrier to active transportation facility implementation.

Furthermore, lighting design should consider the type of pedestrian and cycling facility proposed, as different facilities have different lighting needs and requirements. Pedestrian facilities, on-street cycling facilities, and off-street facilities each have different lighting needs and requirements, as described in further detail below.

Life-Cycle Considerations

Lighting design should consider the serviceability of a proposed lighting system throughout its intended design life, particularly considerations for energy consumption, maintenance, and vandalism. An adequate lighting design should seek to balance providing optimal lighting while minimizing overall energy consumption. Minimizing energy use can be accomplished using LED lighting fixtures, activated lighting systems, lighting timing, and/or efficient lighting design. Over lighting should be avoided as it causes unnecessary and unwarranted energy consumption for a given facility. Lighting design for pedestrian and cycling facilities should account for long-term maintenance considerations and aim to facilitate maintenance, replacement, and cleaning, and be integrated into a local or regional government's existing maintenance program. Vandalism of lighting and lighting fixtures is of concern, particularly in urban areas. As such, specification of lighting fixtures that minimize and discourage vandalism is encouraged.

Users

Lighting design should always consider all users of a facility, as the users determine the type of lighting used, the lighting illumination levels, and the placement and positioning of lighting infrastructure. Lighting design for pedestrians should seek to provide gradual lighting transitions, provide an appropriate colour temperature, and minimize cast shadows. Specific lighting considerations for people with visual impairments should be considered in high traffic areas and frequent points of interest such as arterial roadways and transit facilities.

Lighting design should consider the intended user(s) of the pedestrian or cycling facility, as each user of a facility has different lighting desires and needs. Lighting design requirements, generally, are categorized into lighting for people walking and lighting for people cycling.

The users of both pedestrian and cycling facilities include children, adults, and seniors who walk or cycle as their main mode of transportation. Users of these facilities, particularly multi-use facilities, may also include users with wheelchairs, scooters, in-line skates, skateboards, and recumbent bicycles. Users of pedestrian and cycling facilities typically operate at different speeds, therefore requiring different lighting needs.

For users of a cycling facility, who typically operate at a higher speed than pedestrians, lighting is important because it enhances the visibility of the roadway and pathway surfaces, the surrounding environment, and other users of the facility. It also helps to anticipate potential conflicts and hazards, and aids in wayfinding and ongoing navigation. Typically, bicycle lights are used to indicate their presence to other facility users. However, bicycle lights are not typically powerful enough to adequately illuminate the riding surface or wayfinding devices, and they do not allow bicycle users to be seen from right-angle approaches. Therefore, lighting design of cycling facilities should consider illumination for people cycling at decision points, where signage is located, potential conflict zones, and roadway intersections.

For multi-use facilities, users can include children, adults, and seniors who walk or cycle as their main mode of transportation. Users of these facilities may also include users with wheelchairs, scooters, in-line skates, skateboards, and recumbent bicycles.

TYPES OF LIGHTING

Many active transportation facilities require different mounting styles of lighting than typical road lighting because of the smaller roadway or pathway surface requiring illumination and the human scale of the users.

Street Lamps

The most common lighting for on-street pedestrian and cycling facilities are street lamps. Street lamps are typically used on on-street facilities to illuminate roadways and surrounding infrastructure, including sidewalks and bicycle lanes. Street lamps may be equipped with secondary, shorter luminaires to enhance lighting in dense tree canopies along tree-lined boulevards, where pruning is not possible.

Pedestrian-Scale Lamps

Pedestrian-scale lamps are small-scale street lamps typically placed on off-street facilities such as multi-use pathways and separated bicycle and pedestrian pathways. While pedestrian lamps are more aesthetically pleasing for off-street facilities, their size makes them more conducive to vandalism.

Miscellaneous Lighting

Other types of lighting for pedestrian and cycling facilities exist, such as illuminated bollards, in-ground lighting, and emerging technologies. These types of lighting are mainly used for wayfinding and decorative purposes as they may not provide sufficient illumination for safety and navigation. These types of lighting do not allow users to make out upper bodies and/or faces. They may also require higher maintenance because of vandalism concerns associated with their ease of access to pedestrian and cycling facilities.

Illuminated bollards are a type of bollard that include a lighting fixture, typically affixed to the top of the bollard. Illuminated bollards are typically considered for off-street pedestrian and cycling facilities.

In-ground lighting consists of lighting fixtures whose bulb covers are placed flush with the ground surface. In-ground lighting systems are typically considered for off-road pedestrian and cycling facilities.

Activated lighting systems are a type of lighting that is triggered upon sensing a person walking or cycling. Activated lighting systems are typically considered for pedestrian and cycling facilities that do not generate sufficient traffic to justify ongoing illumination and/or used as a measure of energy conservation. However, use of activated lighting systems should be reconsidered where potential effects of variable lighting on adjacent animal habit exists.

Decorative Street Lighting, Summerland, B.C.

LIGHTING COMPONENTS

Lighting system components are composed of the base, the post, and the fixture (or lamp). For off-street pedestrian and cycling facilities, lighting posts are typically shorter than road lighting. This is because pedestrian and cycling facilities are smaller in road or pathway surface width and area and therefore require less distribution of light over large areas. Moreover, shorter lamp posts evoke a more human scale of infrastructure.

The post height for dedicated pedestrian and cycling facilities (typically off-road facilities) should range between 4.0 to 6.0 metres (as indicated in *ANSI/IES RP-8-18 Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting*). Mid-block crossings are typically designed with lighting posts that are similar in height to adjacent posts or posts that are specified by the authority having jurisdiction.

DESIGN GUIDANCE

Design requirements for lighting are largely dependent on the walking or cycling facility requiring illumination and the intended users of the facility. Furthermore, many communities or agencies have their own standards for lighting within their jurisdiction. As such, all lighting design should be designed at minimum according to the standards imposed by the jurisdiction. There are some additional resources available that provide specific design guidance for lighting on transportation facilities, including:

- TAC *Guide for the Design of Roadway Lighting* (2006)
- MOTI *Electrical and Traffic Engineering Manual* (2013)
- American National Standards Institute *ANSI/IES RP-8-18 Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting* (2018)
- American Association of State Highway and Transportation Officials *Roadway Lighting Design Guide* (2005)

It is important to note that detailed lighting design is generally conducted with the support of detailed lighting software used by an electrical engineer. The guidance in this chapter is not intended to be a replacement, but rather provide best practice considerations and guidance for lighting design specific to pedestrian and cycling facilities.

LIGHTING BY FACILITY TYPE

Required illumination levels can vary depending on the type of facility and the level of activity. It is recommended to include lighting for off-street pathways and on-street bicycle facilities for all new construction or road upgrades. A pedestrian or cycling facility that is designated an all ages and abilities facility and/or is intended to be used for transportation purposes should have illumination along the entire route regardless of facility type. Illumination along the entire corridor will ensure that the pedestrian and cycling facility is accessible and available for all users at all times of day for transportation use.

Pedestrian and cycling facilities that are intended primarily for recreational use during daylight hours may not require full illumination along the extents of the entire route, especially if the facility is located in a non-urban context. Illumination along the entire route may not be practical or appropriate within the environmental context. However, lighting is required at any intersection, junctions, or if the facility is used after dark and in winter months.

The higher the level of activity, the higher the illuminance level, and thus the higher the potential for conflict between users.

Off-Street Facilities

Off-street pedestrian and cycling facilities are defined by TAC as those areas that are located 5 metres or more away from an adjacent roadway. Generally, lighting along off-street pedestrian and/or cycling facilities serves two main purposes: security and guidance.

For people walking, the primary purpose of providing lighting along off-street facilities is to enhance personal security, since these facilities are generally located far from traffic and the roadways; whereas for people cycling, the purpose of providing lighting along off-street facilities is generally to provide guidance along the pathway, illuminate other users of the trail, and anticipate any hazards and potential conflicts.

Regardless of the purpose of the pedestrian or cycling facility, as a minimum requirement, lighting is recommended on off-street facilities a minimum of 25 metres in advance of an intersection[1] . If the pathway is further than 5 metres from an adjacent road, it is recommended that the off-street facility has its own independent lighting system as outlined in the TAC *Guide for the Design of Road Lighting*, Chapter 16 (Off-Road Facilities) and **Table H-42**.

The post height for off-street dedicated pedestrian and cycling facilities should range between 3.0 to 6.0 metres away from adjacent roadways, as this helps to limit glare while still illuminating the pathway.

Lighting is generally considered a requirement for urban residential parks, tunnels, stairs, and areas where security may be an issue. In addition, off-street facilities that serve as an all ages and ability facility within a community's active transportation network and is used for transportation purposes, should have lighting along the length of the route. Off-street facilities that are for recreational use in a non-urban setting may not require lighting depending on the context and use of the facility length.

Table H-42 // Recommended Illuminance Levels for Walkways and Bikeways
Source: TAC *Guide for the Design of Roadway Lighting* – Volume 2 – Chapter 16 – Table 16.1

AREA	MINIMUM AVERAGE HORIZONTAL ILLUMINANCE (LUX)	MAX. HORIZONTAL UNIFORMITY (AVG. TO MIN. ILLUMINANCE)
Walkways and Bikeways	5.0	10.0:1
Pedestrian Stairs	5.0	10.0:1
Pedestrian and Cyclist Tunnels	43.0	10.0:1

On-Street Facilities

On-street pedestrian and cycling facilities are defined by TAC as areas that are located within 5 metres of an existing roadway. The purpose of lighting for pedestrian and cycling facilities adjacent to a road is safety and hazard detection, reading of signs and building numbers, and landmark recognition.

Generally, use of existing roadway lighting is sufficient for facilities located within the roadway allowance, provided the roadway lighting has properly accounted for the level of pedestrian and vehicle activity. On-street facilities with high levels of pedestrian activity or high potential for pedestrian and vehicle conflict will require additional or supplementary illumination through the use of additional lamp posts, secondary luminaires, or pedestrian-scale lighting. The levels of illuminance for on-street facilities are shown in the tables below (**Table H-43** and **Table H-44**). Generally, where the volume of existing or anticipated active transportation users is high, the level of illuminance

1 Ministry of Transportation of Ontario, *Book 18 Ontario Traffic Manual – Cycling Facilities*, December 2013, pg. 116

should be greater. Pedestrian levels refer to the number of pedestrians per hour at the dusk hour.

The levels of pedestrian activity are defined as:

- **High:** Areas where a significant number of pedestrians are expected to be on the sidewalks or crossing the roads after dark (over 100 pedestrians per hour). Examples of high activity areas are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals.
- **Medium:** Areas where lesser numbers of pedestrians utilize the roads at night (10 to 100 pedestrians per hour). Typical this includes downtown office areas, blocks with libraries, apartments, neighbourhood shopping, industrial, parks, and roads with routes transit.
- **Low:** Areas with very low volumes of night pedestrian usage (10 or fewer pedestrians per hour). These can occur on any type of roadway but are likely to be along local and residential roads with single family dwellings, very low density residential developments, and rural or semi-rural areas.

For more information on levels of lighting required based on pedestrian activity and area, refer to TAC *Guide for the Design of Roadway Lighting – Volume 2* – Chapter 9 – Table 9.3.

Pedestrian-Oriented LED Lighting, Vancouver, B.C.

TABLE H-43 // RECOMMENDED ILLUMINANCE LEVELS FOR PEDESTRIANS

Source: TAC *Guide for the Design of Roadway Lighting* – Volume 2 – Chapter 9 – Table 9.3

PEDESTRIAN ACTIVITY	MINIMUM AVERAGE HORIZONTAL ILLUMINANCE (LUX)	MINIMUM VERTICAL ILLUMINANCE AT 1.5M ABOVE PAVEMENT (LUX)	MAX. HORIZONTAL UNIFORMITY (AVG. TO MIN. ILLUMINANCE)
High	20.0	10.0:1	4.0:1
Medium	5.0	2.0:1	4.0:1
Low	3.0	0.8:1	6.0:1

As seen in **Table H-44**, there are two areas that are identified as high conflict areas: 'Mixed Vehicle and Pedestrian' areas, where no physical separation exists between vehicles and pedestrians, and 'Pedestrian Only' areas. For all other areas, the classification is for pedestrian only areas (no mixed vehicle/pedestrian). Areas with a greater level of conflict should have a higher level of illuminance.

CONSIDERATIONS FOR LOCAL ROADS AND NEIGHBOURHOOD BIKEWAYS

Local roads can be very popular routes for walking and cycling as they have lower motor vehicle volumes and speeds which can create a more inviting space for active transportation. Design professionals should note that standard illumination levels along local roads may not be sufficient, particularly if the road is also a designated as a bicycle facility. As a result, neighbourhood bikeways (discussed in **Chapter D.2**) require special consideration when it comes to lighting. These roads are designed to have low motor vehicle volumes and speeds and are designed to be comfortable for people walking and cycling. Adding pedestrian-scale lighting can further enhance the pedestrian environment and can help to communicate to decision-makers and community members that the benefits of neighbourhood bikeways extend beyond cycling.

Design professionals should assess the lighting conditions upon installing a neighbourhood bikeway and, if needed, consider enhancements to the lighting to ensure people cycling are visible, safe, and comfortable riding in all lighting conditions.

Crossings

Potential conflict areas such as intersections, driveways, and alleyway entrances are especially important to illuminate, as all users, especially those at higher operating speeds, need sufficient time to see, assess, and take appropriate action prior to entering the intersection.

Table H-44 // Recommended Illuminance Levels for Pedestrians

Source: RP-8 (2014) - Tables 4, 5 and 6

AREA	PEDESTRIAN ACTIVITY	MINIMUM AVERAGE HORIZONTAL ILLUMINANCE (LUX)	MINIMUM VERTICAL ILLUMINANCE AT 1.5M ABOVE PAVEMENT (LUX)	MAX. HORIZONTAL UNIFORMITY (AVG. TO MIN. ILLUMINANCE)
Mixed Vehicle and Pedestrian	High	20.0	10.0	4.0:1
Pedestrian only	High	10.0	5.0	4.0:1
Pedestrian	Medium	5.0	2.0	4.0:1
Pedestrian	Medium Density Residential	4.0	1.0	4.0:1
Pedestrian	Low Density Residential	3.0	0.8	6.0:1
Pedestrian	Rural/Semi Rural	2.0	0.6	10.0:1

Street lighting, New Westminster, B.C.

Facilities at Intersections

Lighting the intersection helps to make motor vehicle drivers aware of any other users already in the roadway/intersection. At the intersection of an off-street pathway and a roadway, it is recommended that the bicycle facility be illuminated for 25 metres on either side of the intersection so that bicycle users can see the road and are clearly visible to drivers. This applies to both lit and unlit roads. If the road is unlit, transitional lighting should be provided leading up to the intersection so that drivers' vision can adjust to the illuminated intersection.

Signalized Intersections: At minimum, lighting requirements for pedestrian and cycling facilities at signalized intersections should be illuminated to the same levels as that of the intersection. If vertical illuminance is required, then the vertical levels should be equal to or better than required horizontal illuminance levels. When the configuration of an intersection changes, or the classification of a road is modified, the pedestrian conflict level of the intersection (as identified in **Table H-41**) should be revised. When this occurs a lighting evaluation of the entire intersection is recommended to ensure compliance with current standards.

Unsignalized Intersections: Signalized intersections require horizontal and vertical illuminance, whereas unsignalized intersections require only horizontal illuminance. Chapter 12 of the TAC *Guide for the Design of Roadway Lighting* recommends that all pedestrian crosswalks with nighttime pedestrian traffic be illuminated.

Facilities at Mid-Block Crossings

Lighting of pedestrian and cycling facilities at mid-block crossings are important so that vehicle users can anticipate and predict crossing users. To achieve adequate lighting, posts should be strategically placed before and after intersections to ensure positive contrast. Poles should be placed to minimize light pollution to adjacent residences. Mid-block crossings are typically designed with lighting posts that are similar in height to adjacent posts or posts that are specified by the authority having jurisdiction. For more information on lighting at mid-block crossings refer to TAC *Guide for the Design of Roadway Lighting* - Volume 2 – Chapter 12 – Section 12.5.2.

Other Locations

Tunnels and Underpasses: Tunnels and underpasses should be well lit for the security and comfort of people walking and cycling. Ideally, users should be able to clearly see what is happening throughout the entire tunnel or underpass, though this is dependent on the geometry of the tunnel.

Bridges and Overpasses: Overpasses should be lit to ensure that users can see what is happening on the bridge or overpass and can see any hazards or obstructions as well as other users. There are opportunities to use bridge and overpass lighting to enhance and showcase the structure.

Decision and Conflict Points: Lighting is important wherever wayfinding or warning signs exist along a pedestrian and cycling facility. Lighting warrants, as noted below, are used to determine if and where lighting is required based on security problems, high ridership, or where surrounding land uses are particularly active (such as schools or university campuses).

Laneways: In residential areas, proper illumination in laneways that are designated as a bicycle facility can also be important, as many bicycle users will use them to avoid motor vehicle traffic and enter their home from the back, where bicycle storage is often located.

Warrants

There are cases where communities and jurisdictions may use a warrant process to determine if lighting is required along pedestrian and cycling facilities. These vary by community but often take into consideration the volume of users, likelihood of conflict, and presence of hazards.

Lighting on Protected Bicycle Lane, Vancouver, B.C.

Self-balancing electric unicycle, Victoria, B.C.

H.5

NEW MOBILITY INTEGRATION

The growing trend towards new forms of mobility has seen the increasing popularity of electric bicycles (e-bikes), electric kick scooters (e-scooters), and other small, one-person electric vehicles, as well as the wide-scale proliferation of shared mobility systems such as bike share and e-scooter share in communities throughout North America and around the world. This chapter provides guidance related to these new and emerging small vehicle modes, specifically with regards to where they should be operated, where shared mobility systems should be stored, and whether emerging small, one-person electric vehicles require specific design modifications in relation to cycling facilities, sidewalks, and end-of-trip facilities.

The growing trend towards shared mobility and multi-modal transportation is changing the way people are travelling in communities across Canada and around the world. Increasingly, municipalities are needing to work with various levels of government and with community and corporate partners to ensure new transportation options thrive and to provide individuals with more mobility choices. This can support other community-wide goals including: improved accessibility, equity, safety, health, sustainability, and convenience.

Innovations in active transportation have occurred at the vehicle level as well as at the system level. In relation to vehicles, the past few years have witnessed the increasing popularity of electric bicycles (e-bikes) and electric kick scooters (e-scooters), driven by the ever-reducing cost of batteries. As the diversity of small vehicle types increases, important questions regarding where these vehicles should and should not be operated, how and where they should be stored, and whether new design elements need to be considered, are now being explored.

In addition, the last several years have seen a wide-scale proliferation of shared mobility systems such as bike share and e-scooter share in large and mid-sized communities across the globe, including B.C. Dockless bike share, dockless e-bike share, and dockless e-scooter share have now joined the more traditional docked/station-based bike share model in providing additional mobility options within the transportation system. While these new transportation options provide additional choice in mobility to travel consumers, important questions are now being raised around where to park these vehicles when they are not in use.

This chapter provide guidance in relation to these new and emerging mobility modes, specifically with regards to where they should be operated, where shared mobility systems should be stored, and whether emerging small, one-person electric vehicles require specific design modifications in relation to cycling facilities, sidewalks, and end-of-trip facilities.

NEW AND EMERGING MOBILITY TECHNOLOGY

Electric Bicycles (E-Bikes)

Electric bicycles (e-bikes) are an emerging transportation mode that are gaining popularity worldwide. E-bikes have the potential for increasing the appeal of cycling to a larger group of people and extending the range of destinations that can be reached by bicycle. E-bikes can help communities achieve their greenhouse gas reduction targets and, with supportive cycling infrastructure in place, can substitute many medium-distance trips currently taken by motor vehicles. E-bikes can also make cycling a practical transportation choice for seniors and older adults and others with accessibility limitations by reducing the level of physical effort required.

In B.C., e-bikes are currently defined under the *B.C. MVA* as motor assisted cycles. According to the B.C. MVA, a motor assisted cycle means a device:

- To which pedals or hand cranks are attached that will allow for the cycle to be propelled by human power;
- On which a person may ride;
- To which is attached a motor of a prescribed type that has an output not exceeding the prescribed output;
- That meets additional criteria described below:
  - *The motor must be electric with a continuous power output of not more than 500 watts that is incapable of propelling the motor assisted cycle at a speed greater than 32 km/h on level ground;*
  - *Maximum of three wheels in contact with the ground;*
  - *Must be equipped with a mechanism, separate from the accelerator controller, that:*

- *Allows the driver to turn the motor on and off from normal seated position while operating the motor assisted cycle; or*
- *Prevents the motor from turning on or engaging before the motor assisted cycle attains a speed of 32 km/h*

- *The motor of a motor assisted cycle must turn off or disengage if:*
  - *The operator stops pedalling;*
  - *An accelerator controller is released; or*
  - *The brake is applied.*

Under federal regulations, the motor of an e-bike must be incapable of providing further assistance when the bicycle attains a speed of 32 km/h on level ground, and are limited to and an electric motor output of 500 watts.

ICBC notes that e-bikes 'may be operated on the road like any bicycle, except where municipal bylaws restrict operation.' Additionally, ICBC clarifies that the pedals attached to an e-bike must be usable, stating that the 'motor must be capable of being propelled by muscular power using the pedals, but it is not necessary to always be pedalling.'[1]

Similar to a standard bicycle, provincial legislation requires that e-bike users wear a helmet. A driver's license, vehicle registration, and insurance is not required. Section 182.1 of the *B.C. MVA* requires users to be over 16 years of age to operate an e-bike.

1 'Low-powered vehicles', Vehicle Registration, Insurance Corporation of British Columbia, accessed June 11, 2019, ***https://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Default.aspx***

New Mobility Terminology

- **New Mobility:** A blanket term that includes autonomous vehicles, electric motor vehicles, mobility as a service, shared mobility, electric bicycles, and small, one-person electric vehicles. The Design Guide focuses on the components that have direct relevance to active transportation facilities, including shared mobility, electric bicycles, electric kick scooters, and other small, one-person electric vehicles.
- **Shared Mobility:** Systems that allow people to access a network of shared vehicles that have been spread across a community or portion of a community, as opposed to privately-owned vehicles or vehicle rental companies based in a single location. Shared mobility systems currently include: shared motor vehicles, shared bicycles and electric bicycles (including docked and dockless systems), and shared electric kick scooters. The Design Guide focuses on shared bicycles/ electric bicycle systems (currently in operation across B.C.) and shared electric kick scooter systems (which are popular across the United States but are not currently legally permitted in B.C.).
- **Small, One-Person Electric Vehicles:** A category of electric vehicles that includes electric kick scooters, electric skateboards, hoverboards, segways, self-balancing electric unicycles, and other emerging modes. At the time of writing, these vehicles are not permitted on public roadways or sidewalks in B.C. (legality issues are discussed further below). However, some of these vehicles have been observed in operation in communities across the province.

Context for Electric Powered New Mobility: Rapidly Decreasing Cost of Batteries

Electric powered transportation options, such as e-bikes, e-scooters, and electric vehicles (EVs), have become commonplace as the cost of energy storage has decreased (see **Figure H-126**). Battery prices for new mobility devices have fallen since 2010 and are projected to decline even further as manufacturing, and material costs drop. Further near term reductions in costs will likely increase demand for private ownership of electrically powered small vehicles as well as opportunities for profitable shared mobility services.

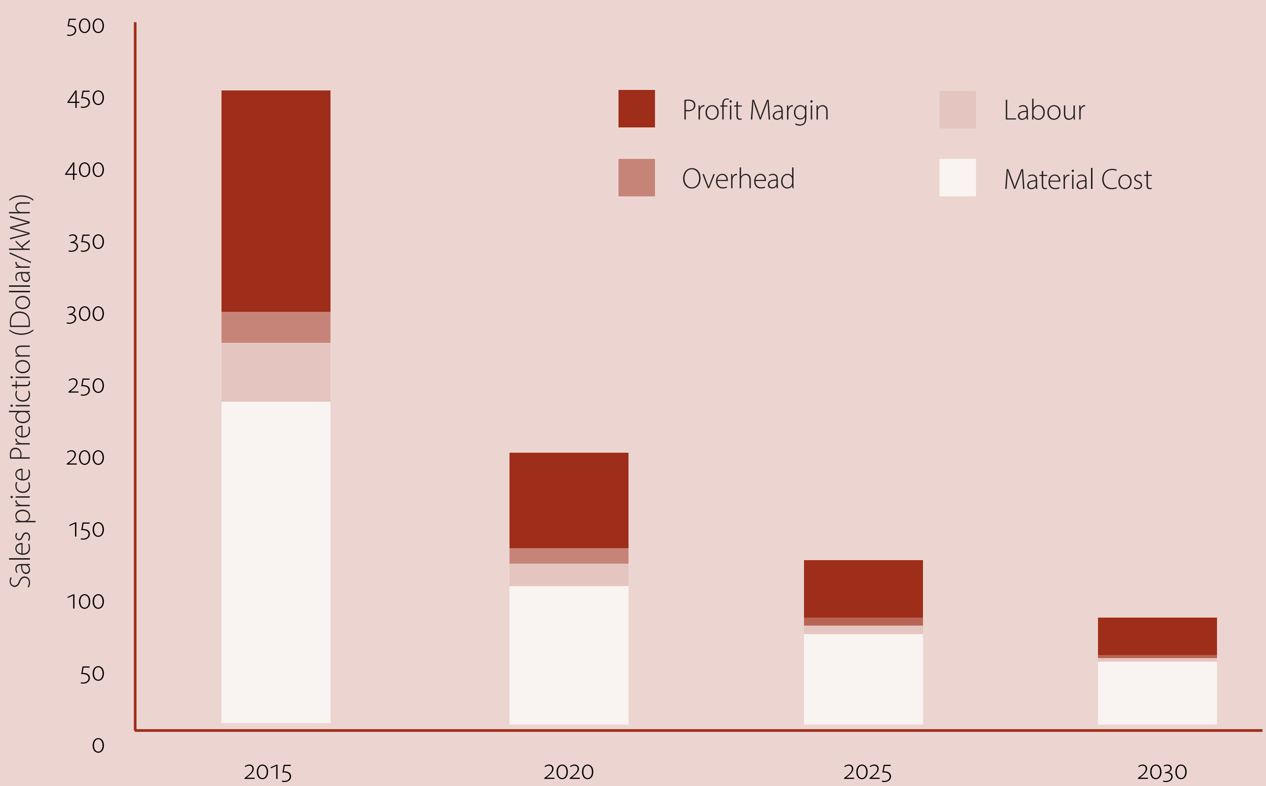


Figure H-149 // Material, Labour and Overhead Costs for Battery Production 2015 to 2030
Source: CB Insights 2019

Electric Bicycle Vehicle Types

E-Bikes, as defined by provincial legislation, encompass a wide-range of vehicle types and can be classed as either *scooter-style e-bikes* or *bicycle-style e-bikes* (see **Table H-45**). Bicycle-style e-bikes are further divided into *powered (throttle controlled) bicycles* and *power-assisted bicycles (pedelecs)*. While all e-bikes have operable pedals, scooter style e-bikes have foot platforms for the rider – similar to Italian Vespa scooters – with pedals offset to the side rendering pedaling optional.

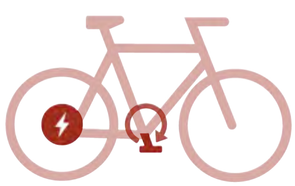
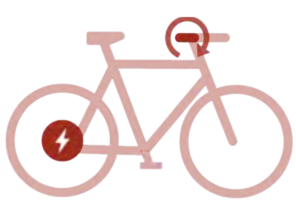
While both vehicle types would be governed to a maximum speed of 32 km/h by law, bicycle-style and scooter-style e-bikes have very different appearances, dimensions, and weights, which may have implications on where they should be operated. Additionally, while pedelecs and throttle controlled bicycle style e-bikes are perceived by the general public as bicycles, a study by the American League of Cyclists (2015) found that nearly three-quarters of respondents did not consider scooter style e-bikes as bicycles.

