SINGAPORE

WALKING AND CYCLING

DESIGN GUIDE

Public Version 1.0

Contributing Agencies

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Land Transport Authority

URBAN REDEVELOPMENT AUTHORITY

With valuable input from:

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jtc

HOUSING & DEVELOPMENT BOARD

NATIONAL PARKS
LET'S MAKE SINGAPORE OUR GARDEN

PUB SINGAPORE'S NATIONAL WATER AGENCY

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Introduction

In November 2014, Prime Minister Lee Hsien Loong announced the goal of moving Singapore towards becoming a car-lite society by promoting and developing better mobility options. One key strategy is to encourage more people to embrace active mobility (i.e walking and cycling) as part of sustainable urban living.

With good infrastructure and a clear framework, walking, cycling and the use of Personal Mobility Devices (PMDs) can serve first- and last-mile trips, reducing reliance on short car journeys and promoting a healthier lifestyle.

This Walking and Cycling Design Guide serves to provide developers, the building industry, consultants, and government agencies a common set of design guidelines to develop active mobility related infrastructure in a holistic and harmonious manner.

1

1 INTRODUCTION

1.1 Vision

Walking and cycling are no longer merely a functional means to get from one point to another. Instead, it is a multi-purpose and multi-sensory experience. Hence, we envision Singapore to be a city that is safe, convenient, comfortable and delightful for all to walk and cycle. A consistent and pleasant design would encourage active mobility as a popular commuting means, as well as an attractive recreational option.

ABOVE: Footpath and cycling path at Ang Mo Kio

1.2 Purpose

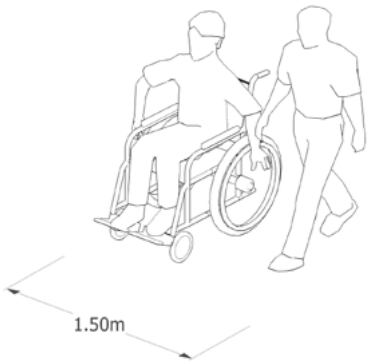
This book is to guide private developers, the building industry, consultants, and government agencies in the planning and designing active mobility infrastructure. It also provides the considerations behind the standard design of the various infrastructure.

It aims to complement various agencies' technical requirements in active mobility related designs*. Where relevant, the Guide will direct readers to more details in agencies' respective documents.

** This Guide complements the prevailing design standards developed by the respective government agencies. Should there be any discrepancies between the Guide and agencies' technical design standards, the latter will take precedence.*

1.3 Pedestrians & Cyclists' Needs

1.3.1 Pedestrian



ABOVE: Space required by a wheelchair user and a pedestrian

Pedestrians refer to a very wide spectrum of commuters who utilise walkways as a means to travel either for leisure or to connect them to and from facilities. Designers should have a good appreciation of the broad range of needs and abilities exhibited by the various user groups in the community. This would enable them to work towards designing an accessible environment where people of different abilities can co-exist with cyclists, Personal Mobility Aids (PMAs) and Personal Mobility Devices (PMDs) to commute safely and independently.

The key groups of users include:

1. Infants and Children
2. Expectant Mothers
3. Older Persons
4. Wheelchair Users
5. The Ambulant Disabled
6. Persons with Visual Impairment
7. Persons with Hearing Impairment

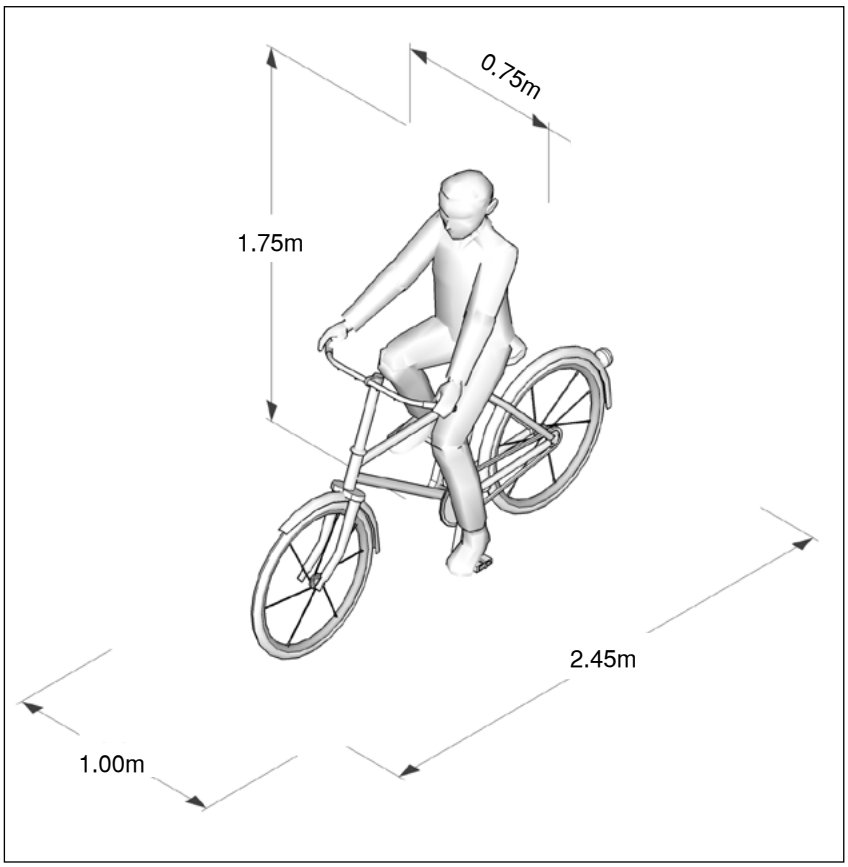
For greater understanding of the above listed profiles, please refer to BCA's Universal Design Guide for Public Places (2016).

ABOVE: Wheelchair user and other users waiting at pedestrian crossing

1.3.2 Cyclist

The ideal condition for cyclists is to have a dedicated route where there is less variation of speeds among the users. However, due to space constraints, cyclists may need to share space and interact with other users.

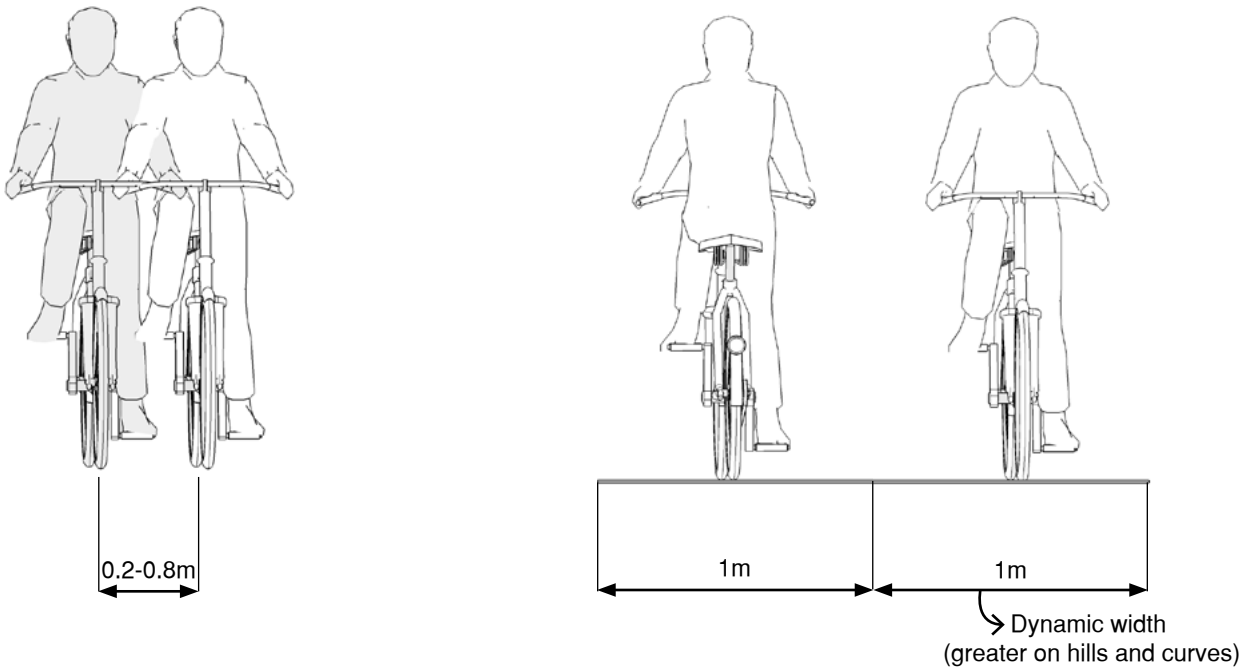
A bicycle needs a minimum space of 0.75m width by 2.45m length, which is equivalent to 3 walking pedestrians. When in motion, cyclists will require more space than pedestrians because of the natural lateral movement to balance. Depending on the cycling speed, an additional space of 0.2-0.8m will be required. The recommended safety comfort distance from other cyclists is 0.5m (Sustrans, 2014).



ABOVE: Spatial dimensions of a cyclist

Deviation when cycling
(greater at low speeds)

Minimum width required by 2 cyclists
(greater where flows are high)



ABOVE: Types of space required by cyclists (adapted from Sustrans, 2014)

1.4 Fundamentals of Active Mobility Design

There are three important planning considerations for active mobility networks. It is vital to understand the rationale of the planned networks so that these fundamentals can be applied when designing active mobility infrastructure.

1.4.1 Safe

Safety is of paramount concern in planning for active mobility networks where commuters should always feel secure and at ease. Hence, sufficient space should be catered for safe manoeuvre.

Speed Limits and Rationale

Cycling on footpaths is allowed up to 10km/h* while cycling on cycling path and shared path is allowed up to 25km/h. The prescribed speed limit of 10km/h is to highlight that cyclists and PMD users should exercise due care and consideration for other users by not travelling too fast relative to pedestrians whom they share the paths with.

The speed limits are determined based on overseas standards (e.g. USA, Canada, etc.) to ensure the safety of the pedestrians while sharing path with the cyclists.

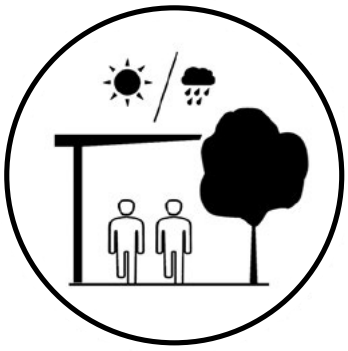
1.4.2 Direct

Direct routes promote accessibility, and save time and commuting distance for pedestrians and cyclists.

In terms of alignment and orientation, ideal active mobility networks should always strive to provide most straightforward routes to promote active mobility as a viable commuting mode.

* Starting from Jan 2019

1.4.3 Comfortable



Comfort refers to the quality of the active mobility commuting experience. Unlike private and public transportation, there are more opportunities to incorporate interesting and interactive elements into active mobility environments. Should planning succeed in creating comfortable, high-quality active mobility environments, it can motivate commuters to switch to active mobility. Design should also take care of users' needs e.g. ease of use, weather protection, intuitiveness, etc.

1.5 Walking and Cycling Network Principles

Considering the needs of different users, a set of principles is developed to guide the planning of active mobility networks.

These principles should be adhered to as far as possible. In the case where deviation from a particular principle is required, it should be done so in the pursuit of an alternative planning principle.

Besides commuting, walking and cycling infrastructure are also designed and built for recreational purposes. For example, recreation is the main drive behind our Park Connector Network (PCN). This is formed by creating regional loops and links that permeate across the island and follow the character of the region. The plan is to construct an islandwide network of linear green corridors that links up major parks and nature sites in Singapore, providing additional recreational areas for activities such as walking, jogging, cycling, and in-line skating.

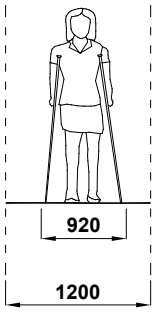
The table on the following page illustrates the relationships between active mobility planning principles and design fundamentals.

Planning Principles	Design Fundamentals			Context	
	Safe	Direct	Comfort-able	Commut-ing	Recrea-tional
Routes are planned around least distance to allow journeys to be completed in the shortest amount of time.	✓	✓		✓	✓
Routes are complete (i.e. do not break or stop abrupt-ly) and link up to origins/destinations.	✓	✓	✓	✓	✓
Routes form an intuitive network that is easy to navi-gate.	✓	✓	✓	✓	✓
Wayfinding is consistent, and punctuates networks to ensure users are able to successfully navigate journeys.	✓	✓	✓	✓	✓
Where feasible, segregated routes for walking and cycling are planned for.	✓			✓	
Routes are barrier and obstacle free.	✓		✓	✓	✓
Routes are treated to be disability-proof to ensure equitable usage by all users.	✓		✓	✓	✓
At grade routes are preferred over grade separated linkages unless there are distinct and strong strategic benefits for having such linkages.	✓	✓	✓	✓	✓
Routes factor aesthetic features and visual appeal in planning design to maximize the value of active mobil-ity networks as 'breaks' to urban facades.	✓		✓	✓	✓
Routes incorporate active-mobility friendly facilities and weather-proofing measures.	✓		✓	✓	✓
Alternative route within comfortable distance shall be made available	✓	✓	✓	✓	
Junctions should be treated such that it is safe and prioritises users	✓		✓	✓	✓
Secure connection at least about every 250m (i.e. punch through huge urban grid)	✓	✓	✓	✓	
Routes are to link to key transportation nodes and amenities	✓	✓		✓	
At areas with MRT station, key amenities, a major arterial road and bicycle parking (at both sides of the roads), routes will be provided at both sides of the road	✓	✓	✓	✓	
Support the City in a Garden initiatives	✓		✓		✓
Link major parks, nature sites and places of interest	✓	✓	✓	✓	✓
Provide accessible recreational and leisure space for the population	✓	✓	✓		✓
Provide green and biodiversity link	✓		✓		✓
Provide green and blue park space by using the both bank of sizable waterbodies to create the spatial leisure environment	✓	✓	✓		✓
To optimise land usage (e.g. footpath and planting verge of the road reserves, vacant space under the rail elevated viaduct; remnant state land, waterbodies and drainage reserves)	✓	✓	✓	✓	✓

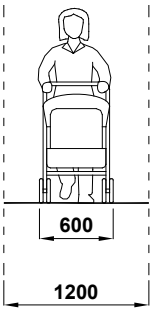
1.6 Universal Design Principles in Active Mobility Designs

As Singapore prepares for a fast ageing population and builds an inclusive society, adopting Universal Design concepts will benefit a wider spectrum of people including Persons with Disabilities (PwD), parents with infants, the young and older persons. It is also important to make our urban infrastructure, including pedestrian footpaths, more senior friendly, catering to the growing population of older persons with limited mobility or mobility aids.

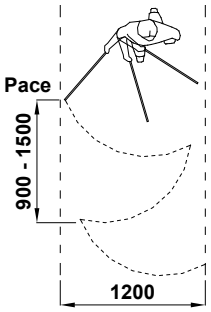
The figure on the right is an illustration from BCA's Code of Accessibility 2013, demonstrating the comfortable walking widths of various users. Walkways with adequate widths for comfortable gaits should be catered for persons using walking aids. This is because the crutch or cane tips often extend down at a wide angle, and pose as an obstacle to other pedestrians who may not notice them.



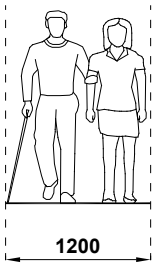
a) Person using crutches



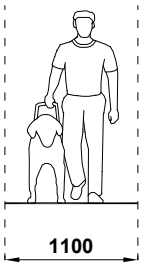
b) Person with baby carriage

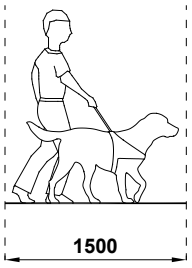


c) Person with visual impairment using a white cane

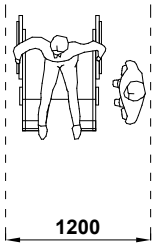


d) Person with visual impairment and a sighted escort

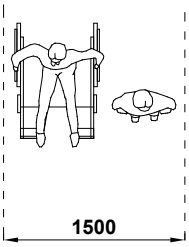




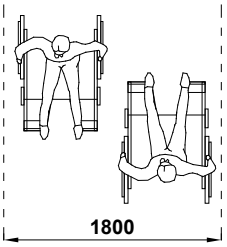
e) Person with visual impairment and a guide dog



f) Wheelchair and a person facing sideways



g) Wheelchair and a person



h) Two wheelchairs

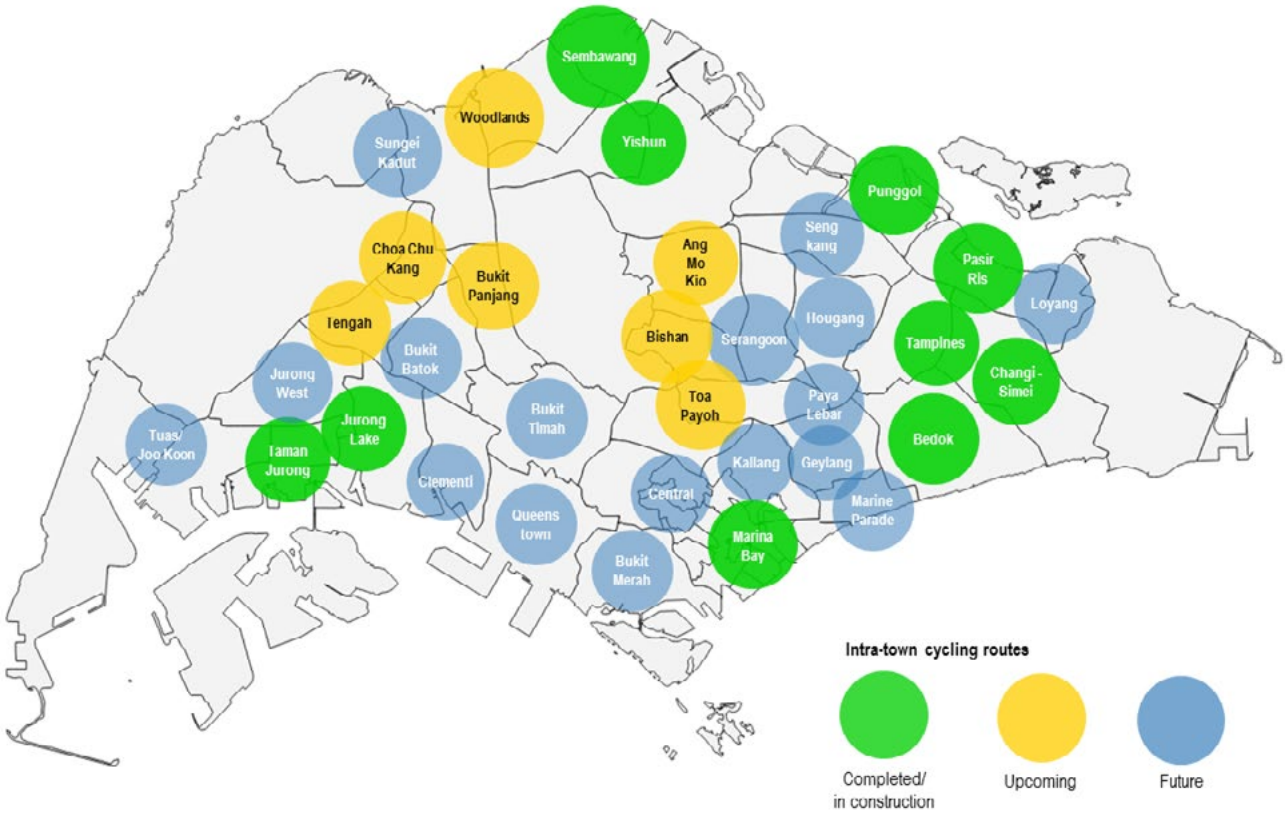
ABOVE: Wheelchair users using public spaces

1.7 Active Mobility Programmes

1.7.1 National Cycling Plan

The National Cycling Plan aims to build on the existing and planned cycling paths and Park Connectors to develop cycling routes for recreational and commuting purposes, which will be integrated into a comprehensive network throughout Singapore.

Under the National Cycling Plan, 700km of dedicated cycling network will be implemented islandwide by 2030, with cycling networks in all HDB towns. These cycling paths will connect cyclists and PMD users from their homes to major transport hubs and key amenities such as food centres, schools, supermarkets and community centres within the town, promoting active mobility as a convenient and attractive mode of transport.



ABOVE: Islandwide intra-town cycling town routes (Updated as of Nov 2018)

1.7.2 Covered Linkway Programme

The Land Transport Authority (LTA) started building covered linkways in 2000 to enhance pedestrians' experience by providing sheltered walkway network between transport nodes and various amenities. They are currently built based on the following guidelines:

1. Between MRT stations and trip-generating hubs such as schools, healthcare facilities, public amenities, and commercial and residential developments within a 400m radius of the stations; and

2. Between bus interchanges/ LRT stations and developments within a 200m radius.

ABOVE: Covered linkway connecting to a bus stop

Roadside Elements

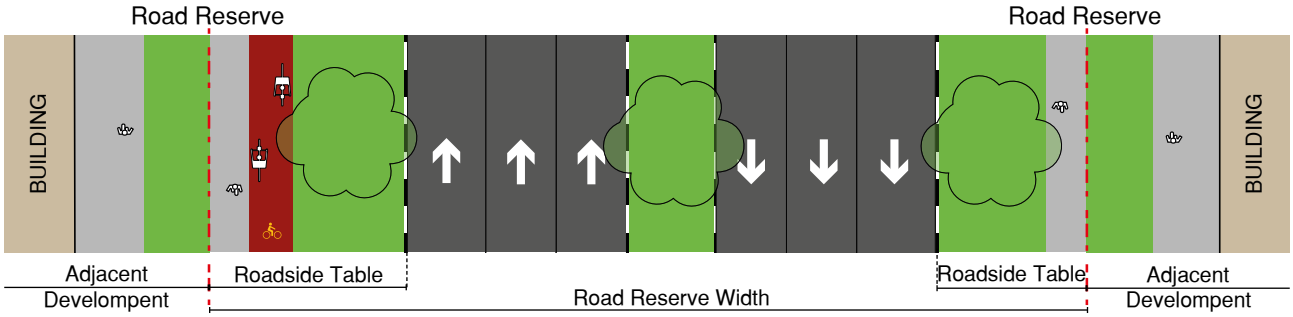
A safe and comfortable environment for recreation and commute is attributed to good urban street design. This is facilitated by a good understanding of roadside elements and street context. Different roadside elements come together to form a safe and comfortable environment for recreation and commute. When designing a roadside element, one has to identify the street type and ensure that the element blends into the street to provide a visually appealing and well integrated urban streetscape.

This chapter establishes the standards for roadside elements and their design considerations. This allows agencies, professionals and developers to understand the importance of complying with them. In all, Singapore's streetscape as a whole will only be as good as the sum of its parts.