Safety Considerations and Operating Speeds

E-bike operating speeds are governed by law that the motor must not be capable of propelling the bicycle above 32 km/h on level ground, which falls within the upper range of conventional bicycle operating speeds (see **Chapter B.4**)[2] . The speed of conventional bicycles depends on a number of factors, including: topography, bicycle model, facility type, and rider ability, with typical adults travelling at average speeds of 15 km/h to 30 km/h on flat level terrain. Although within typical range of cycling speeds, the average speed of e-bikes

2 National Association of City Transportation Officials, Global Street Design Guide, 2016.

Table H-45 // Types of Electric Bicycle allowed under the B.C. MVA

	E-BIKE CLASS	NOTES
	Power-Assisted Bicycle (Bicycle Style E-Bike)	Also referred to as pedal electric bicycle (pedalec), electric pedal assist cycle (EPAC), electrically assisted bicycle, or human-powered hybrid.
	Powered Bicycle (Bicycle Style E-Bike)	Also referred to as throttle-assisted bicycle, electrically propelled bicycle, electric bike power on demand (POD), or motorized bicycle.
 Source: Dennis Sylvester Hurd	Scooter Style E-bike	Small pedals and limited top speed allow this vehicle to meet *B.C. MVA* definition of motor assisted cycle.

speed is greater than that of conventional bicycle because, regardless of topography or rider fitness, they can sustain a faster speed over longer distances.

Another consideration is the weight or dimensions of select bicycle types, particularly scooter-style e-bikes, which can weigh up to 120 kg, compared to conventional bicycles which generally range from 10 to 20 kg. Wider frames can also present a potential safety concern when bicycles are attempting to pass one another.

Because of their power motors, a variety of cargo vehicle e-bicycles are now commonly used in last-mile distribution[3]. Last-mile delivery is changing in cities around the world as delivery businesses begin to embrace pedal-assist delivery options, especially in dense urban centres. Some of these delivery vehicles, such as power-assist cargo tricycles, can be more efficient than traditional delivery in select areas as these vehicles can bypass traffic in bicycle lanes, and can park in commercial loading zones, unregulated zones, regular parking spots, and on sidewalks. Some cargo tricycles can even enter buildings to complete deliveries. Cargo tricycles, however, can weigh up to 300 kg and are 1.2 metres in width, and as such present unique safety and operational challenges. While cargo tricycles are primarily used for deliveries at this stage, similar-framed electric bicycles could be used to transport household goods, and/or other passengers, including young children. As the realm of e-bike vehicle types expand, bylaws and active transportation facility designs will need to be continually reviewed to ensure they are up-to-date.

Operating Guidelines

As e-bikes have the potential to support sustainable transportation by providing practical, affordable alternatives to medium- and longer-distance motor vehicle trips, policies for accommodating power-assisted bicycles should be as permissive as possible, with restrictions imposed only where adverse impacts are likely. Under the *B.C. MVA*, e-bikes are currently able to operate anywhere a standard bicycle is legally permitted, unless further restricted by municipal by-law. Circumstances where municipalities may consider restricting or prohibiting e-bike usage may include:

- Multi-use pathways or bicycle pathways;
- Protected bicycle lanes; and
- Unpaved facilities.

Increasingly, communities are differentiating between *scooter-style* and *bicycle-style* e-bikes in their traffic bylaws. For example, Toronto, Ottawa, and Mississauga prohibit scooter-style e-bikes from operating in protected bicycle lanes and multi-use pathways, but permit their operation in conventional bicycle lanes, under the rationale that it is more difficult for scooter-style e-bikes to safely pass slower moving bicycle users in width-restricted facilities but that they can more easily pull out into a motor vehicle lane to pass in a conventional bicycle lane scenario[4]. In the future, further consideration may be required regarding power-assist cargo tricycles and other similar vehicle types.

From a planning and design perspective, general improvements to cycling infrastructure, including the construction of a network of all ages and abilities cycling facilities, will improve safety for people on both standard bicycles and e-bicycles and further encourage the uptake of these modes among interested but concerned segment of the population.

Storage Guidelines

Building on the guidelines for end-point facilities outlined in **Chapter H.2**, secure and well-designed bicycle parking intended for conventional bicycles will also appeal to e-bike users. According to the Capital Regional District's *Local Government Electric*

Sylvia Green, 'Designing streets for a new kind of delivery vehicle', February 25, 2019, *http://spacing.ca/vancouver/2019/02/25/designing-streets-for-a-new-kind-of-delivery-vehicle/*

4 City of Toronto, Electric Bikes – Proposed Policies and By-laws, December 9, 2013.

Vehicle and Electric Bike Infrastructure Planning Guide[5], e-bike users consider the following three factors particularly important:

1. **Security**: Increase facility security to address theft concerns. E-bikes are more expensive than conventional bicycles, and as such, require secure facilities to prevent theft. General anti-theft measures can include ensuring all bicycle racks are of material and gauge that cannot be altered, ensuring racks are securely fastened, controlling access to bicycle rooms, and effective lighting. Additional security considerations can include the provision of individual bicycle lockers, locating bicycle parking along busy roads, and installing video surveillance (CCTV) and associated signage near bicycle parking areas.
2. **Size**: Design larger bicycle parking spaces to accommodate e-bikes (which are often larger in size).
3. **Electrification**: Provide access to an electrical outlet to facilitate charging. Charging infrastructure can be incorporated directly into the bicycle rack itself, or e-bike parking may be located near (no more than 2 metres) a standard 110V wall receptacle. Attention should be given to ensure the placement of the charging receptacle will not result in a tripping hazard or impede bicycle operation.

5 Capital Regional District, *Capital Regional Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Planning Guide*, November 2018.

Power-assist cargo tricycle in Vancouver, B.C.

Bicycle parking that is specifically designed for e-bike users will also benefit users of conventional bicycles. While long-term e-bike parking (and charging) can be accommodated in single detached and semi-detached dwellings that generally have access to external electrical sockets, specific provisions are required to ensure e-bike parking is provided in multi-unit dwellings and commercial developments. The recommended proportion of bicycle parking spaces in new multi-unit residential and commercial buildings that should meet e-bike design criteria is identified in **Chapter H.2**.

Electric Kick Scooters (E-Scooters) and Other Small, One Person Electric Vehicles

Electric kick scooters (e-scooters) are one of many new forms of mobility that have arrived in communities in North America over the past several years, alongside other small, one-person electric vehicles, including: hoverboards, motorized skateboards, self balancing electric unicycles, and pocket motorcycles. More of these low-powered electric devices are likely to appear in the future as further innovations in mobility occur. E-scooters are reviewed here as they have become increasingly common in U.S. cities as shared vehicles.

E-scooters are single occupant vehicles with an integrated battery that have a maximum speed of 24.9 km/h and have a range of approximately 30 kilometres. E-scooters are a relatively new form of transportation.

While non-motorized scooters have been around for decades, it is only recently that e-scooters have begun to show up in the market in any significant number. Similar devices have been around since the early 2000s when the segway was first introduced, but the costs were simply out of reach for most consumers, and their use was not widespread. In recent years, new technological development and a significant decrease in the price of batteries has made it affordable to produce and purchase a wide array of new mobility devices including e-scooters.

Shared e-scooters, Vienna, Austria

Source: Ivan Radic

Legality of E-Scooters and Other Small, One Person Electric Vehicles

At the time of writing, e-scooters (and similar small, one-person electric vehicles such as hoverboards, motorized skateboards, and self balancing electric unicycles) are not permitted on public roadways or sidewalks in B.C.[6] The *B.C. MVA* defines these vehicle types as motor vehicles, but they do not meet provincial equipment safety standards for on-street use. E-scooters and similar vehicle types may only be operated where the *B.C. MVA* does not apply, such as on private property that does not have public vehicle access, and on trails or pathways (if allowed by municipal bylaw).

Despite an unwelcoming policy climate, e-scooter share companies are entering Canada and have posted want ads in Calgary, Vancouver, and Toronto with the hope that the tide may be turning[7]. Many of the laws that ban e-scooters were developed under different mobility contexts. As demand for these technologies and others grow, the policies may need to be updated .

Safety Considerations and Operating Speeds

E-scooters have a reputation for being dangerous that is not unfounded. A study conducted by the City of Portland's Bureau of Transportation found that the injury rate for e-scooters appeared to be more than 40 times the rate for motorcycles, although injuries were usually minor and either did not require medical attention or required very little[8]. Helmets are a safety issue to consider with e-scooters. Many jurisdictions have chosen to encourage or require helmet usage in a similar way to bicycle helmets.

6 'Motorized scooters and skateboards', Vehicle Registration, Insurance Corporation of British Columbia, accessed June 11, 2019, *https://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Motorized-scooters-and-skateboards.aspx*

7 Ryan Felton, 'E-Scooter Ride-Share Industry Leaves Injuries and Angered Cities in its Path', February 5, 2019, *https://www.consumerreports.org/product-safety/e-scooter-ride-share-industry-leaves-injuries-and-angered-cities-in-its-path/*

8 Ibid.

Injuries and safety concerns also arise from e-scooters being used on sidewalks. Without proper policies in place for how e-scooters should be used, some users end up on sidewalks, which causes conflicts with pedestrians. E-scooters have a maximum speed of 24.9 km/h which is much faster than other sidewalk-bound modes, which can present a high risk for pedestrians, especially when approaching corners. The faster e-scooters can come upon other users quickly which can lead to people being pushed out of the way, tripping, or other injuries.

While e-scooters are both significantly narrower (40 – 45 centimetres) and lighter (12.5 kg) than conventional bicycles, they require a similar operating envelope. At maximum operating speeds of 24.9 km/h, e-scooters fall well within the bounds of typical cycling speeds and, as such, operation within designated cycling facilities is well suited. Some groups have begun to call for the re-branding of bicycle lanes as 'narrow lanes' or 'midspeed lanes' to be more inclusive of the range of small, one-person electric vehicle options now available[9].

Operating Guidelines

Under the *B.C. MVA*, e-scooter operation is not currently legal on roadways in B.C. E-scooters may be considered by local governments in non-street applications such as parks and post-secondary institutions, subject to local bylaws and regulations. Similar to e-bikes, e-scooters have the ability to satisfy an inexpensive need for personalized travel, extending the reach of conventional active transportation to a broader user group, and thereby providing affordable alternatives to automobile travel for many.

Storage Guidelines

E-scooters and other electrically powered small personal mobility devices require similar parking considerations as e-bikes – most notably security, infrastructure flexibility, and proximity to an electrical

9 Angie Schmitt, 'Is it Time to Redefine the Bike Lane?', August 23, 2018, *https://usa.streetsblog.org/2018/08/23/is-it-time-to-redefine-the-bike-lane/*

Self-balancing electric unicycle in Victoria, B.C.

E-scooter in Victoria, B.C.

Man on hoverboard pushing a stroller in Mexico City, Mexico
Source: Paul Sableman

outlet. E-scooters can be equipped with a variety of securing devices including cords and locks so they can be locked to traditional bicycle racks.

In multi-unit and commercial developments, long-term e-scooter parking can be accommodated in secure bicycle parking facilities. The recommended design criteria for e-bicycle parking in new multi-unit residential and commercial developments, which recommends that 50% of long-term and 10% of short-term bicycle parking spaces have access to electricity, supports the needs of e-scooters and other small personal mobility devices that require electric charge and secure storage including hoverboards, motorized skateboards, and self-balancing electric unicycles.

Parking guidelines for e-scooter share are addressed separately later in this chapter.

SMALL VEHICLE SHARING

Bike and E-Bike Sharing

Bike and e-bike sharing provides members with temporary access to a bicycle, through payment for short-term rental periods. Bike share systems are part of current trends in transportation towards shared mobility (including carshare and rideshare), and new mobility modes such as e-scooters, both of which are changing the way people are travelling. Bike share systems also make multi-modal transportation a more practical option, providing an important connection option for the first and last kilometre of trips.

Bike shares around the world each have their own blend of unique characteristics which range from a variety of ownership and operation models, user experiences, distribution, and integration with other modes and systems, among other factors. Bike share systems can make it more convenient and enjoyable for those that walk or use transit daily and can also provide an important service for tourists.

To create and plan for these systems, municipalities are working with various levels of government as well as community and corporate partners to ensure these new transportation options complement and support individuals with more mobility choices.

Modern bike share systems are generally operated as either docked or dockless systems:

- **Docked bike share systems** provide users with access to bicycles that are located throughout a sophisticated network of stations within a specified service area.
- **Dockless bike share systems** eliminate the need for docking stations by integrating GPS units and locking mechanism on bicycles, enabling bicycles to be parked anywhere within a designated service area.

A significant evolution in the bike share industry has occurred recently that has redefined the equation for municipalities. As recently as two years ago, bike share systems were most commonly funded in large part by municipalities who often coordinated (with or without the aid of non-profit agencies or corporate sponsors) the acquisition of stations and bicycles as well as the planning and operation of services. By contrast, many emerging bike and e-bike share systems are instead 100% funded and operated by private actors, with minimal to no cost to municipalities, shifting municipalities into the role of a partner and regulator as opposed to a service provider. Much of this recent shift has been the result of a technological evolution that has allowed for a transition away from the more space and cost intensive docked model to a dockless model, or a hybrid of the two. This evolution has also allowed for greater fleet diversity, with e-bikes and e-scooters now available for short-term rentals in some jurisdictions.

As a result of these changes to the industry, Canada has seen a growth in bike share systems from four systems in 2016 to almost 20 today. All but the original four systems are operating as private dockless (or hybrid) systems with little to no cost to the municipalities or universities they operate within. These shifts in the industry have created a significant opportunity for municipalities across the province to initiate bike and e-bike sharing programs, and the accompanied need for guidance with regards to public parking for these new vehicles.

However, these rapid changes in bike share ownership and operation models over such a short period has resulted in some key lessons and cautionary experiences from other municipalities. The regulation of, and license agreements with, bike share operators are critical to maintaining order, accessibility, equity, and ensuring successful implementation of a system that best serves a community. This is critical to ensure the bike share contributes to the public interest and works in tandem with existing transportation networks and plans. It is also critical to ensure that the city benefit from user data that can be integral to planning and monitoring.

Docked or Station Based Model

Docked bike share systems provide users with access to bicycles that are located throughout a sophisticated network of stations within a specified service area. Typically to serve an effective network, there are dozens to hundreds of docking stations throughout the service network, with more stations being added to locations of high usage, and as system usage grows. Each station has a specific number of docks to secure the bicycles, enabling users to start and end their trip at any station where they find a bicycle or an open dock. A dense network of stations allows users to get closer to their true origin and destination, increasing convenience. From time to time, operators will rebalance bicycles to better distribute them throughout the network.

Docked bike share systems are built and integrated into the existing transportation network. They offer users dependability in knowing where to find bicycles, and are accessed using a membership card, fob, or credit card. Users can generally purchase annual or monthly memberships to the bike share and increasingly can opt to pay per trip. A significant amount of planning goes into the siting and allocation of space for stations, the selection of the number of docks and bicycles at each station, and the overall number of bicycles in a community. The purpose of this planning create

Docked bike share in Vancouver, B.C.

Docked e-bike share in Santa Cruz, California
Source: Paul Wasneski

a reliable network that integrates well with other transportation modes.

Technology in the docking station helps the bike share operator to know how many bicycles are located at each station, and which stations the bicycles travel to. This supports redistribution of the bicycles as well as further planning and expansion. Ownership models vary substantially ranging from publicly owned, non-profit with private contributions, to privately operated. The initial investment in the stations and bicycles is substantial, which can make expanding to accommodate growing demand a challenge. This access to capital is often a limiting factor in the growth model and has prompted a variety of funding partnerships including grants, and sponsorships

Dockless Model

Dockless bike sharing has rapidly emerged as a system type since 2015. Originating in China, the rapid expansion of dockless bike sharing was made possible due to the private ownership of these systems. Substantially more affordable to operate, technology has removed the need for expensive station-based infrastructure, and private operators can access capital to rapidly meet increased demand. Dockless systems offer the user convenience in the ability to generally start and end trips closer to their true destination, with the ability to leave the bicycle where desired. The bicycles are reserved, paid for, and accessed through a user's smart phone app, with users generally paying a per-trip fee based on time. GPS units on both the phone and bicycle provide a great deal of information that can be recorded regarding trip usage and travel patterns, as well as provide customers with a map of all the bicycles they can access nearby.

The convenience of being able to leave a bicycle at the user's true destination has, in certain circumstances, resulted in clutter of public spaces, users leaving bicycles blocking sidewalks, or locking the freestanding bike share bicycles to existing bike parking spaces, thereby reducing the parking for private bicycles. Local governments and private companies are working through unique approaches to deter this behaviour. Some examples include the addition of designated bicycle rack spaces, as well as geo-fenced areas which are programmed into the bike share operators' smart phone app (and often physically painted on the sidewalk) which limit where users can leave the bicycles at the end of their trip. A variety of fees and/or benefits have been implemented to ensure users are leaving the bicycles in these spaces.

Equity and accessibility have also been an evolving factor. Since users mainly access these bicycles by a smart phone app linked to their credit card, more accessible options are being developed to fully accommodate other users who may not have access to either. Municipalities are also requesting in agreements with service providers that they ensure bicycles are present otherwise located.

Dockless ownership models have evolved, growing from strictly private, to partnership options between non-profits focused on operations and membership services, and private companies focused on hardware and software. The system setup and operations of dockless systems are complex and vary in nature, which is why it is critical to enter into agreements and partnerships with a strong understanding of necessary by-laws, local policies, and contractual agreements that benefit both the municipality and the bike share operator.

Dockless bike share parking (Haven), University of British Columbia, B.C.
Source: Alex Taciuk

The attributes of docked and dockless bike share service models, as well as hybrid service models, are summarized in **Table H-46**.

E-Scooter Sharing

E-scooter sharing is a new form of shared mobility being introduced in cities across North America. Initiated by the private sector, e-scooter sharing platforms allow members to unlock e-scooters with their smart phones and use them for point-to-point transport, just like dockless bike and e-bike share systems. Like bike and e-bike sharing, e-scooter sharing can provide cost-effective options for last mile travel and more mobility options for areas poorly served by transit. E-scooters are now being provided for rent by a number of private companies in many U.S. cities. In these cities, e-scooters are generally parked on city sidewalks and are unlocked via a smart phone app. However, as noted above, the operation of e-scooters is not currently permitted within the public right-of-way in B.C. (or any other jurisdiction in Canada at the time of writing). The City of Waterloo initiated a 1-year pilot project for a small area near the University of Waterloo that is limited to private driveways, paths, and campus roads.

Table H-46 // Comparison of Bike Share Service Models

	DOCKED	DOCKLESS	HYBRID
Trip Start / End Locations	Station based – trips start and end at stations	Roaming – Trips start and end closer to their true origins and destinations. Trips can be completed through wheel locking or lock-to attachments in the bicycle which can lock the bicycle to adjacent infrastructure.	Systems that include a mix of both station-based and dockless elements. Users are encouraged to return bicycles to designated stations or hubs through a mixture of incentives and disincentives.
Locking Mechanism	Locks into docking station	Wheel lock or lock to system	Wheel lock or lock to systems
Location Monitoring Systems	Locates where bicycles are picked up and returned: Radio Frequency Identification Devices (RFIDs) Station occupancy rate monitoring through real-time General Packet Radio Service (GPRS)	GPS unit on bicycles and/or user cell phones	GPS unit on bicycles and/or user cell phones
Reservation/Booking System	Reservation made at station using membership card/fob/credit card	Reservation made by cell phone and charged to user credit card	Reservation made by cell phone and charged to user credit card

Small Shared Vehicle Parking

The proliferation of small shared vehicles has implications on parking and curbside management for municipalities beyond their sheer operation. The need for shared vehicle parking adds an additional competing interest to the public right-of-way, which already must accommodate motor vehicle and small vehicle travel, vehicle parking, pedestrian through movement, street furniture, and approaches to and from property.

Docked Bike Share

Docked bike share requires an intricate network of docking stations, typically located 200 to 400 metres apart. Docking stations can be located on public or private land, in parks and on road right-of-way. Typically, docking stations are located in plazas, on wide sidewalks, or in repurposed curbside motor vehicle parking zones.

Dockless Bike, E-Bike, and E-Scooter

Dockless bike, e-bike, and e-scooter share operates under the assumption that public space is available for parking small shared vehicles between uses. Small shared vehicle parking must compete for public right-of-way space with existing uses including space required for pedestrian travel, bicycle lanes, motor vehicle lanes, vehicle parking, building access and egress, and road amenities including street furniture, road trees, outdoor restaurant seating, etc. Ultimately, it is up to municipalities to allocate public space for new shared mobility services within the right-of-way and mitigate against negative externalities including piles of bicycles near popular destinations and bicycles blocking the pedestrian right-of-way.

The Institute for Transportation and Development Policy (ITDP) *Bike Share Planning Guide* provides guidelines to manage public space with the introduction of bike share services. These guidelines have been updated to reflect all shared small vehicle services and, alongside key specifications for designated parking areas, form the core recommendations in this section.

Case Study

E-Scooter Operation, Waterloo, ON

The only jurisdiction in Canada to permit e-scooter rentals is currently the City of Waterloo. The City worked with *Lime* to establish an e-scooter *pilot route* along the Laurel Trail connecting David Johnson Research and Technology Park through Waterloo Park. The city used a geofence – a virtual barrier – to try and keep riders inside that test area – to varying degrees of success. Scooters can only be operated on trails and private driveways in the Waterloo pilot and are not permitted on public roads, in accordance with the *Ontario Highway Traffic Act*. When on the sidewalks, docking stations should be located in the Furnishing Zone, and should not be placed in a location that obstructs pedestrians, building entrances, or existing street furniture. If docking stations are located within the curb-to-curb space, care must be taken to ensure docking stations do not obstruct existing cycling or motor vehicle through traffic.

To manage limited right-of-way space alongside the introduction of a new competing interest, municipalities should (at minimum) consider the following:

- **Fleet Size Caps:** Limit the number of bicycle or scooter operators can have on the road to ensure roads are not over-burdened by new vehicles. A balance needs to be struck between providing a sufficient fleet size to support efficient and effective shared services without overcrowding public space with infrequently used vehicles.
- **Require Timely Response to Parking Complaints:** Service agreements are structured to obligate operators to respond

in a timely manner to poorly parked vehicles (typically 2 hours).

- **User Education:** Operators should include key information about parking protocol on their website and mobile application and may be required to include this information on vehicles themselves.
- **Lock-to requirements:** Lock-to technology requires bikes and e-bikes to be locked to existing infrastructure (bicycle rack, signpost, etc.) for a user to end a ride. This has been shown to reduce instances of tipped-over bikes and bicycle blocking pedestrian rights-of-way, but it requires a robust network of bicycle racks and other infrastructure to function. Not all bike share (and zero scooter share) operators currently support this function.

Dockless Small Vehicle Parking Areas

Unlike docked bike share, where trips can only be ended at defined docking stations, dockless small vehicle sharing technically permits users to end their trips anywhere within a defined service area. This can include on sidewalks, roadways, parks, private property, and building approaches. To ensure small vehicle parking occurs where it is best suited and does not infringe upon other roadway users, the following guidelines should be considered:

- In areas of high demand or where competition for scarce sidewalk space is high, designated shared small vehicle parking zones should be established. In these areas, geo-fencing, or the establishment of virtual perimeters for real-world geographic areas, should be considered to restrict the ability to end a trip outside of a designated zone. Municipalities should be mindful to not over-regulate small vehicle parking areas. While blanket parking restrictions (with accompanying designated shared small vehicle parking zones) will improve the use of designated zones and reduce vehicle clutter, they also reduce the ability of these systems to provide true point-to-point connectivity, reducing their convenience.
- Designated small vehicle parking zones should be sited and installed by the municipality for use by all dockless services (shared bike, e-bike, e-scooter). Establishing mode and company agnostic designated zones allows for a more efficient utilization of scare sidewalk space, provides choice in service provider (and potentially mode) for shared small vehicle service users, improves vehicle availability, and promotes the conscious establishment of network infrastructure. Municipal staff will need to work with operators to ensure the GPS technology on their small vehicles is accurate enough to recognize vehicles parked within the designated areas as complying, and that parking areas are clearly defined across all real-time service maps. Parking area costs can be offset through operator fees.
- Designated small vehicle parking zones should be clearly and consistently signed or marked on the pavement, as depicted in **Figure H-150**.
- Designated small vehicle parking zones should have good visibility to small shared vehicle users, pedestrians, and other roadway users, including motor vehicles.
- Municipalities requiring bicycle share vehicles be locked-to infrastructure should ensure adequate provision of bike racks in designated small vehicle parking bicycle zones or work with operators to override lock-to requirements for designated zones.
- As an option, highly utilized designated small vehicle parking zones could be monitored by CCTV and could include power supply for charging electrically powered small vehicles.
- Where required, designated zones should be located in one of the following areas:

- *On private property (subject to negotiation with the property owner);*
- *On wide sidewalks (minimum width 2 metres) outside the Traffic Zone and Frontage Zone. Designated small vehicle parking zones should not block access to benches or other existing street furniture (excluding lamps) and should not block parking metres. In some contexts, where sufficient width exists, designated parking zones may also be installed in the Frontage Zone and on private property adjacent to building entrances, as long building entrances are not impeded;*
- *In plazas, and wider pathways in unobtrusive areas;*
- *On raised curb extensions / bulb-outs;*
- *In repurposed on-street curbside parking spaces. Distinct colour or shading could be used to clearly differentiate designated small vehicle parking zones from adjacent motor vehicle parking; consideration could be given to protecting and demarcating these zones*

- Outside of restricted parking areas, shared vehicle parking could be permitted in the public right-of-way, under the following conditions:
  - *Shared vehicles may park on public sidewalks that are wider than 2 metres providing that a 2 metre wide Traffic Zone is maintained for sidewalk users. Shared vehicles may not park on sidewalks less than 2 metres wide.*

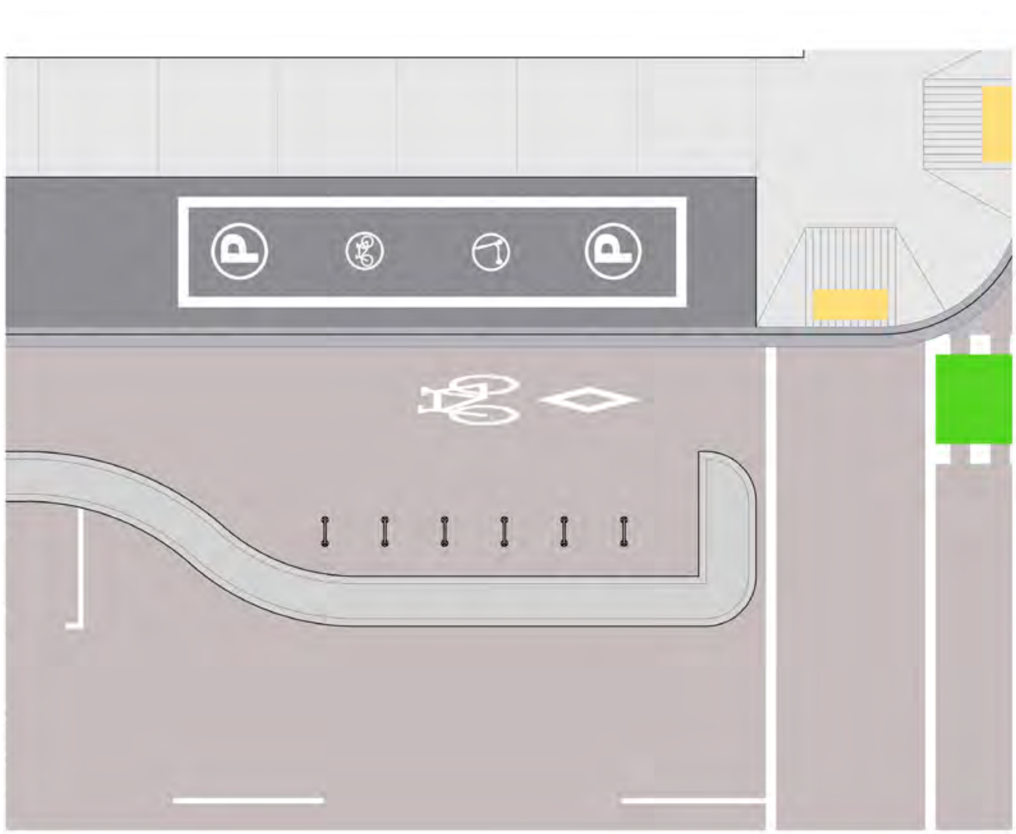


Figure H-150 // Small Shared Vehicle Parking Zone (Demarcated by Pavement Markings)

- *Shared vehicles should park in the Furnishing Zone and must not park in a way that obstructs the Traffic Zone, Frontage Zone, or property access. Shared vehicles must not block curb let-downs, driveways, or street furniture.*
- *Shared vehicles may park on-street in residential areas, wherever a motor vehicle may be legally parked. Shared small vehicles must be parked in a way that does not obstruct motor vehicle passage.*

- Municipalities may or may not permit shared vehicle parking in public parks. Permitting small vehicle parking in parks can increase access to parks but may also encourage the operation of small vehicles on internal park pathways.

Dockless bicycle and e-scooter parking
Source: Austin Transportation

I.

POST IMPLEMENTATION

I.1 Celebrating + Launching

I.2 Monitoring + Reporting

I.3 Maintenance

Fort Street protected bicycle lane launch, Victoria, B.C.

I.1

CELEBRATING + LAUNCHING

Innovative and engaging education and outreach efforts can help to celebrate and build support for active transportation projects and encourage their use. Incorporating a communication and education strategy into a project's capital budget can help to continue community engagement after the project is completed. This chapter outlines some of the tools and techniques that can be used to ensure the community is engaged in the planning, development, and installation of a project from start to finish, and that they are excited and aware of the project upon completion and opening.

PROJECT PLANNING AND DESIGN

Engaging with residents and stakeholders on the planning and design of active transportation facilities is a critical component to the success of a project. It is essential that the engagement undertaken is intentional and effective at gathering input and providing information. One way of elevating public support is by providing opportunities for community members to interact with and assess the impacts of new potential designs through the use of pilot projects, as discussed below. Community awareness and support throughout the process can help to build excitement and identify community champions.

It is important to identify, review, and confirm the engagement goals for a project. Based on these goals, a series of engagement strategies should be identified to be used during the different phases of a project. The establishment of goals upfront provides a framework to reflect on the benefits and challenges of a proposed project, and to prioritize different proposed alternatives. Documentation of the outreach process can help elected officials understand the level of effort put forth and support a design or plan when it is brought before them for adoption.

Pop-Up Protected Bike Lane, Windsor, ON

PILOT PROJECTS

Pilot or 'pop-up' projects can provide community members with the opportunity to experience a project design during the engagement process and/or before construction begins. Pilot projects are quick-build strategies that can be used to trial operational changes, including: different lane configurations, pavement markings, traffic control changes, introduction of new materials, or other streetscape features. Showcasing potential infrastructure changes allows community members to learn about and interact with the proposed design concept in the actual space, and provides an opportunity to share concerns that can be used to refine the final design.

Pop-Up Protected Bike Lane, Winnipeg, MB

Examples of treatments that can be used for pilot projects include using plastic bollards or planters to delineate a temporary bicycle facility, or creating curb extensions using planters to highlight what a road may feel like with more space for people walking.

Pilot projects can also be paired with community festivals or events to encourage community members to try out the facility.

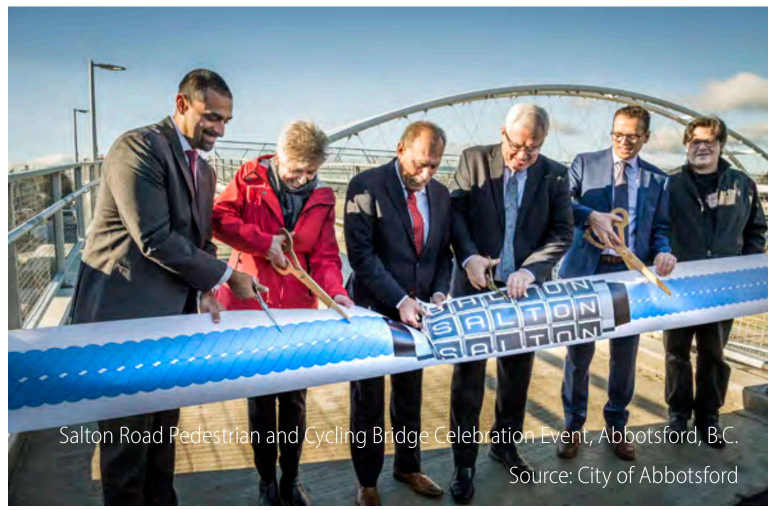
These strategies typically create excellent publicity for a project and generate the community buy-in needed to support final design and construction.

LAUNCH AND CELEBRATIONS

Upon the installation of a new active transportation facility, it is important to inform residents and stakeholders that were involved in the planning and design process that the project is complete and ready for use. It is also important to ensure that the broader public is also made aware of the new active transportation facility. There are a number of methods and strategies that communities can use to celebrate the installation of new active transportation projects through website material, videos, posts on social media, and events that raise awareness and get people excited about active transportation changes in their community. This component of the project should be considered as part of the overall budget at the start of a project and not as a later add on.

Launch events are organized to mark the official opening of a new active transportation facility. They are intended to celebrate the new facility and raise awareness within the community with a 'ribbon cutting' type event. They can be attended by elected officials, members of the media, stakeholders, and the public. They are intended to be fun but also educational in nature.

Salton Road Pedestrian and Cycling Bridge Celebration Event, Abbotsford, B.C.
Source: City of Abbotsford



Salton Road Pedestrian and Cycling Bridge Celebration Event, Abbotsford, B.C.
Source: City of Abbotsford


Salton Road Pedestrian and Cycling Bridge Celebration Event, Abbotsford, B.C.
Source: City of Abbotsford

Case Study

Fort Street Roll Out, Victoria, B.C.

In May 2018, the City of Victoria hosted a celebration party – referred to as the 'Fort Street Roll Out' – to celebrate the opening of new protected bicycle lanes and streetscape improvements on Fort Street The celebration party featured live music, family activities, interactive stations, safety ambassadors, photo stations, and free bicycle rentals. The event featured activities on each block with a 'passport' designed to encourage walking and cycling on the corridor. Visitors were encouraged to visit stations to get a stamp and enter to win one of four new bicycles and other draw prizes. The event was held in conjunction with a variety of community partners, including Fabulous Fort, the Downtown Victoria Business Association (DVBA), and PARC Retirement Residences.

Safety tips and project information were displayed, and road user education activities, including free cycling safety courses were offered throughout June, July and August 2018.

INFORMATION AND EDUCATION

A lack of education and familiarity of new infrastructure can be a barrier to use. A lack of understanding of what its purpose might be or how it is supposed to be used can prevent people who are 'interested but concerned' about active transportation from trying out new facilities. Some new facilities, such as coloured pavement markings, bicycle boxes, and protected bicycle lanes can be confusing to people when they are first implemented.

Ensuring that an education component is included as part of the launch plan for any new active transportation infrastructure can help introduce a community to the new facilities. The educational materials can be created by the jurisdiction responsible for implementation or as part of a partnership between community and cycling groups or other organizations or agencies with an interest in active transportation. Educational material can be available at community meetings, shared through community media streams, and/or be a component of a programmed event, as discussed in more detail below.

Examples of ways in which communities can provide and share information about active transportation include:

- **On-line,** including providing information on a dedicated project webpage with supporting resources, videos, and social media;
- **Published materials** can be provided on-site, handed out by ambassadors, available in community facilities or businesses; and
- **Signage** can be provided on-site to show examples of how to use a new active transportation facility.

Signage indicating how to use a zebra crosswalk to cross a protected bicycle lane, Vancouver, B.C.

Signage indicating where to park adjacent to a parking protected bicycle lane, City of North Vancouver, B.C.

Case Study

Educational Brochures, Calgary, AB

In 2015, the City of Calgary implemented a network of protected bicycle lanes in its downtown core. The City had not previously installed protected bicycle lanes, and the treatments were unfamiliar to many road users. To help raise awareness of the new infrastructure, the City developed a brochure providing information for all road users about the new downtown bicycle network, including an overview of the new types of infrastructure along with tips and maps illustrating how to use the new infrastructure for all road users, including people driving, cycling, and walking. The brochure was made available at kiosks at multiple locations on the downtown bicycle network and on-line.

BICYCLES AMBASSADORS AND MAYORS

A number of communities, including the City of Winnipeg, City of Edmonton, and City of Calgary have had 'bicycle ambassadors' on the ground at new facilities to answer community questions and concerns, distribute educational materials to community members at key destinations, and facilitate bicycle rides along new facilities while teaching safe habits. These can be municipal employees or summer students, or be part of a collaboration between local organizations, such as local business improvement associations. Ambassadors should be highly visible and recognizable in bright, coloured, branded clothing, and should have a positive attitude to help all road users. To help raise visibility of its ambassadors, the City of Edmonton used a branded cargo bike that ambassadors used to travel along the bicycle network to answer questions. Ambassadors can be present along the facility as well as go to major employers and community events to help share information. Ambassadors can also make use of existing resources and programming. For example, in Winnipeg, the city partnered with existing

Bicycle ambassador using branded cargo bike, Edmonton, AB business improvement associations who already had a broader ambassador program in place to equip its ambassadors with information about new cycling facilities. These ambassadors can answer questions and support all road users.

Many communities around the world, including the City of Victoria, are also creating 'bicycle mayor' positions. Bicycle mayors are volunteers who can be used to help identify and lead projects that increase cycling to uncover economic, health, and environmental benefits.

ONGOING COMMUNITY PROGRAMMING

Programming can be an effective tool to continue to build support and raise awareness for active transportation and showcase active transportation facilities as a community asset. By continuing to showcase active transportation projects through community engagement, a municipality or governing body can continue to raise awareness and excitement for existing projects. Potential activation programs include:

- **Open Street Events:** These events temporarily close streets to motor vehicle traffic, so that communities can use them for any activity, except for motor vehicle travel. Community members can experience the street in a new way using the space to bike, walk, dance, lounge, and celebrate, among many other activities. Locating such an event in proximity to a new active transportation facility will provide additional exposure. Open Streets events can range from a one-day event or span a season. They can help pilot a permanent open streets installation.

Case Study

Educational Guide, Vernon, B.C.

The City of Vernon recently adopted a new Traffic Bylaw, which updated regulations about how residents get around the city by car, by foot, by bike, and using 'small-wheeled transportation,' a term that covers skateboards, longboards, foot-operated scooters and children 12 and under riding bicycles.

The city has developed an educational guide called 'This is How We Roll' to introduce residents to the rules about small-wheeled transportation and to help residents navigate Vernon's transportation network.

This guide was developed in a graphic, engaging format and is available on-line. The guide introduces residents to the different types of facilities people will see around Vernon and what they need to know to navigate them.


Calgary, Alberta

- **Community Festivals:** Communities often host festivals or events a few times per year. These provide great opportunities for community members to learn about changes in their community while having fun. Sharing information on new active transportation projects and events through the distribution of informational flyers or setting up a booth is a simple way of generating interest and excitement for a project.
- **Community Bicycle Rides:** Events like community bicycle rides create opportunities to bring a variety of community members together for a bicycle ride to share an experience on new or existing bicycle infrastructure. This type of event can encourage individuals new to cycling a chance to experience cycling in the city in a safe and inviting environment.

This chapter outlines the value of benchmarking and monitoring active transportation activity within a municipality and along corridors, the different types of data that can be collected, and examples of how the data can be reported back to the public and other stakeholders.

Case Study

Bicycle Ambassador Program, Calgary, AB

Every year since 2015, the City of Calgary's Bicycle Program has hired summer students as bicycle ambassadors to deliver cycling education, encouragement and engagement for the various bikeway projects throughout Calgary. The principle goals of the bicycle ambassadors are to:

- Educate road users on the safe and proper use of cycling infrastructure;
- Encourage people cycling to set a good example for others and to follow the rules of the road; and
- Encourage Calgarians to try the bicycle facilities in Calgary.

The Bicycle Ambassadors use a variety of engagement methods to support a robust education program that suits a variety of learning types. Throughout the summer the team created key messages, provided resources, and developed interactive activities to encourage more meaningful engagement.

Each summer, bicycle ambassadors participate in hundreds of conversations with Calgarians. In these conversations, the team uses several key messages to educate the public on safe cycling, encourage best practices, and address comments and concerns. Key messages include:

- Protected bicycle lanes and other bikeway projects give Calgarians more transportation options.
- Bicycle facilities provide dedicated spaces for people who bike, while maintaining spaces for those who walk, drive or take transit.
- The city works closely with stakeholders and residents to plan, design, and implement bike projects in Calgary.

In the summer of 2017, the bicycle ambassadors attended 41 events and interacted with 3014 Calgarians. These conversations took place at a variety of venues including festivals, office road shows, on-street pop up events, on-street outreach, community events and more.

Case Study

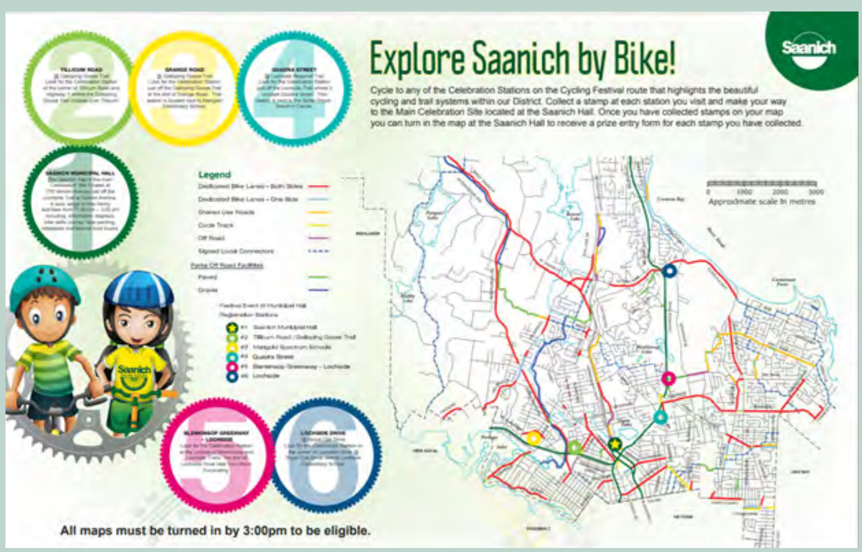
Saanich Cycling Festival, Saanich, B.C.

Every year, the District of Saanich hosts the Saanich Cycling Festival. The festival included a main celebration site at municipal hall with a range of booths and free family activities, including:

- Bike Rodeo;
- Cycling Obstacle Course and Skills Challenge;
- Kids Decorated Bike Parade;
- Face Painting;
- Inflatables;
- Interactive Information Booths;
- Bike Safety Tent;
- Festival Food Carts; and
- Concessions.

The event also includes a festival route that includes a number of community celebration stations, where participants can collect stamps on an event map. Participants can return their completed event map to win a variety of prizes.

The festival also includes a kids' decorated bicycle ride, with a choice of either a 1.5 km or 2.2 km route.



Source: District of Saanich


Source: District of Saanich


Source: District of Saanich


Source: District of Saanich

Bicycle counter with display, Galloping Goose Regional Pathway, Victoria, B.C.

I.2

MONITORING + REPORTING

This chapter outlines the value of benchmarking and monitoring active transportation activity within a municipality and along corridors, the different types of data that can be collected, and examples of how the data can be reported back to the public and other stakeholders.

DATA COLLECTION AND MONITORING APPROACHES

Evaluation is one of the 'Five Es' that makes up a comprehensive approach to active transportation planning and design, along with engineering, education, encouragement, and enforcement. Monitoring active transportation usage, patterns, and trends allows for evaluation to take place. This is critical to improve a community's understanding of the use of its active transportation facilities and can allow municipalities to plan for necessary improvements to their active transportation networks. This chapter outlines a comprehensive approach to monitor active transportation, including data collection, evaluation, and reporting.

Monitoring trips made by active transportation, and the use of active transportation facilities, is important to enhance a community's understanding of overall patterns and trends for trips made by active modes. Monitoring helps to determine the impact investments in infrastructure are having on attracting users. It helps to understand trends and changes in use, including hourly, daily, seasonal, and annual variations. It can help to determine if a community is achieving its goals related to active transportation. It provides communities with information on the usage of different facility types which can help support future design options and implementation decisions in the future. Finally, monitoring also allows communities to assess the need for infrastructure improvements such as widening facilities, providing new or alternative routes, and monitoring route safety and changes in collision rates based on before and after collision data.

Establishing an active transportation data collection and monitoring program provides an objective, systematic, consistent, and ongoing way to count and monitor active transportation usage, patterns, and trends. Monitoring active transportation activity and the impact of investments in infrastructure requires a strategic perspective and a detail-oriented approach. As the collection of data can sometimes be considered expensive, coordinating counts with the collection of other data can allow opportunities to reduce costs and effort, while increasing the ability to integrate and use different existing datasets together to create further value.

The approach to data collection and monitoring of active transportation activity is determined by the goal of the data collection program. Understanding why data is being collected, the application of data, and the needs of the end user are critical to identifying the appropriate data collection and monitoring approach. Needs are likely to vary significantly between communities and agencies within the province. For example, while some municipalities and agencies may have formalized, ongoing, comprehensive active transportation count programs, many municipalities have only collected and/or used bicycle and pedestrian data on a sporadic basis or have never collected this data in the past.

There are several elements that should be considered when designing an active transportation data collection and monitoring approach or strategy. These elements include:

- **Selecting count locations** (these may vary depending on the mode that is being counted);
- Selecting a consistent **count time period;**
- Selecting appropriate **data collection materials, technology, and equipment;**
- Developing a clear data collection **methodology;**
- Supporting opportunities for volunteer counts by **developing consistent materials;**
- Developing **data archival formats;**
- Establishing **data analysis techniques;**
- **Providing training** for both counting (where applicable) and analysis; and
- Developing a **data reporting methodology.**

TYPES OF DATA

The types of data that can be collected as part of an active transportation monitoring program are discussed below.

Overall Usage Levels

There are many data sources to assess participation in active transportation at the city-wide or neighbourhood scale, and at the corridor scale.

City-wide or neighbourhood scale data looks at transportation patterns at a macro scale. It does not look at specific corridors but can be used to understand overall trends and patterns. This data is generally large-scale and can be quite labour intensive. Examples include:

- **Travel Diary Surveys:** Origin and destination travel diary surveys are conducted in many communities to gather overall travel patterns and behaviour data of residents in a municipality or region for all modes of transportation, typically over a 24-hour or longer period. The travel information collected consists of data such as mode of transportation, origins and destinations, trip purposes, trip start and end points, and day of travel. Travel diary surveys are typically conducted as part of a broader data collection program every four to five years and typically include all modes of transportation. Specifically, for active transportation related monitoring programs, travel diary surveys typically provide information about the total number of walking and cycling trips, walking and cycling mode share, purpose of walking and cycling trips, distance of trips made by walking and cycling, and demographic information such as age, gender, and income. This information can be used to determine the effectiveness of active transportation-related investments and relative trends of walking and cycling at a city-wide or neighbourhood-scale but cannot be used to monitor use on individual corridors.
- **Census Data:** Statistics Canada conducts the Canada Census every five years. The Census includes questions related to 'journey to work,' which provides data similar to travel diary surveys. However, this is typically of a much larger sample size with less detail and data collected per sample. An important limitation of census data is that it only includes commute trips to work or school, whereas travel diary survey data typically includes trips for all purposes. Similar to travel diary surveys, this Census data can be used to determine the effectiveness of active transportation-related investments and relative trends of walking and cycling at a city-wide or neighbourhood-scale but cannot be used to monitor use on individual corridors.
- **Civic Census:** This presents an opportunity to include questions about travel patterns to obtain city-wide data on a more frequent basis. Municipalities can include a 'journey to work' question in their own local census — ideally, this question should be asked every year, although every two years is also acceptable.
- **Household Telephone Surveys:** Household telephone surveys can be conducted to obtain representative, statistically significant information specifically targeted towards active transportation. Unlike travel diary surveys, which objectively report actual travel patterns over a 24-hour period or longer, telephone surveys are intended to capture information about self-reported typical travel patterns. Telephone surveys can also be very effective in creating understanding of broader barriers and motivators to active transportation, which can be important to help inform the planning and design process.
- **Cordon Counts:** Establishing a cordon or boundary around a designated area and collecting data on how people travel into and out

of the cordon during a set period. For example, a community may consider conducting a yearly cordon count of its downtown core. To do this, a community can perform manual counts at screenline locations around the cordon over a set time period during the same time of year on an annual basis. Each screenline location may only be counted on a single day, so it may not be appropriate to compare one year to the next at any given location given that weather can impact the number of people walking and cycling. However, because the entire area count takes place over the same span of time, it is possible to compare the overall cordon count year to year because the weather averages out. Corridor-specific data can also be collected along specific corridors, as discussed in further detail below.

Safety

In addition to capturing use, monitoring of active transportation should also include surveillance for safety issues.

The safety of vulnerable road users is often a variable that is tracked as part of an active transportation monitoring program. For both people walking and cycling, safety is a critical issue mainly due to the vulnerable nature of people walking and cycling relative to motor vehicles.

In B.C., safety data is often based on insurance data collected and provided by the Insurance Corporation of British Columbia (ICBC) or collision data collected and provided by police. This data includes reported collisions between motor vehicles and people cycling or walking.

The Limitations of Collision Data

Reported collision data is often the primary source of data that is used to analyze and report on the safety of active transportation. However, reported collision data does not provide complete information on collisions involving other active transportation users. Additionally, this data often under reports actual safety issues, as it does not include unreported collisions between people driving and people walking or cycling; collisions between people walking or cycling and other road or pathway users; other types of incidents resulting in injuries; or near misses that did not result in an actual collision. As a result, it is important to try and capture safety data when conducting other interactive data collection.

Research Note

Cycling Safety - Findings from The Cyclists' Injuries & The Cycling Environment Study:

Collisions and injuries that are a result of cycling are often underreported. The Cycling in Cities Program at the University of British Columbia conducted the Cyclists' Injuries & the Cycling Environment (BICE) study. The study found that only 37% of cycling injury crashes were a result of collisions with motor vehicles, including 8%, which were a result of a collision with a motor vehicle door. A further 12% were a result of a fall to avoid a collision, including 10% to avoid a motor vehicle and 2% to avoid another type of collision. The study found that just under half (47%) of recorded cycling injury crashes were a result of an interaction with a motor vehicle. The remaining cycling injury crashes (53%) resulted from collisions with surfaces (such as potholes, gravel, leaves, tracks, roots, icy or wet surfaces), infrastructure (such as bollards, furniture, curbs, fences, speed bumps, stairs), or other route users (such as pedestrians, other bicycle users or animals). This has important implications for the type of data that is often collected, as it is important to recognize that reported collision data is likely only providing a small snapshot of the overall causes contributing to cycling collisions and injuries. [1]

1. Kay Teschke et al., Bicyclists' Injuries and the Cycling Environment study (Cycling in Cities Program, UBC).

Other Types of Safety Data

There are other ways communities have been monitoring active transportation safety. BikeMaps (BikeMaps.org) collects data on cycling trouble spots from people using the network (see **Figure I-151**). The data is crowd-sourced and self-reported. The platform collects data on cycling safety, hazards, and locations where bicycle theft occurred. The website includes a mapping system that is designed to allow citizens to map locations of cycling incidents and provide more detail about the event itself and what occurred. As the data is self-reported, it allows for people to provide input on near-misses and collisions that do not involve motor vehicles that are not included in ICBC data. The data has been used by municipalities in a number of ways. For example, the District of Saanich used data from ICBC and BikeMaps.org to identify their top safety locations for spot improvements. Other communities that have used BikeMaps.org have found opportunities to adjust infrastructure based on the early reporting of near misses and hazards. Researchers have also been looking at the value of collecting data on injuries that occur on active transportation trips.

While there are currently several sources of safety data, there are opportunities to develop more robust datasets and to continue to consolidate, study, and review data as it is available.

The availability of active transportation-related safety data is limited for any given location due to the relatively low number of reported incidents involving active transportation users, particularly people cycling. In order to develop an evidence-based process that can be used to make crucial investment decisions it is important to be sure that the data provided is current, accurate, and has been compiled from a number of sources.

In addition to collision data, injury data can be used to assess active transportation safety. Injuries can be reported through Health Authorities, especially for non-motor vehicle related incidents (such as collisions between people walking and cycling, including collisions on off-street pathways). Some jurisdictions have focused on enhancing this type of data collection. It is recommended that active transportation collision and injury data both be collected and that they be harmonized so that it can be more effectively and efficiently used in active transportation safety analyses. Data is also required regarding injury severity to better understand how these injuries impacted the active transportation users in the short and long term. This would require an organized recording and sharing of active transportation injury data between multiple organizations.

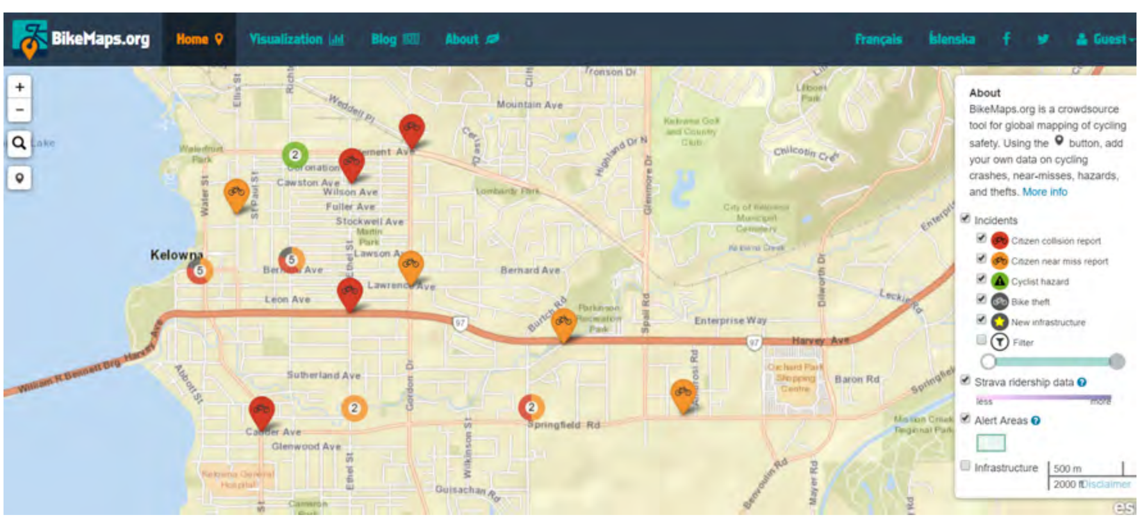


FIGURE I-151 // EXAMPLE OF SELF-REPORTED DATA THAT CAN BE COLLECTED THROUGH BIKEMAPS.ORG
Source: bikemaps.org

The historical safety information of a specific corridor or network should be compiled prior to any installation and monitored annually following the installation of new active transportation facilities. This allows for an evaluation of any safety benefits of the facility.

An important consideration with safety data is to understand absolute changes in collisions, as well as changes in collision rates. Collision rates can be developed by comparing monthly or annual collision rates along a given corridor before or after a change in infrastructure. Collision rates can also be developed based on exposure, which could include the number of active transportation collisions per unit of motor vehicle trips and/or active transportation trips. This type of collision rate calculation would require motor vehicle and/or cycling and/or pedestrian count data.

Infrastructure

It can beneficial to monitor and report on key metrics on active transportation infrastructure development. This can include factors such as the development of bicycle network kilometres (as well as the total kilometres of proportion of the network that is considered comfortable for people of all ages and abilities), new sidewalks, off-street pathways, bicycle parking supply, and the quality of bicycle facilities. Tracking types of infrastructure development can allow municipalities to assess what facilities are most effective at increasing ridership, and how other key metrics may influence people's decision to walk or cycle.

Other Measures

Additional measures such as the potential economic impact of installing active transportation infrastructure, can help to strengthen the case for installing active transportation infrastructure and dispel some common myths associated with the impact of cycling facilities at the micro-scale (corridor) and/or macro-scale (neighbourhood, city, or region). Other additional measures include, multi-modal level of service (MMLOS), changes in traffic congestion or travel time, individual business trip surveys, or observations pertaining to sidewalk cycling or one-way riding can also be collected as part of a monitoring program. These examples would likely require in-person interviews, surveys or manual observations. They can be helpful measures to compare before and after results of infrastructure installation.