2

2 ROADSIDE ELEMENTS

Roadside elements refer to those within the roadside table, which facilitate the movement of people along the road. They form the key urban design elements to make the public streetscape friendly, vibrant and attractive. They are typically located within the road reserve that indicates the extent of the existing or future road and its related facilities such as footpaths, cycling paths, bus-bays, covered linkways and other commuter facilities.



Below are the key roadside elements that promote active mobility. They are provided along almost all road carriageway except expressways and semi-expressways.

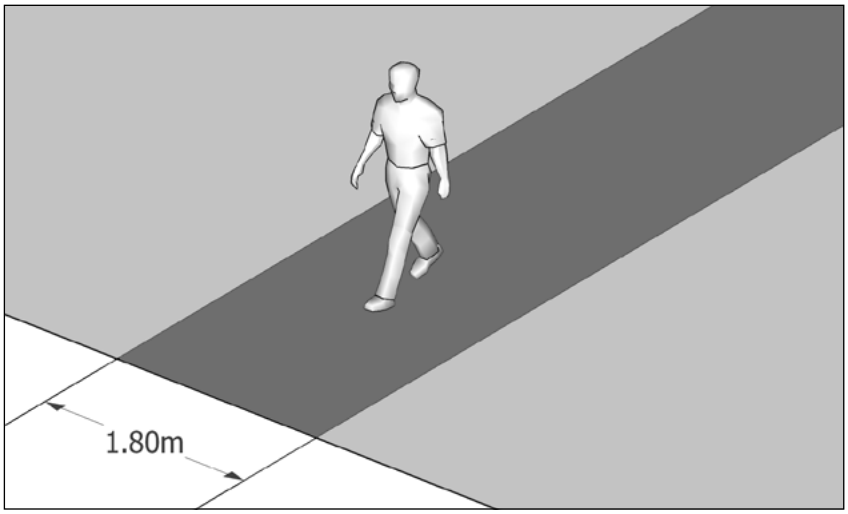
2.1 Footpath

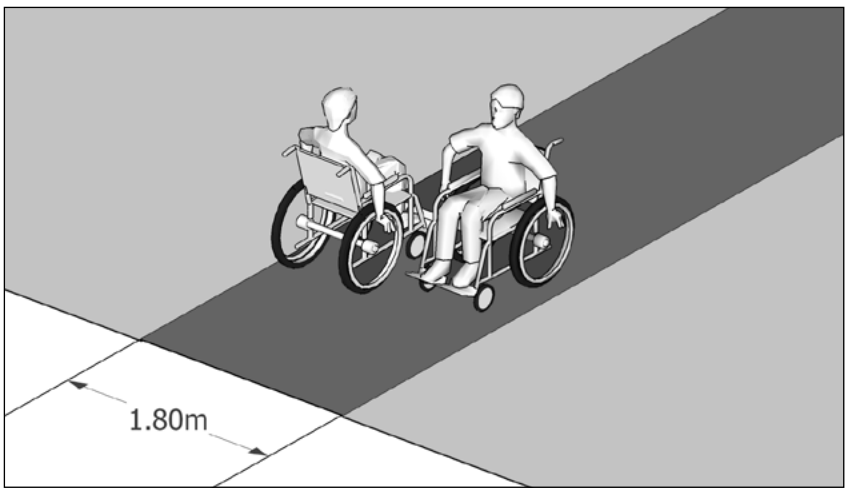
Footpath is a vital roadside element as it facilitates pedestrian movement and enhances overall connectivity. Accessible, safe, comfortable and well-maintained footpaths enhance walking experience and promote walking as a mode of transport for short-distance commuting.

2.1.1 Standalone Footpath

With Singapore's ageing population, the use of Personal Mobility Aids (PMAs), (e.g. wheelchairs, mobility scooters, etc.) is becoming more prevalent. New footpaths have been increased from 1.5m to 1.8m, which is the adequate width for two typical wheelchairs to pass each another (see Chapter 1.6 for details).

However, where there are observed or projected high pedestrian volume, footpath widths of more than 1.8m would be considered.

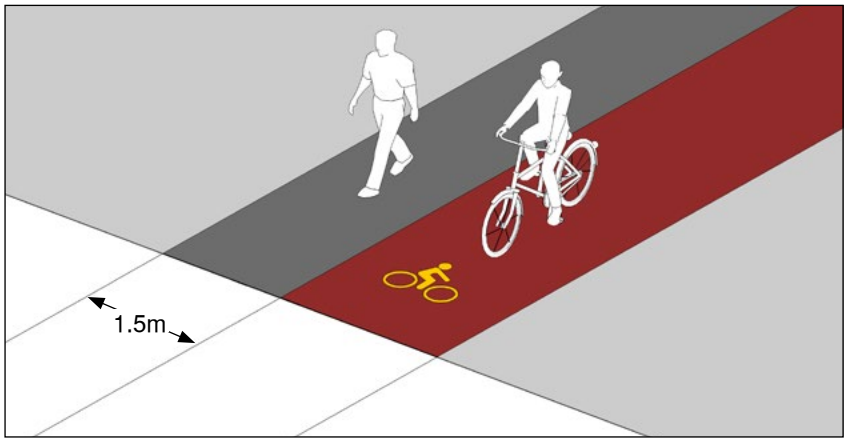




ABOVE: Design considerations for 1.8m standalone footpath

2.1.2 Footpath Next To Cycling Path

Cycling paths adjacent to footpaths may be used to negotiate manoeuvring space required by pedestrians, including wheelchair users. Under such circumstances, 1.5m is adopted as the dedicated pedestrian width.



ABOVE: Dimension of footpath is 1.5m when sited next to a cycling path

2.1.3 Materials

Concrete is used as the material for footpaths because of its skid resistant property (BPN ≥ 45) and durability. Good levelling and workmanship of floor finishes should be ensured to avoid undulation and protrusions that may result in trips and falls.

Regular maintenance and renewal of footpaths and pavement surfaces is important to ensure a non-slip and level surface.

ABOVE: Typical roadside footpath made with concrete

2.1.4 Features For Pedestrians with Vision Impairment

① Tactile tiles and kerb ramps are provided at areas near crossings to remind pedestrians, especially pedestrians with vision impairment, to be vigilant while crossing the road.

ABOVE: Tactile tile

ABOVE: Placement of tactile tiles at crossing

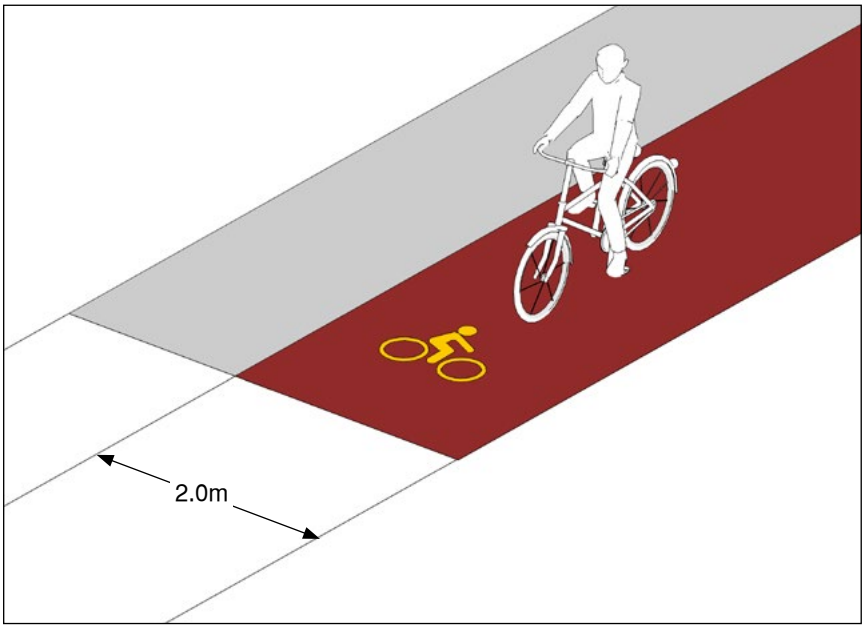
2.2 Cycling Path

For safety, cycling paths are designed to be separated from vehicular traffic on a different level. These paths are designed to separate the pedestrians and cyclists to minimise conflict. Finding sufficient space to cater for cycling paths is a challenge in the land-constrained Singapore. Thus, land owners and agencies need to work together to agree on the desired outcome and trade-offs.

ABOVE: Terra cotta cycling path

2.2.1 Intra-town Cycling Path

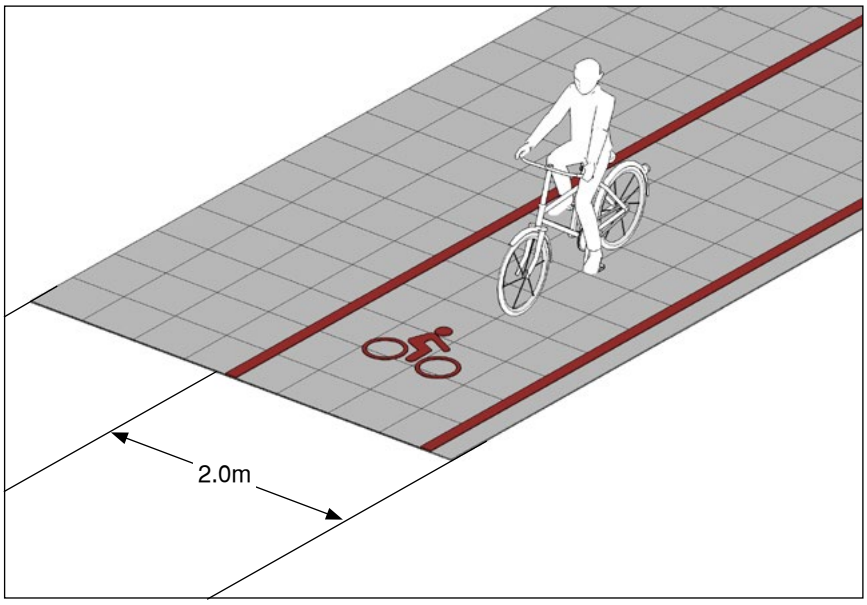
Intra-town cycling paths facilitate short utilitarian distance trips within the town, and connect cyclists to the major public transport nodes (e.g. MRT, bus interchange). To improve the first- and last-mile connectivity, commuters are encouraged to cycle as a commute option to save time.



ABOVE: Intra-town cycling path requires minimally 2m width for bi-directional movements.

2.2.2 Cycling Path in Central Area

To keep the character of the Central Area, its cycling path will adopt a less intrusive demarcation while still using similar colour as those in outside Central Area. Two solid red or yellow lines will be used on the existing pavement to demarcate the cycling path. This treatment may also be applied to Business Parks.

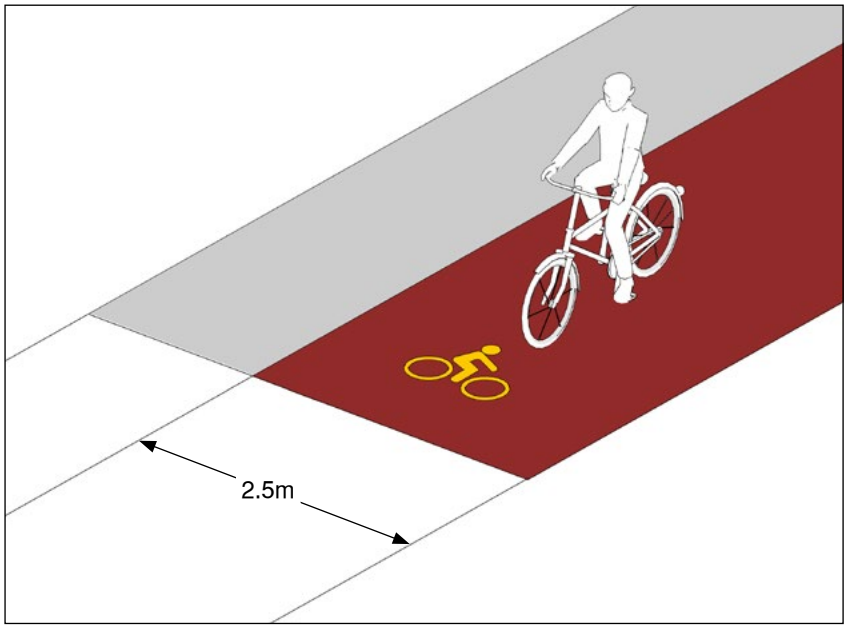


ABOVE: 2m solid red cycling path in Central Area (to trial out)

2.2.3 Inter-town Cycling Path

Inter-town routes facilitate commuting, recreational and longer distance trips to connect people between towns, as well as to the city.

They are designed for seamless travel with minimal stops and detours, which will optimise cycling over long-distance commutes.



ABOVE: Inter-town cycling path requires minimally 2.5m width for bi-directional movements.

2.2.4 Park Connector Network (PCN)

The Park Connector Network (PCN) forms the linear open spaces and links up major parks and nature sites in Singapore, providing additional recreational areas for activities such as walking, jogging, cycling and in-line skating. The intention is to create and evolve a network of park connector loops across the whole island to make it convenient for residents to travel from park to park or start their recreational activities close to homes or where they work.

They have evolved throughout the years and the PCNs are becoming part of the commuting network between homes to transport nodes too.

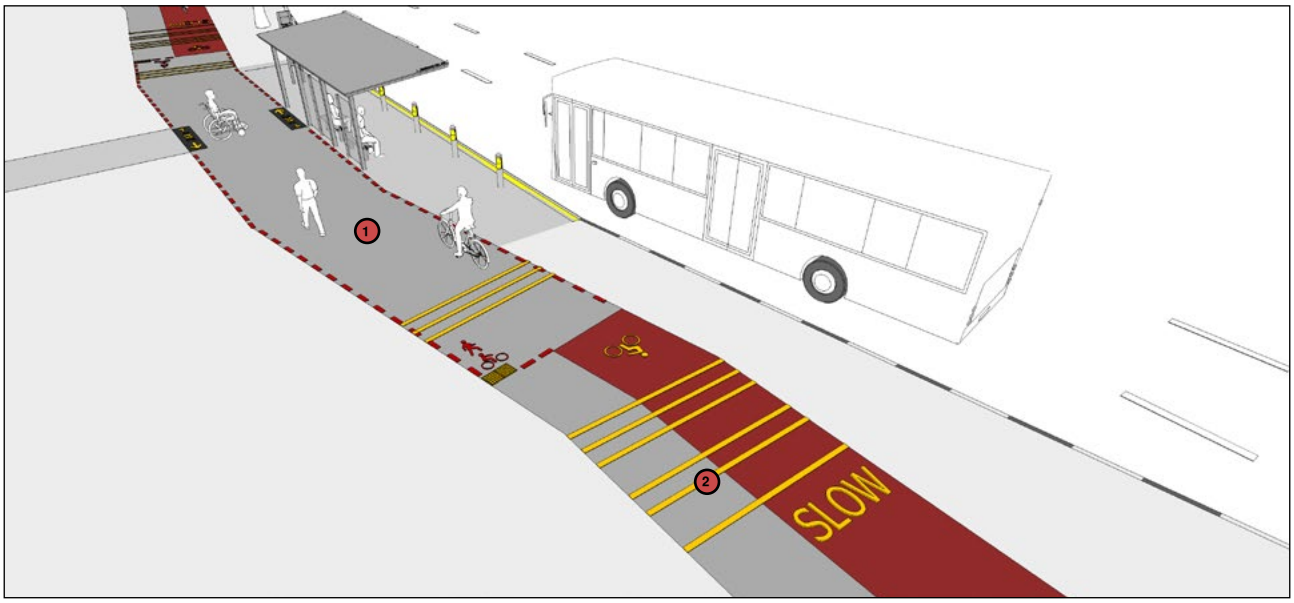
PCNs are usually built within both road and drainage reserves with a 4-metre wide track where space allows for distinctive planting schemes and provisions of advanced play and fitness equipment, shelters, seats and toilets to fit the needs of the people. The paths are made of continuous black asphalt, with markings to identify it as a Park Connector.

ABOVE: Park Connectors: tracks with typically 2.5m catered for cycling, 1.5m for walking & jogging

2.2.5 Cycling Path Features

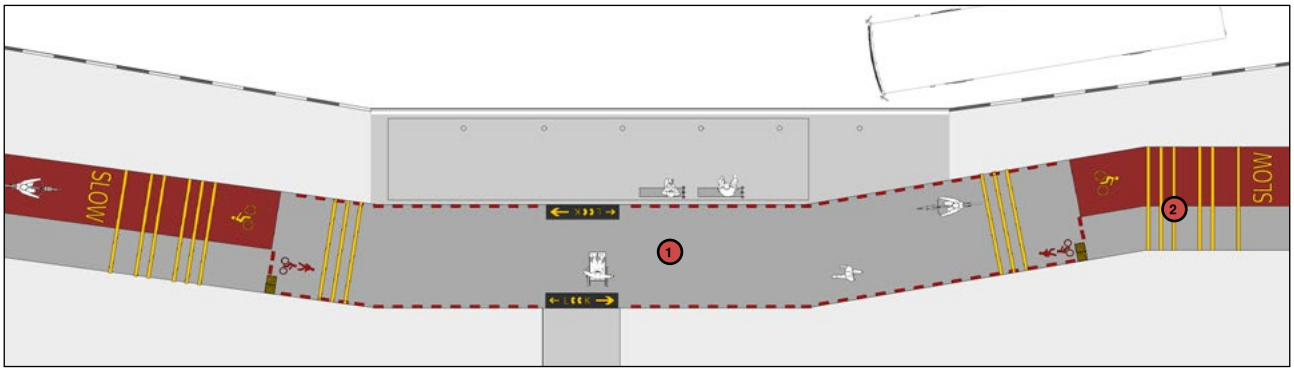
Pedestrian Priority Zone (PPZ)

Pedestrian Priority Zone (PPZ) is a special zone applied in areas with high potential of conflict between pedestrians and cyclists. It is commonly implemented along the cycling path behind bus stops to inform cyclists that they have to give way to the pedestrians at and near bus stops. PPZ will also be implemented at the waiting area of pedestrian crossings, MRT entrances, Pick-up Drop-Off points, etc.



1 **PPZ**
At PPZ, cyclists will become more alert and slow down to walking speed

2 **Speed Reduction Strips**



Cycling Logo

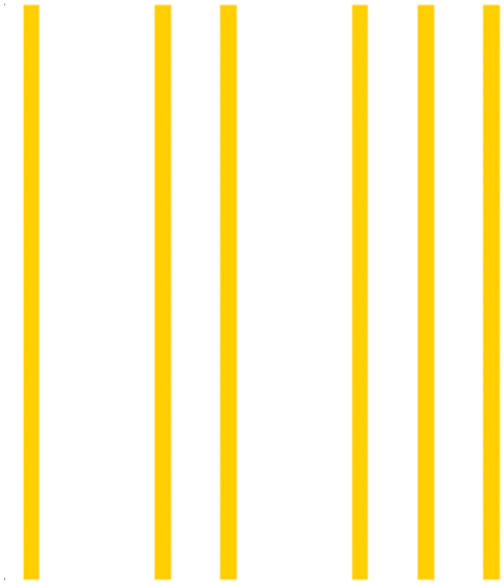
The cycling logo is used as a visual cue to identify a cycling path.

The cyclist in the cycling logo is designed upright as speeding is not encouraged and cyclists should be gracious to other users.

ABOVE: Typical cycling logo on cycling paths

RIGHT: Cycling logo implemented on ground

Speed Regulating Strip
Speed regulating strips are applied at interaction zone to to regulate cyclists' speed for the safety of themselves and others. It also provide cyclists with visual and/or physical cues to prompt them to slow down and watch out for other users.



3mm strip
3mm thick strips are selected as they can adequately slow down and inform cyclists about the potential conflict/ danger ahead of them.

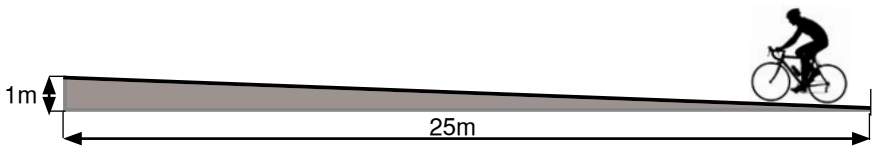
Thicker strips will reduce the contact between the bicycle wheel and path surface, which may cause cyclists on road bikes to skid. It is also a tripping hazard to pedestrians.

'Look' Marking
This marking is placed at locations with high pedestrian flow going across the cycling path. This marking is to inform pedestrians to look out for oncoming cyclists.

The marking is in yellow and against a black background to increase its prominence to pedestrians.

'Slow' marking
This is placed along cycling paths to inform cyclists to slow down.

Gradient of 1:25
According to AASHTO*, gradient of 1:25 is the comfortable gradient for cyclist to cycle over long distance.



* American Association of State Highway and Transportation Officials (AASHTO)

Material/ Surfaces

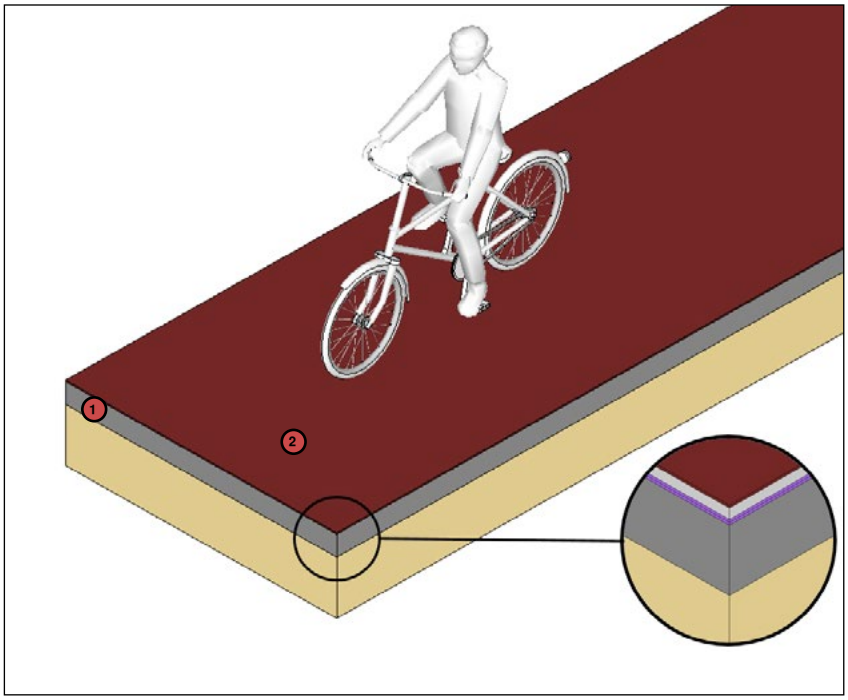
Coloured High Strength Coating System
- Skid Resistance ≥ 45 BPN
- Durable (resistant to wear and tear).

Brown Red Path (Colour code: RAL 3011)
- Red colour is applied to the cycling path to increase its visibility and reinforce the priority of the users on the footpath and cycling path.

Note: This does not apply to Park Connector Network (PCN) and Round Island Route (RIR).