Counting Active Transportation Users

Active transportation count data involves the collection of pedestrian and bicycle traffic volumes along key corridors and at specific locations throughout a community. This is vital to the establishment of a long-term active transportation monitoring program and the evaluation of projects and policies.

Many communities only collect active transportation data through short duration counts, often as part of established motor vehicle count programs. These short duration counts are often collected only for a few hours on a given day, once every several years. Short duration counts are typically intended to be a snapshot in time, but can be significantly affected by the effects of seasons, time of day, and weather conditions. These factors all have a significant impact on active transportation trips and can make comparing short count data collected one year to another problematic.

Count data should be collected before the installation of a new or enhanced active transportation facility. This is likely most applicable for cycling facilities, but can also apply to multi-use pathway upgrades or corridors without existing pedestrian facilities. It is recommended that permanent, automatic bicycle and pedestrian counters, where applicable, be included in the capital cost of all new active transportation facility projects and be installed in conjunction with the construction of new facilities. Ongoing operational costs should also be considered and budgeted for.

Case Study

The Economics of Cycling - Bikenomics - A Primer on the Economic Impact in the Capital Region , Greater Victoria, B.C.

The Capital Regional District initiated a study to better understand the economic impact of cycling. Communities within the region identified several key goals including increasing local jobs and economic activity. They identified priorities that included attracting tourists, knowledgeable workers, and supporting local businesses. The region recognized that active transportation can play a role in achieving these goals.

This report highlighted several key statistics and interviews with business and community leaders in the capital region that acknowledge the positive economic impact cycling has on communities.

The report highlighted the economic benefits from the following areas:

- Cycling Tourism: Over 3 million visitors spend almost a billion dollars when visiting Greater Victoria each year. Five percent of visitors (150,000 people a year) who come to the Greater Victoria area cycle while visiting, and 24,000 passengers arrive via ferry each year with their bicycles.
- Technology Sector: The region has seen a boom in the technology sector and in 2015 was home to over 884 tech firms. With so many high tech firms there is a strong demand for highly qualified professionals. The report looked at some of the major attraction factors for talent, and found one strong factor was having flexible commuting options that allow people to walk and bike to work. Candidates were also looking for easy access to outdoor recreation, including mountain biking.
- Bicycle Shops: There are 32 bicycle retailers in Greater Victoria, which is four times more than the per capita national average. In 2015, these stores had almost 200 employees and $4.5 million in direct economic impact (through wages, rent, and buying local goods and services).
- Jobs: Jobs directly related to cycling contribute to economic stimulus. The economic impact of cycling is often more about the indirect impact than the direct jobs that it provides. Building cycling facilities and having more people riding bikes has a long range effect on a city's, quality of life, sense of place and in attracting people to live, work, visit and shop.

https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/Pedestrian-Cycling-Master-Plan/crd_bikesed-booklet-version.pdf?sfvrsn=4c194fca_2

Case Study

Economic Impact Studies, Toronto, ON

The City of Toronto has conducted studies to understand the economic impacts of the installation of cycling infrastructure on specific corridors. Economic impact studies have been conducted on Bloor Street including the most recent *Bloor Street West Bike Lane Pilot Economic Impact Study*. The study was originally commissioned by the Bloor Annex BIA, the Korea Town BIA, and the Metcalf Foundation in October 2015. The study was completed by The Centre for Active Transportation, which partnered with academic researchers from the University of Toronto to collect and analyze the data. The study was commissioned in anticipation of the pilot bicycle lane being installed on Bloor Street the following summer. The intent of the study was to investigate the economic impacts – positive, negative or neutral – of the bicycle lane, as well as its effect on the travel patterns and attitudes of visitors and merchants.

The key findings of the study were broken into four themes below and includes sample of the data presented:

- Customer Counts: 'The number of businesses that reported 100 customers or more per day increased in the study area on both roads. On both roads, locals (those living or working in the area) were 2.6 times more likely than those coming from further away to spend at least $100 per month.'
- Customer Frequency: 'People who arrived on foot or on bike visited Bloor the most often, and people who drove or took transit visited nearly four days less per month.'
- Shifts in Travel Patterns and Parking: 'The percentage of customers cycling to Bloor nearly tripled (from 7% to 20%), a substantially higher increase than on Danforth Avenue, which has no bike lane. The majority of merchants believed that at least 25% of their customers are driving to Bloor; however fewer than 10% of customers reported arriving by car.'
- Perceptions on Safety and Feedback on the Bicycle Lane: 'After the installation of the bike lane, the proportion of visitors who perceived Bloor Street as safe for cycling more than tripled (from 17% to 61%) and doubled among merchants (from 13% to 27%), while perceptions of safety on Danforth dropped (from 22% to 10%).'

https://www.tcat.ca/wp-content/uploads/2017/10/Bloor-Economic-Impact-Study-Full-Report-10-11-2017.pdf

In addition, if short duration counts for active transportation are collected as part of motor vehicle count programs, the locations selected may also not be the preferred locations to monitor active transportation. In addition, short duration counts should avoid being undertaken during special events such as festivals or holidays which may skew the data. Unlike motor vehicle traffic, some types of walking and cycling facilities may see greater use on evenings or weekends than during traditional morning and afternoon peak periods for motor vehicles. This is particularly true if the use is more recreational in nature.

As such, where possible, ongoing permanent counts are preferred over short duration counts for active transportation. Multiple technologies can be used to improve the robustness of the data collection program.

If it is not feasible to install a comprehensive network of automatic, permanent counters throughout a given community, these can instead be installed at select strategic locations to obtain permanent count data that can then be used to develop adjustment factors based on considerations such as season, month, time of year, or weather. These adjustment factors can be used to extrapolate trends from short duration counts. In addition, multiple technologies can be used to help validate the accuracy of the data, such as using pneumatic tubes in addition to inductive loops to ensure the inductive loops are properly calibrated. Finally, by using multiple technologies, practitioners can help gather additional data, such as using infrared and inductive loops together to distinguish and gather data for both people walking and cycling.

Table 1-47 summarizes various active transportation traffic count technologies including some of the benefits and challenges of each. A comprehensive summary of various count technologies can be found in the following Transportation Research Board (TRB) National Cooperative Highway Research Program (NCHRP) documents:

- *Guidebook on Pedestrian and Bicycle Volume Data Collection;* and
- *Methods and Technologies for Pedestrian and Bicycle Volume Data Collection.*

Selecting the proper counting technology is critical for either people walking or cycling, particularly now that other active modes of transportation are emerging. For example, the operating performance of some pedestrian counting technology varies depending on winter, extreme heat, or rainfall conditions. Areas with high occlusion also determines the counting technology of choice. In addition, some technologies come with software that allows for watching its operating performance live. This allows for the ability to determine margin of error and validate the data. Some technologies also come with basic statistical analysis packages.

Intercept Survey

The purpose of an intercept survey is to obtain information about people walking or cycling along a specific corridor or route. The information is gathered in person and goes beyond simple observations. This type of survey collects data and includes non-residents such as visitors in the sampling, providing a more complete picture of a corridor's overall users and their behaviour. This can also be an opportunity to ask people walking and cycling how they arrived at their destination. This can often be useful for projects in commercial areas that may have impacts on on-street parking, as this can provide the municipality as well as the business community an opportunity to understand what mode of transportation people are using to arrive at their destinations.

Travel Time Survey

A travel time survey is used to collect trip travel time data between origin and destination points, and points along the travelled route. This information allows for the definition of a baseline indication of travel times, delay, and general congestion within and across a community. This methodology would be less applicable to walking trips but can be used for cycling trips.

TABLE I-47 // ACTIVE TRANSPORTATION COUNT TECHNOLOGIES

TECHNOLOGY	MODE OF TRANSPORTATION	BENEFITS	CHALLENGES
Manual Counts Manual Counts are taken by field data collectors to count the number of people walking and cycling based on observations. Manual counts are typically short-term.	**Walking** **Cycling**	■ High level of accuracy ■ Allows for additional observations (gender, turning movements, etc.) ■ No technology is required ■ Can count all modes including both people walking and cycling and other forms of active transportation such as skateboarding, in-line skating, etc ■ Suitable for shorter counts	■ Accuracy of data may be impacted at high volume locations ■ Labour intensive and requires significant resources ■ Can be expensive ■ Weather and seasonal variations may limit accuracy ■ Limited duration and frequency ■ Due to variability and short duration, it is difficult to compare manually counted data by year
Video Through the use of video cameras, counts are conducted as changes occur across the video scene. Video cameras can include thermal imaging that can count based on the temperature signatures of different road users.	**Walking** **Cycling**	■ High resolution ■ High accuracy ■ Video can also be used to analyze safety and behaviour ■ Cameras with thermal capabilities can count in all conditions ■ Can be used for long or short counts	■ May be affected by visibility ■ Can be extensive and manually intensive to install and relocate
Infrared Infrared devices (Active and Passive) detect an object passing through an infrared beam. Active devices have a transmitter and a receiver, an infrared beam travel between the two. Passive devices project an infrared beam from a fixed point.	**Walking** **Cycling**	■ Relatively high accuracy ■ Active infrared can distinguish between people walking and cycling ■ Can distinguish direction ■ Can be easy to move and relocate ■ Little maintenance required	■ Passive infrared can not distinguish between people walking and cycling ■ Can be subject to vandalism ■ Accuracy can diminish when groups are counted

TECHNOLOGY	MODE OF TRANSPORTATION	BENEFITS	CHALLENGES
Piezoelectric Piezoelectric strips or pads that can detect a change in pressure on the pad. The technology can be embedded in the ground or used for short term counts.	**Walking (some vendors)** **Cycling**	▪ Can record speed ▪ Can distinguish direction of travel ▪ Relatively high accuracy	▪ Has a relatively short battery life and storage capacity ▪ Can be subject to vandalism ▪ Expensive
GPS Enabled Route Trackers GPS enabled route trackers such as Strava and Ride Report allow app users to track distance travelled, speed and route. Data can be purchased to provide a sense of trip patterns and route choice. In addition, GPS enabled public bike Share bicycles can also provide opportunities to track detailed travel information.	**Walking (depends on technology)** **Cycling (more typical)**	▪ Data can be used to create easy to read heat maps of heavily used routes ▪ Potentially high number of users ▪ Best used when combined with other traffic count data	▪ Potential bias towards recreational riders ▪ Limited to users of the app ▪ Concerns over accuracy and challenges deciphering the data
Pneumatic Tubes Pneumatic tubes are pressure sensing devices that are laid across a path of travel to record pressure on the tube. They are typically used for short-term counts.	**Cycling**	▪ Relatively high accuracy ▪ Operate effectively in all light conditions ▪ Easy to move and relocate ▪ Ideal for short/temporary traffic counts ▪ Direction of travel can be determined ▪ Relatively inexpensive	▪ Installation and location selection may take time ▪ Can not count pedestrians ▪ Accuracy may diminish with groups ▪ Difficult to maintain or relocate as they are embedded ▪ Some may not detect bicycles that have low amounts of metallic content
Magnetometre and Radar Sensors Magnetometres can be embedded in the pavement to detect bicycles as they pass the respective sensor. Radar sensors are installed on structures above the pavement to detect a change in a radar beam, and can count at night with the use of infrared cameras above ground.	**Cycling**	▪ Typically used on pathways ▪ Radar sensors are more commonly used on roadways	▪ Accuracy can diminish with groups ▪ Difficult to maintain ▪ Challenges counting pedestrians

For example, this data can be used to assess the travel time impacts of a new cycling route and can be employed to provide key information that may otherwise not be available from other methods. GPS enabled route trackers can be an inexpensive tool for gathering this type of data.

REPORTING METHODS AND COMMUNICATION

A clear reporting methodology is required to ensure that the active transportation data collected is analyzed, presented, and reported to staff, decision-makers, and the public in a systematic and consistent fashion over time. This will allow for the clear monitoring of active transportation trends as well as progress towards achieving transportation related goals.

An important part of collecting data is ensuring that it is analyzed and that the findings are communicated to the general public in a format that is transparent, visible, and easy to understand.

This can involve installing visual bicycle count displays at prominent locations along the bicycle active transportation network, so the numbers are easily viewed by both people walking, cycling, and people driving. In addition, Some cities, including the City of Kelowna, publish their bicycle network traffic count data on-line, which allows members of the public to view the results. Both of these tools help dispel myths that people might have about whether the bicycle network is well-used.

As another mechanism for sharing data, several communities in Canada and internationally have developed report cards or yearbooks that report back statistics and provide updates on the current state of active transportation within a community. These documents are often considered both a way to report back on statistics and figures and also as a community-wide marketing and communication campaign.

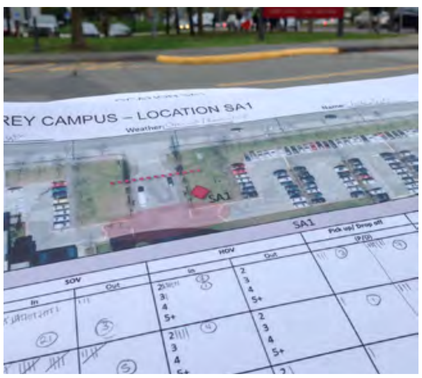
Case Study

Walking + Cycling Report Card, Vancouver, B.C.

A report card is a tool to monitor and present information about the current state of walking and cycling to residents and stakeholders in an engaging and graphic format. It can be used to assess if a community is achieving its active transportation objectives and report on important public input that can be used and incorporated into the active transportation planning process.

The City of Vancouver has published a Walking + Cycling Report Card annually since 2015. The report card highlights key statistics related to active transportation in Vancouver. The format of each of the report cards includes an overview of trends and highlights, and highlights the policies that are influencing active transportation in Vancouver. The report card presents statistics on mode share (city-wide and by neighbourhood), trip purpose, trip distance, and safety. Each report card also highlights some key active transportation infrastructure projects the city has been working on over the previous year. The document also outlines statistics on improvements to accessibility and multi-modal transportation integration, and highlights some of the promotion and education initiatives the city has undertaken.

Additionally, sharing bicycle and pedestrian count, travel survey data, and other data collected on-line promotes transparency and allows the public to monitor trends over time. For example, in many cases, bicycle count data is reported as a change from before and after a bicycle facility was implemented. It should be noted that using percentages to report increases or decreases on routes that have low usage can be seen as controversial by some people if baseline data is low. It is important to consider how the reporting back of active transportation data is messaged.



Manual Count Form


Pneumatic Tubes


Inductive Loops


Bicycle counter with display

Video

City of Vancouver, B.C.
Source: Mike Zipf

I.3

MAINTENANCE

While providing new infrastructure to promote walking and cycling is often seen as a top priority, ongoing rehabilitation and maintenance of existing infrastructure needs to be an equally important focus. Maintenance needs to be considered at all stages of the planning and the design process. Maintenance is necessary to keep active transportation facilities functional and usable throughout all seasons, which ensures that facilities are universally accessible throughout the year. In some situations, however, maintenance can be overlooked or neglected due to tight operating budgets, large outstanding maintenance needs, or an insufficient inventory of active transportation maintenance issues.

Bicycles are generally more sensitive to the condition of a facility as compared to motor vehicles. As a result, relatively small debris or obstructions can create safety issues for people cycling. Hospital records indicate that 50 to 70% of treated cyclist injuries are non-motor vehicle related[2] . Studies have shown that the most common types of non-motor vehicle injury crashes were a result of bicycle users crashing because of surface conditions (holes, bumps, roots, debris, leaves, etc.), colliding with infrastructure (curbs, bollards, posts, etc.), or colliding with a person cycling, person walking, or animal[3].

Providing a high level of maintenance throughout all seasons ensures that jurisdictions that invest in active transportation facilities can anticipate that many people will choose to walk and cycle year-round.

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2. Lopez, D. S., D. B. Sunjaya, S. Chan, S. Dobbins, and R.A. Dicker, R. A. (2012). Using Trauma Center Data to Identify Missed Bicycle Injuries and Their Associated Costs. Journal of Trauma and Acute Care Surgery, Vol. 73, No. 6, pp. 1602-1906.

3. City of Vancouver. (2015). Cycling Safety Study. *https://vancouver.ca/files/cov/cycling-safety-study-final-report.pdf*

WINTER MAINTENANCE

Studies have found that people will be more willing to walk and bicycle year-round if facilities are maintained throughout the winter months. Studies in Sweden, Montreal, Minneapolis, and Calgary have shown that an estimated 20 to 25% of the existing cycling population continues to cycle in the winter. It is estimated that improved winter maintenance could lead to an additional 12 to 24% mode share retention[4]. The key to ensuring people can walk and cycle in winter months is the provision of well-established, high-quality programs that prioritize maintaining routes year-round.

Sidewalk Snow Clearing

Sidewalk snow removal practices vary between communities. In some cases, property owners are responsible for clearing the sidewalks outside their homes and businesses. In other communities, the city or jurisdiction is responsible for clearing all or most sidewalks within the community. There can be variations of this as well. In most cases, a municipality or jurisdiction will clear sidewalks that are located adjacent to its property.

If a community is responsible for sidewalk snow removal, it typically identifies priority snow clearing routes. Prioritization is typically based on road classification, whether the corridor is a transit route, and its proximity to destinations such as schools, hospitals, and community centres. Typically, snow clearing is required to be completed within 24 to 48 hours of a snow event.

A municipal bylaw typically regulates sidewalk snow removal. The bylaw should outline responsibility, timeline for snow removal, and guidance on where cleared snow should be stored to address drainage, accessibility, and bus stop access. Enforcing sidewalk snow removal bylaws is an important component to ensure that people are able to travel safely and comfortably along sidewalks year-round. Established penalties for infractions and what steps the community will take to ensure sidewalks are kept clear need to be outlined and made transparent to all parties.

Bicycle and Pathway Network Snow Clearing

Snow Clearing Prioritization

To manage the resources and expectations for winter maintenance, maintaining the bicycle network should be treated in the same way as the rest of the road network. This means that the highest demand bicycle facilities would receive the highest priority snow clearing treatment, and other bicycle routes being treated subsequently depending on their network importance. Typical practice is that the highest priority route(s) would provide network connections and each subsequent priority will then help to fill out network density.

The desired pavement condition after plowing and de-icing should be identified for each priority level and facility type. Three facility priority levels are recommended for snow clearing purposes along bicycle routes:

- **Priority I bicycle routes**: These include all on-street and off-road bicycle facilities that have high daily bicycle traffic volumes and provide important connections across the bicycle network. These routes provide connections to

4. Fisher, Cara. (2014). Cycling Through Winter. *http://www.cip-icu.ca/Files/Awards/Plan-Canada/Cycling-Through-Winter*

schools, transit, high density neighbourhoods and business districts. Typically, the highest quality bicycle facilities, such as protected bicycle lanes, would make up Priority I bicycle routes. These routes should be plowed within 24 hours of the end of a snow event. On-street bicycle facilities should be cleared to bare pavement, and off-road pathways should be maintained to a compacted snow surface for graveled pathways and to bare pavement for paved surfaces. Snow piles should be stored sufficiently away from the bicycle facility, and care should be taken to ensure that snow melts do not lead to ponding or icing on the bicycle facility. Gaps in the snow piles may be required periodically to allow for drainage, or in some areas snow removal may be required.

- **Priority II bicycle routes:** These include bicycle routes with medium daily bicycle traffic volumes, and their connections. These routes should be plowed and/or salted within 48 hours of the end of snowfall. On-street bicycle facilities should be cleared to bare pavement, and off-road pathways should be maintained to a compacted snow surface for graveled pathways and to bare pavement for paved surfaces.
- **Priority III bicycle routes:** These are routes with low daily bicycle traffic volumes. These routes should be plowed within 72 hours of end of snowfall to a bare pavement.

To encourage cycling as a mode of commuting to work, communities should strive to ensure that the winter bicycle network is cleared of snow in the morning. This allows people to comfortably and reliably commute to work and/or school by bicycle each day.

A jurisdiction's prioritization for clearing bicycle facilities can be done separately from snow clearing for roads. For example, a local road that is a low priority for motor vehicles may contain a high priority bicycle route. In this case, the bicycle facility along with the road might be cleared prior to other higher classification roads without bicycle facilities.

Where bicycle facilities such as off-street pathways are in areas under the jurisdiction of different departments or agencies, they may be cleared by a different maintenance team than those clearing on-street bicycle facilities. In this case, winter maintenance priorities should be co-ordinated to ensure a consistent level of service, both in timing and extent of clearing. Considerations can be made to consolidate maintenance responsibilities for the network under one group or department. Having maintenance responsibilities under one group or department can result in efficiencies and improved service.

It is important to ensure that if a high-quality bicycle facility is cleared adjacent to a sidewalk, the sidewalk should be cleared as quickly as the bicycle facility. If a bicycle facility is cleared and an adjacent sidewalk is not cleared, pedestrians may choose to walk in the bicycle facility of the sidewalk.

Bicycle Facility Design for Efficient Snow Storage

Snow storage can present a significant challenge along bicycle facilities. Bicycle lanes often become the area for snow storage on the road, making the bicycle facility narrow or unusable. One of the most effective ways to mitigate snow storage and clearing is through careful consideration of maintenance during the planning and design process.

There are several road planning and design elements that can be considered:

- **Design roads and facilities with sufficient space for snow storage: Figure 1-152** shows undesirable designs for snow storage, which cause snow to collect in the bicycle lane, decreasing its width. On new streets or street rehabilitation projects that include both protected or unprotected bicycle facilities (or may include them in the future), sufficient space should be provided to allow for a desired 1.8 metre bicycle facility and a 1.8 metre storage space for snow on the side of the road or in the Furnishing Zone between the Pedestrian Through Zone and the bicycle facility. This will allow typical truck-mounted snowplows to plow snow into the designated storage space rather than the bicycle lane. A 1.8 metre width also allows some narrowing of the bicycle lane due to snow build up while still maintaining its functionality.

  Where feasible, a wide bicycle lane buffer can also be provided to increase the amount of storage space for snow (**Figure 1-153**). Alternatively, a protected bicycle lane may be used, providing

Figure 1-152 // Undesirable Designs for Snow Storage

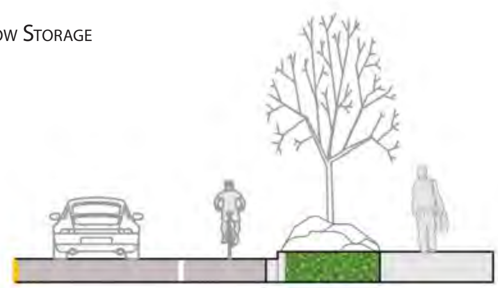


Figure 1-153 // Desirable Design for Snow Storage - Painted Bicycle Lane

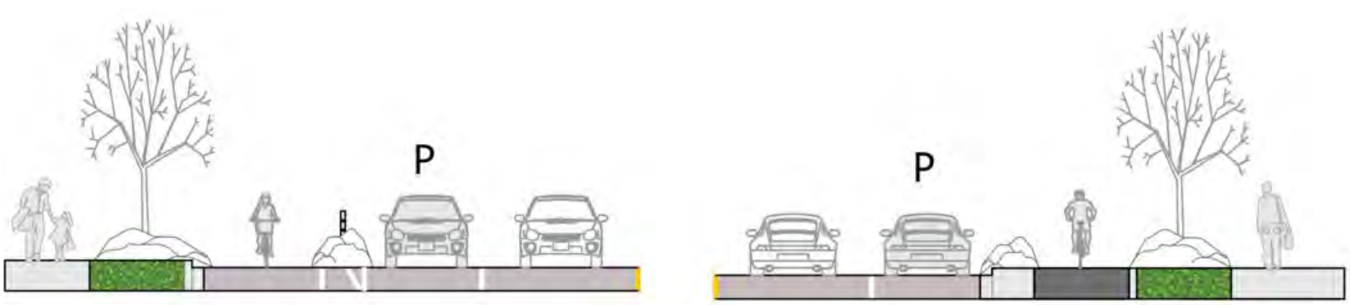


Figure 1-154 // Desirable Design for Snow Storage - Protected Bicycle Lane even more snow storage (**Figure 1-154**). A minimum 0.6 metre buffer is recommended to accommodate moderate amounts of snowfall with minimum encroachment upon the bicycle lane. If the bicycle lane is protected, this design will require the use of a narrower snowplow to clear the facility. When storing snow in an on-street buffer, room for snow melt and sufficient crossfall needs to be designed to ensure that icing does not occur across the bicycle facility.

- **Provide a wide buffer on sidewalks:** Buffer space should be provided along the Furnishing Zone in order to allow the Furnishing Zone to be cleared without pushing the snow into any adjacent bicycle facility.
- **Remove snow from the storage locations:** Snow storage can be located in the centre of the road along medians, in the boulevard and sidewalk buffer, and, in the case of protected bicycle lanes, in the road buffer. Snow removal from these temporary storage locations may be necessary as part of efforts to reduce icing over of the bicycle facility due to freeze/thaw cycles. Snow removal can be particularly important in urban and city centre environments and can be completed using a variety of equipment including loaders.
- **Consider the type of separation used and how it can be maintained during the winter:** If flexible delineators are used to provide physical separation and are bolted down to the road, freeze thaw cycles may result in higher maintenance costs. Using epoxy to fix delineators to the road (rather than bolting directly to the road), has not been shown to be an effective alternative in winter cities. In most cases, the delineators should not be removed in winter due to the need to rehabilitate bolt holes and the need to re-bolt delineators into the road at the end of winter.

  Other types of separation, including curbs, medians, barriers, and planters, may require specialized equipment for snow maintenance crews to work around them. If planters are used as a measure to provide physical separation between a bicycle facility and a road, the planters should be removed over the winter in order to facilitate snow removal or snow storage and to minimize damage to the planters. Where low curbs or medians may be covered by snow and invisible to snow clearing crews, a visible vertical element, such as a flexible delineator or snow pole, should be considered to draw attention to the hidden element. Depending on the size and shape of the medians or curb bulbs, the placement of three vertical elements can help better define the curve or edge of the median.
- **Consider providing walking and cycling facilities at the same vertical level:** When considering facilities at a different vertical level than the road, consider using sidewalk-level (protected bicycle lanes). This may allow for both facilities to be cleared at the same time and may reduce or eliminate the need for specialized equipment. However, the ease of maintenance should be balanced with pedestrian safety and the function of the facility. The shared space would need to accommodate people with visual disabilities, who may have trouble distinguishing between the sidewalk-level protected bicycle lane and the sidewalk.
- **Restrict on-street parking during snow events:** Where a bicycle facility is located between on-street parking and the motor vehicle lane, parking along the road can be restricted during snow events to allow this space to become temporary snow storage space. While this may not be an option for all roads, it could be utilized along priority bicycle routes in the winter. When motor vehicles are parked in the road during snow clearing the snow can accumulate in the bicycle lane but can also create a barrier making it challenging for smaller vehicles to exit their parking spot.

Bicycle Route De-Icing Considerations

There are two primary strategies for de-icing roads in winter maintenance programs: reactive and proactive. An approach that is reactive is characterized as applying de-icing material to the road surface after the snow event. The snow or ice is plowed off the surface and the de-icing material is applied to the road to break the bond between the ice and the road. A proactive or anti-icing approach is where the de-icing material is applied to the road before an expected snow event (approximately two hours). This is the more effective de-icing strategy and usually means that less de-icing material and snow clearing is needed. Following the snow event, the road is cleared, and additional de-icing material is added as necessary.

The section below provides an overview of the common types of de-icing materials used on roads and bicycle facilities along with their advantages and disadvantages.

- **Road Salt** is applied to the road and needs to be crushed by tires to dissolve most effectively. The dissolution of the salt creates a brine that prevents ice from bonding to the road. As bicycles have skinner tires and are lighter than motor vehicles, they do not crush ice as effectively. The disadvantages of salt are that it is a highly corrosive material and salt-infused stormwater runoff can cause environmental damage. Bicycles with exposed gears are especially susceptible to corrosion caused by road salt.
- **Pre-Wetted Salt** is road salt that is sprayed down with a brine solution. This occurs either upon application or in storage prior to being loaded in trucks. Some advantages of using pre-wetting over dry salt include quicker reaction times, less material, and improved application accuracy. This type of treatment may require special equipment and additional labour to prepare. Pre-wetted salt is also corrosive to bicycles and gears.
- **Sand and Gravel** are primarily used to provide traction but have little ability to melt ice. The application of sand is usually done in conjunction with other de-icing treatments. While sand is good for providing traction and to help salt stay in place, too much sand can pose a hazard for people cycling. Sand can get trapped in the bicycle's mechanisms, it can be hazardous to bicycle tires, and wet sand can get on a bicycle user's clothes. Sand, particularly if combined with salt, can also have a negative environmental impact. If sand is applied to a road with a bicycle facility, it should be cleared as soon as possible when the threat of snow and ice has subsided. Gravel is not recommended for use along roads with on-street bicycle facilities.
- **Beet Juice Additive** has been used by some jurisdictions as an additive to other de-icing applications to reduce the number of de-icing applications required and reduce costs. It is an inexpensive additive that improves the adherence of salt and sand to the road and lowers the freezing temperature of the ice. Beet juice adheres well to the road, and it is less corrosive than using plain road salt. Beet juice still has a negative environmental impact.
- **Cheese Brine Additive** can be used as an additive to salt. The brine helps the salt adhere to the road and has a lower freezing temperature. Cheese brine additive is also more environmentally friendly than pure salt applications or beet brine and can provide cost savings to municipalities by reducing salt expenditures. Cost savings will vary depending on the proximity to local production sources, as transportation is a major cost factor of supplying the additive.

- **Heated bicycle paths** have been installed in European cities such as Amsterdam, Netherlands and Umea, Sweden. Heating the bicycle facility can help prevent the formation of ice and the accumulation of snow, resulting in cost savings from snow clearing and de-icing materials. However, installation and ongoing heating costs will be higher than regular bicycle facilities.
- **Warm Wetted Sand**: This material is applied using a specialized truck with a water tank, water heater, and separate sand storage. The sand and hot water are mixed upon application and a spreader is used to apply it to the road. Wet sand provides better traction than dry sand and reduces the overall amount of sand needed on the road. Similar to sand, warm wetted sand can get caught in bicycle gears and riders' clothing.

Jurisdictions should consider piloting different de-icing techniques to see which will work best and may consider evaluating the use of sand and gravel along their on-street bicycle facilities. If sand and gravel are used, they should be swept periodically to avoid accumulation on bikeways. All roads with on-street bicycle facilities should be swept for winter debris as soon as the threat of snow has passed.

Snow Clearing Vehicles

The different types of active transportation facilities have unique dimensions and characteristics, meaning that a variety of snow clearing vehicles may be required to maintain the active transportation network throughout the winter.

During the planning and design process, jurisdictions should work with their maintenance crews to ensure they have the equipment and resources available to maintain and clear new active transportation facilities. These considerations early in the process can help to ensure designs are consistent and lessen the need for specialized equipment and training. As new active transportation facilities are installed, jurisdictions should be prepared to dedicate additional resources to clearing snow, ice, and debris from bicycle facilities, especially facilities that may be too narrow for traditional snow removal vehicles. The preferred practice is to design protected bicycle lanes and off-road pathways so that typical truck-mounted plows can clear them. In order to do this, the protected bicycle lane and buffer or pathway should have at minimum 2.4 metres of clear space (2.7 metres preferred).

Many jurisdictions that experience snow and ice in the winter have a fleet of small, specialized snow clearing vehicles and attachments that can be mounted to pick-up trucks, All terrain vehicles (ATVs), or other small utility vehicles. Some vehicles can serve both as snow clearing equipment during the winter and road sweepers throughout the rest of the year. Sweepers are typically very effective at clearing to the bare pavement, especially when combined with a brine de-icing solution. Sweeper attachments can be mounted on most existing snow clearing equipment, and some vehicles can be outfitted with both a plow and a sweeper.

FACILITY SWEEPING

To ensure active transportation facilities are safe, comfortable, and attractive for people, they must be kept clear of debris. Gravel, broken glass, leaves, or other debris can act as a barrier to both walking and cycling. They can create a slipping or collision hazard, puncture bicycle tires, and be blown or be kicked up by users.

Sidewalk Facilities

Like snow and ice, in many jurisdictions sweeping sidewalks of leaves and debris is the responsibility of the property owner and is regulated through a bylaw. This bylaw needs to be enforced by the jurisdiction to ensure compliance.

Bicycle and Pathway Facilities

Jurisdictions should develop a regularly scheduled inspection and maintenance program for road sweeping that helps ensure that road debris is regularly swept and cleared. Recommended guidance for road sweeping includes:

- Incorporate bicycle facilities into established road sweeping programs and ensure that special considerations for these facilities are followed. This includes ensuring debris is picked up in curbed sections of the roadway or sweep debris into gravel shoulders for sections without curbs;
- Establish a schedule that prioritizes sweeping roads with bicycle facilities seasonally. Jurisdictions may need to perform additional sweeping in the spring to remove debris from the winter;
- Sweep bicycle facilities whenever there is an accumulation of debris that may pose a hazard on the facility;
- Pave gravel driveway approaches to minimize loose gravel on paved road shoulders; and
- Perform additional sweeping in the fall in areas where leaves accumulate.

Off-street pathways can be maintained by a separate team than those sweeping and clearing the roads. Therefore, a separate inspection and maintenance program may need to be developed for off-street pathways.

Example of poor surface condition - poor drainage.

Example of poor surface condition - ponding.

SURFACE CONDITIONS AND QUALITY

Sidewalk Facilities

Many communities and jurisdictions do not have defined processes for assessing existing sidewalk facilities to determine when they need to be repaired or replaced. Typically, jurisdictions receive most of their input on facility quality from residents and address maintenance issues through a complaint-based system. By developing a sidewalk and pathway assessment program that includes a regularly scheduled assessment and maintenance program, a more objective and systematic process can be developed to identify infrastructure improvements.

Bicycle Facilities

Cracks, potholes, depressions, catch basin grates, and ponding can all be hazardous to people cycling. The impacts of cuts in surface material due to construction activities (saw cuts and excavation for utility work) in bicycle facilities need to be considered. Cuts in surface materials results in locations where there can be an inconsistent riding surface. Construction activities can also result in surface material issues due to backfilling and compaction that includes uneven surfaces. Recommended guidance for surface conditions includes the following:

- Maintain a smooth surface clear of cracks, potholes, depressions, or bumps to reduce hazards for all users;
- Establish a spot improvement program for bicycle facilities that allows people cycling to report specific problems using a smartphone app, website, and/or by texting or calling a dedicated number;
- Include extra width on new bicycle facilities in locations that are prone to surface quality issues such as potholes, cracks, or frequent debris, to allow people cycling to avoid problem areas;
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings;
- Inspect the pavement two to four months after trenching construction activities are completed

Example of poor surface condition - longitudinal cracks.

Example of clear surface condition, Castlegar, B.C.

to ensure that excessive settlement has not occurred;

- Utilize bicycle-friendly pavement preservation alternatives to chip seals to create more stable surfaces. Alternatives include microsurfacing and slurry seals;
- If chip sealing is to be performed, use the smallest possible chip size on bicycle facilities. Sweep loose chips regularly following application;
- During chip seal maintenance projects, if the pavement condition of the bicycle facility is satisfactory, it may be appropriate to chip seal the travel lanes only. However, use caution when doing this so as not to create an unacceptable ridge between the bicycle facility and travel lane;
- Ensure facility surfaces are clear of water and have proper drainage;
- Ensure all new drainage grates be bicycle-friendly, including grates that have horizontal or diagonal slats on them or no grate, so that bicycle tires and assistive devices do not fall through the vertical slats. Consider creating a program to inventory all existing drainage grates and replace hazardous grates as necessary; temporary modifications such as installing rebar horizontally across the grate should not be an acceptable alternative to replacement;
- Consider gutter to pavement transitions and ensure that the difference between the gutter and pavement at transition points is no more than 6 millimetres. To provide additional seamless space along the bicycle facility, when paving is taking place as part of surface overlay and/or re-construction projects, the gutter pan can 'buried'. If the gutter pan is 'buried', care should be taken to ensure that the drainage pattern for the road is maintained, including adjustments to drainage structures (if required) to match the new pavement surface elevation to avoid abrupt vertical changes; and
- Pavement overlays are important opportunities to improve conditions for people cycling, if done carefully. A ridge should not be left in the area where people are riding (this occurs where an overlay extends part-way into a bicycle facility).

VEGETATION MANAGEMENT

Landscaping and vegetation management can be important along active transportation facilities, as facilities can become inaccessible due to overgrown vegetation. It is important to ensure that all landscaping is designed and maintained to ensure compatibility with the intended users. Jurisdictions should monitor facilities to ensure they are clear of encroachment by vegetation, such as overgrown grass, bushes, or tree branches. Signage, signal heads, and sightlines should not be obstructed by vegetation. After major damage incidents such as a flood or major storm, bicycle facilities should be checked, and debris should be removed as quickly as possible. Root barriers can be installed during construction as a preventative measure to mitigate surface damages and hazards caused by plant roots.

MAINTENANCE OF SIGNAGE AND PAVEMENT MARKINGS

The visibility of signage and pavement markings is required to help identify the facility type to all road users, allow or restrict certain types of vehicles, warn users of potential conflict zones, and provide wayfinding for users. Regular inspection of signage and pavement markings, including intersection and crosswalk treatments, is necessary to ensure they are kept in good condition. Pavement markings with paint should be refreshed annually, or twice a year if needed. Pavement markings using thermoplastic last longer and may not need to be refreshed annually. Reapplication of pavement markings also varies depending on the location of the marking.

The choice of material for pavement markings is important and typically depends on the type of users. For example, markings under motor vehicle traffic wear out faster than other markings. The material used should be durable, highly visible, and should provide adequate traction in all road conditions. Coloured pavement along bicycle facilities can either be in the form of an overlay on the existing pavement or it can be embedded into the pavement itself by mixing coloured pigment into asphalt. Glass beads can also be mixed into the pavement markings to increase retro reflectivity.

Overlay treatments include paint, epoxy (including Durable Liquid Pavement Markings (DLPM) and Methyl Methacrylate (MMA), thermoplastic, and tape. For roadways under MOTI jurisdiction, transportation professionals should review the MOTI *Recognized Products List* (April 1st 2019 Edition).

- Paint is the least expensive and most widely used treatment but is non-durable and is easily worn off by motor vehicle traffic and the elements, especially in winter climates. Its lifespan is typically 12 to 48 months. Paint has a low level of retroreflectivity. Care also needs to be taken to ensure friction is maintained in wet and winter conditions.
- Epoxy (including: DLPM and MMA) DLPM can be applied as a paint or spray but is sensitive to moisture and temperature (requiring longer dry times). MMA is a durable but more expensive product that consists of a two-part liquid application that can be installed at a wide range of temperature. These products have a lifespan of 12 to 48 months, are more expensive than paint, and have a medium level of retroreflectivity. They can be combined with abrasive materials to ensure friction is maintained.
- Thermoplastic and tape are durable plastic materials that can be pre-formed and assembled, making them easier to apply and more durable than MMA. Thermoplastic markings and some preformed marking tapes need to ensure steps are taken to ensure friction is maintained with wear, which may be an issue for cyclists. Skid-resistant materials may be mixed into the thermoplastic or applied on top of the markings. They have a longer life span (thermoplastic 48 to 72 months, tape 36 to 96 months). The life span varies depending on the amount of snow and ice, as well as the number of motor vehicles travelling over them. Primer-sealers can be applied prior to the application of most thermoplastic to increase the durability and strength.

Winter is an important consideration when discussing bicycle pavement markings. Recessing pavement markings has been shown to increase marking life expectancy in cold weather climates. Markings are recessed by milling the area of pavement 3.0 millimetres in depth where pavement markings are applied. While this installation method is more expensive, it may save maintenance costs over the long-term if the facility is located on a road that receives heavy plowing.

TEMPORARY AND SPECIAL EVENT CONSIDERATIONS

During special events, construction, and maintenance work, it is imperative that people walking and cycling are adequately accommodated to ensure facilities are still accessible. Jurisdictions should consider developing a Road Maintenance Management Plan to accommodate people walking and cycling during these events.

Route closures and major detours for people walking and cycling should be avoided wherever possible. Instead, the walking and/or cycling facility should be continued through the affected area using temporary designated facilities. It is not recommended to divert people walking and cycling to other corridors or even requiring them to cross the road. Temporary facilities should maintain the constrained limit width of the desired walking and cycling facility.

If the affected area involves a construction site with hoarding, the hoarding structure should be constructed to accommodate people walking and cycling. If this is not possible, it may result in shared - use conditions, where people cycling, and walking may need to share the facility. In such cases, signage should be provided to indicate to people walking and cycling that conditions have changed, and their behaviour needs to change. This includes signage indicating that people walking and cycling should share the space, and advising people cycling to travel slowly or to dismount.

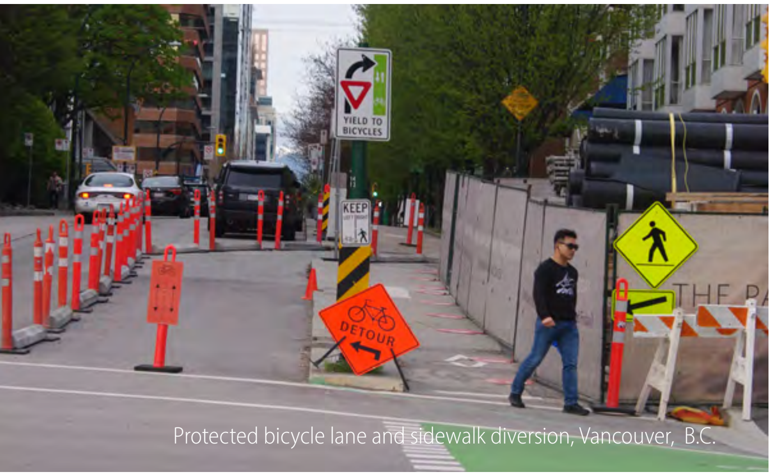
If constrained limit widths cannot be achieved to accommodate people walking and cycling, Dismount and Walk signage (MUTCDC RB-79,RB-79T; B.C. B-R-101-2 Series) can be considered, as shown in **Appendix B**. However, it should be recognized this may result in low compliance. The TAC *Bikeway Traffic Control Guidelines for Canada* indicates that the Dismount and Walk sign should only be used in exceptional circumstances.

If route closures cannot be avoided, people must be warned of these closures in advance and given adequate detour information to bypass the closed section. Users should be warned using standard signage approaching each affected section. For example, Bicycle Lane Closed Sign (MUTCDC TC-68; B.C. B-C-002 Series) accompanied by Bicycle Lane Detour Markers (MUTCDC TC-70, TC-71; B.C. B-C-004 Series) where appropriate), including information on alternate routes and dates of closures. These signs are included in **Appendix B** for reference. Signage should never be placed within the bicycle facility, as this forces people cycling to use the road or sidewalk.

Alternative routes should provide reasonable directness, equivalent traffic characteristics, and be signed. Recommended guidance for detour routes includes:

- Provide fire and police departments with map of bicycle route system, along with access points to gates/bollards;
- Enforce speed limits and other rules of the road; and
- Enforce all trespassing laws for people attempting to enter adjacent private properties.

Construction Management, Vancouver, B.C.
Source: Rod Preston



Protected bicycle lane and sidewalk diversion, Vancouver, B.C.

Painted bicycle lane diversion, Vancouver, B.C.

Vancouver, B.C.

ANNUAL MAINTENANCE PROGRAM AND LIFE-CYCLE CONSIDERATIONS

Communities should develop an ongoing maintenance program that will maintain active transportation facilities year-round. Regularly scheduled maintenance will ensure that these facilities are safe and comfortable for all users at all times of the year. At minimum, semi-annual maintenance should be conducted in the spring and fall to clean up debris and repair any damage that has occurred as a result of seasonal changes.

Creating and maintaining an inventory of maintenance issues along active transportation facilities is a useful way to track maintenance concerns and identify problem areas that may require additional mitigation or more frequent maintenance. Creating a scheduled maintenance program can also help track annual operational costs by facility type, aid in establishing future budgets and inform future design choices.

It is important for jurisdictions to consider active transportation facilities as assets and to appropriately manage them. Since many of these facilities, particularly bicycle facilities, are new, communities should:

- Track and update their inventory of assets;
- Schedule maintenance, repair and preservation activities;
- Develop maintenance standards (for items such as signage, pavement surface quality, pavement marking replacement timeframes, or snow clearance time);
- Inspect facilities and track them against maintenance targets; and
- Set and adjust maintenance budgets as necessary to meet maintenance targets (or adjust maintenance targets to match budgets).

Event zone signage, City of Vancouver, B.C.
Source: Dylan Passmore

It is also important to consider life-cycle cost, accounting for other components of active transportation facilities, such as bollards, ramps, planters, pavement markings, lighting, and surface materials. This information can then be used to compare different materials, installation techniques, and maintenance practices. Having a better understanding of the cost of active transportation facilities can help to enhance financial planning and costing out future projects.

Windsor, ON.

ACRONYMS

ACRONYM	DEFINITION
AAA	All Ages and Abilities
APBP	Association of Pedestrian & Bicycle Professionals
B.C.	British Columbia
CPTED	Crime Prevention Through Environmental Design
CROW	CROW refers to the Dutch *Design Manual for Bicycle Traffic* (2016). CROW is the Dutch abbreviation of the *Information and Technology Centre for Transport and Infrastructure.*
FHWA	Federal Highway Association
GBA+	Gender-Based Analysis Plus
MOTI	Ministry of Transportation and Infrastructure
MUP	Multi-Use Pathway
MUTCDC	Manual on Uniform Traffic Control Devices Canada
MVA	Motor Vehicle Act
NACTO	National Association of City Transportation Officials
TAC	Transportation Association of Canada
TWSI	Tactile Walking Surface Indicator

GLOSSARY

TERM	DEFINITION
Absolute Minimum Width	The lowest end of a design domain value for a bicycle facility component (e.g. lane, buffer), beyond which a bicycle facility component would be rendered unsafe and unusable. The absolute minimum should only be used for short distances, when reasonable consideration has been given to local context, and if maintenance equipment is able to fit within this width.
Active Transportation Facility	Features such as sidewalks, bicycle lanes, multi-use pathways, and pedestrian bridges that both promote and enhance active transportation.
Advisory Bicycle Lane	Advisory bicycle lanes are bicycle-priority areas within a shared street environment, where people cycling have priority within dedicated lanes but where motorists may legally enter the bicycle lanes to pass oncoming motor vehicles.
All Ages and Abilities (AAA)	Active transportation facilities that are considered safe and comfortable for people of all ages and abilities. A range of bicycle facility types may be considered to be AAA facilities, depending on their design and the surrounding context.
Ancillary Zone	A flexible space located on street within the roadway that is not designated for motor vehicle through traffic, but that supports the primary functions of either the roadway or the sidewalk. Uses can include on-street motor vehicle or bicycle parking, bicycle facilities, docked bike share stands, loading zones, transit stops, taxi or ride hailing zones, curb extensions, parklets, or patios. This space also includes the concrete gutter and, depending on the street design, may be used for snow storage. See Chapter C3 for design guidance.
Bicycle	A type of 'cycle' (see definition of cycle below).
Bicycle Accessible Shoulder	Bicycle accessible shoulders are paved spaces on the right side of rural roads and highways, and along certain urban streets, that can be used by people riding bicycles as well as by other street users.
Bicycle Facility	A roadway, part of a roadway, or off-street pathway intended for the use of bicycles and sometimes skateboards, in-line skates, scooters, or other active modes, either exclusively or shared with vehicular traffic or pedestrians.
Bicycle Lane	A lane intended for the exclusive use of bicycles and sometimes skateboards, in-line skates, scooters, or other active modes, within a roadway used by motorized vehicles.
Bicycle Pathway	A bicycle facility, physically separated from roadways, where motor vehicle traffic, except maintenance vehicles, is excluded.
Bicycle Rider Spectrum	A method of categorizing people's willingness to use a bicycle for transportation, first developed by the City of Portland. The general population is classified into a 'bicycle rider spectrum' made up of the following four groups of bicycle riders, ordered by their level of stress and risk tolerance from high to low: 'strong and fearless,' 'enthused and confident,' 'interested but concerned,' and 'no way, no how.' Market research has shown that the percentage of people who fall into each category will differ slightly in different municipalities.
Bicycle Through Zone	The Bicycle Through Zone exists on streets with bicycle facilities. On some streets, the Bicycle Through Zone takes the place of the Ancillary Zone, but not always. However, an Ancillary Zone with on-street parking may still be provided adjacent to a Bicycle Through Zone. See Section D for design guidance
Bioswale	Bioswales (also known as biofilters, infiltration swales, grassed swales, or in-line bioretention) are vegetated open channels designed to attenuate and treat stormwater run-off for a defined water volume. Bioswales convey larger stormwater volumes from a source to a discharge point, similar to an open ditch. However, unlike ditches, they intentionally promote slowing, cleansing, and infiltration along the way. A sloped base to facilitate this water movement distinguishes bioswales from rain gardens.
Clear Zone	The roadside area immediately adjacent to the outer travelled lane, clear of hazards, which may be used safely by errant vehicles.

TERM	DEFINITION
Comfort Zone	A designated zone with a shared street environment that provides a clear pathway for pedestrians, separated from mixed motor vehicle traffic. The Comfort Zone is the shared street equivalent of the Pedestrian Through Zone.
Complete Street	A street designed and operated to enable safe and efficient access for all street users, including people walking, cycling, and using other active modes, in addition to transit and motor vehicle users. Complete streets are designed to integrate all transportation modes while responding to local context and considering the needs of people of all ages and abilities.
Constrained Limit Width	The lower end of a design domain value for a bicycle facility component (e.g. lane, buffer), for use when providing the desired width is not feasible. The constrained limit width is likely to offer inferior operational performance and user experience as compared to the desired width, but it may be less costly to construct, and it provides design flexibility.
Continuous Tree Trenches	A system of street trees connected by an underground infiltration system, allowing the roots of neighbouring trees to interconnect and share resources.
Control Vehicle	The largest and least maneuverable user or vehicle that will infrequently use the street. The control vehicle should be accommodated but not prioritized in street design. It may need to operate at lower speeds and take wide or multi-point turns.
Crash Cushion	A device that prevents an errant vehicle from impacting fixed object hazards by gradually decelerating the vehicle to a safe stop or by redirecting the vehicle away from the hazard.
Crime Prevention Through Environmental Design (CPTED)	A multi-disciplinary approach for reducing crime through urban and environmental design and the management and use of built environments. For more information, visit: www.cpted.net/
Cross-Ride	Cross-rides (also known as elephant's feet and cross-bikes) are the bicycle equivalent of a crosswalk. They are intended to alert all street users of a bicycle crossing. Cross-rides consist of a series of white squares laid out in parallel lines across a street. They can be enhanced by adding the bicycle symbol and/or applying a green surface treatment. Cross-rides are not currently defined in the B.C. MVA, meaning that they have no legal status and have limited application on MOTI facilities. However, municipalities may enact bylaws that define cross-rides and permit them on municipal streets.
Crosswalk	As defined in the B.C. MVA: (a) a portion of the roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by signs or by lines or other markings on the surface, or (b) the portion of a highway at an intersection that is included within the connection of the lateral lines of the sidewalks on the opposite sides of the highway, or within the extension of the lateral lines of the sidewalk on one side of the highway, measured from the curbs, or in the absence of curbs, from the edges of the roadway.
Cul-de-sac	A dead-end street that is only connected to other streets on one end.
Curbside Activity	Uses of the street immediately adjacent to the curb that can have an impact on the function and design of bicycle and pedestrian facilities, and which may present challenges to people with disabilities. Curbside activities include motor vehicle parking, loading, and transit stops.
Cut throughs	A pathway that runs between two properties to connect two segments of a pedestrian facility, bicycle route, or off-street pathway that are separated by development or open space. They are typically paved or a hard surface. Cut-through pathways make neighbourhoods more walkable and bikeable by shortening distances and providing important connections to destinations.
Cycle	A device having any number of wheels that is propelled by human power and on which a person may ride and includes a motor assisted cycle, but does not include a skateboard, roller skates or in-line roller skates;
Daylighting	The removal of sightline obstructions such as vegetation, parked motor vehicles, or other physical objects near intersections and conflict points along bicycle facilities in order to facilitate increased visibility between bicyclists and other street users.

TERM	DEFINITION
Design Domain	A geometric design concept used in the TAC Geometric Design Guide for Canadian Roads that includes a range that has a relationship with the fitness-for-purpose of the design element. For example, design domain is used to provide a range of values for bicycle facility components, such as the width of a bicycle lane. The TAC Geometric Design Guide for Canadian Roads includes four levels within the design domain: practical lower limit, recommended lower limit, recommended upper limit, and practical upper limit. For the purposes of the Design Guide, the primary focus is on those levels that TAC identifies to be part of the recommended lower Limit (referred to as constrained limit in the Design Guide) or recommended higher limit (referred to as desirable in the Design Guide).
Design Guide	The B.C. Active Transportation Design Guide (this document).
Design Speed	A speed selected for purposes of design and correlation of the geometric features of a road.
Design User	The target user or user group for which a bicycle facility is designed. For example, a design professional may want to design a facility that serves the 'interested but concerned' segment of the population (see Bicycle Rider Spectrum) or a AAA facility (see All Ages and Abilities (AAA) Bicycle Facility).
Design Vehicle	The vehicle whose dimensions and speed potential are used to dictate the minimum design requirements for a given street or facility. When designing a bicycle facility, the bicycle is used as the design vehicle. Bicycles are not uniform in size or operating style, so variations in bicycle design must be considered.
Desire Lines	A desire line (or desire path) is a path created by erosion from human or animal traffic. The desire line typically represents the most direct or easily navigated route between two destination.
Desired Width	The recommended design domain value for a bicycle facility component (e.g. lane, buffer) that is likely to provide optimum operational performance and user experience. Design professionals are encouraged to design bicycle facilities using the desired width whenever feasible.
Detectable Warning Surface	A surface that is detectable underfoot or by a cane. Detectable warning surfaces can alert and/or guide people with blindness or low vision. tactile walking surface indicators (TWSI) are recommended by the CSA as the standardized detectable warning surface treatment. Changes in surface material, such as providing a strip of softscape (e.g. grass) or textured surface material next to hardscape (e.g. concrete) can also function as a detectable warning surface.
Dooring	When a bicyclist collides with the door of a parked motor vehicle that has been opened suddenly into the path of the bicyclist. Bicycle facilities should be designed to minimize the risk of dooring by removing motor vehicle parking adjacent to bicycle facilities or separating the parking from the bicycle facility using a painted and/or physical buffer.
Frontage (Service) Road	A roadway contiguous to a through roadway so designed as to intercept, collect and distribute traffic desiring to cross, enter or leave the through roadway and to furnish access to property.
Frontage Zone	This is the area adjacent to properties, such as building entrances, front yards, stoops, vending, café seating, and building-related utilities. This area may be part of the public right-of-way, or private, if a building setback is present. The Frontage Zone predominantly applies to an urban street context as it is typically private front yard space in a local or suburban context. See Chapter C3 for design guidance.
Furnishing Zone	The space that provides physical separation between the sidewalk and the bicycle lane.
Gender-Based Analysis Plus (GBA+)	GBA+ is an analytical process used to assess how diverse groups of women, men and non-binary people may experience policies, programs and initiatives. The 'plus' in GBA+ acknowledges that GBA goes beyond biological (sex) and socio-cultural (gender) differences. GBA+ is the process by which a policy, program, initiative or service can be examined for its impacts on various groups. GBA+ provides a snapshot that captures the realities of diverse groups of women, men and non-binary people affected by a particular issue at a specific time. This means that analysts, researchers, evaluators, and decision-makers are able to continually improve their work and attain better results for Canadians by being more responsive to their specific needs and circumstances. For more information, visit: https://cfc-swc.gc.ca/gba-acs/index-en.html
Geometric Design	The selection of the visible dimensions of the elements of a roadway.
Grade Separation	Vertical separation of two intersecting roadways or a roadway and a railway.