ABOVE: Typical cycling path finishes & markings

BELOW: Materials of cycling path pavement

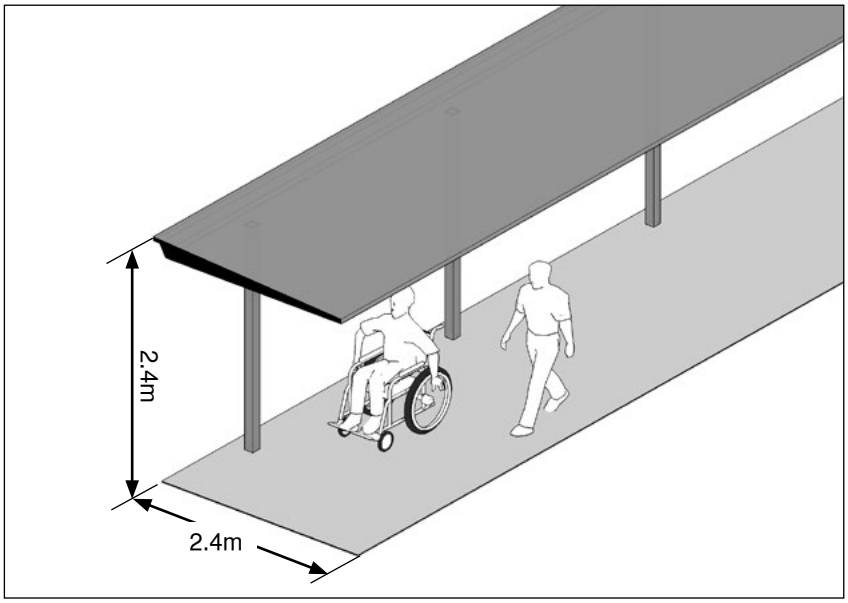


1. Existing old rigid pavement
2. Brown red material uniformaly spread

2.3 Covered Linkway

Given the climate of Singapore, weather protection is an important factor for consideration in the design of our infrastructure. Covered linkways are shelters over footpaths to shield pedestrians from the weather while travelling from one place to another.

According to studies, weather protection is often one of the most important factors that affects people's decision to walk. Hence, to promote active mobility, the implementation of covered linkways at key locations is important.



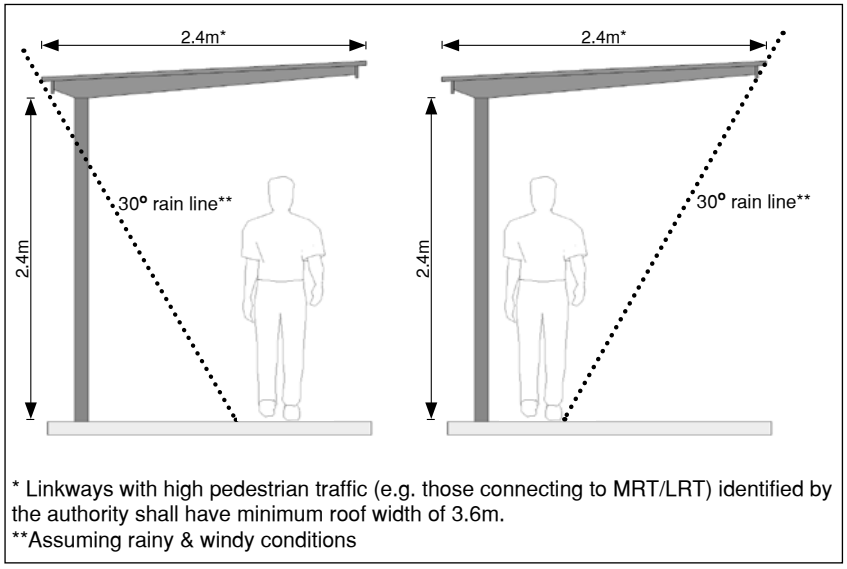
2.3.1 Standard Covered Linkway

Height & Width

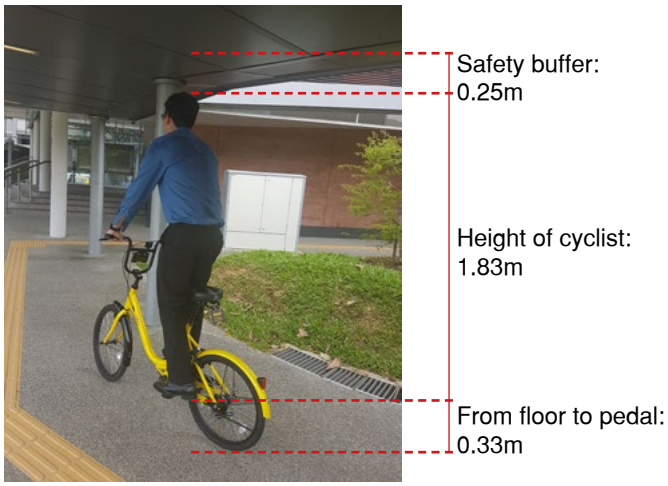
The height and width ratio of the covered linkway is designed to provide protection to pedestrians and cyclists from light rain and direct sunlight.

Its height also takes into consideration cyclists using the covered linkway:
- 95th percentile of Singaporean height is 1.83 m
- Diameter of bicycle wheel is 0.66 m
- Pedal is in-line with the centre of the bicycle wheel
- Safety buffer = 0.25m
- Total height = 1.83m + (0.66m)/2 + 0.25m ≈ 2.40m

Refer to LTA's Architectural Design Criteria (ADC) for more details on the covered linkway requirements.



* Linkways with high pedestrian traffic (e.g. those connecting to MRT/LRT) identified by the authority shall have minimum roof width of 3.6m.
**Assuming rainy & windy conditions



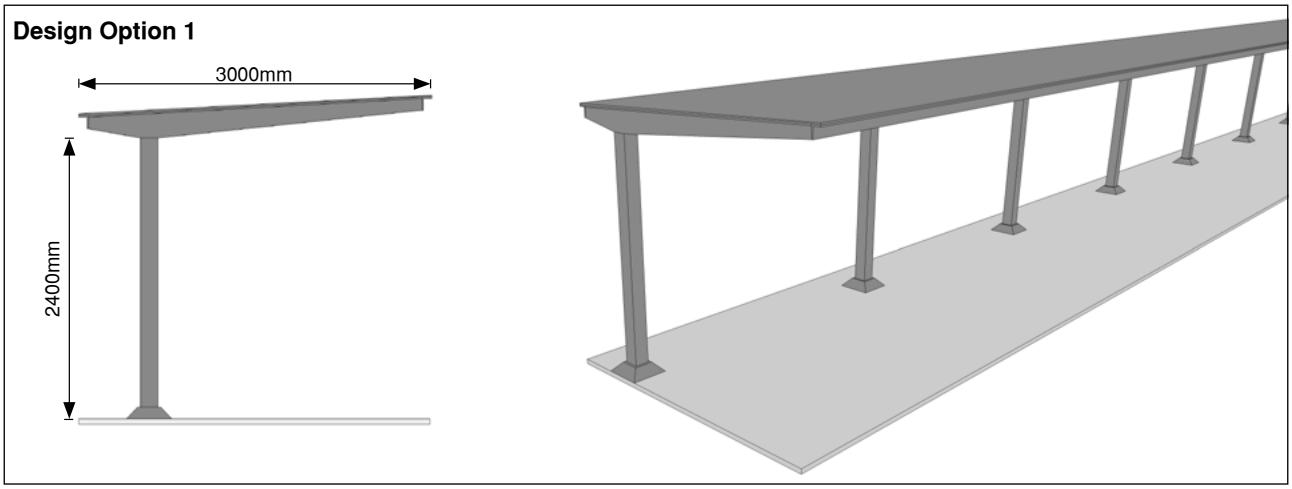
2.3.2 HDB's Covered Linkway Designs

To harmonise with LTA's covered linkway design, HDB has streamlined the designs of the covered linkway in the public housing estates to two simple designs. The design of covered linkway is intended to blend in with the environment, and achieve aesthetic harmony between precincts. Designs could be guided but not be limited to the illustrations shown in this Guide. HDB is open to creative ideas and solutions.

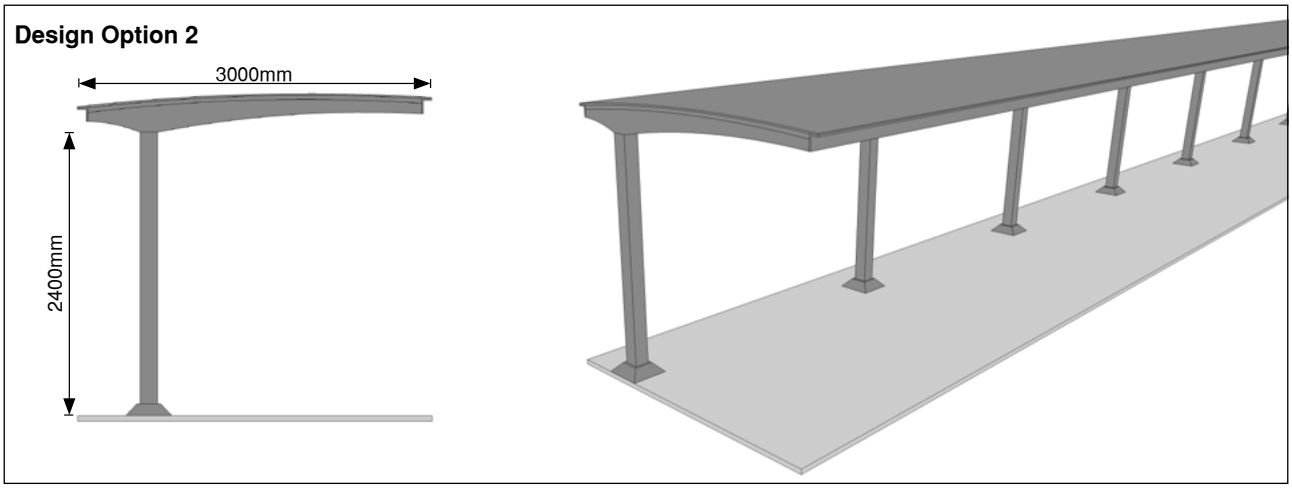
Design Principles:
a) Shallow Roof Profile & Neutral Colour
To allow the buildings and surrounding landscape to take centre stage, the use of a shallow roof profile and neutral colour (i.e. light grey/ mid grey/ off-white) is recommended.

b) Columns on One Side & Lightweight Roofing and Structures
For a more porous walking experience, columns are to be only on one side of the covered linkways, and lightweight roofing and structures are to be used.

Design Option 1



Design Option 2

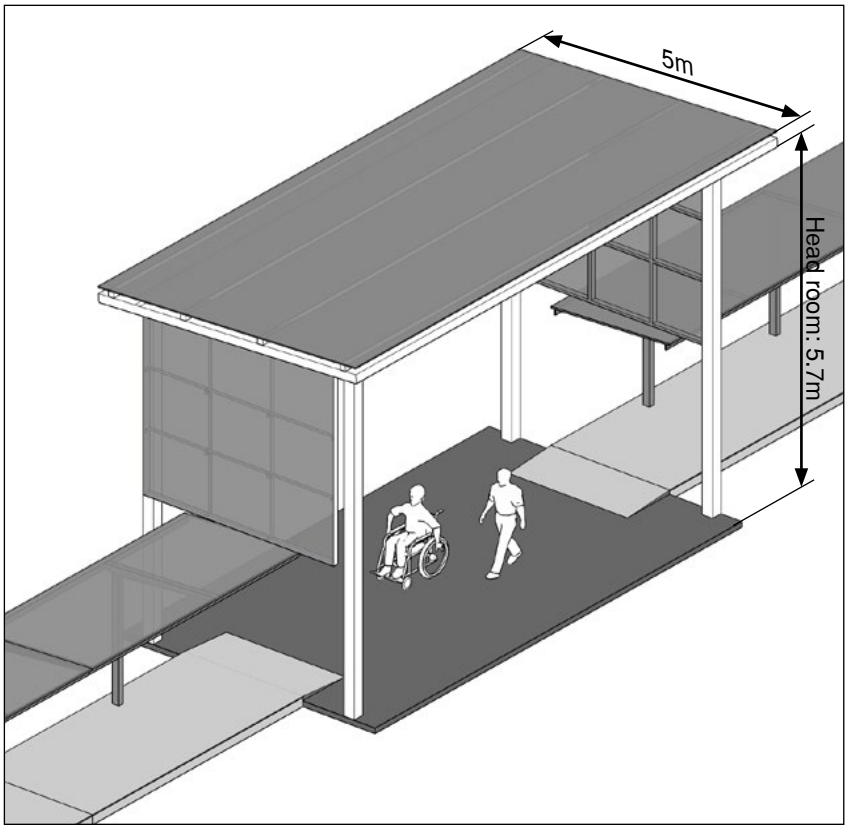


2.3.3 High Covered Linkway

High covered linkways are provided across minor roads and vehicular accesses to link low covered linkways on both sides to facilitate weather protection for pedestrians/ cyclists.

The height of the high covered linkways is designed to allow vehicles to pass through. With such height, the shelters need to be wider to shield pedestrians/ cyclists from the weather as much as possible.

High covered linkways are provided with drop panels at the interface with the low covered linkways to minimise rain from splashing onto the footpaths.



ABOVE: High covered linkway over a local access road

2.3.4 Rest Areas Along Covered Linkways

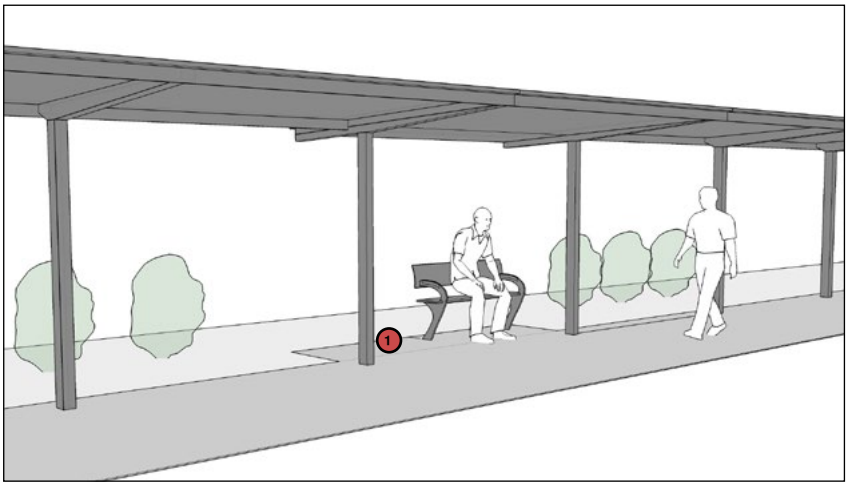
To enhance the walking experience of the elderly and wheelchair users, covered linkways are complemented with rest areas at recommended intervals of 70-100m*, subject to site context. Such rest areas comprise a bench and wheelchair parking space. To maintain a clear passage for the footpath, the rest area is set in an alcove.

The following should be considered when planning for rest areas along covered linkways.

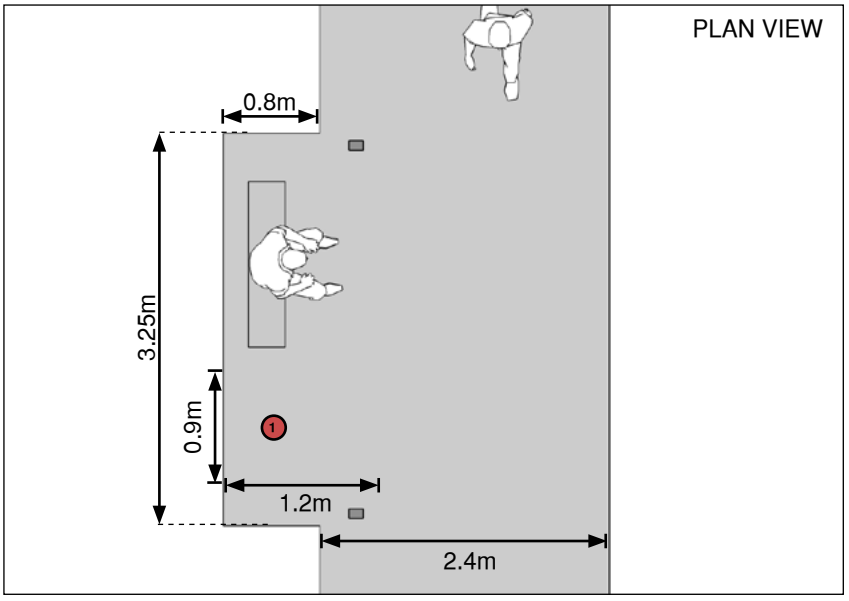
1) Whether there are already other seating provisions in the vicinity;

2) Keep a safe distance from traffic junctions and carriageways; and

3) Allow sufficient buffer from adjacent developments to avoid potential disturbances.



1 Parking space for wheelchair users



2.3.5 Sheltered Pedestrian Waiting Area

Covered linkways provided at the waiting areas of the pedestrian crossings are called sheltered pedestrian waiting areas. The sheltered pedestrian waiting area is designed to provide enough coverage area to protect the pedestrians from light rain and direct sunlight while waiting to cross the road.

1 Sheltered Pedestran Waiting Area

* Currently, BCA's Code on Accessibility in the Built Environment stipulates rest area to be implemented at every 50m interval. Rest area spacing along covered linkways and Round Island Routes (RIR) will be assessed case-by-case.

2.3.6 Common Features of Covered Linkway, Bus Stop & Taxi Stand

Structure

Cantilevered roof with columns sited away from the carriageway is the preferred design as it provides more circulation space for commuters.

ABOVE: Recently implemented covered linkway with cantilevered roof

ABOVE: Cantilevered roof with column sited nearer to developments

Interfacing

Panels are used to connect the shelter with adjacent structures to minimise rain splashing onto the footpath.

1 Interface of two different covered structures

Lighting

LED lightings are provided. The lights and lighting fixtures are encased within the roof rafters to minimise any damage.

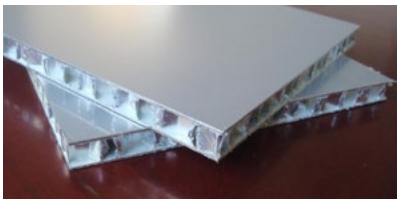
The lux level of lighting shall not be glaring, affecting the vision of motorists.

Refer to Chapter 2.10 and LTA's Architectural Design Criteria for more details on lux levels.

ABOVE: Covered linkway lighting

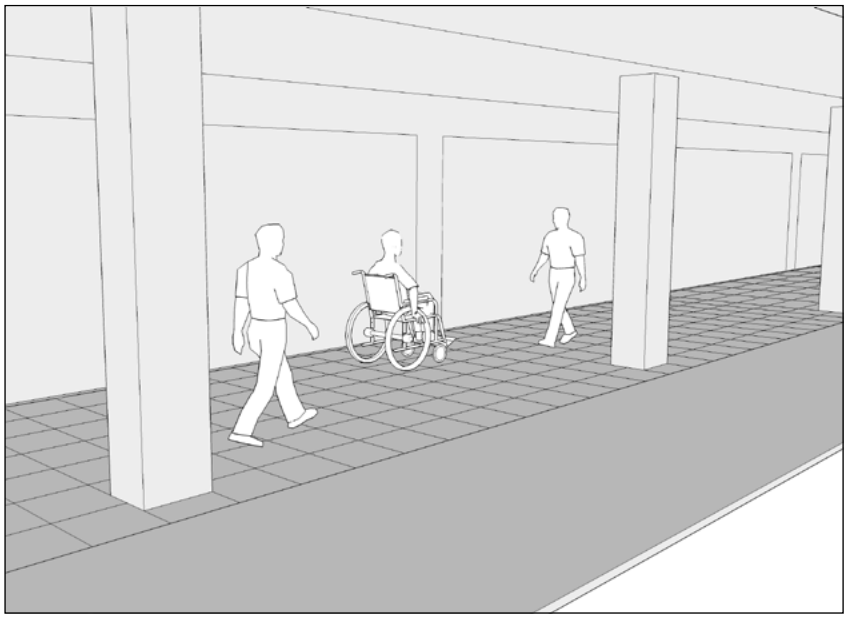
Material

Light-weight honey comb aluminium roof panels are used. Columns are applied with anti-stick paint for ease of maintenance.



2.4 Covered Walkway

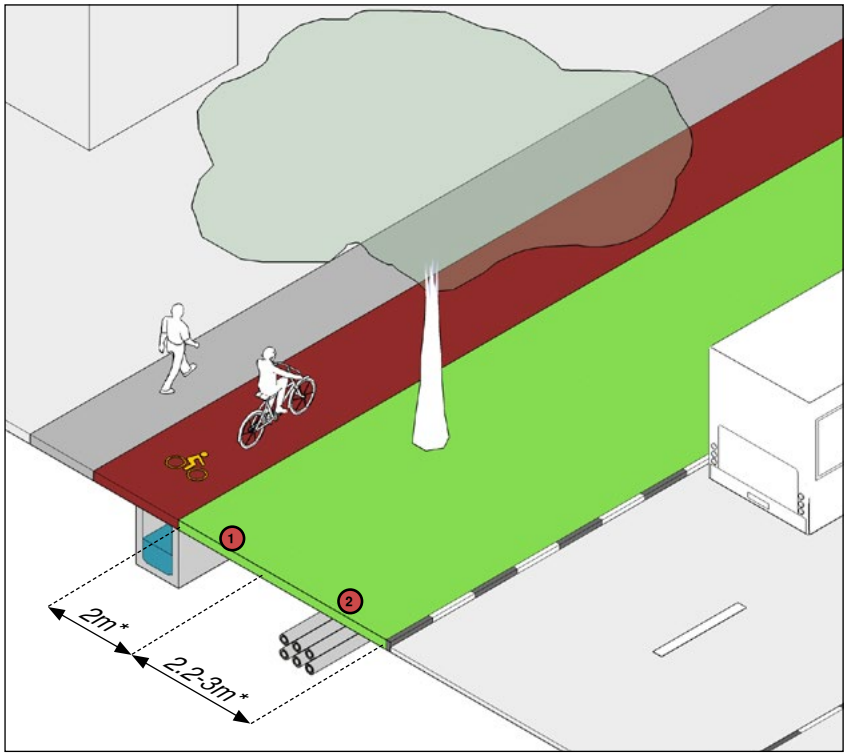
Covered walkways are sheltered paths within developments. They share a similar purpose as covered linkways. They are commonly found in Central Area and more are being implemented in regional centres and business parks (e.g. Woodlands Regional Centre).



2.5 Roadside Verge

Our city is made up of extensive roadside greenery that forms the backbone of our City in a Garden. It is important to ensure that sufficient roadside verge is provided for tree planting to sustain the pervasive sense of greenery, which is a distinct characteristic of Singapore. A tree-lined street will also provide for a more pleasant environment for pedestrians and cyclists.

Roadside verge consists of the tree planting and service verges. Their dimensions shall be in accordance with LTA's Code of Practice for Works on Public Streets. The requirements for the roadside verge are highlighted in the table below. The planting scheme along the roadside depends on the existing site condition and landscaping theme for the area.