TERM	DEFINITION
Highway	Synonymous with roadway but generally limited to higher-speed roadways in rural areas. However, in the B.C. MVA, 'highway' includes: (a) every highway within the meaning of the Transportation Act, (b) every road, street, lane or right of way designed or intended for or used by the general public for the passage of vehicles, and (c) every private place or passageway to which the public, for the purpose of the parking or servicing of vehicles, has access or is invited, but does not include an industrial road.
Horizontal Illumination	Measured at grade and is key for enabling bicycle users to see the surface condition, pavement markings, obstacles, and the direction of the bicycle facility.
Illuminance	The density of luminous flux incident on a surface (e.g. the amount or intensity of light received by a surface), measured in lux.
Illumination	A qualitative or general term designating the act of lighting or the state of being lit.
Luminaire	A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.
Luminous Flux	The amount of light produced by a light source, measured in lumens.
Motor Vehicle	A vehicle, not run on rails, that is designed to be self-propelled or propelled by electric power obtained from overhead trolley wires but does not include mobile equipment or a motor assisted cycle.
Multi-Use Pathway (MUP)	A path with multiple users of different types (e.g., pedestrians, bicycles, and similar user types); MUPs may be shared (all users share the same pathway space, with or without a marked centre line) or may be separated (e.g., the pathway is separated into parallel travelled ways, e.g., one exclusively for pedestrians and one exclusively for bicycles, skateboards, and other active transportation users).
Neighbourhood Bikeway	Neighbourhood bikeways (also known as bicycle boulevards, bicycle priority streets, local street bikeways, and neighbourhood greenways) are streets with low motor vehicle volumes and speeds that have been enhanced to varying degrees to prioritize bicycle traffic. Bicycle boulevards should include signage and pavement markings and can also include a range of traffic calming and diversion measures to facilitate through movement by bicycles, while reducing motor vehicle volumes and speeds as necessary.
New Mobility	A broad term that covers new and emerging forms of transportation, including autonomous vehicles, electric motor vehicles, mobility as a service, shared mobility, electric bicycles, and small, one-person electric vehicles.
Operating Speed	The 85th percentile speed of vehicles at a time when traffic volumes are low and drivers are free to choose the speed at which they travel.
Pedestrian	A person walking, including people using mobility aids such as canes, walkers, manual wheelchairs, electric wheelchairs, and mobility scooters.
Pedestrian Through Zone	This is the most important area of the street for safe, accessible, and efficient movement of pedestrians. The width of this zone depends on the street context and the volume of pedestrian activity anticipated for the corridor or block. This area should be entirely free of permanent and temporary objects. See Chapter C.2 for design guidance.
Phytoremediation	The use of living green plants for in situ removal, degradation, or containment of contaminants in soils, sludges, sediments, surface water, and groundwater.
Posted Speed	A speed limitation introduced for reason of safety, economy, traffic control and government regulatory policy aimed at encouraging drivers to travel at an appropriate speed for surrounding conditions.

TERM	DEFINITION
Motor Assisted Cycle	According to the B.C. MVA, a device: (a) to which pedals or hand cranks are attached that will allow for the cycle to be propelled by human power, (b) on which a person may ride, (c) to which is attached a motor of a prescribed type that has an output not exceeding the prescribed output, and (d) that meets the other criteria prescribed under section 182.1 (3) of the MVA.
Protected Bicycle Lane	A protected bicycle lane is a dedicated bicycle facility for the exclusive use of people cycling that is physically separated from motor vehicles and pedestrians by vertical and horizontal elements.
Public Realm	The collection of outdoor spaces between buildings that is publicly accessible, comprising streets, squares, courtyards, pathways, parks, and open spaces.
Road	Synonymous with road/roadway, but generally used in contexts that prioritize motor vehicle travel, such as highways. Streets and roads are generally classified based on their typical functional and operational characteristics.
Roadway	According to the B.C. MVA: The portion of the highway that is improved, designed or ordinarily used for vehicular traffic, but does not include the shoulder, and if a highway includes two or more separate roadways. The term 'roadway' refers to any one roadway separately and not to all of them collectively.
Shared Lane	Designated shared-use lanes (also referred to as marked wide curb lanes) are lanes on a street designed to allow sufficient width for a motor vehicle to safely overtake a bicyclist, without crossing over into the adjacent or oncoming motor vehicle lane. Shared lanes are located on streets with higher motor vehicle volumes and speeds (as opposed to bicycle boulevards).
Shared Mobility	Systems that allow people to access a network of shared vehicles that have been spread across a community or portion of a community, as opposed to privately owned vehicles or vehicle rental companies based in a single location. Shared mobility systems currently include shared motor vehicles, shared bicycles/electric bicycles (including docked and dockless systems), and shared electric kick scooters.
Shared Street	A shared space is a street designed to be shared by pedestrians, cyclists, and slow-moving motorists, with no physical separation of modes and typically an emphasis on use as a livable public space.
Shorelining	A form of navigation used by people with visual impairments that involves following a wall, curb, or other contrasting surface to the one a person is walking on in order to maintain a specific orientation while travelling through environments.
Shoulder	That part of a roadway contiguous with the travelled way intended for emergency stopping, and/or lateral support of the roadway structure. It may also be configured to be accessible for bicycle travel.
Shy Distance	The space between vehicles or pedestrians as they pass each other or vertical objects, such as bollards or fence posts. Adequate shy distance must be provided along bicycle facilities in order to ensure the safe operation of a bicycle. The amount of shy distance required for safety tends to increase with speed.
Small, One-Person Electric Vehicles	A category of electric vehicles that includes electric kick scooters (e-scooters), electric skateboards, hoverboards, segways, self-balancing electric unicycles, and other emerging modes. At the time of writing, these vehicles are not permitted on public roadways or sidewalks in British Columbia (legality issues are discussed further below). However, these vehicles have been observed in operation in communities across the province.
Sidewalk	A travelled way intended for pedestrian use, following an alignment generally parallel to that of the adjacent roadway.
Street	Synonymous with road/roadway but generally limited to lower speed roads in urban areas and implies multimodal use. Streets and roads are generally classified based on their typical functional and operational characteristics.
Street Buffer Zone	The space that provides physical separation between the bicycle lane and motor vehicle lane.

TERM	DEFINITION
Tactile Attention Indicators	A tactile walking surface indicator comprising truncated domes that alert people of an impending change in elevation, conflicts with other transportation modes, and other potential hazards.
Tactile Direction Indicators	A tactile walking surface indicator that uses elongated, flat-topped bars to facilitate wayfinding in open areas. The elongated bars indicate the travel direction.
Tactile Walking Surface Indicators (TWSI)	A warning treatment that alerts the pedestrian to the presence of a street crossing through a tactile surface and/or contrasting colour. TWSIs may also enhance the sidewalk-crosswalk interface by guiding pedestrians with visual or other disabilities to and from the crosswalk with directional grooves. Examples of TWSI materials include tactile dome pads or directional tiles.
Traffic Control Device	A sign, signal, line, metre, marking, space, barrier or device placed or erected by authority of the minister responsible for the administration of the B.C. Transportation Act, the council of a municipality or the governing body of a Treaty First Nation or a person authorized by any of them to exercise that authority.
Traffic Control Signal	A traffic control device, whether manually, electrically or mechanically operated, by which traffic is directed to stop and to proceed.
Traffic Zone	A street zone that accommodates users travelling through a road or accessing destinations along the road. Traffic Zone uses can include motor vehicle through traffic, transit, goods movement, and bicycle travel. The Traffic Zone can be divided into multiple lanes that are shared by multiple users or dedicated to certain vehicles (such as exclusive transit lanes). Medians and refuge areas can also be included within this zone.
Uniformity Ratio	A term used in lighting design that describes the ratio of maximum to minimum illumination levels. Lighting uniformity is the human perception of how evenly illumination is distributed.
Universal Design	The design of products, environments, programs, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. 'Universal design' shall not exclude assistive devices for a particular group.
Vehicle	A device in, on, or by which a person or thing is, or may be, transported or drawn on a highway, but does not include a device designed to be moved by human power, a device used exclusively on stationary rails or tracks, mobile equipment, or a motor assisted cycle.
Vertical Illumination	Measured 1.5 metres above grade and allows bicycle users to see other people walking and cycling, street signs, and vertical obstacles such as tree branches.
Walkshed	The acceptable walking range around a specific location. A walkshed is typically displayed as a walking area measured by walking time or distance from a specific point on a map.
Warrant	A criterion that identifies a potential need for a physical feature, such as a traffic barrier, extra lane, or other item.

REFERENCES

AASHTO. 2012. *Guide for the Development of Bicycle Facilities*. Washington, DC: American Association of State Highway and Transportation Officials.

AC Transit. 'Multimodal Corridor Guidelines.' AC Transit. 2018.

Alta Planning + Design. 2011. *Capital Regional District Pedestrian and Cycling Master Plan Design Guidelines*. Capital Region District.

Anderson, T., F. Bredal, M. Weinreich, N Jensen, M Riisgaard-Dam, and Malene Kofod Nielsen. 2012. *Collection of Cycle Concepts 2012*. Holstebro: Cycling Embassy of Denmark.

Appleyard, Bruce, and Lindsey Cox. 2006. 'At Home in the Zone: Creating Livable Streets in the U.S.' J*ournal of the American Planning Association* 30-35.

Association of Pedestrian and Bicycle Professionals. 'Bicycle Parking Guidelines 2nd Edition.' *Association of Pedestrian and Bicycle Professionals*. 2010.

—. 'Navigating without Curbs – Accessibility on Shared Streets.' *Association of Pedestrian & Bicycle Professionals*. 2019.

British Columbia Ministry of Transportation and Highways. 'Pedestrian Crossing Control Manual for British Columbia.' *Province of British Columbia*. 1994.

—. 'Manual of Standard Traffic Signs & Pavement Markings.' *Province of British Columbia*. 2000.

British Columbia Ministry of Transportation and Infrastructure. 'British Columbia's Bicycle Traffic Control Guidelines – Draft.' *Province of British Columbia*. 2012.

—. 'Electrical and Traffic Engineering Manual.' *Province of British Columbia*. 2013. http://www.th.gov.bc.ca/publications/eng_publications/electrical/electrical_and_traffic_eng/Electrical_Signing_Design_Manual/tableofcontents.htm

—. 'Overview of B.C. Highway Functional Classification'. *Province of British Columbia*. 2014. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/planning/inventories/bc_numbered_hwy_functional_classes.pdf

—. '2016 Standard Specifications for Highway Construction.' *Province of British Columbia*. 2016.

—. 'Bridge Standards and Procedures Manual.' *Province of British Columbia*. 2016.

—. 'BC Supplement to TAC Geometric Design Guide 2019 – 3rd Edition.' *Province of British Columbia*. 2019.

BC Transit. 'Infrastructure Design Guidelines.' *BC Transit*. 2010.

—. 'BC Transit Infrastructure Design Summary.' *BC Transit*. 2018.

Bell, PJ. 'Coming to A Stop – All Ages and Abilities Bicycle Parking in New and Existing Development.' *City of Vancouver*. 2015.

—. 'Whose (Bike) Lane Is It? – A Study of Bicycle Lane Usage in Vancouver.' *University of British Columbia*. 2016.

Bell, PJ, Peter Lipscombe, Michael Meyer, and Tess Munro. 'Life Behind the Scenes – Neighbourhood Laneway Infill Strategy for the West End.' *University of British Columbia*. 2016.

Ben-Joseph, Eran. 'Changing the Residential Street'. *Journal of American Planning Association. Vol 61, No. 4.* 1995. http://web.mit.edu/ebj/www/doc/JAPAv61n4.pdf

Biddulph, Mike. 2001. *Home Zones: A Planning and Design Handbook*. Bristol: The Policy Press.

—. 2007. *Introduction to Residential Layout*. Burlington: Butterworth-Heinemann.

Broom, Nathan, Eric Anderson, Vince Caristo, Ryan Dodge, Jennifer Donlon-Wyant, Sarah Figliozzi, Elco Gauw, Dan Jatres, David Loutzenheiser, Heath Maddox, Brian Patterson, Cara Seiderman. 'Essentials of Bike Parking.' *Association of Pedestrian and Bicycle Professionals*. 2015.

Canadian Standards Association (CSA Group). CSA B651-18: *Accessible design for the built environment*. 2018. https://store.csagroup.org/ccrz__ProductDetails?sku=2702123

Capital Regional District. 'Capital Region Local Government Electric Vehicle (EV) + Electric Bike (E-Bike) Infrastructure Planning Guide.' *Capital Regional District*. 2018. https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/infrastructure-planning-guide_capital-region-ev-ebike-infrastructure-project-nov-2018.pdf?sfvrsn=d767c5ca_2

Chan, Kenneth. 'Laneway BBQ Party Coming to Gastown this Saturday.' *Daily Hive*. 2017. https://dailyhive.com/vancouver/laneway-backyard-bbq-gastown-2017

Chartier, G., Eichenbaum, T., Jacobson, M. et al. 2017. *Canadian Roundabout Design Guide*. Ottawa, ON: Transportation Association of Canada.

Chiu, M., Clayton, C., Millen, G. et al. 2017. *Geometric Design Guide for Canadian Roads*. Ottawa, ON: Transportation Association of Canada.

Chow, R., J. Mah, R. Duckworth, B Bielkiewicz, J Aoro, G Dunn, D Ekkelenkamp, Brian Latte, H Putz, and Paul Shaflik. 2003. *Highway Lighting Guide*. Edmonton: Alberta Transportation.

City of Boston. 2013. 'Boston Complete Streets – Design Guidelines.' *City of Boston*. 2013.

City of Calgary. 2016. *Centre City Cycle Track Pilot*. Final Report, Calgary: City of Calgary.

City of Cambridge. 2013. 'Bicycle Parking Guide.' *City of Cambridge*. 2013.

City of Copenhagen. 2013. *Focus on Cycling: Copenhagen Guidelines for the Design of Road Projects*. Copenhagen: City of Copenhagen.

City of Maple Ridge. 'Strategic Transportation Plan.' *City of Maple Ridge*. 2014. https://www.mapleridge.ca/DocumentCenter/View/3400/Final-Report---October-16-2014?bidId=

City of Toronto. 'Electric Bikes – Proposed Policies and By-laws.' *City of Toronto*. 2013. https://www.toronto.ca/legdocs/mmis/2014/pw/bgrd/backgroundfile-65205.pdf

City of Trail. 'Arts and Culture.' *City of Trail*. Accessed May 13, 2019. http://www.trail.ca/en/play/arts-and-culture.asp

City of Vancouver. 'Report – Naming of West End Lanes and New Temporary City Hall Plaza.' *City of Vancouver*. 2017. https://council.vancouver.ca/20171128/documents/other1.pdf

—. 'Transportation Design Guidelines: All Ages and Abilities Cycling Routes.' 2017. *City of Vancouver*. Accessed May 30, 2019. https://vancouver.ca/files/cov/design-guidelines-for-all-ages-and-abilities-cycling-routes.pdf

—. 'Accessible Street Design.' *City of Vancouver*. Accessed May 21, 2019. https://vancouver.ca/files/cov/AccessibleStreetDesign.pdf

—. 'Bike Rack Design Contest Summary.' 2019. *City of Vancouver.*

—. 'Engineering Design Manual (1st ed.)' *City of Vancouver*. 2018. Accessed May 28, 2019. https://bids.vancouver.ca/bidopp/RFA/Documents/PS20181461-CityofVancouver-EngineeringDesignManualFirstEdition2018.PDF

City of Victoria. 'Bicycle Parking Strategy.' *City of Victoria*. 2011.

—. 'Downtown Public Realm Plan & Streetscape Standards.' *City of Victoria*. 2017.

—. 'Fan Tan Alley.' *City of Victoria*. Accessed May 13, 2019. https://www.tourismvictoria.com/see-do/activities-attractions/attractions/fan-tan-alley

Complete Streets for Canada. 'Canada's Complete Streets Hub.' *Clean Air Partnership*. Accessed May 13, 2019. https://www.completestreetsforcanada.ca/

Clayden, Andy, Keith McKoy, and Andy Wild. 2007. 'Improving Residential Liveability in the UK: Home Zones and Alternative Approaches.' *Journal of Urban Design* 55-71.

Collarte, Natalia. 2014. *The American Woonerf: Creating Livable and Attractive Shared Streets*. Thesis: In partial fulfillment of the requirements for the degree of Master of Arts in Urban and Environmental Policy and Planning, Boston: Tufts University.

CROW. 2016. *Design Manual for Bicycle Traffic*. Utrecht: CROW.

Dickman, D., Falbo, N., Durrant, S. et al. 2016. *Small Town and Rural Multimodal Networks*. Washington, DC: Federal Highway Administration.

Dill, Jennifer. 2015. *Four Types of Cyclists: A National Look*. Webinar, Portland: Portland State University.

Dill, Jennifer, Nathan McNeil, Joseph Broach, and Liang Ma. 2014. 'Bicycle boulevards and changes in physical activity and active transportation: Findings from a natural experiment.' *Preventative Medicine* 74-78.

Donahey, Thomas J, and Dennis Burkheimer. 1996. 'Prewetting with Salt Brine.' *Semisequicentennial Transportation Conference Proceedings*. Ames: Iowa State University.

Federal Highway Administration (FHWA). *Separated Bike Lane Planning and Design Guide*. 2015. Washington, DC: Federal Highway Administration.

—. 'Achieving Multimodal Networks – Applying Design Flexibility & Reducing Conflicts.' U.S. *Department of Transportation. 2016.* https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/fhwahep16055.pdf

—. *Incorporating On-Road Bicycle Networks into Resurfacing Projects*. 2016. Washington, DC: Federal Highway Administration.

—. 'Accessible Shared Streets – Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities.' *U.S. Department of Transportation*. 2017.

—. 'FHWA Guidebook for Measuring Multimodal Network Connectivity.' *U.S. Department of Transportation*. 2018. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/fhwahep18032.pdf

—. 'Bikeway Selection Guide.' *U.S. Department of Transportation*. 2019. https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

Felton, Ryan. 'E-Scooter Ride-Share Industry Leaves Injuries and Angered Cities in its Path.' *Consumer Reports, Inc*. 2019. https://www.consumerreports.org/product-safety/e-scooter-ride-share-industry-leaves-injuries-and-angered-cities-in-its-path/

Fisher, Cara. 2014. *Cycling Through Winter*. Ottawa, ON: Canadian Institute of Planners.

Fitzpatrick, K., Carlson, P., Brewer, M., and Wooldridge, M. 2000. 'Design Factors That Affect Driver Speed on Suburban Streets,' Transportation Research Record: Journal of the Transportation Research Board No. 1751. Washington, DC: Transportation Research Board of the National Academies, pp. 18—25.

Frank, Lawrence D., Meghan Winters, Brian Patterson, Cora L. Craig. 'Promoting Physical Activity through Healthy Community Design.' *The Vancouver Foundation*. 2009. http://atl.sites.olt.ubc.ca/files/2011/07/VanFdnStudy.pdf

Frohnwieser, Anna, Richard Hopf, and Elisabeth Obserzaucher. 'Human Walking Behavior: The Effect of Pedestrian Flow and Personal Space Invasions on Walking Speed and Direction.' *Human Ethology Bulletin* 28(3), 20-28. 2013.

Geller, Roger. 2009. *Four Types of Cyclists*. White Paper, Portland Bureau of Transportation: Portland.

Gibbs, Margaret, Sany Zein, and Carl Shaflik. 'Illumination of Isolated Rural Intersections.' *Transportation Association of Canada*. 2001.

Gilpin, J, N Falbo, M Repsch, and A Zimmerman. 2015. *Lessons Learned: Evolution of the Protected Intersection*. White Paper, Portland: Alta Planning + Design.

Gilpin, J., N. Falbo, and M. Williams. 2017. *Lessons Learned: Advisory Bike Lanes in North America*. White Paper, Alta Planning + Design.

Global Designing Cities Initiative. 'Shared Streets.' *National Association of City Transportation Officials*. Accessed May 13, 2019. https://globaldesigningcities.org/publication/global-street-design-guide/streets/shared-streets/

Goldberg, Stephanie. 'Isn't it time you paid Grandma a visit?' *Vancouver Public Space Network*. 2017. http://vancouverpublicspace.ca/2017/07/27/isnt-it-time-you-paid-grandma-a-visit/

Green, Sylvia. 'Designing streets for a new kind of delivery vehicle.' *Spacing*. 2019. http://spacing.ca/vancouver/2019/02/25/designing-streets-for-a-new-kind-of-delivery-vehicle/

Hall, Edward. 'The Hidden Dimension.' *Random House Inc*. 1966.

Harris, M Anne, Conor Reynolds, Meghan Winters, Mary Chipman, Peter Cripton, Michael Cusimano, and Kay Teschke. 2011. 'The Bicyclists' Injuries and the Cycling Environment study: a protocol to tackle methodological issues facing studies of bicycling safety.' *Injury Prevention*.

Harris, M Anne, Conor Reynolds, Meghan Winters, Peter Cripton, Hui Shen, Mary Chipman, Michael Cusimano, et al. 2013. 'Comparing the effects of infrastructure on bicycling injury at intersections and non-intersections using a case–crossover design.' *Injury Prevention* 303-310.

Institute for Transportation and Development Policy. 'The Bikeshare Planning Guide.' *Institute for Transportation and Development Policy*. 2018.

Insurance Corporation of British Columbia. 'Vehicle registration – Low-powered vehicles.' *Insurance Corporation of British Columbia*. Accessed May 21, 2019. https://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Default.aspx

—. 'Vehicle registration – Motorized scooters and skateboards.' *Insurance Corporation of British Columbia*. Accessed May 21, 2019. https://www.icbc.com/vehicle-registration/specialty-vehicles/Low-powered-vehicles/Pages/Motorized-scooters-and-skateboards.aspx

Jackson, James. 'Waterloo's electric scooter program proved popular and is set to return next spring.' *Metroland Media Group Ltd*. 2018. https://www.therecord.com/news-story/9062314-waterloo-s-electric-scooter-program-proved-popular-and-is-set-to-return-next-spring/

Jaffe, Eric. '6 Places Where Cars, Bikes, and Pedestrians All Share the Road as Equals.' *The Atlantic Monthly Group*. 2015. https://www.citylab.com/solutions/2015/03/6-places-where-cars-bikes-and-pedestrians-all-share-the-road-as-equals/388351/

Karim, Dewan. 'Narrower Lanes, Safer Streets.' *Canadian Institute of Transportation Engineers*. 2015.

Komorowski, Bartek. 2017. 'Paradigm Shift: Enabling Winter Cycling through Better Design and Maintenance.' *Winter Cities Shake-Up Conference*. https://etouches-appfiles.s3.amazonaws.com/html_file_uploads/0cde09bf510ec37a0f8264694a1d7c1b_011_BartekKomorowski.pdf?response-content-disposition=inline%3Bfilename%3D%22011_Bartek%20Komorowski.pdf%22&response-content-type=application%2Fpdf&AWSAccessKeyI

Kraay, Joop. 1986. 'Woonerf and other Experiments in the Netherlands.' *Built Environment* 12: 20-29.

Lopez, D S, D B Sunjaya, S Chan, S Dobbins, and R A Dicker. 2012. 'Using Trauma Center Data to Identify Missed Bicycle Injuries and Their Associated Costs. Journal of Trauma and Acute Care Surgery.' *Journal of Trauma and Acute Care Surgery* 73 (6): 1602-1606.

Lusk, Anne, Peter Furth, Patrick Morency, Luis Miranda-Moreno, Walter Willett, and Jack Dennerlein. 2011. 'Risk of injury for bicycling on cycle tracks versus in the street.' *Injury Prevention* 131-135.

MassDOT. 2015. *Separated Bike Lane Planning & Design Guide*. Boston, MA: Massachusetts Department of Transportation.

McLean, D., G. Smallwood, and K Cvetkovic. 2006. *Guide for the Design of Roadway Lighting*. Ottawa, ON: Transportation Association of Canada.

MnDOT. 2015. *Traffic Engineering Manual*. Roseville, MN: Minnesota Department of Transportation.

Monsere, Chris, Jennifer Dill, Nathan McNeil, Kelly Clifton, Nick Foster, Tara Goddard, Matt Berkow, et al. 2014. *Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S*. Final Report, Portland: Portland State University.

Montufar, Jeannette, Garreth Rempel, and Sarah Klassen. 'Pedestrian Walking Speed for Traffic Operations in Canada.' *Transportation Association of Canada*. 2013.

Montufar, Jeannette, Keenan Patmore, and Geni Bahar. 'Pedestrian Crossing Control Guide – Third Edition.' *Transportation Association of Canada*. 2018.

MTO. 2013. *Ontario Traffic* Manual: Book 18 - Cycling Facilities. St Catherine's, ON: Ministry of Transportation of Ontario.

National Association of City Transportation Officials. 'Case Study – Bell Street Park Shared Street, Seattle.' *National Association of City Transportation Officials*. Accessed May 13, 2019. https://nacto.org/case-study/bell-street-park-seattle/

—. 'Don't Give Up at the Intersection – Designing All Ages and Abilities Bicycle Crossings.' N*ational Association of City Transportation Officials*. 2019.

—. 2017. *Designing for All Ages & Abilities: Contextual Guidance for High-Comfort Bicycle Facilities*. New York: National Association of City Transportation Officials.

—. 2016. *Global Street Design Guide*. New York: National Association of City Transportation Officials. https://globaldesigningcities.org/publication/global-street-design-guide/

—. 2011. *Urban Bikeway Design Guide*. New York: National Association of City Transportation Officials.

National Disability Authority. 'What is Universal Design.' *National Disability Authority*. Accessed May 13, 2019. http://universaldesign.ie/What-is-Universal-Design/

—. 'Building for Everyone: A Universal Design Approach.' *National Disability Authority*. Accessed May 15, 2019. http://universaldesign.ie/Built-Environment/Building-for-Everyone/#figBfE9Planning

Porter, A., Stewart, W., Ramsay, B. et al. 2007. *Roadside Design Guide*. Edmonton: Alberta Transportation.

Portland Bureau of Transportation. 'TRN-10.09 - Bicycle Rack Permit.' *The City of Portland*. 2015. https://www.portlandoregon.gov/citycode/article/43223

Portland Bureau of Transportation. 2015. *Portland's Neighbourhood Greenways Assessment Report*. Portland, OR.

Province of British Columbia. 'Design Exception Process.' *Province of British Columbia*. 2018. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/transportation-infrastructure/engineering-standards-and-guidelines/technical-circulars/2018/t05-18.pdf

—. 'Annotated Bibliography on Universal Design.' *Province of British Columbia*. Accessed May 13, 2019. http://housing.gov.bc.ca/pub/htmldocs/pub_universaldesign/glossary.htm

—. 'B.C. Community Road Safety Toolkit – Introduction to the BC Community Road Safety Toolkit.' 2018. *Province of British Columbia*. Accessed May 21, 2019. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/resource-kit-community-road-safety-toolkit-introduction.pdf

—. 'B.C. Community Road Safety Toolkit – Module 1: Protecting people walking and cycling.' *Province of British Columbia*. 2018. Accessed May 21, 2019. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/community_road_safety_toolkit_module1.pdf.

—. 'B.C. Community Road Safety Toolkit – Module 2: Safe Roadway Designs to Protect All Road Users.' *Province of British Columbia*. 2018. Accessed May 21, 2019. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/resource-kit-community-road-safety-toolkit-module2.pdf

—. 'B.C. Community Road Safety Toolkit – Module 3: Implementation Tools and Strategies. *Province of British Columbia*. 2018. Accessed May 21, 2019. https://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/resource-kit-community-road-safety-toolkit-module3.pdf

—. 'Motor Vehicle Act [RSBC 1996] Chapter 318.' *Province of British Columbia*. Accessed May 21, 2019. http://www.bclaws.ca/civix/document/id/complete/statreg/96318_00

—. 'Motor Vehicle Act – Motor Vehicle Regulations.' *Province of British Columbia*. Accessed May 21, 2019. http://www.bclaws.ca/civix/document/id/complete/statreg/26_58_01

Quimby, Allan, and James Castle. 'A Review of Simplified Street Schemes.' *Transportation for London*. 2006. http://content.tfl.gov.uk/review-of-simplified-streetscape-schemes.pdf

Reardon, Mitchell. 'Is Vancouver Ready to Grow from Laneways to Living Lanes?' *Spacing*. 2016. http://spacing.ca/vancouver/2016/10/03/vancouver-ready-grow-laneways-living-lanes/

—. 'Inside Out: Getting Ready for Laneway Living Rooms.' *Vancouver Public Space Network*. 2017. http://vancouverpublicspace.ca/2017/06/28/inside-out-getting-ready-for-laneway-living-rooms/

—. 'Alleys, Laneways and Life Between Buildings.' *Spacing*. 2018. http://spacing.ca/vancouver/2018/06/04/alleys-laneways-life-buildings/

Regnier, Sheri. 'Events to Incorporate Trail's Iconic Covered Stairs.' *Black Press Media*. 2015. https://www.trailtimes.ca/community/events-to-incorporate-trails-iconic-covered-stairs/

Richardson, D., McLaughlin, D., Kowpak, D. et al. 2014. *Traffic Signal Guidelines for Bicycles*. Edited by G Noxon. Ottawa, ON: Transportation Association of Canada.

Rick Hansen Foundation. 'Accessibility Matters'. *Rick Hansen Foundation*. Accessed May 13, 2019. https://www.rickhansen.com/become-accessible.

Ronald L. Mace Universal Design Institute. 'About UDI'. Ronald L. Mace Universal Design Institute. http://udinstitute.org/aboutudi.php (accessed May 13, 2019).

Schepers, Paul, and Karin Klein Wolt. 2012. 'Single-bicycle crash types and characteristics.' *Cycling Research International* 2: 119-135.

Schmitt, Angie. 'Is It Time to Redefine the Bike Lane.' Streetsblog USA. 2018. https://usa.streetsblog.org/2018/08/23/is-it-time-to-redefine-the-bike-lane/

Skene, M., and M. Jacobson. 2012. *Bikeway Traffic Control Guidelines for Canada. 2nd*. Ottawa, ON: Transpotation Association of Canada.

Solomon, Hart, Brian Malone, Jaime Garcia, Giovani Bottesini, Sovandary Hoeun, and Gene Chartier. 'Canadian Guide to Traffic Calming – Second Edition.' *Transportation Association of Canada*. 2018.

Stutts, J C, and W Hunter. 1999. *Injuries to Pedestrians and Bicyclists: An Analysis Based on Hospital Emergency Department Data*. Washington, DC: Federal Highway Administration.

Tefft, Brian. 'Impact Speed and a Pedestrian's Risk of Severe Injury or Death.' *American Automobile Association*. 2011. https://aaafoundation.org/impact-speed-pedestrians-risk-severe-injury-death/

Teschke, Kay, M Anne Harris, Conor C.O. Reynolds, Meghan Winters, Shelina Babul, Mary Chipman, Michael D Cusimano, et al. 2012. 'Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study.' *American Journal of Public Health* (American Public Health Association) 102 (12): 2336-2343.

Teschke, Kay, Theresa Frendo, Hui Shen, Anne Harris, Conor C. Reynolds, Peter A. Cripton, Jeff Brubacher, Michael D. Cusimano, Steven M. Friedman, Garth Hunte, Melody Monro, Lee Vernich, Shelina Babul, Mary Chipman, and Meghan Winters. 'Bicycling Crash Circumstances Vary by Route Type: A Cross-Sectional Analysis.' *BMC Public Health, 14:1205: 1471-2458*. 2014.

Teschke, Kay, Hui Shen, Anne Chinn, Liliana Quintero, Felita Ong, and James Wei. 2018. 'Traffic Circles – Impact on motor vehicle, cyclist-MV, & pedestrian-MV crashes with injuries.' Paper presented at *2018 Conference of the Canadian Association of Road Safety Professionals,* Victoria, BC, June 10-13, 2018.

Town of Banff. 'Shared Street.' *Town of Banff*. 2019. http://banff.ca/index.aspx?NID=969

—. 'Request for Direction – Bear Street Shared Street Concept.' *Town of Banff*. 2019. http://banff.ca/DocumentCenter/View/6301

Traffic Operations and Management Standing Committee. 2014. *Manual of Uniform Traffic Control Devices for Canada (MUTCDC)*. 5th. Ottawa, ON: Transportation Association of Canada.

TransLink. 'Bus Infrastructure Design Guidelines.' *TransLink*. 2018.

Transport Canada. 2016. 'Grade Crossings.' *Grade Crossings Regulations: what you need to know*. https://www.tc.gc.ca/media/documents/railsafety/GradeCrossingsCanada_EN_2016_PRE_ACCESSIBLE.pdf

—. 2014. *Grade Crossings Standards*. Ottawa: Transport Canada.

—. 2018. *Safety Measures for Cyclists and Pedestrians around Heavy Vehicles*. Ottawa: Transport Canada.

Transport for London. 2014. *London Cycling Design Standards*. London: Transport for London.

United Nations. 'Conventions on the Rights of Persons with Disabilities and Optional Protocol.' *United Nations*. Accessed May 13, 2019. https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf

United Way. 'Storm the Stairs.' *United Way*. 2019. http://uwtraildistrict.org/event/storm-the-stairs-2/

Universal Design Network of Canada. 'About Us.' *Universal Design Network of Canada*. Accessed May 13, 2019. https://universaldesign.ca/

University of British Columbia. 'Vancouver Campus Plan – Part 3: Design Guidelines.' *University of British Columbia*. 2010. https://planning.ubc.ca/sites/planning.ubc.ca/files/images/VCPUdate2018_Part3.pdf

Urban Racks. 'Urban Racks Bicycle Parking Guidelines.' *Urban Bicycle Parking Systems Inc*. 2014.

Van Veen, Dick and Justin Goulding. 'University of Victoria – Bicycle Strategy: Integrating Bicycles and Conflict Management.' *Mobycon*. 2017.

Vélo Québec. 2010. *Planning and Design for Pedestrians and Cyclists*. Montreal: Vélo Québec.

Victoria Transport Policy Institute. 2016. 'Glossary.' *On-line TDM Encyclopedia*. Victoria Transport Policy Institute, August 25, 2016. https://www.vtpi.org/tdm/tdm61.htm (accessed December 19, 2018).

Walker, L., M. Tresidder, and M. Birk. 2009. *Fundamentals of Bicycle Boulevard Planning & Design*. Portland: Portland State University.

Wheels for Wellbeing. 'A guide to inclusive cycling – First edition.' *Wheels for Wellbeing*. 2017.

Willis, Sean, Dean Cooper, Ryan Martinson, Aasha Williams-Blanco, Penny Dunford, Dena Ghoneim, Jenelle Anderson, Rhonda Shewchuk, Heather Dean, and Megan Straker. 'Trails in Alberta Highway Rights-of-Way Policies, Guidelines, and Standards'. *Government of Alberta*. 2015. http://www.transportation.alberta.ca/Content/docType233/Production/Trails-HWY-ROW-apr2015-f.pdf

Wisconsin Transportation Information Center. 2005. *Using Salt and Sand for Winter Road Maintenance*. Bulletin, Madison: Wisconsin Transportation Information Center, WI.

Winters, Meghan, Kay Teschke, Michael Grant, Eleanor Setton, and Michael Brauer. 2010. 'How Far Out of the Way Will We Travel?: Built Environment Influences on Route Selection for Bicycle and Car Travel.' *Transportation Research Record* 1-10.

Winters, Meghan and Kay Teschke. 'Designing Cities for Cycling.' Poster Presentation, *ProWalk ProBike Conference,* Seattle, WA, September 2-5, 2008.

Winters, Meghan and Kay Teschke. 2010. 'Route Preferences Among Adults in the Near Market for Bicycling: Findings of the Cycling in Cities Study.' *American Journal of Health Promotion* 25-1.

Woodward, Sonia. 'Universal Design 101.' *Rick Hansen Foundation*. 2017. https://www.rickhansen.com/news-stories/blog/universal-design-101

World Health Organization. 'Deafness and hearing loss.' *World Health Organization*. Accessed May 13, 2019. https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss

APPENDIX A: PROJECT PARTICIPANTS

The British Columbia Active Transportation Design Guide (Design Guide) was developed under the direction of the British Columbia Ministry of Transportation and Infrastructure (MOTI) with support by Urban Systems. Accessibility guidance was provided by Universal design (UAD). Signal guidance was provided by P.K. Consulting, LLC.

PROVINCE OF BRITISH COLUMBIA

The following provincial government staff participated in the creation of the Design Guide:

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WEBINAR AND ON-LINE SURVEY PARTICIPANTS

Stakeholders from across the province were invited to participate in the development of the Design Guide through the participation of webinar and an on-line survey. The following organizations participated in webinars and/or completed the on-line survey regarding the Design Guide:

BC Cycling Coalition
BC Ferries
BC Randonneurs Cycling Club
BC Recreation and Parks Association
Bikemaps.org
Capital Regional District
City of Coquitlam
City of Courtenay
City of Delta
City of Kamloops
City of Kelowna
City of Maple Ridge
City of Nelson
City of New Westminster
City of North Vancouver
City of Penticton
City of Powell River
City of Richmond
City of Surrey
City of Vancouver
City of Vernon
City of Victoria
Columbia Shuswap Regional District
Comox Valley Regional District
Cowichan Valley Regional District
District of Central Saanich
District of Kitimat
District of New Hazelton
District of North Saanich
District of North Vancouver
District of Oak Bay
District of Saanich
District of Sooke
District of Sparwood
District of Squamish
District of Summerland
District of West Vancouver
Engineers and Geoscientists BC
Greater Nanaimo Cycling Coalition
Greater Victoria Cycling Coalition
HUB Cycling
Islands Trust
Municipality of North Cowichan
New Westminster & Burnaby Walkers' Caucus
Regional District of Central Kootenay
Regional District of Central Okanagan
Regional District of Nanaimo
Resort Municipality of Whistler
Shuswap Trail Alliance
Spinal Cord Injury BC
Strathcona Regional District
Town of Comox
Town of Sidney
TransLink
Township of Spallumcheen
University of British Columbia
Village of Pemberton
Walk Metro Vancouver
Walk On Victoria
Whistler Cycling Club
Wolverine Nordic and Mountain Society

APPENDIX B: SIGNAGE AND PAVEMENT MARKINGS

There are two primary sources of signage in British Columbia. The Ministry of Transportation and Infrastructure (MOTI) oversees the B.C. Provincial Sign Program and maintains the *Catalogue of Standard Traffic Signs and Supplemental Traffic Signs*, which apply on all roadways under provincial jurisdiction. Meanwhile, the TAC *Manual of Uniform Traffic Control Devices for Canada (MUTCDC)* provides national guidance for the use of traffic control devices, including signage and pavement markings. TAC *MUTCDC* signage is typically used on roadways that are under local and regional government jurisdiction. Other sources of signage and pavement markings include the TAC *Bikeway Traffic Control Guidelines for Canada and the TAC Pedestrian Crossing Control Guide*.

The TAC guidance and the B.C. Provincial Sign Program use different sign codes: for example, the sign code for a Stop sign is MUTCDC RA-1 (using TAC guidance) or B.C. R-001 Series (using the B.C. Provincial Sign Program). There is overlap between the two systems, but there are also signs that are unique to each system. There are also some signs that have similar meanings but different designs – some with minor differences and some more noticeable. Where two different codes exist for the same sign, each code has been referenced in the Design Guide. If the sign appears in only one guide, that code has been referenced. Design professionals are encouraged to review each signage system and consider the jurisdiction and the most appropriate sign for each application.

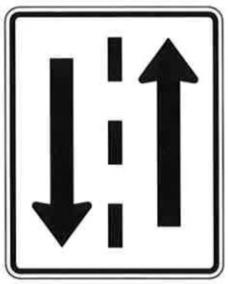
Please note that the information provided in this section is based on the TAC guidelines and the B.C. Provincial Sign Program, as indicated above. All pavement markings and signage should reflect the most current edition of each of the reference documents. Design professionals are reminded that the traffic control devices included in Appendix B are not an exhaustive list of traffic control devices. A more exhaustive list of available traffic control devices that includes signage, pavement marking, and signals can be found in the documents referenced above.

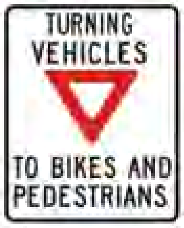
SIGNAGE

REGULATORY SIGNS			
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RA-1	 R-001 Series		**Stop Sign** The Stop sign indicates to cyclists that they must stop before entering the intersection and must not proceed until it is safe to do so.
 RA-2	 R-002 Series		**Yield Sign** The Yield sign indicates to drivers that they must yield the right-of-way before entering the intersection or roundabout, and must not proceed until it is safe to do so.
 RA-3R, RA-3L	 PS-005 Series		**School Crosswalk Sign** The School Crosswalk sign is used to indicate the location of a school crosswalk. The sign is placed on either side of the crosswalk using the right and left version so that the pedestrian symbols are walking toward the centre of the road.
 RA-4R, RA-4L	 PS-003 Series		**Pedestrian Crosswalk Sign** The Pedestrian Crosswalk sign is used to indicate the location of a school crosswalk. The sign is placed on either side of the crosswalk using the right and left version so that the pedestrian symbols are walking toward the centre of the road.
 RA-5	N/A		**Special Crosswalk Overhead Sign** The Special Crosswalk Overhead sign indicates the location of a special crosswalk. This sign must be installed over the road.

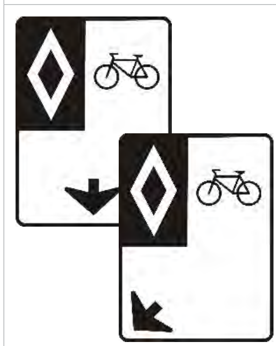
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RA-8	N/A		**In-Street School Crosswalk Sign** The In-Street School Crosswalk sign may be used to increase the conspicuity of key pedestrian crosswalks in a school area. The In-Street School Crosswalk sign shall not be used at crosswalk locations that are controlled by a stop sign or a traffic signal. The In-Street School Crosswalk sign shall be placed on the roadway centre line or on a median island if present.
 RB-9S	 R-009 Tabs		**Except Bicycles Tab Sign** Used with Turn Control signs, Entry Prohibited signs and other regulatory signs where bicycles are exempt from the specific regulation.
 RB-10	 R-017-2 Series		**Through Traffic Prohibited Sign** The Through Traffic Prohibited sign indicates to drivers that they are not permitted to proceed straight ahead.
 RB-11L	 R-015-L Series		**Left Turn Prohibited Sign** The Left Turn Prohibited sign indicates to drivers that they are not permitted to turn left.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-11R	 R-015-R Series		**Right Turn Prohibited Sign** The Right Turn Prohibited sign indicates to drivers that they are not permitted to turn right.
 RB-14R	 R-016-1R Series		**Turn Right Sign** The Turn Right sign indicates to drivers that they are required to turn right only.
 RB-17R	 R-117-R		**Right Turn on Traffic Signal Prohibited Sign** The Right Turn on Traffic Signal Prohibited sign indicates to drivers that during the red traffic signal indication, they are not permitted to turn right.
 RB-17L	 R-117-L Series		**Left Turn on Traffic Signal Prohibited Sign** The Left Turn on Traffic Signal Prohibited sign indicates to drivers that during the red traffic signal indication, they are not permitted to turn left.
 RB-21	 R-008-1LR Series		**One-Way Sign** The One-Way sign indicates to drivers that traffic is allowed to travel only in the direction of the arrow, on the road or section of road.

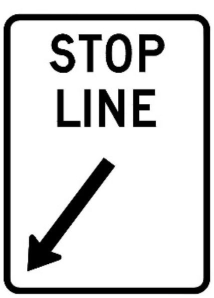
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-23	 R-009-1 Series		**Entry Prohibited Sign** The Entry Prohibited sign indicates to drivers that vehicular traffic is not permitted to enter the road at the location of the sign.
 RB-24	 R-010 Series		**Two-Way Traffic Sign** The Two-way Traffic sign indicates to drivers that the section of road that they are travelling on is a two-way road. This sign is recommended on roadways with advisory bicycle lanes.
 RB-25	 R-014-R Series		**Keep Right Sign** The Keep Right sign indicates that traffic is required to pass on the right of obstructions, such as medians, islands or underpass piers.
 RB-37	N/A	 Custom – City of Vancouver	**Turning Vehicles Yield to Bicycles Sign** The Turning Vehicles Yield to Bicycles sign may be used at conflict zones where motorists are required to cross a cyclist facility and are required to yield to the cyclist. The sign should incorporate the type of cycling facility present in the conflict zone (e.g. dashed bicycle lane lines, green paint, direction of travel etc.) Customized versions of the RB-37 sign with a supplemental 'Yield to Bicycles' tab have been developed by other municipalities (e.g., City of Vancouver) for improved visibility and readability.

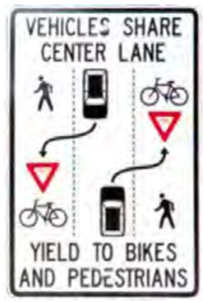
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-38	N/A	 R10-15 alt. *Custom (MassDOT)*	**Turning Vehicles Yield to Bicycles and Pedestrians Sign** The Turning Vehicles Yield to Bicycles and Pedestrians sign may be used where motorists are required to cross or share a facility used by cyclists and/or pedestrians and are required to yield to the cyclists or pedestrians. Customized versions of the RB-38 sign have been illustrated in other guidelines. For example, the R10-15 alt. sign shown in the MassDOT guide.
 RB-39	N/A		**Yield to Pedestrians Sign** The Yield to Pedestrians sign may be used where cyclists are required to cross or share a facility used by pedestrians and are required to yield to pedestrians.
 RB-41R	 R-082-R1 Series		**Right Turn Only Lane Sign** The Right Turn Only Lane sign indicates to drivers approaching an intersection in the designated lane that they must only turn right from the designated lane at the intersection.
 RB-51	 P-001 Series		**Parking Prohibited Sign** The Parking Prohibited sign indicates that parking is prohibited at all times on all days, in the direction(s) of the arrow(s).

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RE	 P		**Stopping Prohibited Sign** The Stopping Prohibited sign indicates that stopping is prohibited at all times on all days, in the direction(s) indicated by the arrow(s).
  RB-66	  PS-012 Series		**Pedestrian Prohibited Sign** The Pedestrian Prohibited sign indicates that pedestrians are prohibited in a specific area.
  RB-79 RB-79T	 B-R-101-2  B-R-101-2 Series, B-R-101 Tabs		**Dismount and Walk Sign** The Dismount and Walk sign indicates to people cycling to dismount and walk their bicycle through a specific area. The Dismount and Walk tab may be used to enhance the compliance of the sign.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-85	N/A		**Motorcycles Prohibited Sign** The Motorcycles Prohibited sign indicates that motorcycles are prohibited in a specific area
 RB-88	 R-122-1 Series		**Automobiles Prohibited Sign** The Automobiles Prohibited sign indicates that automobiles are prohibited in a specific area
 RB-90, RB-91	N/A		**Reserved Bicycle Lane Sign** The Reserved Bicycle Lane sign indicates that a lane is reserved for the exclusive use of bicycles. Reserved Bicycle Lane signs should be mounted either directly above (RB-90) or adjacent to (RB-91) the reserved lane. Reserved Bicycle Lane signs should be installed at a minimum of one sign between each intersection, with the first sign installed a maximum of 15 metres past the end of the curb radius. Signs should be installed at 200 metre intervals after the first signs.
 RB-92	N/A		**Reserved Bicycle Lane Ends Sign** The reserved Bicycle Lane Ends sign must be installed at the end of the reserved lane denoting the end of the bicycle lane.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-82	N/A		**Reserved Bicycle Lane Begins Sign** The reserved Bicycle Lane Begins sign must be installed at the beginning of the reserved lane denoting the start of the bicycle lane.
N/A	N/A	 Custom Sign	**Custom Reserved Bi-directional Bicycle Lane Sign** Custom signage for bi-directional protected bicycle lanes, such as the custom Reserved Bi-directional Bicycle Lane sign used by the City of Edmonton, may be used to further clarify the facility for cyclists and motorists.
 RB-93	N/A		**Shared Pathway Sign** The Shared Pathway sign indicates that both cyclists and pedestrians are permitted to use the path.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 RB-94L  RB-94R	 B-G-003-1 Series  B-G-003-1R Series  B-G-003-1L Series  B-G-003-2L Series  B-G-003-2 R Series		**Pathway Organization Sign** The Pathway Organization sign indicates to cyclists and pedestrians how to share a path on which there is a designated area provided for each.
 RC-4R	 R-025-R Series		**Stop Line Sign** The Stop Line sign indicates the point at which drivers approaching a traffic control device must stop their vehicles.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
N/A	N/A		**Advisory Bicycle Lane Sign** The custom Advisory Bicycle Lane sign is used where motorists are required to share the center travel lane and pass one another by temporarily pulling into the advisory bicycle lane. Motorists must yield to people cycling in advisory bicycle lanes when a sidewalk is present for people walking.
N/A	N/A		**Multi-Use Crossing Sign** The custom Multi-Use Crossing sign is used to indicate the location of a multi-use crosswalk.
N/A	N/A		**Bicycle Signal Sign** The custom Bicycle Signal sign is used to inform people on bicycles and motorists of a bicycle signal.
N/A	N/A		**Bicycles Use Pedestrian Signal Sign** The custom Bicycles Use Pedestrian Signal sign is used to inform people on bicycles and motorists that people cycling are to follow the pedestrian signals instead of the motor vehicle signals.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
N/A	N/A	  	**Shared Street Signage** The custom Shared Street signs have been used by municipalities to demarcate the entrance to a shared street where motorists need to travel at the speed of people walking.
 TC-68	 B-C-002 Series		**Bicycle Lane Closed Sign** The Bicycle Lane Closed sign is used to warn cyclists that a bicycle lane is temporarily closed.
 TC-70	 B-C-004-1A Series		**Bicycle Lane Detour Marker Sign** Bicycle Lane Detour Marker signs are used to direct people cycling to follow an alternative route when a work zone requires bicycle lane closure. Marker signs should be installed whenever a Bicycle Lane Closed sign is temporarily installed.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 TC-71	 B-C-004-2 Series		**Bicycle Detour Ends Sign** Bicycle Detour Ends sign may be installed to denote the end of the detour.
		WARNING SIGNS	
 WB-3	 W-020 Series		**Two-Way Traffic Ahead Sign** Used to warn all road users on a one-way street that they are approaching a section with two-way traffic.
 WB-4	 W-012 Series		**Signal Ahead Sign** The Signal Ahead sign is used to indicate the presence of a traffic control signal ahead. This sign may be used when the signals are not visible for a distance of 120m.
 WC-2	 PS-002 Series		**Pedestrian Crosswalk Ahead Sign** Install the Pedestrian Crosswalk Ahead sign when the visibility of the crosswalk area is limited. This sign must be installed 50-150 metres in advance of pedestrian crosswalks.
 WC-16	 PS-004 Series		**School Crosswalk Ahead Sign** Used in advance of a school crossing when no School Area signs are present.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 WC-20  WC-20S	N/A		**Shared-Use Lane Single File Sign** Used to warn motorists and cyclists that cyclists are allowed full use of the lane ahead and to warn motorists that the lane is too narrow for side-by-side operation. Shared-use lane markings should be used to mark the location where cyclists should position themselves within the lane. **Single File Supplementary Tab Sign** The Single File supplementary tab sign (WC-20S) must be used to convey the meaning of this sign.
 WC-44	N/A		**Bicycle Trail Crossing Side Street Sign** The Bicycle Trail Crossing Side Street sign indicates to drivers that a bicycle path, which runs parallel and in close proximity to the through road, intersects a crossroad such that insufficient distance is available on the crossroad between the bicycle trail crossing and the through road for proper siting of the WC-7 sign.
 WC-44T	N/A		**Trail Crossing Tab Sign** The temporary Trail Crossing Tab sign is used for educational purposes after the WC-44 sign is installed.
 WA-36L	W-054-L Series		**Object Marker (Left)** The Object Marker (Left) is used to mark obstructions on the left side of the road or bikeway.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 WA-36R	W-054-R Series		**Object Marker (Right)** The Object Marker (Right) is used to mark obstructions on the right side of the road or bikeway.
 WA-36	W-054-D Series		**Object Marker** The Object Marker is used to mark obstructions adjacent to or within the road or bikeway, such as bridge piers and traffic islands.
 WA-9	 W-062 Series		**Chevron Alignment Sign** The Chevron Alignment signs may be used to provide additional guidance to drivers where there is a change in the horizontal alignment of the road.
 WA-8	 W-014 Series		**Checkerboard Sign** The Checkerboard sign indicates the termination of a road.

MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 WA-8R	 W-015 Series		**Checkerboard Sign** The Checkerboard signs indicate an abrupt change of alignment at a turn or a curve. The black arrow indicates the direction taken by the curve or turn.
 WA-2R	 W-002-R Series		**Single Curve Sign** The Single Curve sign indicates that there is a single curve in the road ahead.
 WA-50	 W-108-2 Series		**Neighbourhood Speed Hump Sign** The Neighbourhood Street Hump sign indicates a vertical deflection of the road surface, including measures such as a speed hump, raised crosswalk or raised intersection.
 WC-43	N/A		**Contraflow Bicycle Lane Crossing Sign** The Contraflow Bicycle Lane Crossing sign indicates to drivers that they are approaching a road with one-way vehicular traffic and two-way bicycle traffic.
 WC-46	 W-129-2 Series		**Pedestrian and Bicycle Crossing Ahead Sign** The Pedestrian and Bicycle Crossing Ahead sign indicates to drivers that they are approaching a location where a multi-use path crosses the road. The WC-7S Crossing Supplementary tab sign must be used to convey the meaning of the Bicycle Crossing Ahead sign.

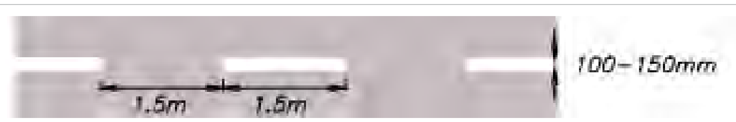
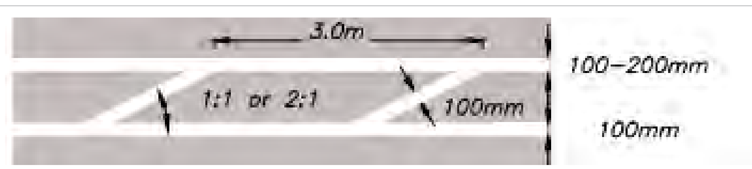
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
 WC-7R	 W-129-1 Series		**Bicycle Crossing Ahead Sign** The Bicycle Crossing Ahead sign indicates to drivers that they are approaching a location where a bicycle path crosses the road.
 WC-7S	 W-129 Tab		**Crossing Supplementary Tab** The Crossing Supplementary tab sign must be used to convey the meaning of the Bicycle Crossing Ahead sign.
 WC-19  WC-19S	 W-132-1 Series  W-132-1 Tab		**Share the Road Sign** Used to warn drivers that they are to provide adequate driving space for cyclists and other vehicles on the road. **Share the Road Supplementary Tab Sign** The Share the Road supplementary tab sign (WC-19S) must be used to convey the meaning of this sign.
 WB-10	N/A		**Reserved Bicycle Lane Ahead Sign** The Reserved Bicycle Lane Ahead sign may be used to warn drivers that they are approaching a reserved bicycle lane.