1 Planting Verge*

2 Service Verge*

* Planting verge and Service verge shall be in accordance with LTA's Code of Practice for Works on Public Streets.

Requirements For Roadside Verge

Soil	Turf	Gradient of Slope
Minimum 2.0m soil depth - Top layer 1.0 depth of Approved soil mixture (ASM) for the planting verge - Bottom layer (1.0m depth soil) There should not be any hardcore or construction debris within the backfill soil/material for the roadside verge.	50mm thick Axonopus compressus (cow grass) in close turfing	Generally to be (1:40). The finished soil level of the verge is to be 25mm below footpath.

Please refer to NParks' Guidelines on Greenery Provision and Tree Conservation for Developments for more detailed specifications for roadside verge, soil and planting.

2.5.1 Tree Planting Verge

This is the portion of the roadside verge tree planting. Its typical width is 2m. There should be no encumbrances (e.g. underground services) within the tree planting verge so as not to stymie tree planting. Services that are required to transverse through a tree planting verge into an adjacent building plot are to be laid at least 2.0m below ground level, where possible, and away from any existing roadside tree.

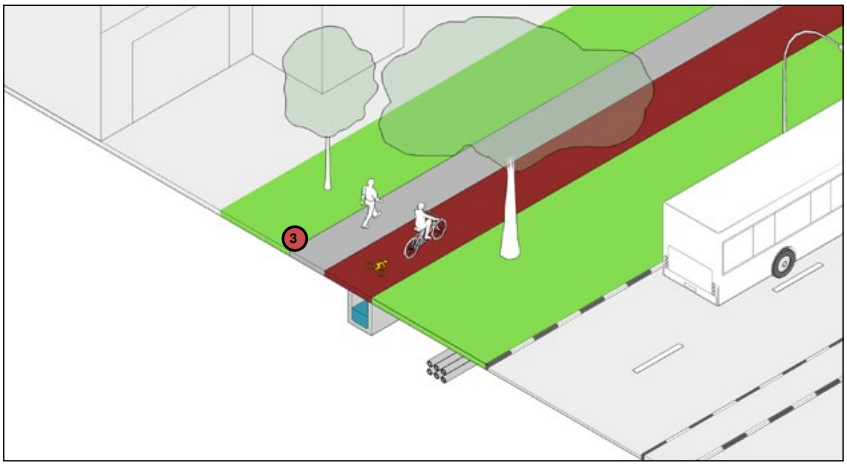
1 Planting Verge 2 Service Verge

2.5.2 Service Verge

This is the portion of the roadside verge that is allocated for the laying of underground services (e.g. water and gas pipes). Its width may vary depending on the road reserve width.

2.6 Green Buffer

Green buffer is the planting area within and along the boundary of premises adjoining a public road. It is not part of the road reserve. When planted up lushly with trees and shrubs, it serves as a buffer between the development and the road, and contributes to a more pleasant environment. The green buffer is also important in augmenting the roadside greenery, which is a key element of our City in a Garden.



3 Green buffer as part of developments

2.6 Green Buffer (Cont'd)

Green buffer is required along the sides of the development boundaries that front a public road. Its width is to be provided in accordance with the road category. The classification of the road category is available from the Land Transport Authority (LTA) through the purchase of the Road Interpretation Plan.

1 Green buffer as part of developments

2.7 Roadside Drain

Drainage can be an important element to enhance commuters' walking and cycling experience. Roadside drain refers to drains within road reserve. The capacity of the drain is determined using the Manning's Formula which is dependent on factors such as the size (width and depth), geometry (channel shape or rectangular) or bed gradient.

In the past, roadside drains are generally designed as open drains (composite channel drain/ U drain) beside the footpath to maintain visual connection with water and to facilitate maintenance. Today, with the increasing land scarcity, land is being optimized by reconstructing the open drains into box drain for the top of the drains to be used as footpath and/or cycling paths.

Roadside drains typically range from 0.6m-1.2m in width. In some cases, they can be wider due to the catchment served by the drain. For these cases, appropriate drainage reserves (DR) shall be set aside for these drains in accordance to the current edition of Code of Practice on Surface Water Drainage. DR/s required for drains sited along roadside that cannot be accommodated fully within the road reserve shall be secured for the drains.

Please refer to PUB's Code of Practice on Surface Water Drainage for more information on drain* and grating designs.

ABOVE: Open Composite channel drain beside footpath

ABOVE: Roadside drain reconstructed as box drain which doubled up as footpath

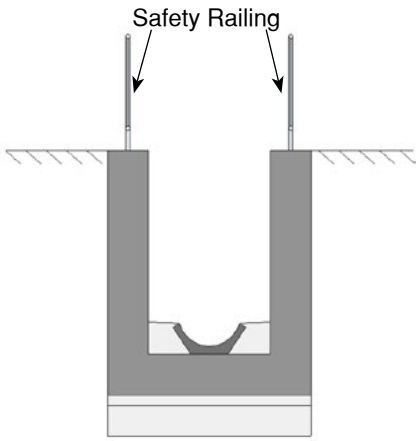
*The details of the drain shall apply to drains outside road reserve.

2.7.1 Types of Roadside Drain

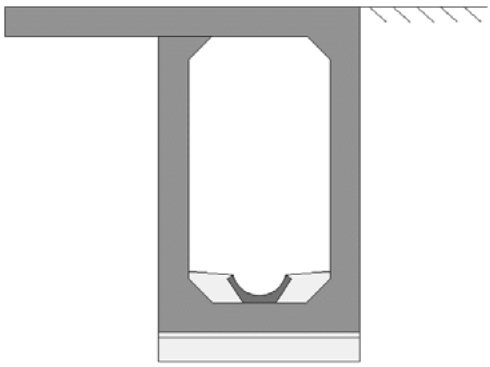
Below are the various types of roadside drains*. For closed drains, the proposed footpath, cycling path or covered link-way sited on top of the drain is provided with an effective drainage system to intercept and discharge the surface water runoff. Effective drainage is especially important in areas where path level is lower than existing surrounding grounds (e.g. steep slope adjacent to path or footpath lower than adjacent verge). Runoff from all the paths shall be effectively drained away without causing flooding problem on top of the paths and the adjacent areas.

Appropriate gratings are provided on the footpath at regular intervals to facilitate inspection and maintenance. The drain gratings are designed to ensure safety of the pedestrians from tripping and to provide effective drainage to minimise flooding on the footpaths, cycling paths and adjacent areas. The drain gratings shall be implemented in accordance to LTA's Stand Details of Road Elements.

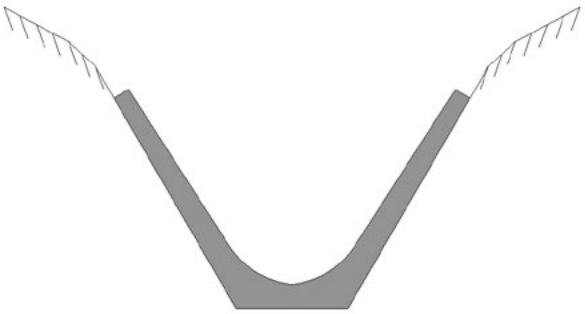
U-Drain



Box Drain



Composite Channel



* Some roadside drains are not entirely within the road reserve.

2.8 Bus Stop

A bus stop is a designated place where buses stop for passengers to board or alight from the bus. It consists of a few of the following components.

1. Bus Shelter - A covered structure sheltering commuters from the weather and almost always comes with seats. Footpath, covered linkway and cycling path should be aligned behind the bus stop, where possible.

2. Bus Bay - A dedicated bus stopping zone off the main road. Where there is limited space for off road bus stopping zones, a yellow rectangle box is painted on the road to mark the designated bus stopping area.

3. Bus Pole - A metal pole erected beside the bus stop, which shows the bus routes that call at the particular stop. These poles often come with small notice boards which provide bus timings (usually for services with limited frequency), diversion notices, or other relevant bus service updates.

4. Information Panel - An encased information board with service information. It is regularly updated by LTA with new routes or changes to existing information.

5. Safety Bollards - Bollards are steel and concrete structures which reduce the severity of impact due to collision by errant motorists and are painted in grey with a retro reflective yellow sheet and printed with black arrows on the upper portion. Safety bollards are provided at all bus stops for the safety of commuters. Refer to LTA's Standard Details of Road Elements for more details.

2.8.1 Typical Bus Shelter

Height and Width

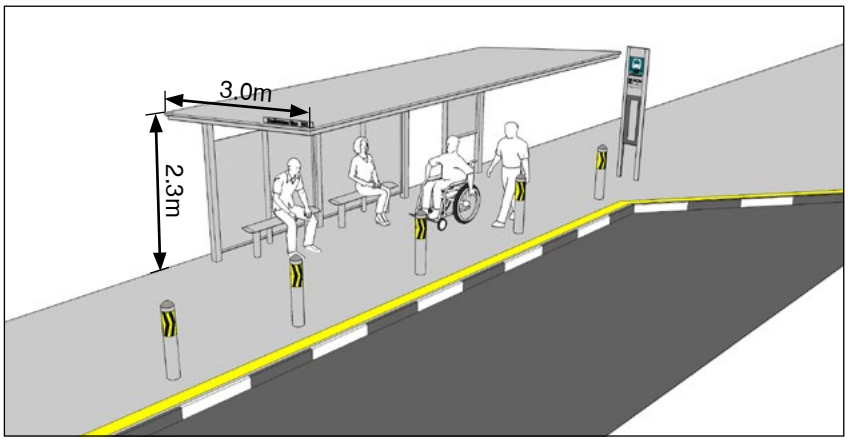
The width of the shelter is designed to accommodate seating space, circulation space for a wheelchair user and standing space for commuters.

The height of the shelter is designed to protect pedestrians from the light rain and direct sunlight.

Bus shelters are sized and built based on its commuter's usage / boarding counts.

Bus stops are designed to be barrier free for commuters. Hence, steps are not permitted at the alighting and boarding area of the bus stop.

Refer to LTA's Architectural Design Criteria for more detailed requirements.



ABOVE: Illustration and photo of a bus shelter

2.8.2 High-roof Bus Shelter

To shield commuters from light rain and direct sunlight during boarding and alighting from buses, high bus shelter roofs are preferred for bus stops with bus bays near MRT stations, considering the high commuter volume at such bus stops.

The high roofs over the bus bays are provided with height clearance for buses to pass through. More detailed requirements can be found in LTA's Architectural Design Criteria.

Either a drop panel or a second roof is provided at the commuter waiting area to screen commuters from rain splashes. For the ease of maintenance, as mentioned in LTA's Architectural Design Criteria, glass and other materials shall not be used for structural and architectural finishes.

1 Drop panel

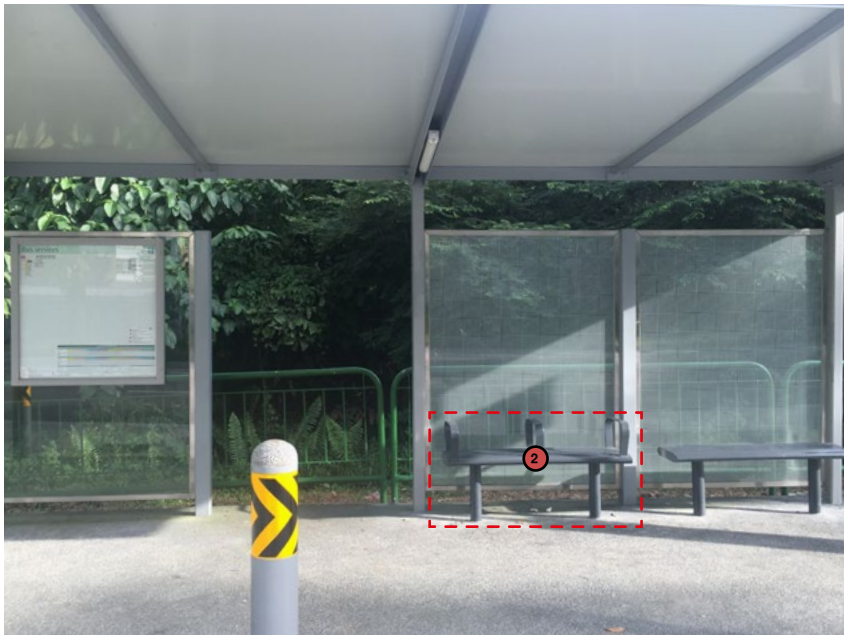
2.8.3 Bus Stop Features

Bench

Benches are provided at every bus stop and some benches are fitted with arm-rests to aid the elderly.

Benches are designed to prevent water stagnation.

Weather screens are provided behind benches where accessibility and circulation are not compromised.



2 Bench

2.9 Taxi Stand

A roadside taxi stand is a designated area for taxis to pick up waiting passengers. It consists of components similar to bus stops such as a taxi stand shelter, taxi bay, taxi identity signs and notice boards. For developments' taxi stands, we recommend to integrate them with the development itself.

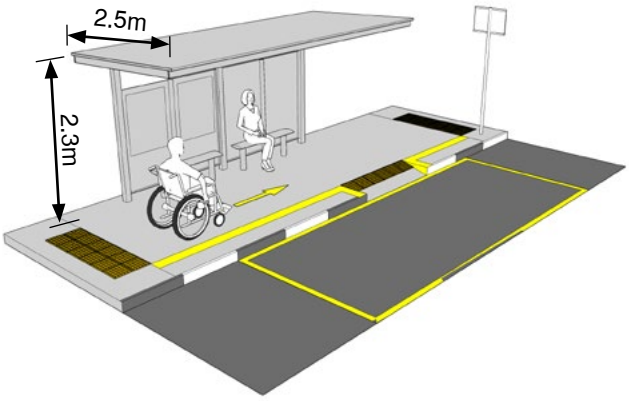
Height and width

The width of the shelter is designed to accommodate seating space for commuters and circulation space for a wheelchair user.

The height of the shelter is designed to protect commuters from the light rain and direct sunlight.

Ramps and tactile tiles are provided to aid barrier-free access to board and alight the taxi.

Refer to LTA's Architectural Design Criteria for more detailed requirements.



Typical taxi stand shelter

1	2	3	4	5	6
Tactile Tile	Notice Board	Weather Screen	Bench	Taxi Shelter	Taxi Stand Pole

High roof taxi/ passenger pick-up/ drop-off shelter

For taxi stands near MRT entrances, high roofs over the bays with the appropriate height clearances and widths necessary to shield commuters from the light rain and direct sunlight when alighting and boarding are provided. More detailed requirements can be found in LTA's Architectural Design Criteria.

7 Either a drop panel or a second roof is provided at the commuter waiting area to screen commuters from rain splashes. For the ease of maintenance, as mentioned in LTA's Architectural Design Criteria, glass and other materials shall not be used for structural and architectural finishes.

2.10 Lighting

For paths along the roadside, there is a need to ensure adequate street lighting for the safe passage of all users. Adequate lighting is necessary for users (e.g. pedestrians, cyclists, motorists, etc.) to identify and react to the following situations:

a) Alignment of the paths;
b) Sharp bends, humps and fixed obstacles;
c) Objects on the surface such as stones, tree branches;
d) Potholes or cracks in the surface;
e) Position and speed of other users;
f) Junctions carrying other users.

2.10.1 General Lighting Illuminance

Illuminance Level: As a guide, the designed lighting levels for the different categories of road for new Street Lighting are as shown below.

The uniformity is defined as the ratio of minimum illuminance to the designed average illuminance.

Locations	Minimum average illuminance (at floor level)	Illuminance Uniformity
Cycling Path	5 lux	0.25
Cycling path (At junctions)	10 lux	0.25
Covered Linkway	10 lux	0.25
High Covered Linkway	30 lux	0.4
PCN	5 lux	-
RIR	7.5 lux	-

Note: The guidelines for lighting levels for Covered Linkway and High Covered Linkway are also applicable to linkways within HDB estates.

2.10.2 Placement of Lamp Post for Active Mobility

As a principle, lamp posts are placed along the planting verge between trees to avoid the tree roots.

We may explore siting them in other locations when under land constraints, subject to case-by-case assessment.

ABOVE: Lamp post placed along planting verge, at tree interval

2.10.3 Design of Street Lighting

The design of street lighting for public roads shall comply with but not limited to the latest edition of BS 5489, BS EN 13201, CIE (International Commission on Illumination) and the relevant authorities' codes, regulations and standards.

For the purpose of design, road surface shall be taken as Class R3 road (Asphalt CIE R3). Lighting design should be carried out with a recognised lighting design software (e.g. Calculux, Dialux, etc.) that is commonly provided by the lighting supplier.

For LTA's detailed technical requirements, drawings and guidelines on the submission of design drawings for public street lighting, footpath lighting, cycling path lighting and zebra crossing flashing beacon lighting system, please refer to LTA's Public Street Lighting Guidelines.

2.10.4 Cycling Path Lighting Design

Design Details	Design Rationale
Height	3.5m pole shall be used for dedicated cycling path lighting design.
Light sources	Use LED lighting technology.
Interfacing lamp post with vegetation	Work closely with NParks to ensure that the placement of vegetation and type of vegetation will not obstruct lighting throw from the lamp posts.
Placement of lamp post near residential area	At or near residential areas, lamp posts are positioned such that they do not cause glare or shine into residences. If necessary, add on louvers or shields to block out lighting throw into nearby residences.
Maintenance of lighting	Use a standard type of lighting design so that the implementation, maintenance and replacement works are cost effective. For tourism districts, decorative lightings can be used after careful consideration of overall costs to ensure prudent use of public funds.

ABOVE: Lamp post along cycling path

2.10.5 Cycling Path Lighting Within Covered Linkway

Where a cycling path runs next to a covered linkway, we recommend the lighting to be shared between the cycling path and the covered linkway to minimise land required for dedicated lamp posts for the cycling path.

Design Details	Design Rationale
Height	In this case for cycling paths, it is recommended to place lightings at least at a height of 2.4m* so that the lighting throw is downwards onto the path, and will not cause glare to the users. This is to ensure that the lighting fixtures will meet the international standards for glare ratings.

*2.4m height may vary, depending on the actual height of the covered linkway.

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Roadside Typologies

In Singapore, walking and cycling paths along the roadside will form the bulk of our active mobility network. To move to car-lite, we are carving out more space for walking and cycling paths and their supporting infrastructure. In our high-density urban environment, the appropriate placement of the elements within the roadside is essential to optimise space and ensure greater safety for pedestrians and cyclists.

Chapter 3 illustrates the standard typologies of roadside elements - how each of them described in Chapter 2 is positioned in relation with one another along the roadside. The chapter is divided into 3 sections, namely: i)Standard Typologies, ii) Central Area Typologies and iii) Park Connector Network (PCN) & Round Island Route (RIR) typologies.

3.1 Standard Typologies

3.2 Central Area Typologies

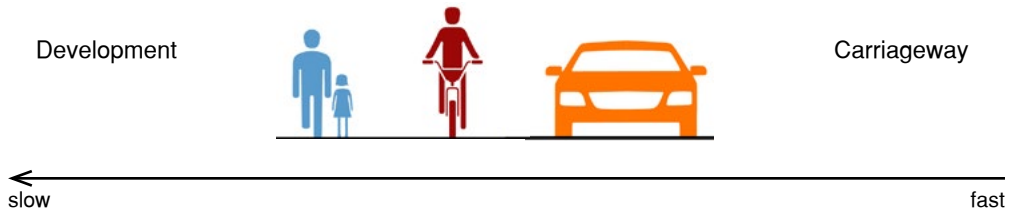
3.3 PCN & RIR Typologies

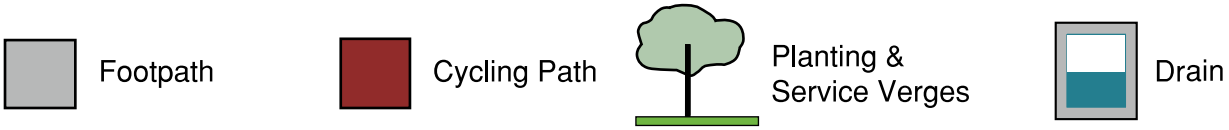
3

3 ROADSIDE TYPOLOGIES

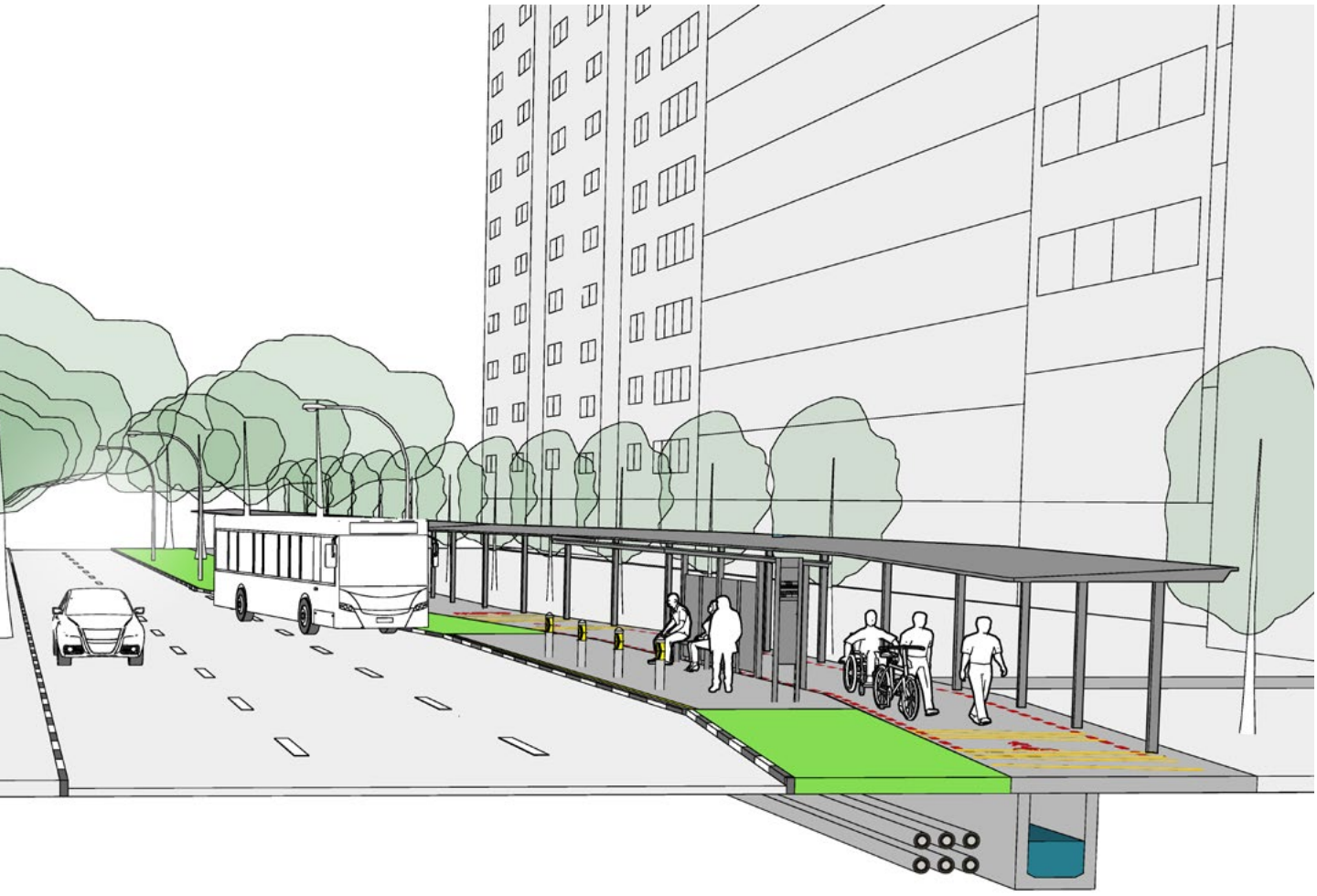
3.1 Standard Typologies

The placement of cycling path and footpath are according to the gradation of speed, with the former closer to the carriageway and latter closer to developments.

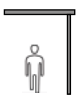




The smooth gradation of speed (see the previous page) would ensure that pedestrians would meet the other pedestrians walking at similar speeds first when coming out of the adjacent developments. The footpath acts as a buffer to allow cyclists to have more time to react to users on the footpath.



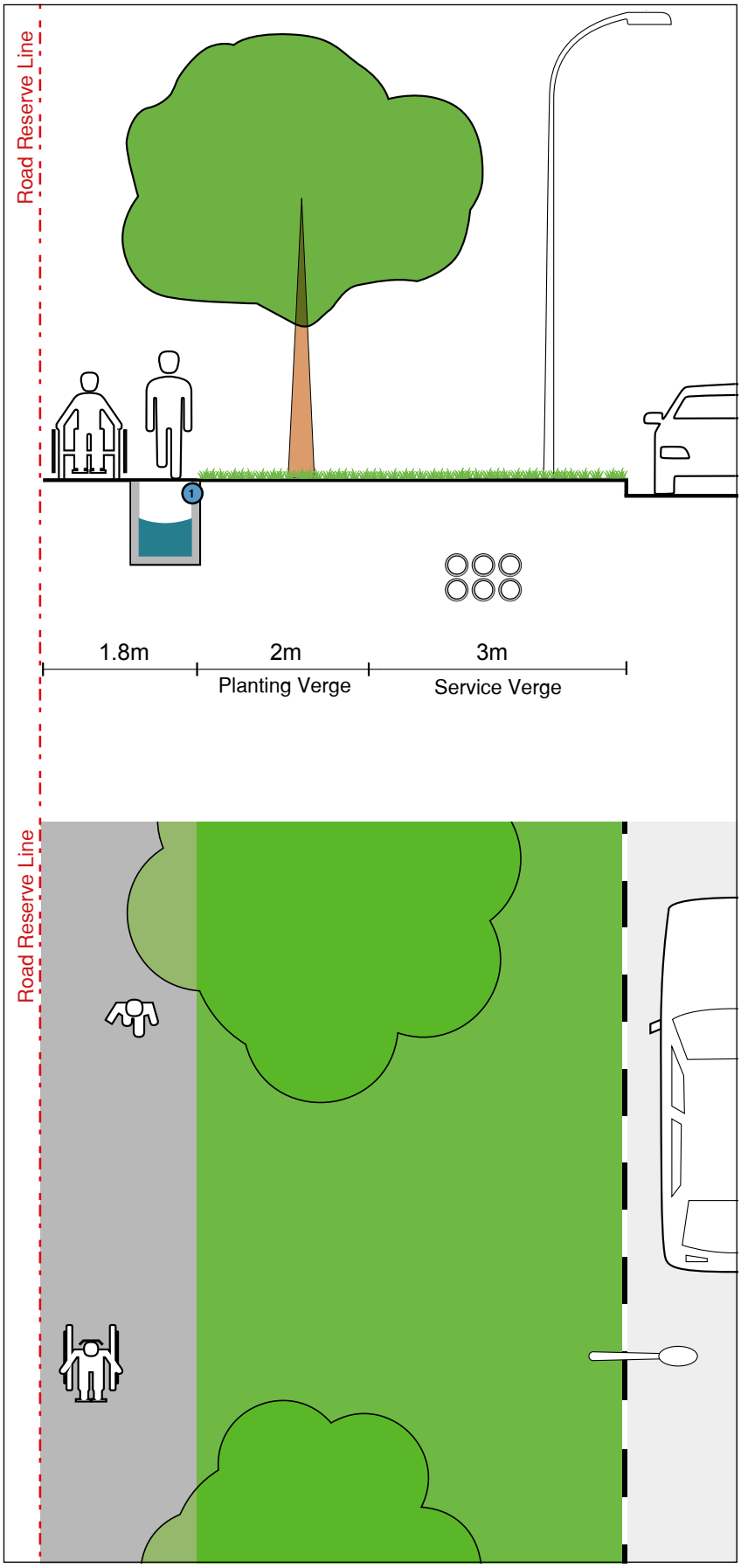

Bus Stop


Covered Linkway


Pedestrian Priority Zone

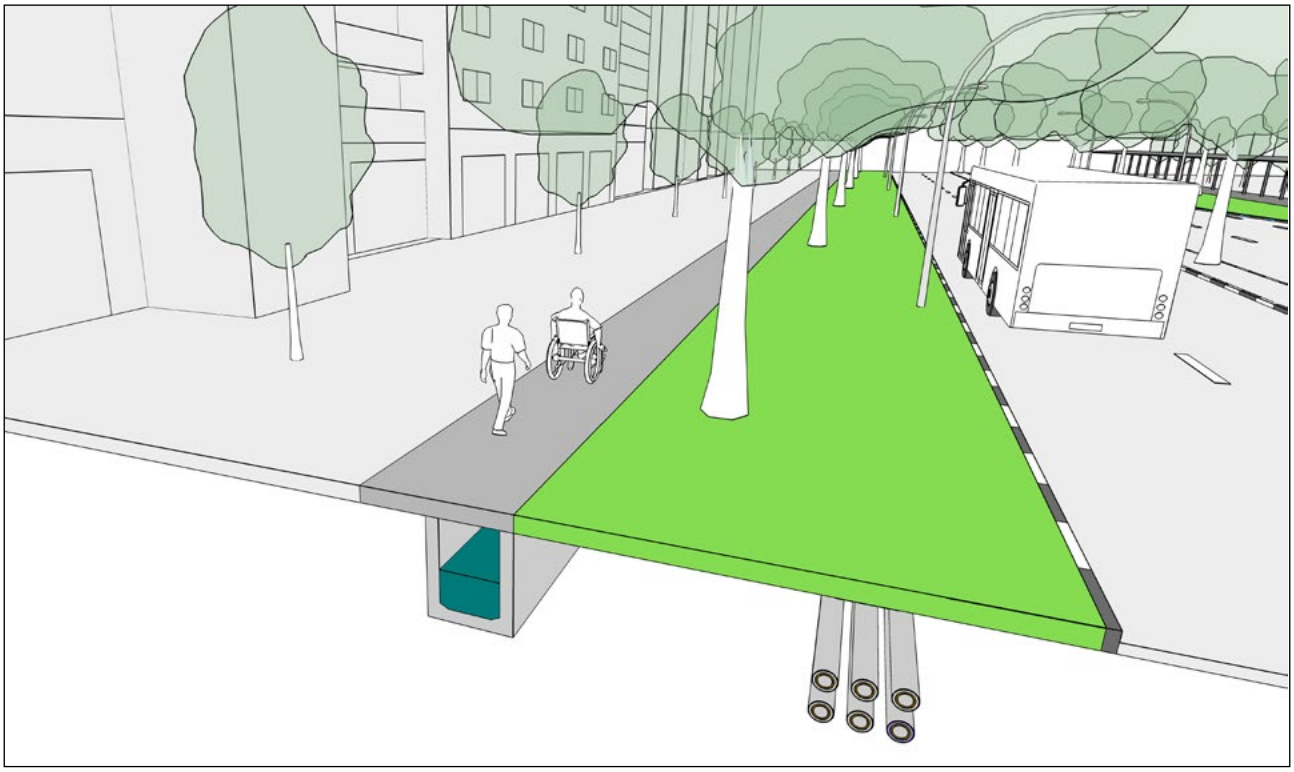

Utilities

3.1.1 Footpath



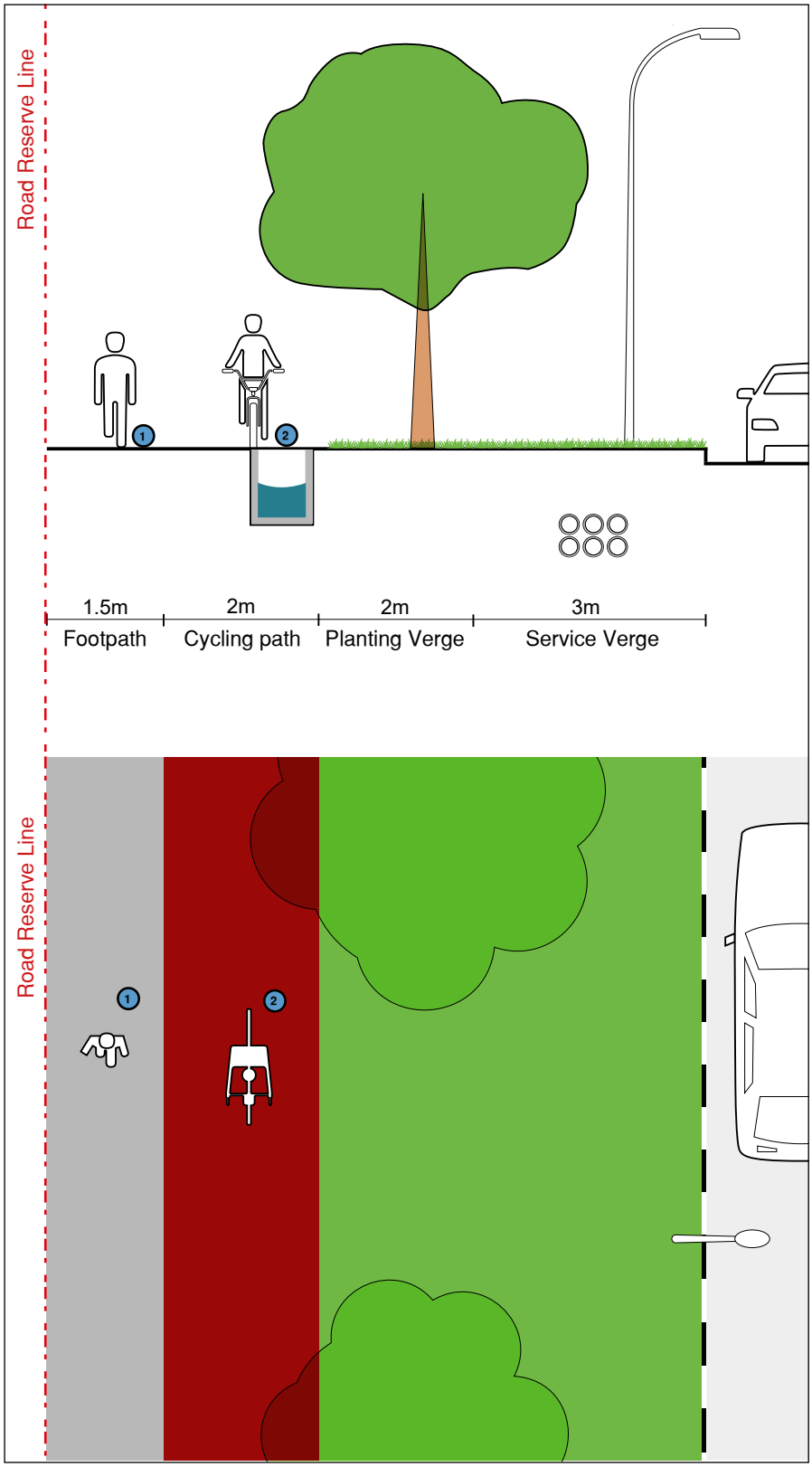
1

As per current standard, the drain is aligned along the planting verge, which applies to all roadside typologies.

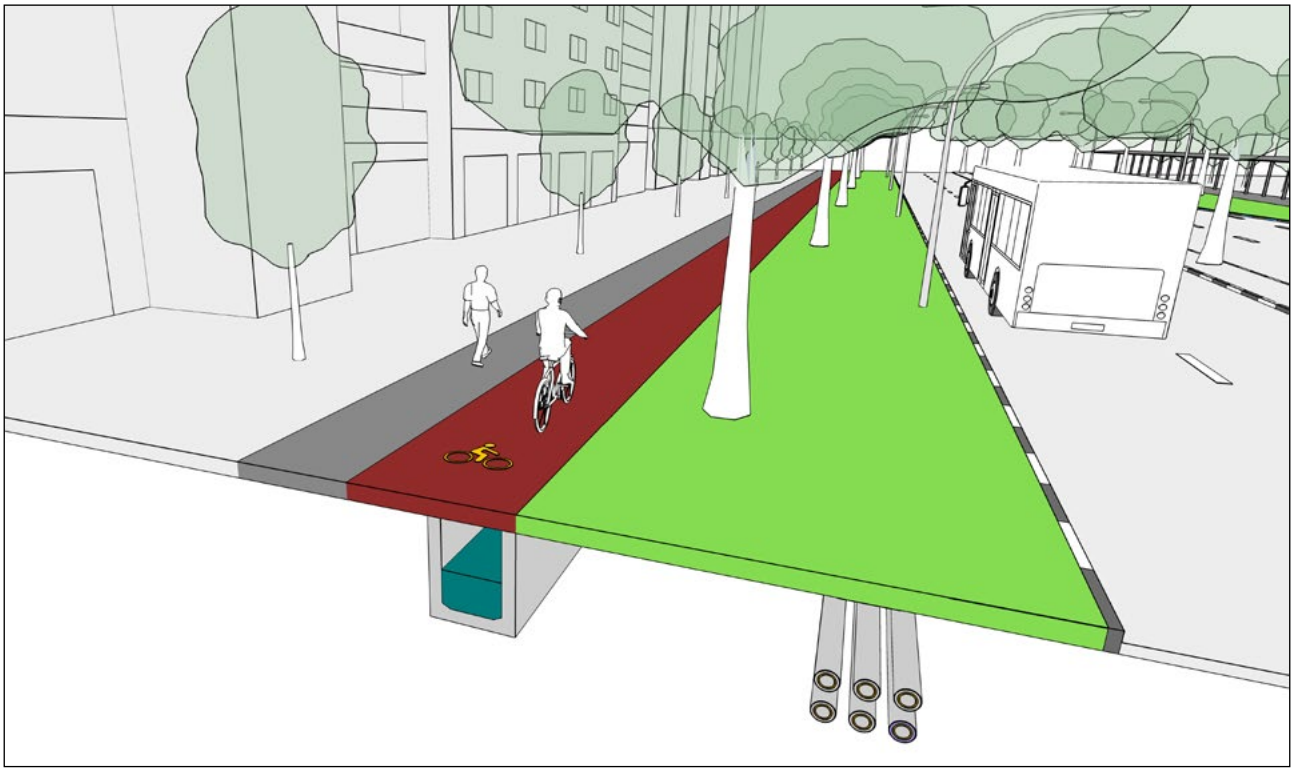


ABOVE: Roadside footpath

3.1.2 Footpath & Cycling Path

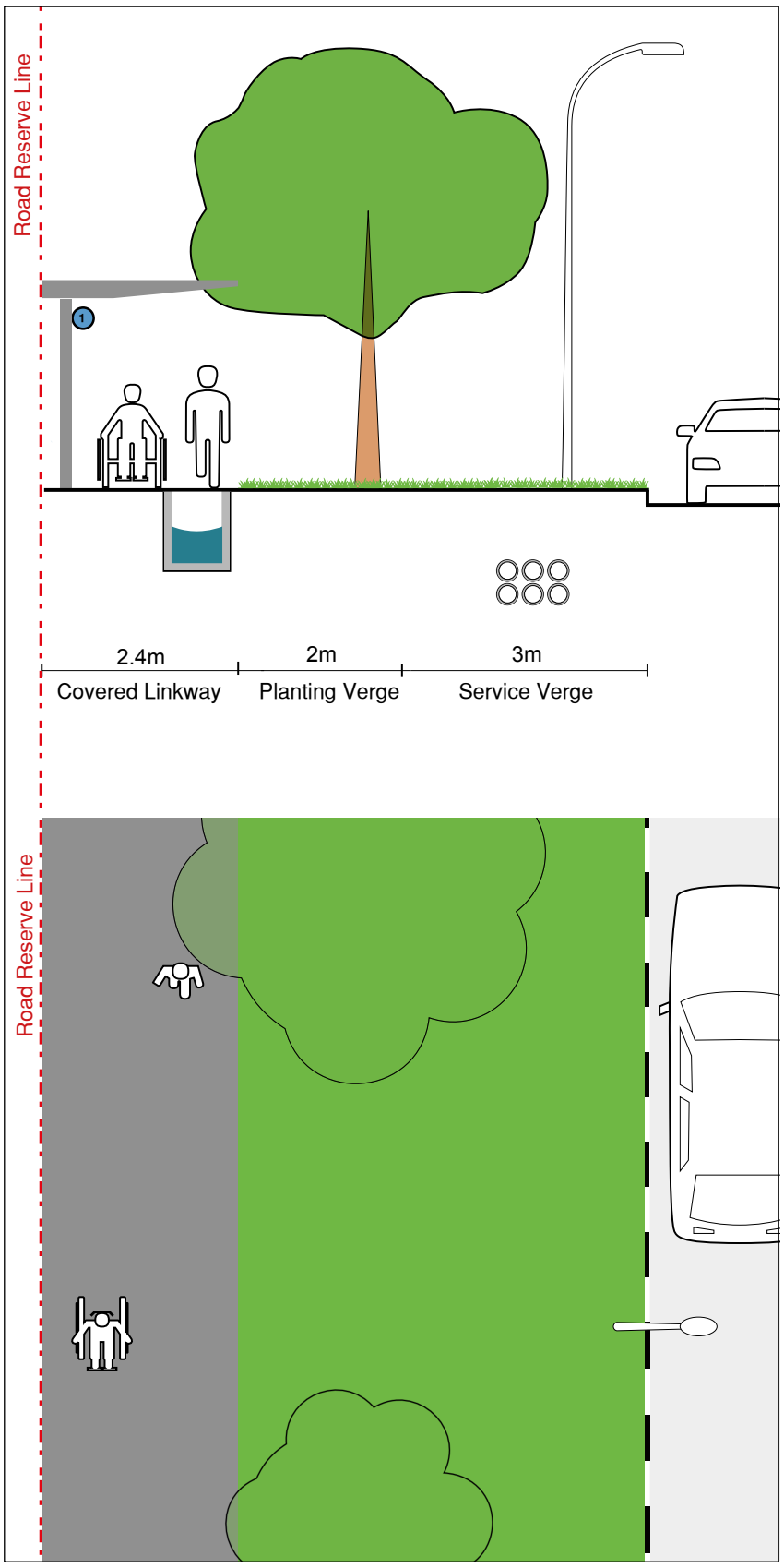


1. Footpath is located closer to developments
2. Cycling path is located closer to the carriageway



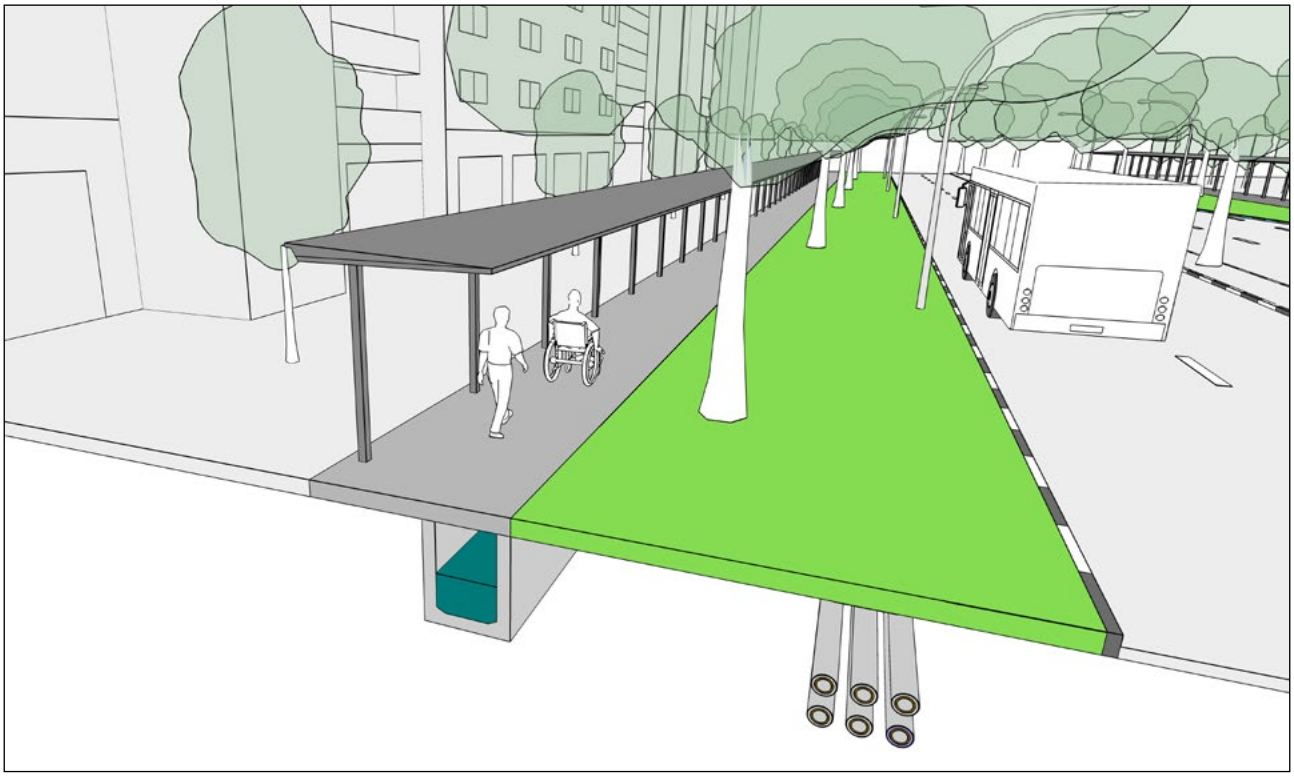
ABOVE: Roadside cycling path and footpath

3.1.3 Covered Linkway



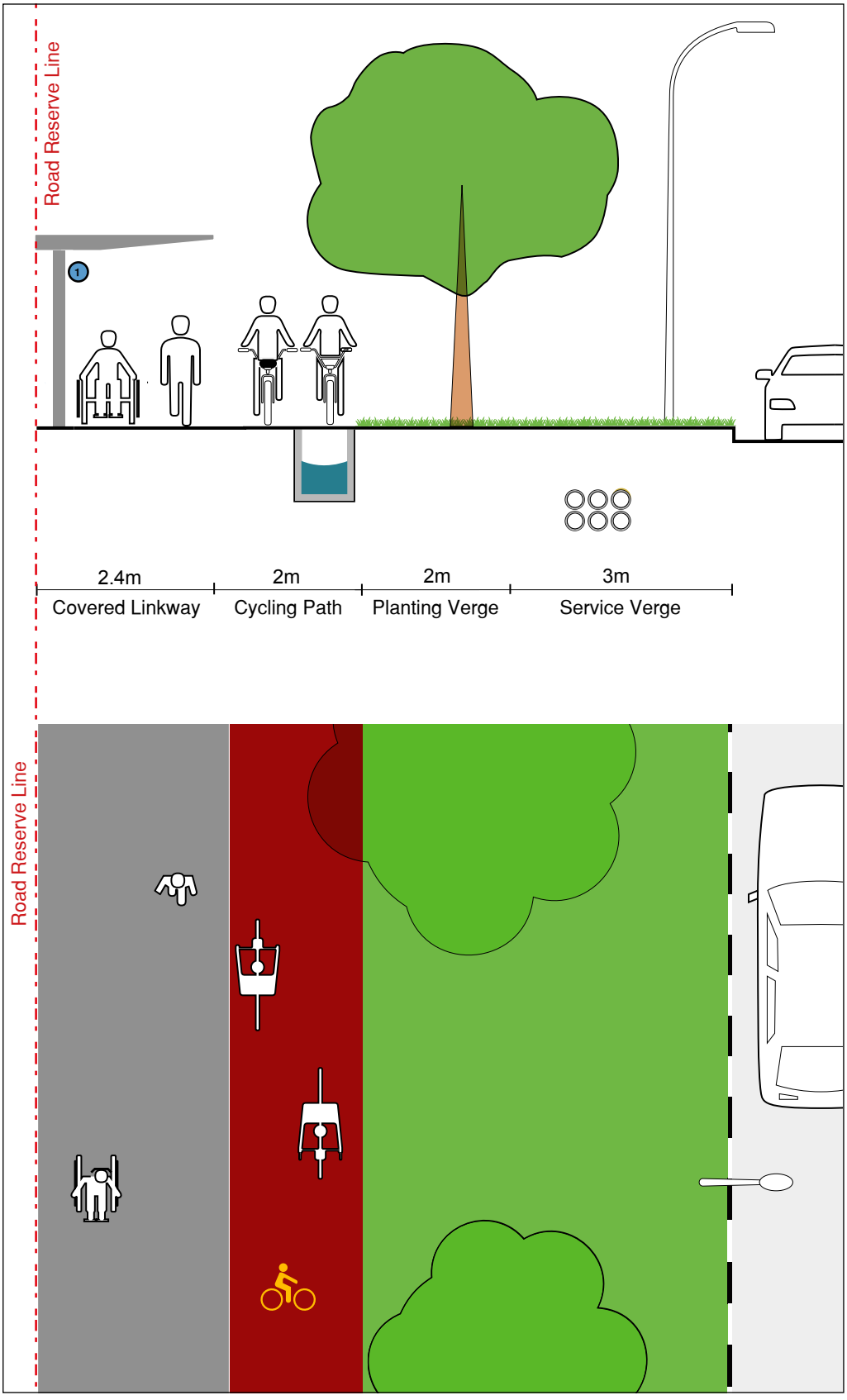
1

We recommend a cantilevered structure for covered linkways where the column is sited nearer to developments to ensure a more visually spacious streetscape and minimise visual clutter along the roadside.