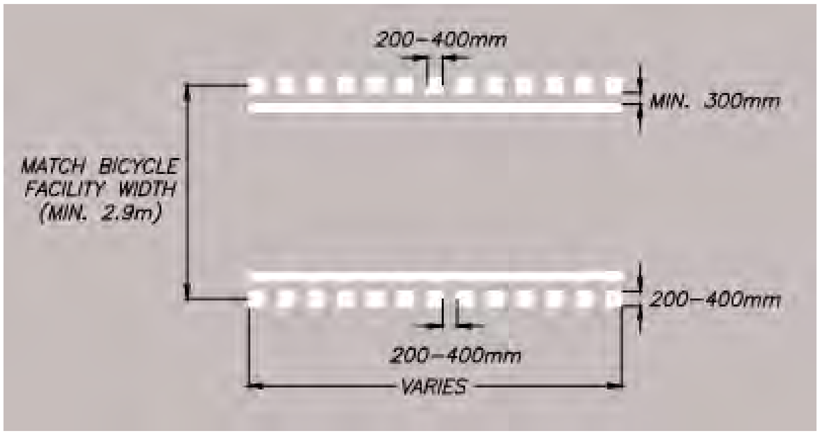
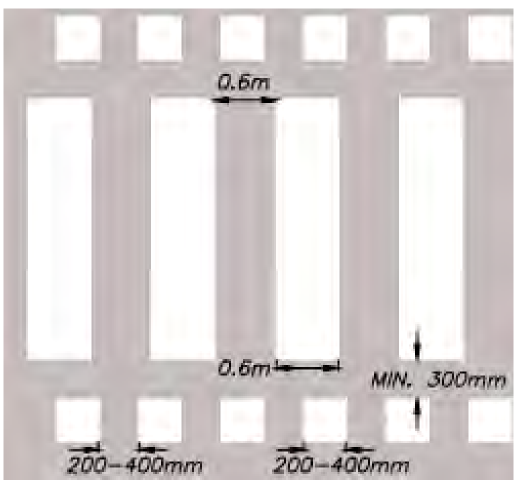
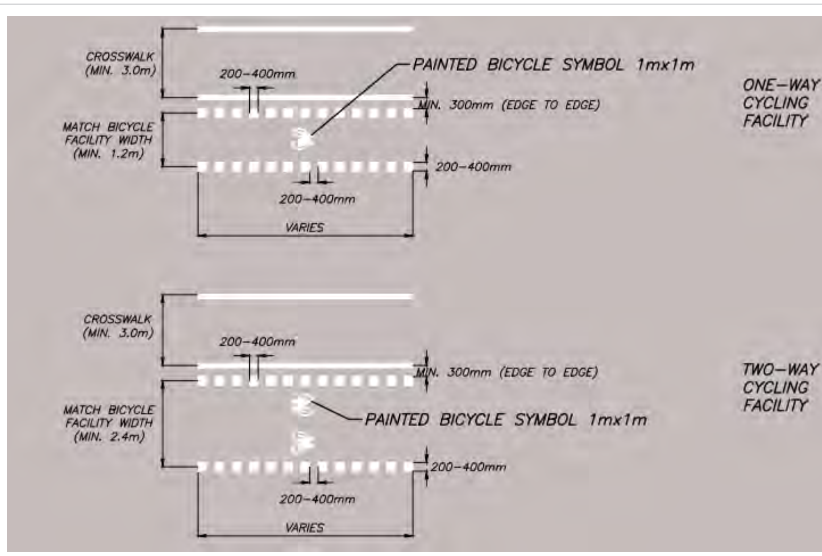
MUTCDC SIGN CODE	B.C. SIGN CODE	CUSTOM SIGNS	DESCRIPTION
   WC-48 WC-48S WC-49	 W-130 Series		**Advance Warning of Bicycle Signs** Used to indicate to drivers in advance of a confined structure that there is a high probability of encountering a bicycle user in the area. Refer to the MUTCDC for application considerations.
	INFORMATION SIGNS		
 IB-23	 B-G-001 Series	    Custom - City of Vancouver	**Bicycle Route Marker Sign** The Bicycle Route Marker sign provides route guidance for cyclists and indicates the streets, highways and separate facilities that form part of a bicycle route system. Arrows can be added to the Bicycle Route Marker sign to provide wayfinding guidance on bicycle routes. Bicycle symbols can be added to side-mounted or overhead street name blades to indicate bicycle corridors.

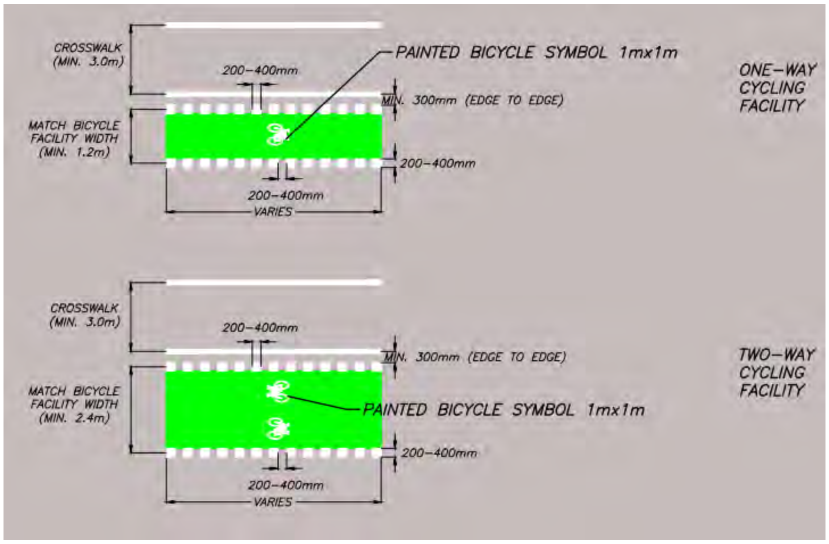
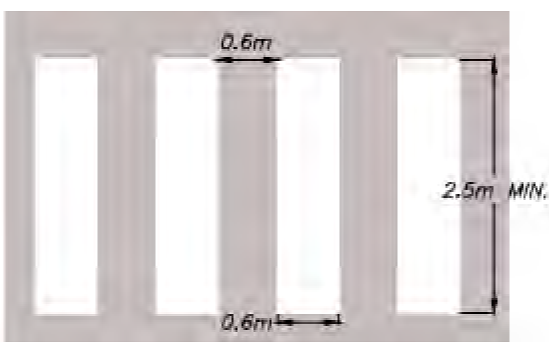
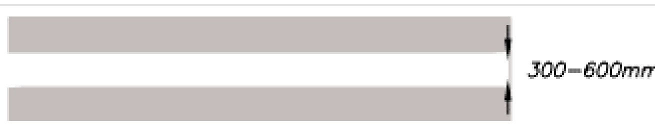
PAVEMENT MARKINGS

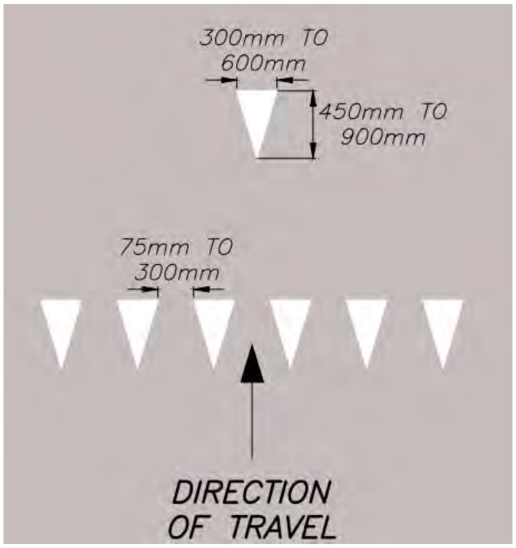
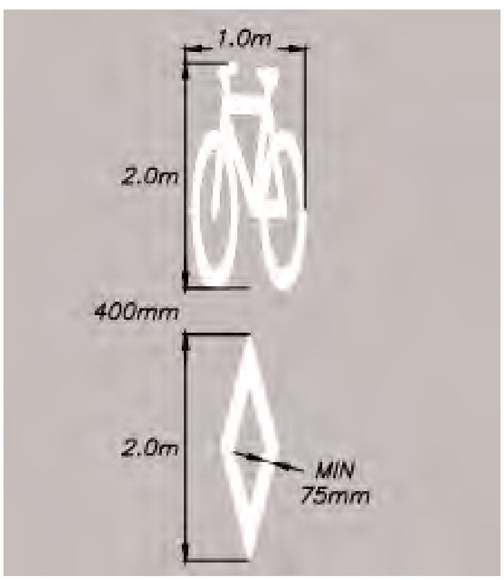
Pavement markings are an important element of the traffic control system for all road users. As stated in the TAC *MUTCDC*, they serve a variety of functions, including defining lanes, separating opposing traffic flows, passing controls, lane usage and designation, pedestrian crosswalks, stop lines, parking areas and symbol and word messages. Under favourable conditions, pavement markings convey information to the motorist, people walking, and people cycling without diverting their attention from the road or bikeway. However, they have limitations: they may be entirely covered by snow; they may not be clearly visible when wet; and they may have limited durability.

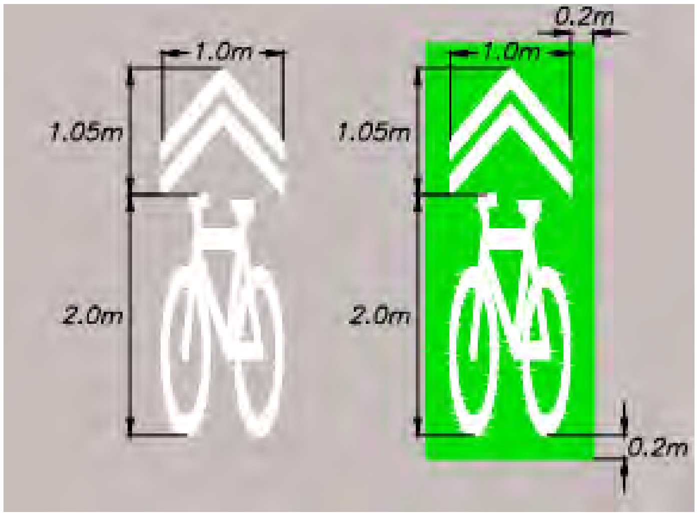
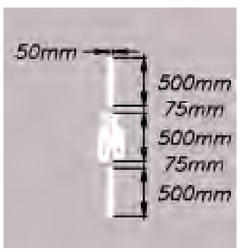
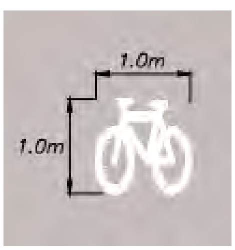
Pavement markings for bicycle and pedestrian facilities fall into three categories: longitudinal, transverse and symbol markings. The principles for the design of pavement markings are outlined in Division C1 of the TAC *MUTCDC. Pavement markings must be uniform in design position and application. Pavement markings should be designed in accordance with the design standards in Division C1 of the* TAC *MUTCDC as well as the* MOTI *Manual of Standard Traffic Signs and Pavement Markings. Design* professionals are reminded that the pavement markings included in **Appendix B are not an exhaustive** list. A more exhaustive list of available traffic control devices that includes pavement markings, signage, and signals can be found in the documents listed in the introduction of **Appendix B above.**

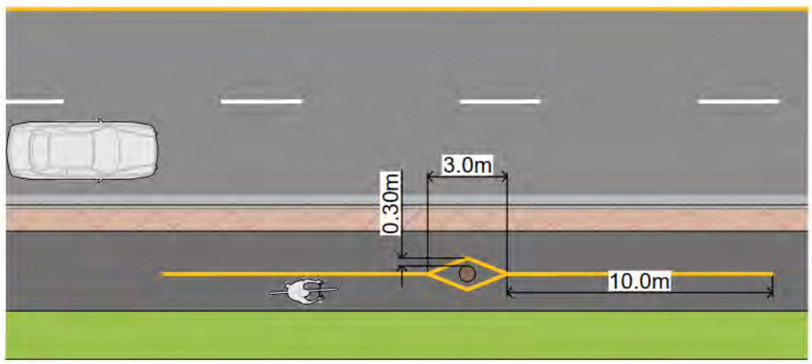
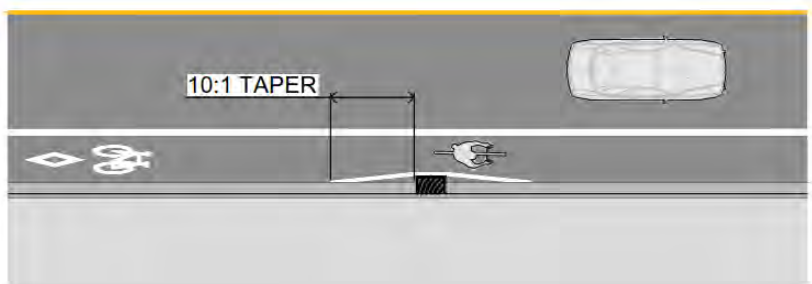
LONGITUDINAL		
The longitudinal pavement marking widths shown in the figures indicate the desired widths. Acceptable ranges are noted in the table below.		
Name	Dimensions	Description
Bicycle Lane (Solid)		Delineates the edge of a travel lane dedicated for bicycle use where travel is permitted in the same direction on both sides of the line.
Bicycle Lane (Dashed)		Permits motor vehicles to cross the bicycle lane to perform a turning movement.
Bicycle Lane Guidelines (Dashed)		Delineates the edge of bicycle travel lanes through intersections where cross-ride markings have not been installed.
Contra-Flow Lane		Separates bicycles and moving vehicles travelling in the opposite direction.
Buffered Bicycle Lane		Creates greater separation for bicycles and moving vehicles travelling in the same direction. When the width of buffer is < 300mm, the inner line can be omitted. When the width of the buffer is ≤ 600mm the diagonal hatching is optional.

TRANSVERSE		
Name	Dimensions	Description
Combined Cross-ride / Elephant's Feet at Twin Parallel Line Multi-Use Crossing		Used to define a combined crossing area for people cycling and walking at multi-use pathways. These markings are not sufficient by themselves and shall always be used in conjunction with crosswalk signs or signals. **Note: The use of enhanced green pavement markings should not be used at multi-use crossings (combined cross-rides and crosswalks). The use of green should only be used for dedicated cycling facilities (see below).**
Combined Cross-ride / Elephant's Feet at Zebra Multi-Use Crossing		Used to define a combined crossing area for people cycling and walking at multi-use pathways that cross where a zebra crosswalk would be installed. **Note: The use of enhanced green pavement markings should not be used at multi-use crossings (combined cross-rides and crosswalks). The use of green should only be used for dedicated cycling facilities (see below).**
Cross-ride / Elephant's Feet and Crosswalk at Protected Bicycle Lane or Multi-Use Pathway Crossing		Used to define a street crossing area for people walking and people cycling at a protected bicycle lane or separated multi-use pathway.

Name	Dimensions	Description
Enhanced Cross-ride / Elephant's Feet at Bicycle Pathway or Multi-Use Pathway Crossing – With Green Conflict Pavement Marking		Enhanced pavement markings with green colour used to define an area for people walking and people cycling in protected bicycle lanes or separated bicycle pathways to cross intersections, laneways, and driveways. When the protected bicycle lane crosses an intersection with pedestrian facilities, the required spacing between the crosswalk and cross-ride is given.
Twin Parallel Line Crosswalk		Used to define a crossing area for people walking at intersections with traffic control, such as traffic signals or stop control. Twin parallel line crosswalks can be combined with elephant's feet markings to indicate a shared-use crossing.
Zebra Crosswalk		Used to define a crossing area for people walking at uncontrolled intersections where heightened visibility is desired and at all mid-block crossings. Zebra crosswalk markings offer greater conspicuity than twin parallel line crosswalk markings and shall be used at all school crosswalk locations. Zebra crosswalk markings may be considered at locations with large numbers or percentages of older pedestrians or locations with high activity of pedestrians with mobility or visual impairments.
Stop Bar		Used to define the location for people on bicycles to stop.

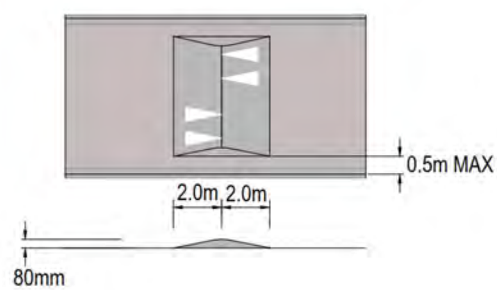
Name	Dimensions	Description
Advance Yield (Shark's Teeth)		Used in advance of marked or signed crossing to discourage the approaching vehicle from stopping too close to the crossing. Advance Yield markings also can be used to increase awareness that the approaching vehicle must yield to those in the crossing. Advance Yield pavement markings can be directed at either motor vehicle traffic or in bicycle facilities directed at people cycling.
SYMBOLS		
Name	Dimensions	Description
Bicycle Symbol Reserved Use Lane		Pavement marking to indicate exclusive use of non-motorized vehicles. Symbols should be centred in the bicycle lane spaced at 75 m or as conditions dictate, and approximately 10 m downstream from an intersection or crosswalk. Directional arrow markings may also be used to identify the correct direction of cyclist movement in a bicycle lane.

Name	Dimensions	Description
Bicycle Shared Use Lane Symbol (Sharrow)		Pavement marking to indicate shared use of the roadway with people on bicycles and motorized vehicles. Symbols should be spaced at a minimum 75 m and approximately 10 m downstream from all intersections. Green backed sharrows should be used where protected bicycle lanes merge into a shared-use lane, and locations without physical protection where enhanced visibility is desired.
Bicycle Detection Symbol		Pavement marking to indicate location of bicycle actuation loop. Symbol should be placed at the most sensitive area of detection.
Non-Elongated Bicycle Symbol		Pavement marking used at conflict markings, bicycle pathway crossings, bicycle boxes or in two-stage turn boxes applications.
Custom Wayfinding Symbol		Wayfinding pavement marking to direct people on bicycles along bicycle routes.
Custom Multi-Use Wayfinding Symbol		Wayfinding pavement marking to direct people on bicycles and walking along multi-use pathways.

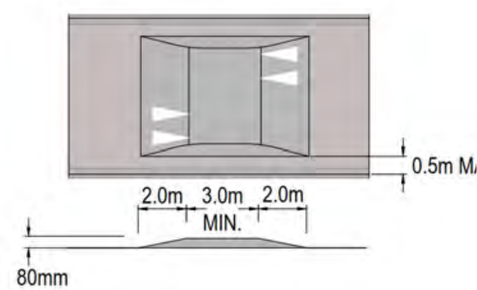
Name	Dimensions	Description
Hazard Pavement Marking for Obstructions within Pathway		Pavement marking to indicate an obstruction within the pathway. Typically used in advance of centre line bollards, hydro poles, light poles and other infrastructure.
Hazard Pavement Marking for Obstructions Curbside		Pavement marking to indicate an obstruction curbside adjacent to painted bicycle lanes. Typically used to demarcate infrastructure such as manhole lids, catch basin grates etc.

APPENDIX C: TYPES OF TRAFFIC CALMING DEVICES

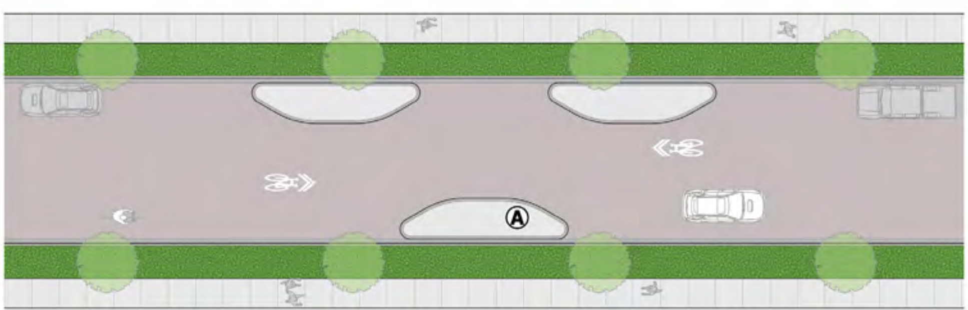
Speed Hump



Speed Table

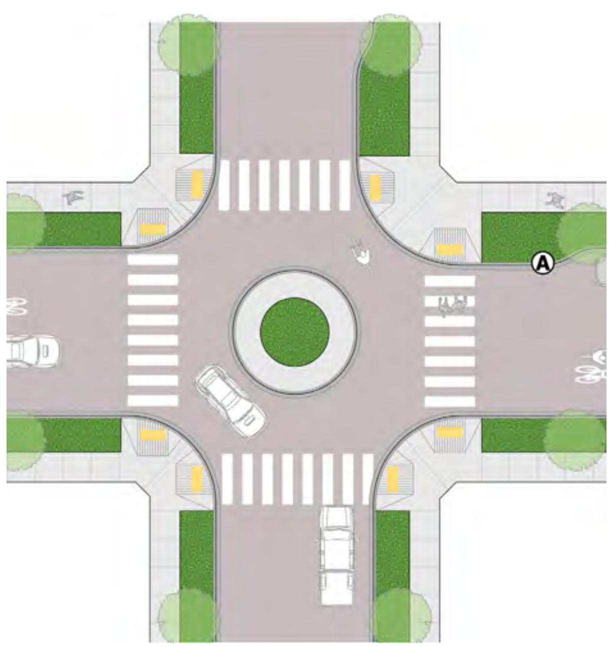


Chicane

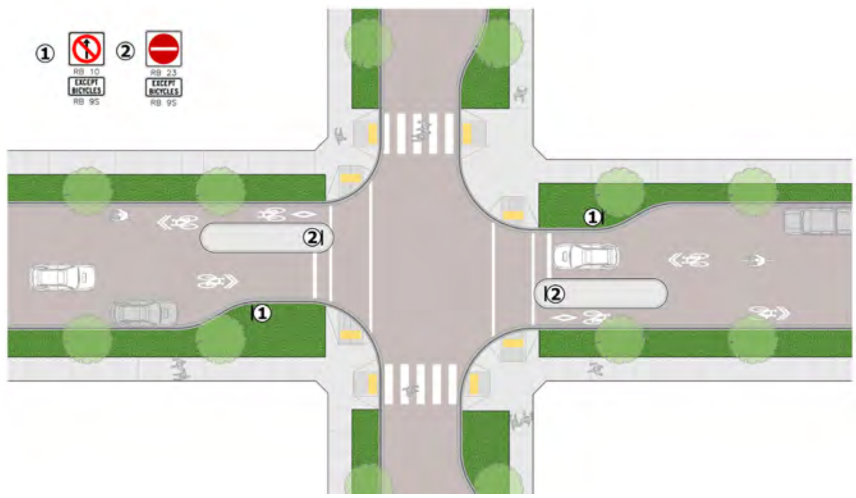


Raised Intersection

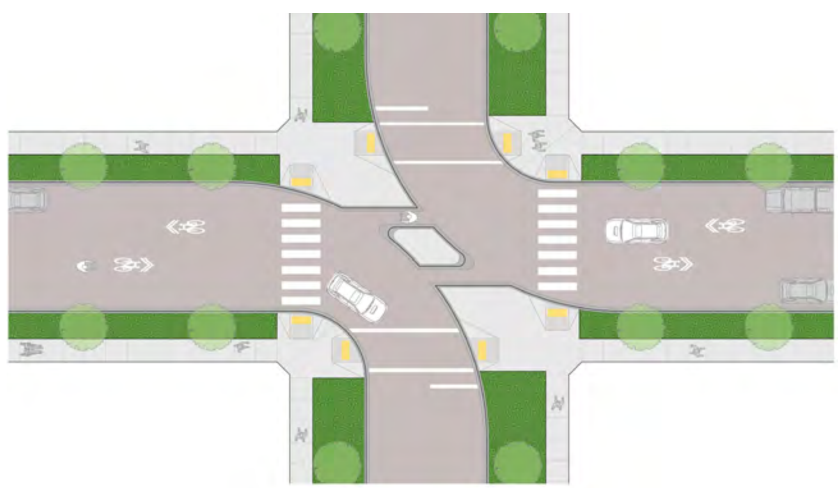
Traffic Circle



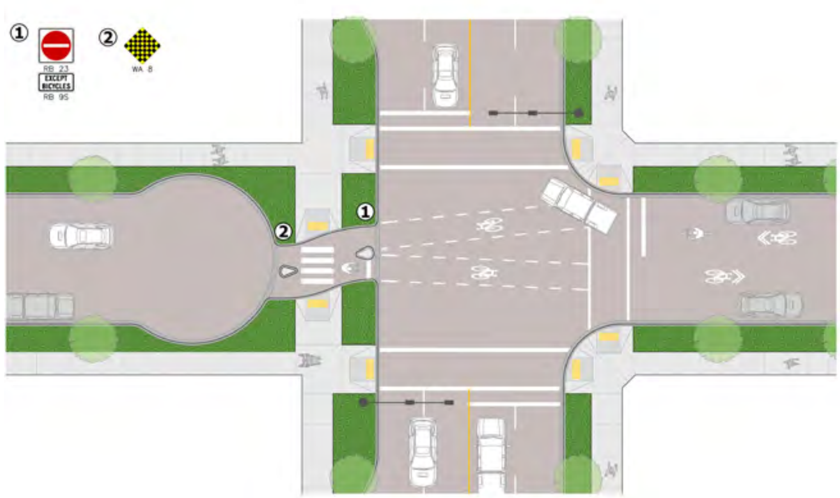
Directional Closure



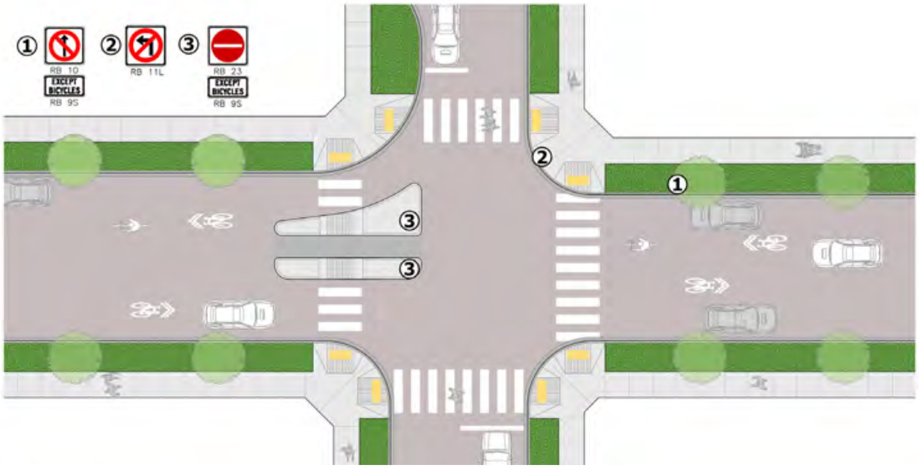
Diverter



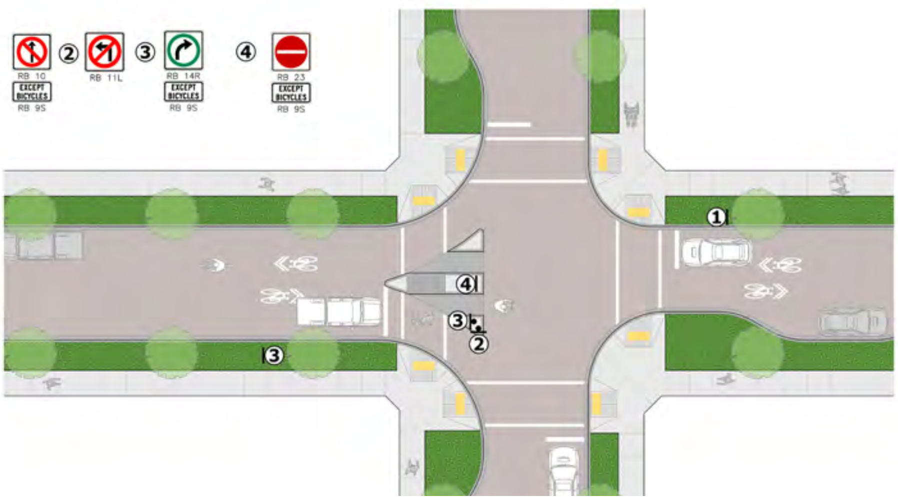
Full Closure



Intersection Channelization



Right-In / Right-Out Islands



Raised Median

About the B.C. Active Transportation Design Guide

The British Columbia Active Transportation Design Guide helps transform how we get around in a way that reduces pollution and leads to better health outcomes for people, while making our communities cleaner and more liveable. The Design Guide is a detailed planning and engineering reference that provides practical design and application guidance for active transportation infrastructure for jurisdictions of all sizes. It incorporates theory, recent research, design concepts, best practices, new methodologies, and innovations to maximize the benefits of investing in active transportation infrastructure.

The Province thanks everyone who participated in the shaping of this Design Guide and we look forward to working with all stakeholders across B.C. to design and build infrastructure using this information. Working together we can build the best B.C. possible and enable everyone to choose active transportation.