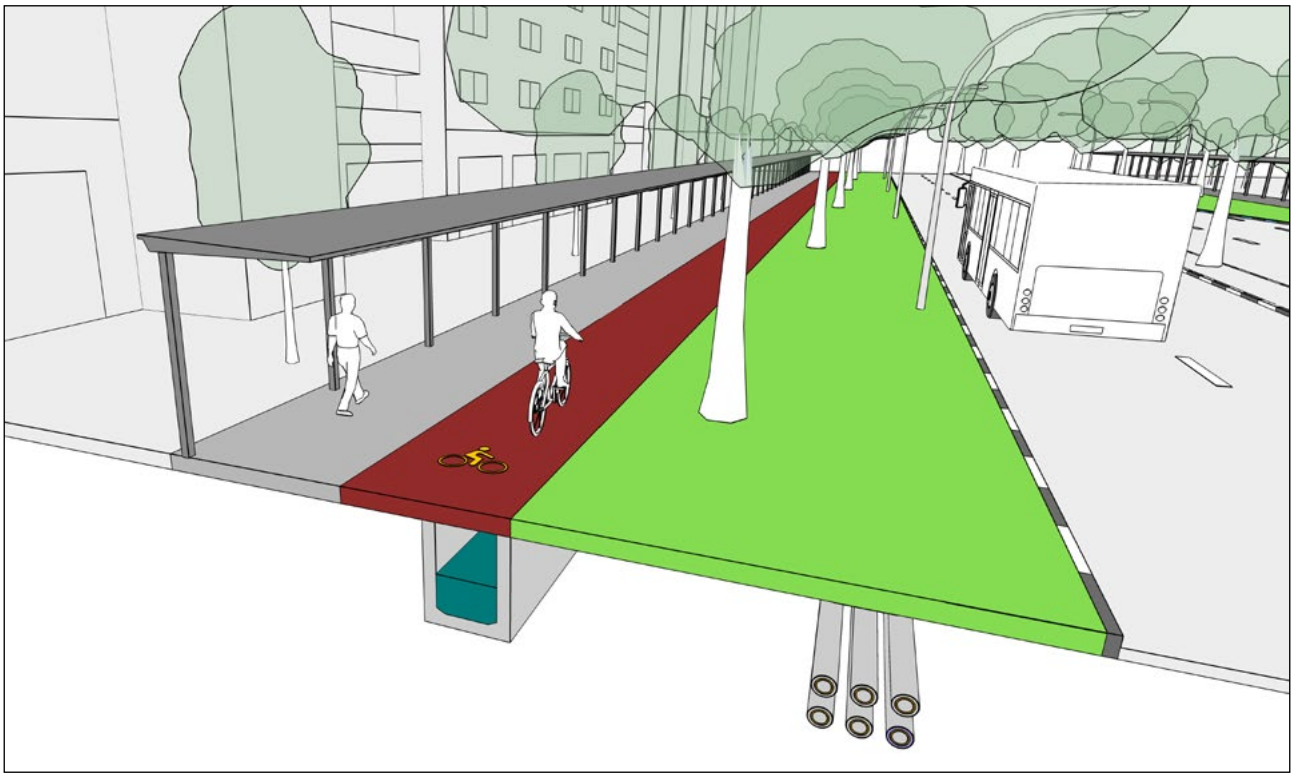


ABOVE: Photo of roadside with covered linkway

3.1.4 Covered Linkway & Cycling Path

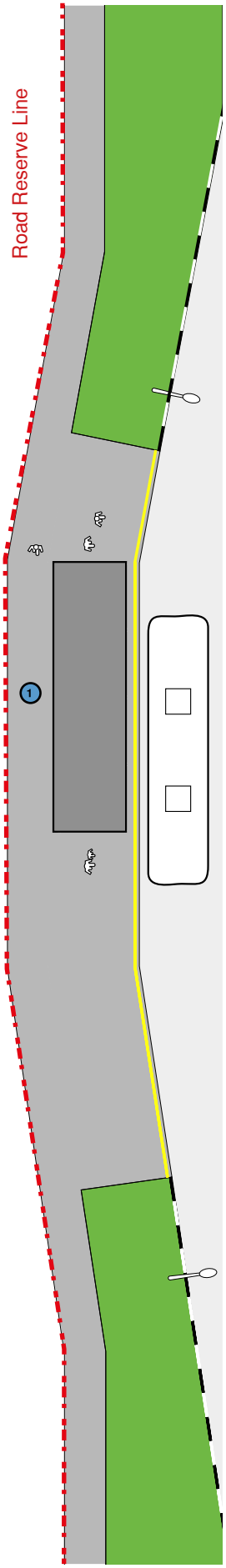


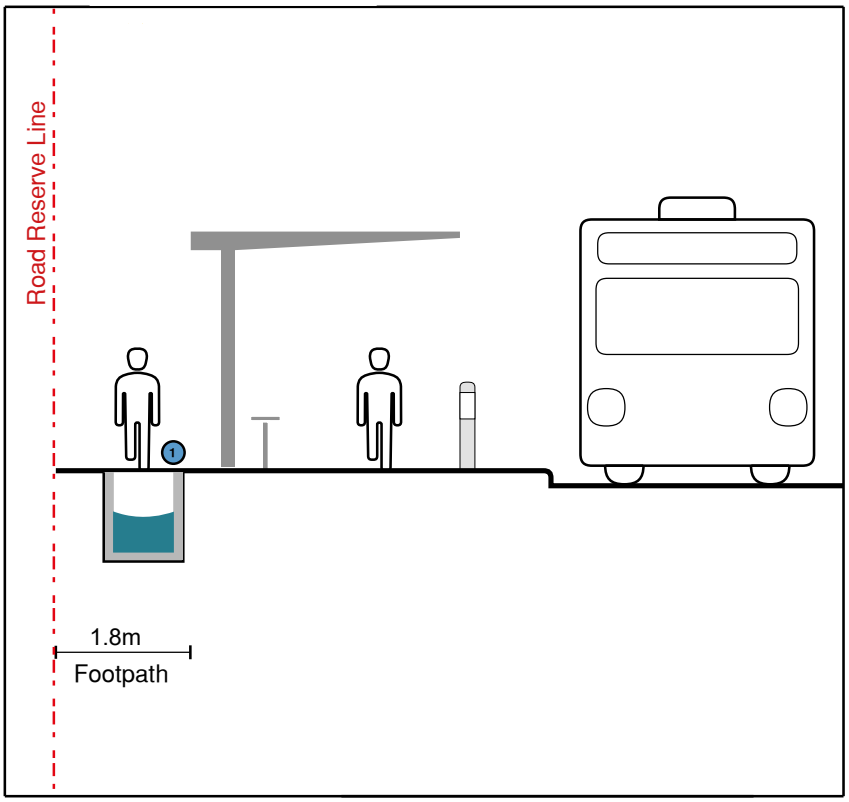
1 Another reason of siting the covered linkway columns closer to developments is to minimise obstructions to the pedestrians and cyclists.



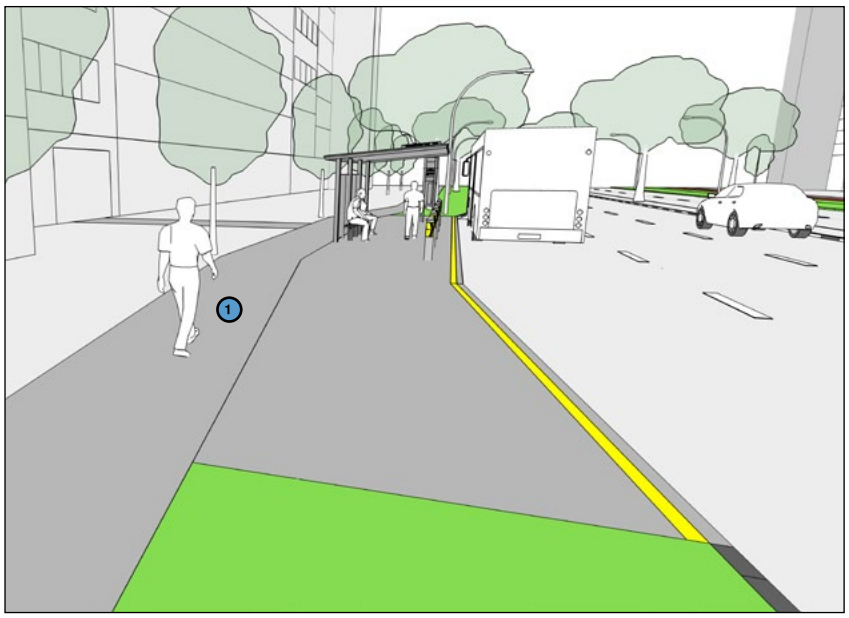
ABOVE: Perspective of roadside with cycling path and covered linkway

3.1.5 Bus Stop & Footpath

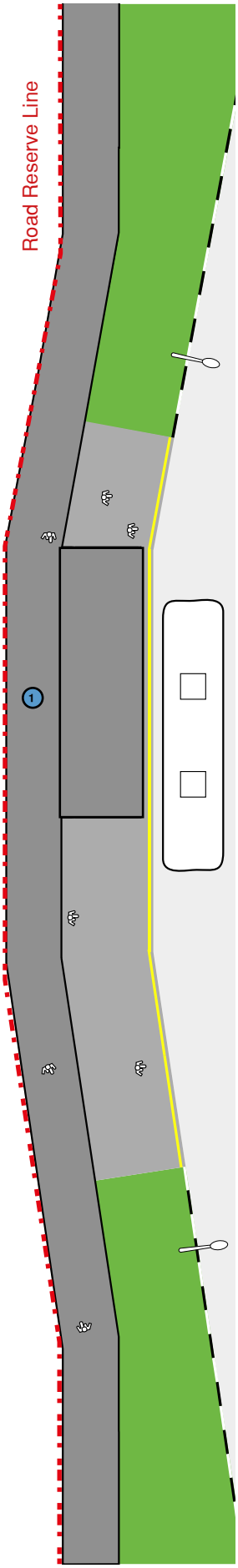


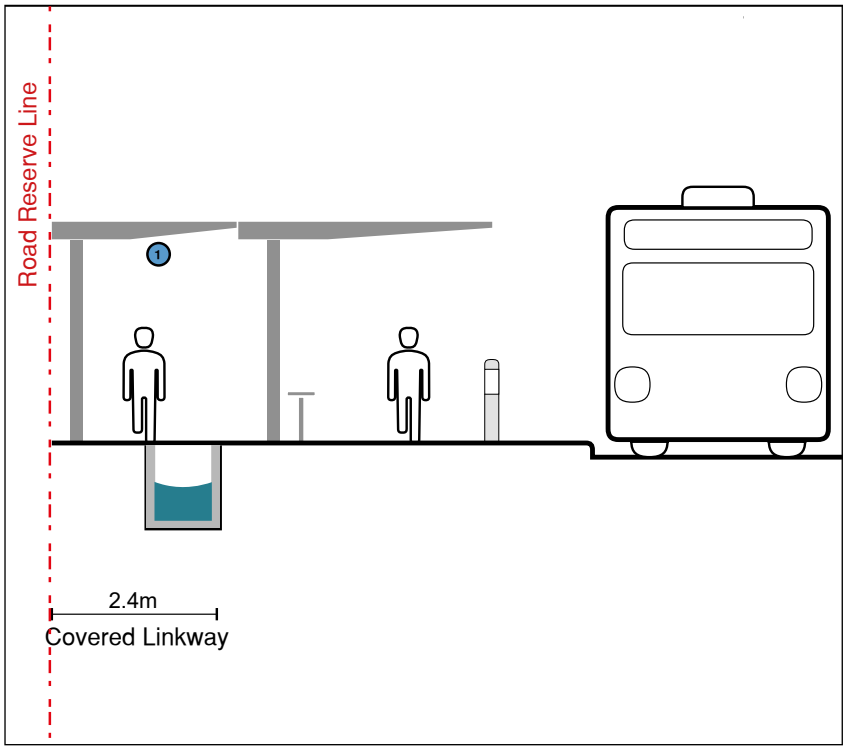


1 We recommend the footpath to be aligned behind the bus stop to create more space and minimise congestion at the bus stop to facilitate commuters boarding and alighting.

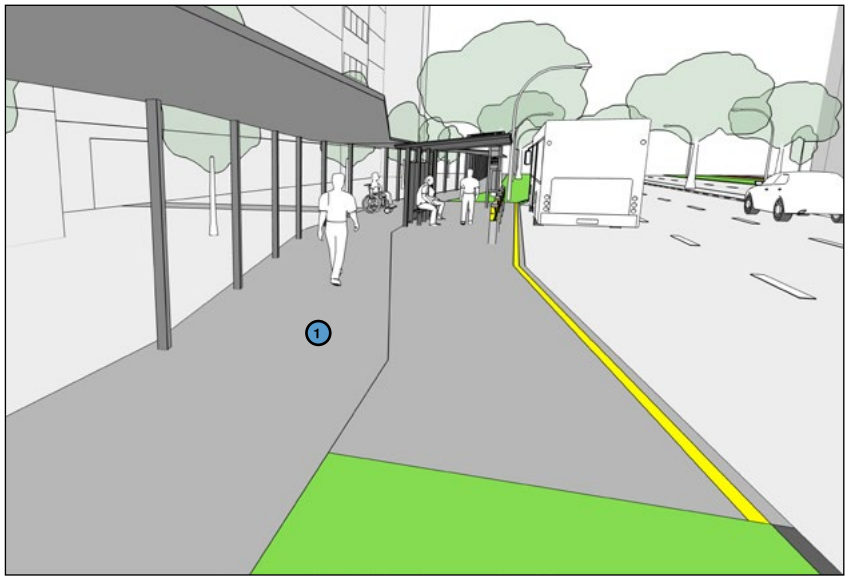


3.1.6 Bus Stop & Covered Linkway

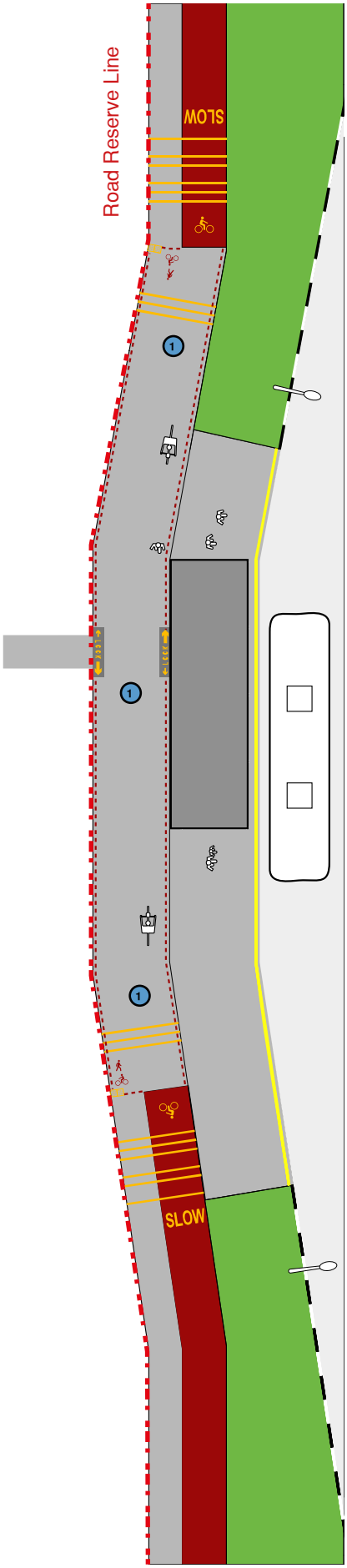


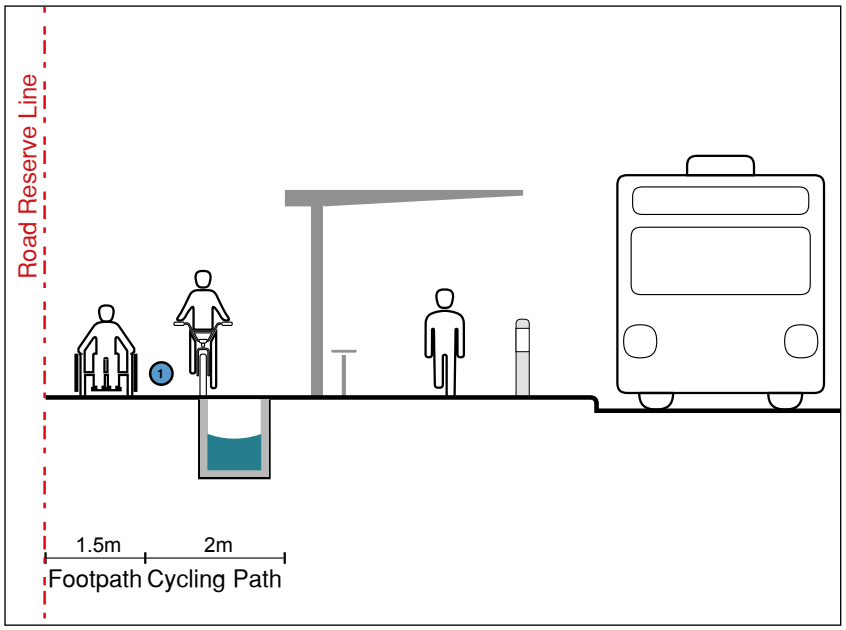


1 Similarly for the covered linkway, we recommend it to be aligned behind the bus stop to create more space and minimise congestion at the bus stop to facilitate boarding and alighting for commuters.



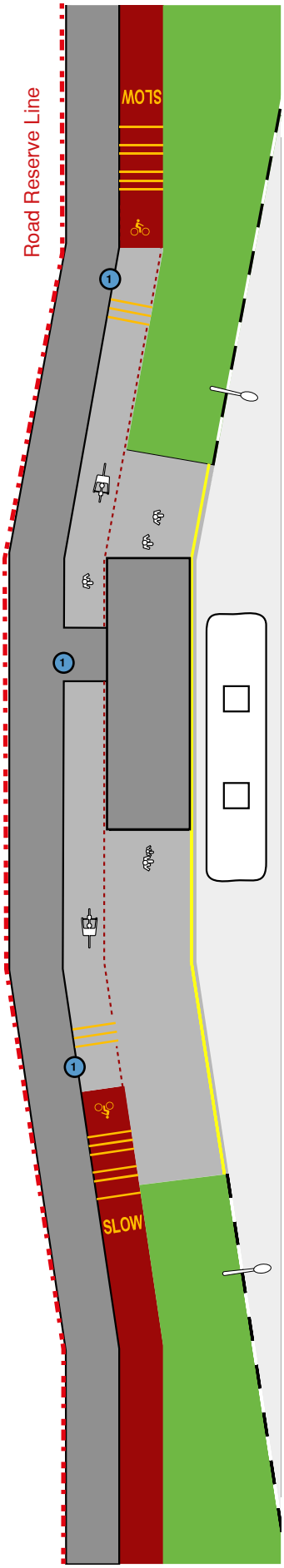
3.1.7 Bus Stop, Cycling Path & Footpath

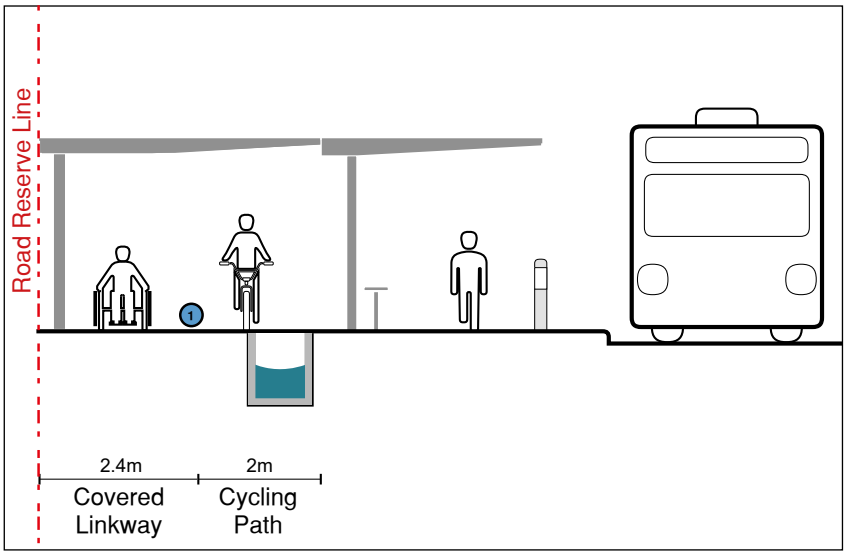




1 Pedestrian Priority Zone (PPZ) is behind and near the bus stop where cyclists are expected to look out and give way to pedestrians. Refer to Chapter 2.2.5 for design details on PPZ.

3.1.8 Bus Stop, Cycling Path & Covered Linkway



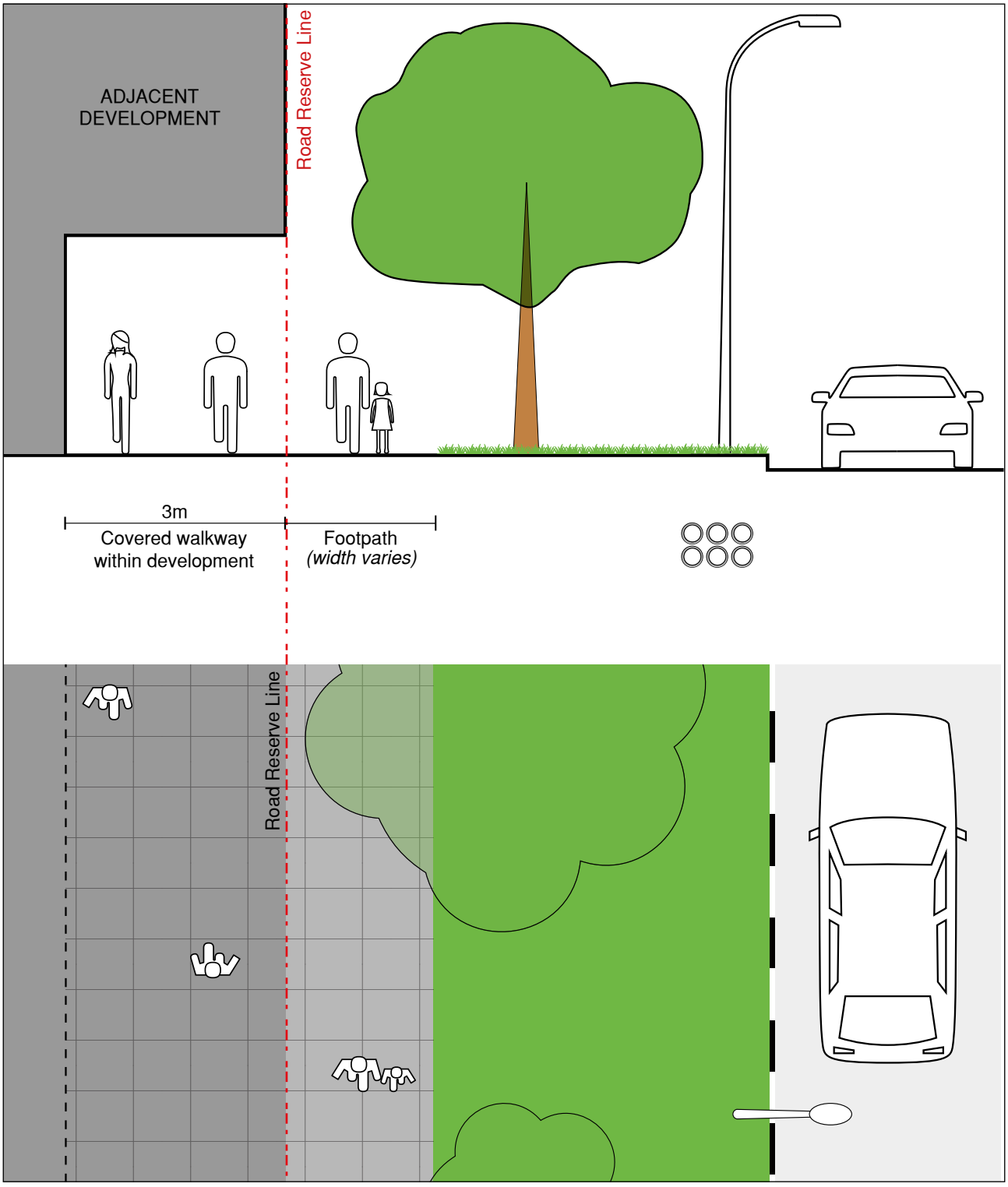


1 Pedestrian Priority Zone (PPZ) is behind and near the bus stop where cyclists are expected to look out and give way to pedestrians. Refer to Chapter 2.2.5 for design details on PPZ.

3.2 Central Area Typologies

The Central Area has a different set of roadside typologies. This is because most buildings here are built next to the Road Reserve Line with the provision of a covered walkway along the 1st storey of developments next to an open footpath. These covered walkways, together with the adjacent open footpaths within Road Reserve, form part of the comprehensive pedestrian network planned for the City Centre and provide users with an all-weather route.

3.2.1 Covered Walkway & Footpath

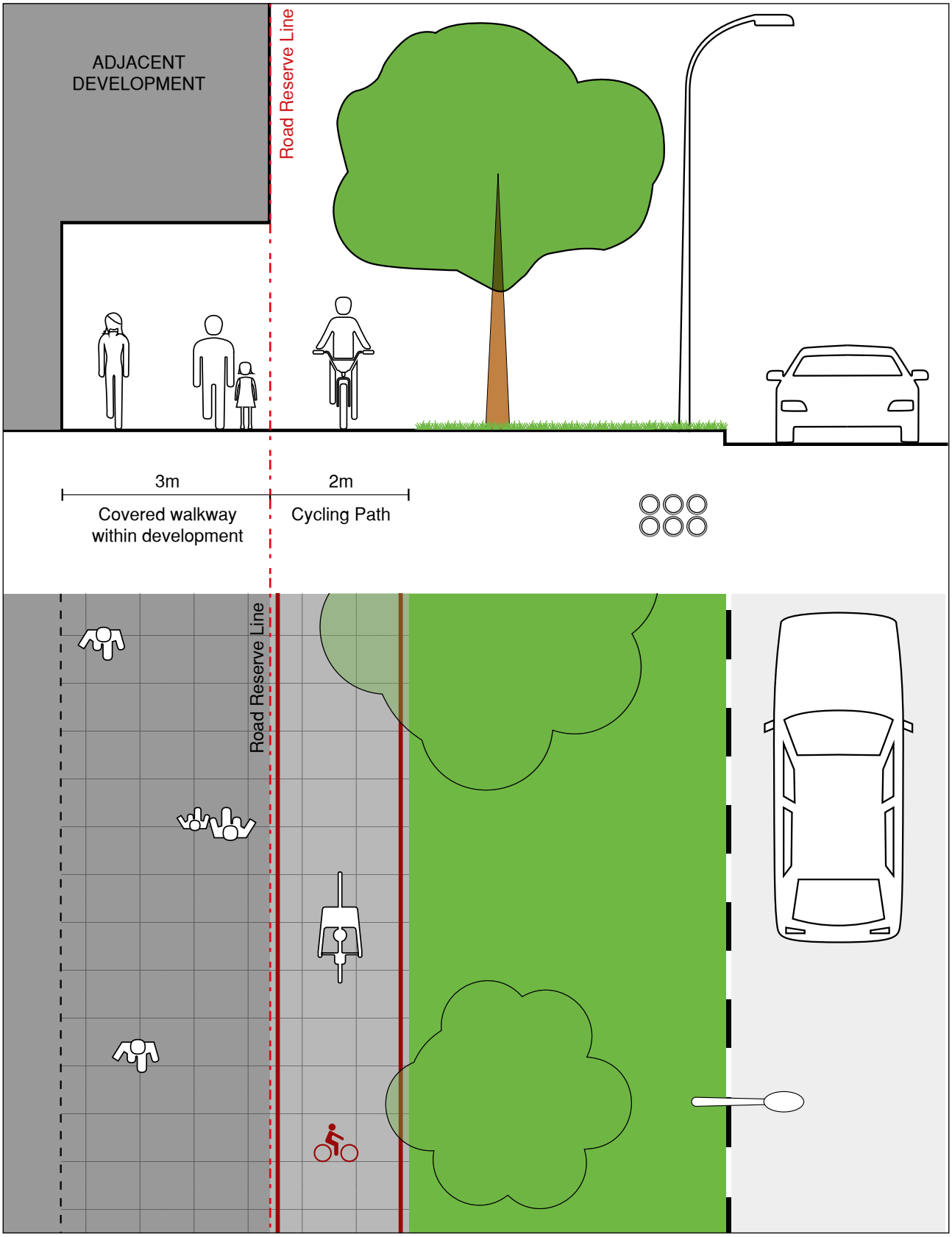


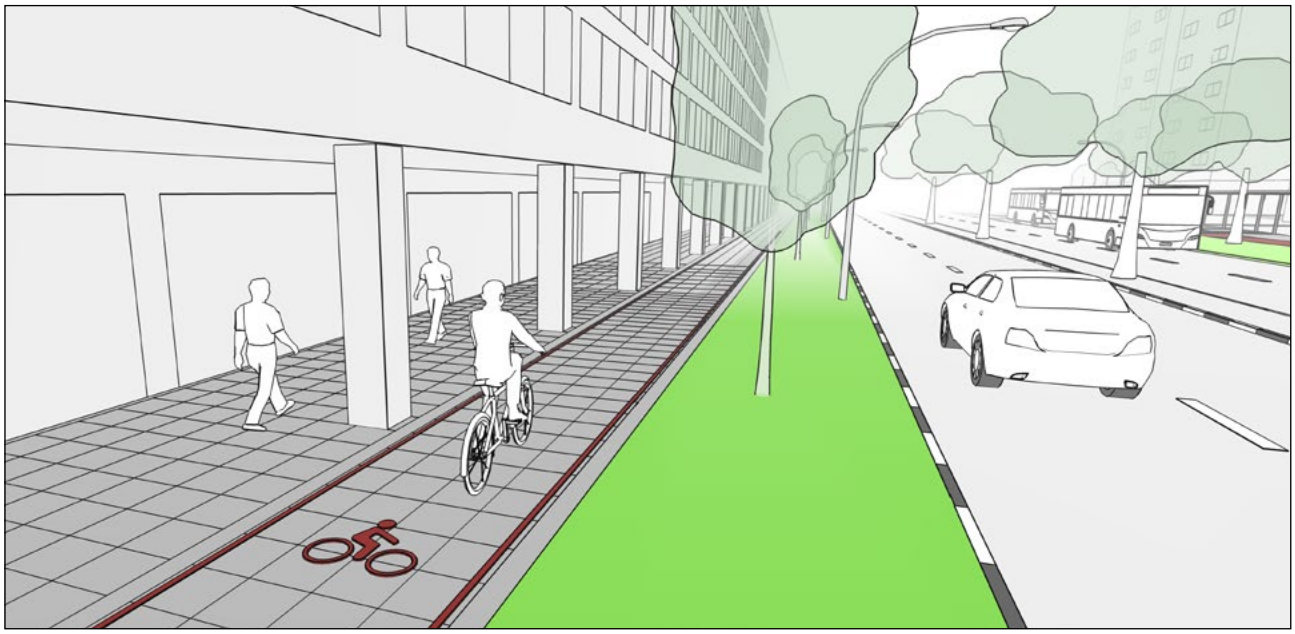
ABOVE: Perspective of roadside with covered walkway and footpath

ABOVE: Covered walkway and open footpath along Shenton Way

3.2.2 Covered Walkway & Cycling Path

Where there is sufficient space and a cycling path is planned next to the covered walkway, a 2m-wide dedicated cycling path is preferred.

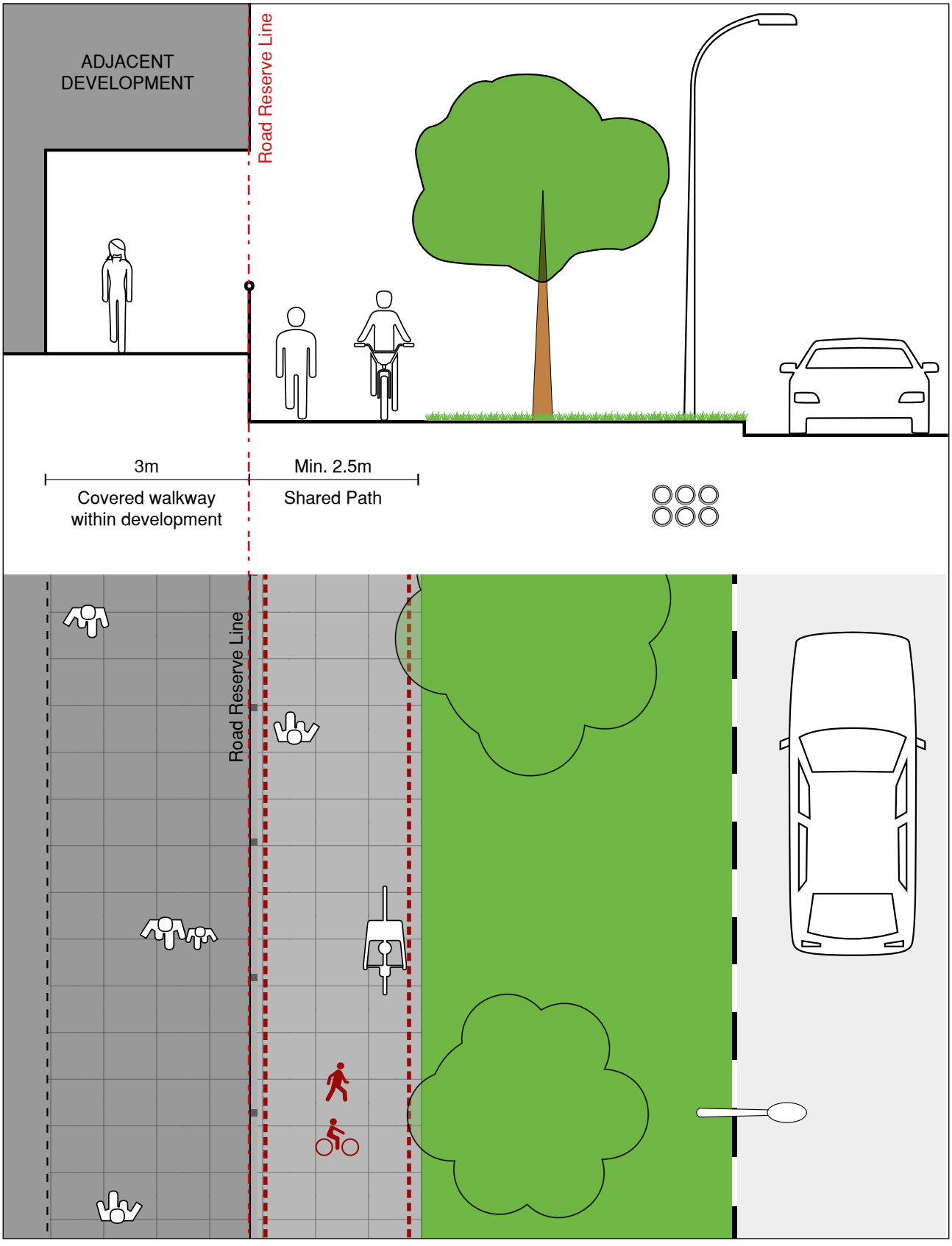




ABOVE: Perspective of roadside with covered walkway and cycling path

3.2.3 Raised Covered Walkway & Lowered Shared Path

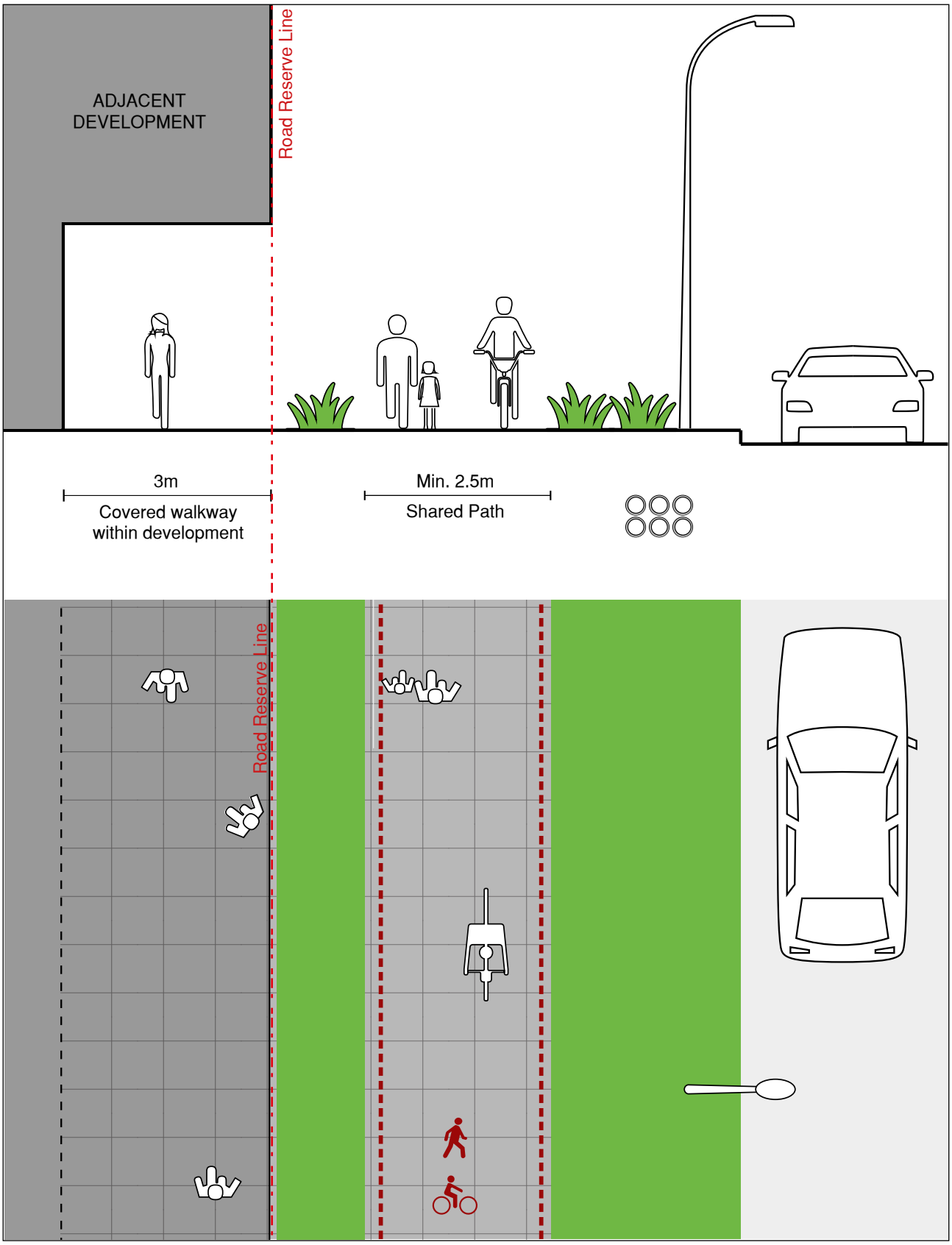
When the covered walkway is at a different level from the open footpath, the cycling path is to be a shared path with a minimum width of 2.5m.

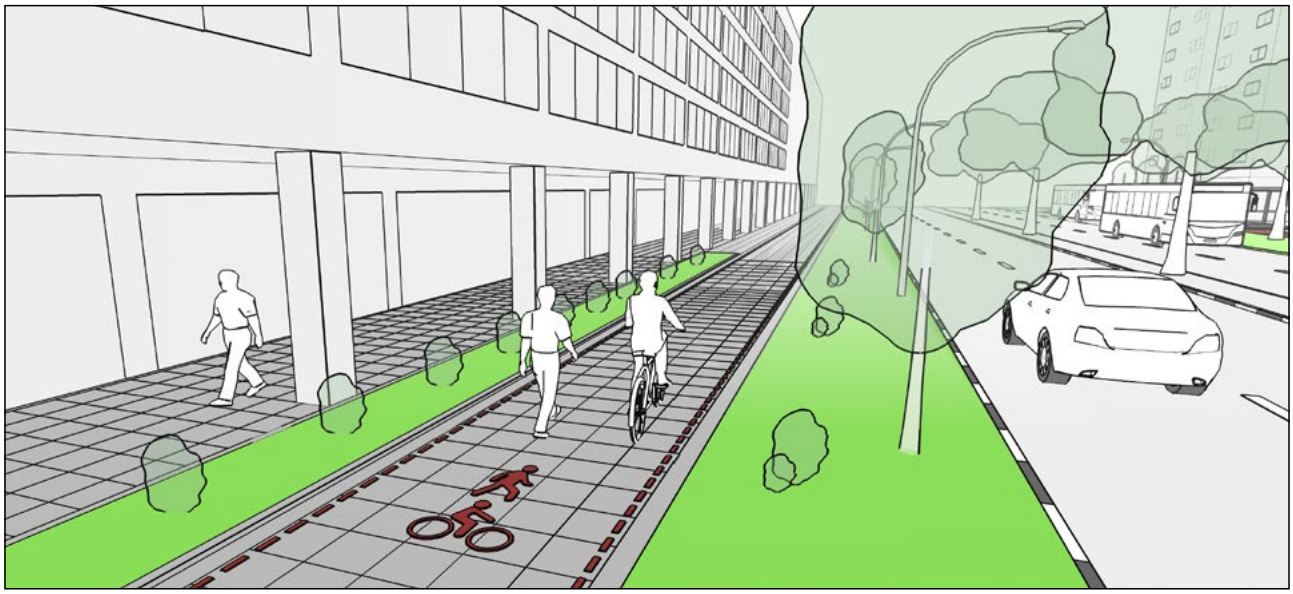


ABOVE: Perspective of raised covered walkway and lowered shared path

3.2.4 Elements between Covered Walkway and Open Footpath

Scenario 1 - Where the covered walkway and open footpath are separated by planting, for example, the cycling path is to be a shared path with a minimum width of 2.5m.

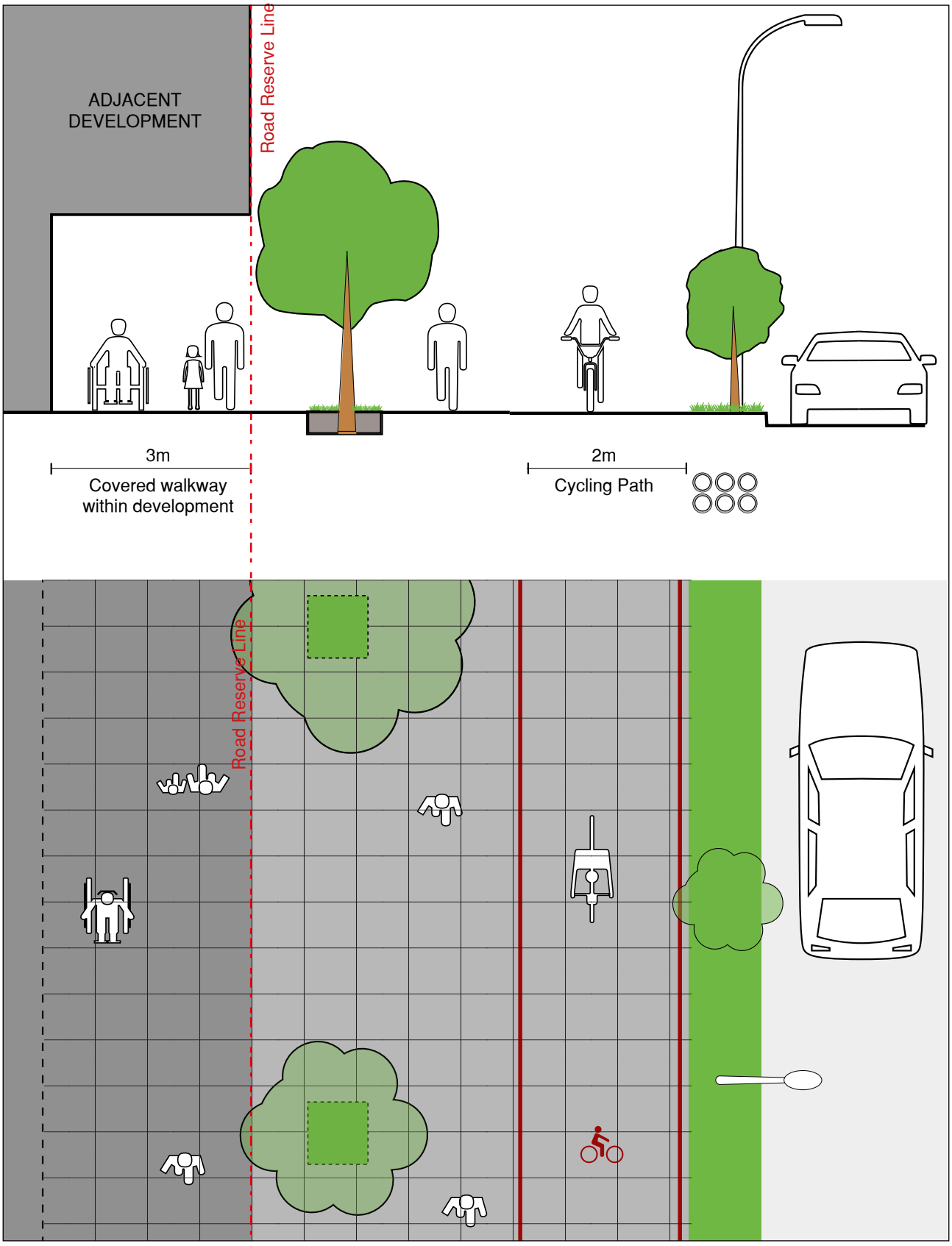


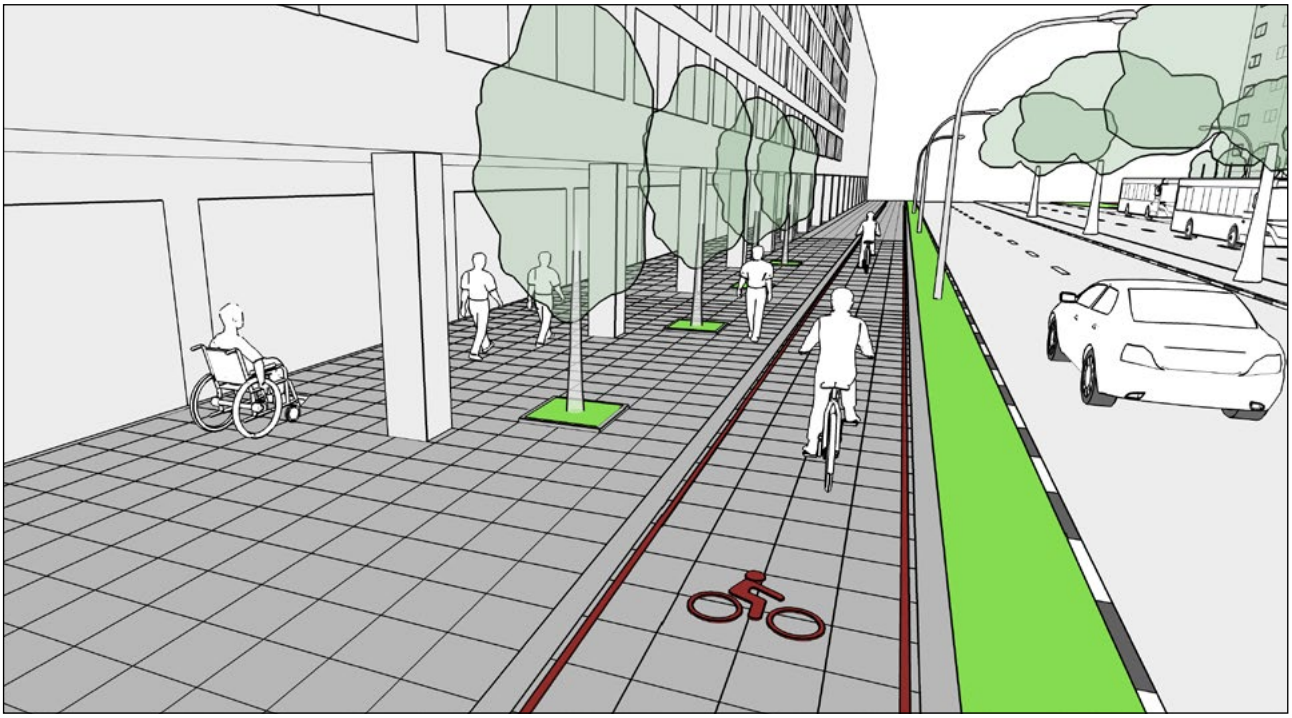


ABOVE: Perspective of Scenario 1 involving covered walkway and shared path

3.2.5 Elements between Covered Walkway and Open Footpath

Scenario 2 - Where there are tree pits located between the open footpath and the covered walkway, a 2m-wide dedicated cycling path shall be provided closer to the side of the road carriageway.

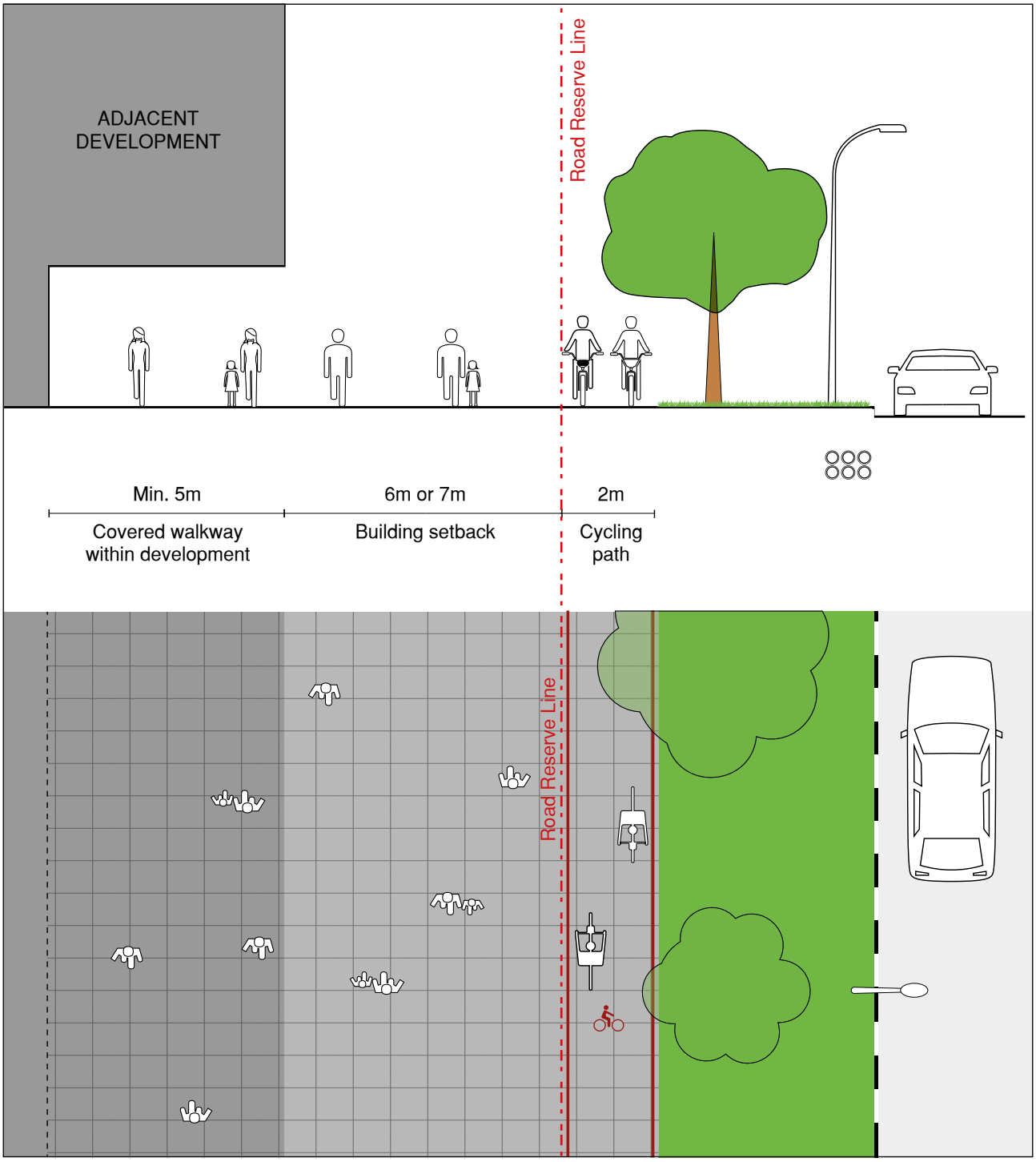


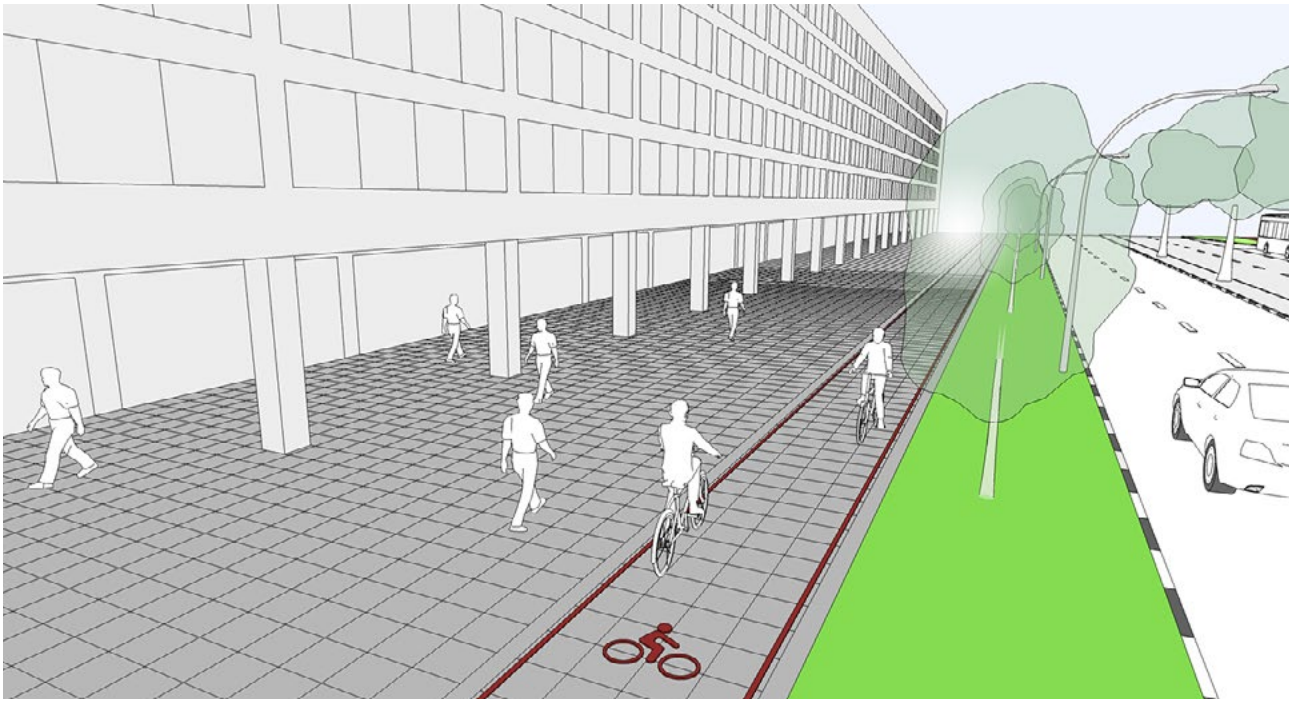


ABOVE: Perspective of Scenario 2 involving covered walkway, open footpath and cycling path

3.2.6 Covered Walkway, Building Setback and Cycling Path (Marina Bay)

This typically applies to the Marina Bay area, where there is building setback for the developments.





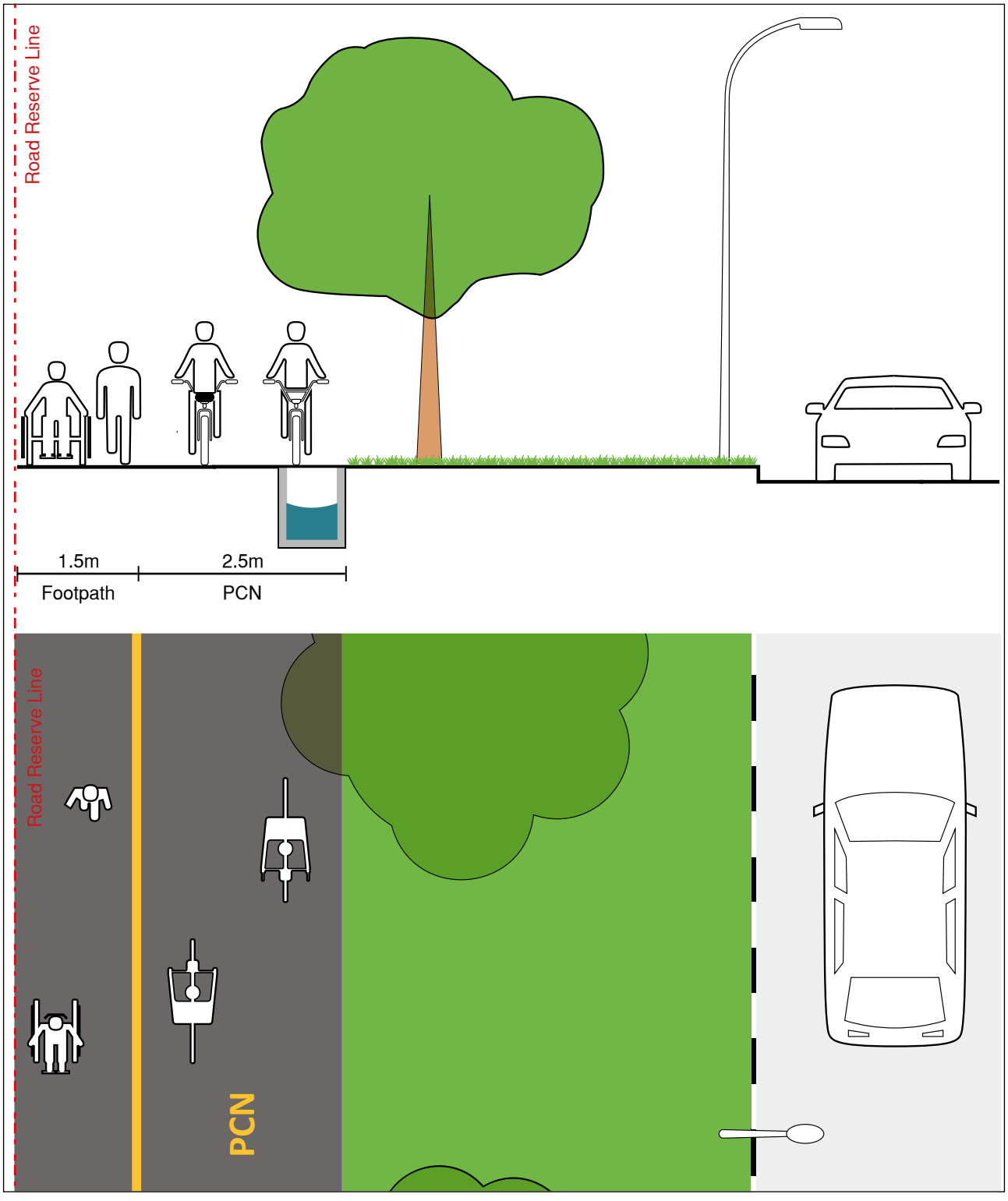
ABOVE: Perspective of covered walkway within development, with building setback and cycling path

3.3 Park Connector Network (PCN) & Round Island Route (RIR) Typologies

The Park Connector Network (PCN) paths are typically made of continuous black asphalt. Standard PCN paths are 4m in width - 1.5m will be labelled as footpath and 2.5m as PCN. Should the path be less than 4m wide, its footpath portion will remain as 1.5m and PCN portion be reduced.

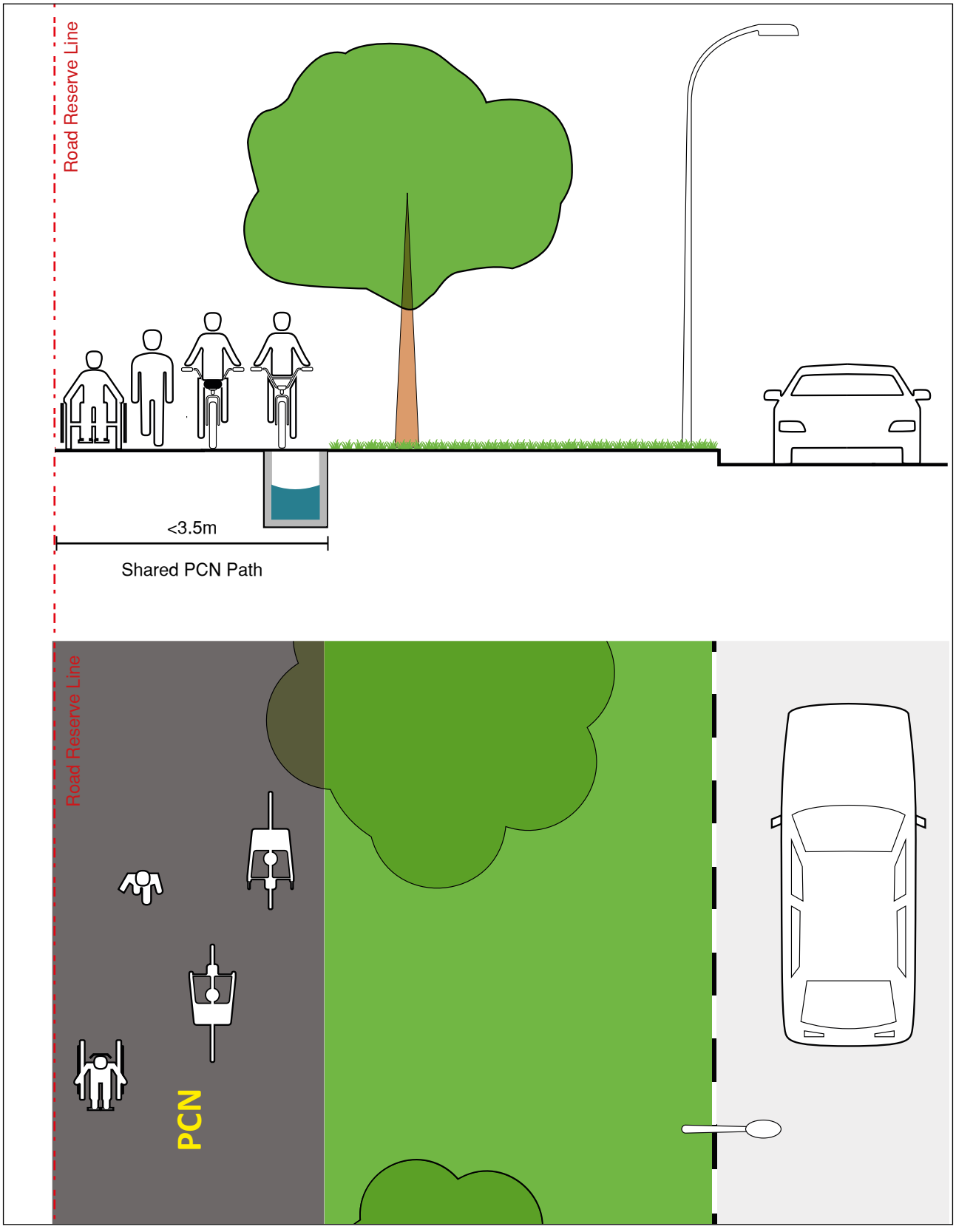
PCN follows two standard typologies dependent on the path width: 1) 4m segregated path and 2) shared path for those with less than 3.5m width.

3.3.1 Segregated PCN Path (4m width)



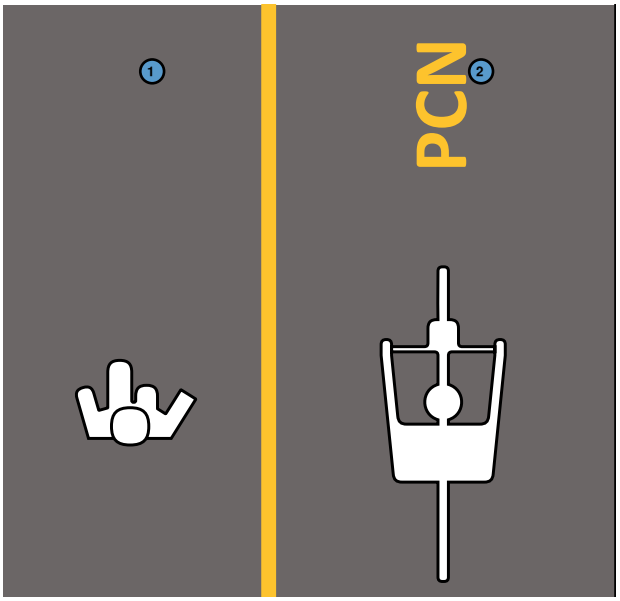
3.3.2 Shared Path (less than 3.5m width)

Where there is less than 3.5m space available, a shared path is preferred. The entire path will simply be labelled 'PCN'.



3.3.3 Harmonisation Between PCN and Cycling Path Network (CPN)

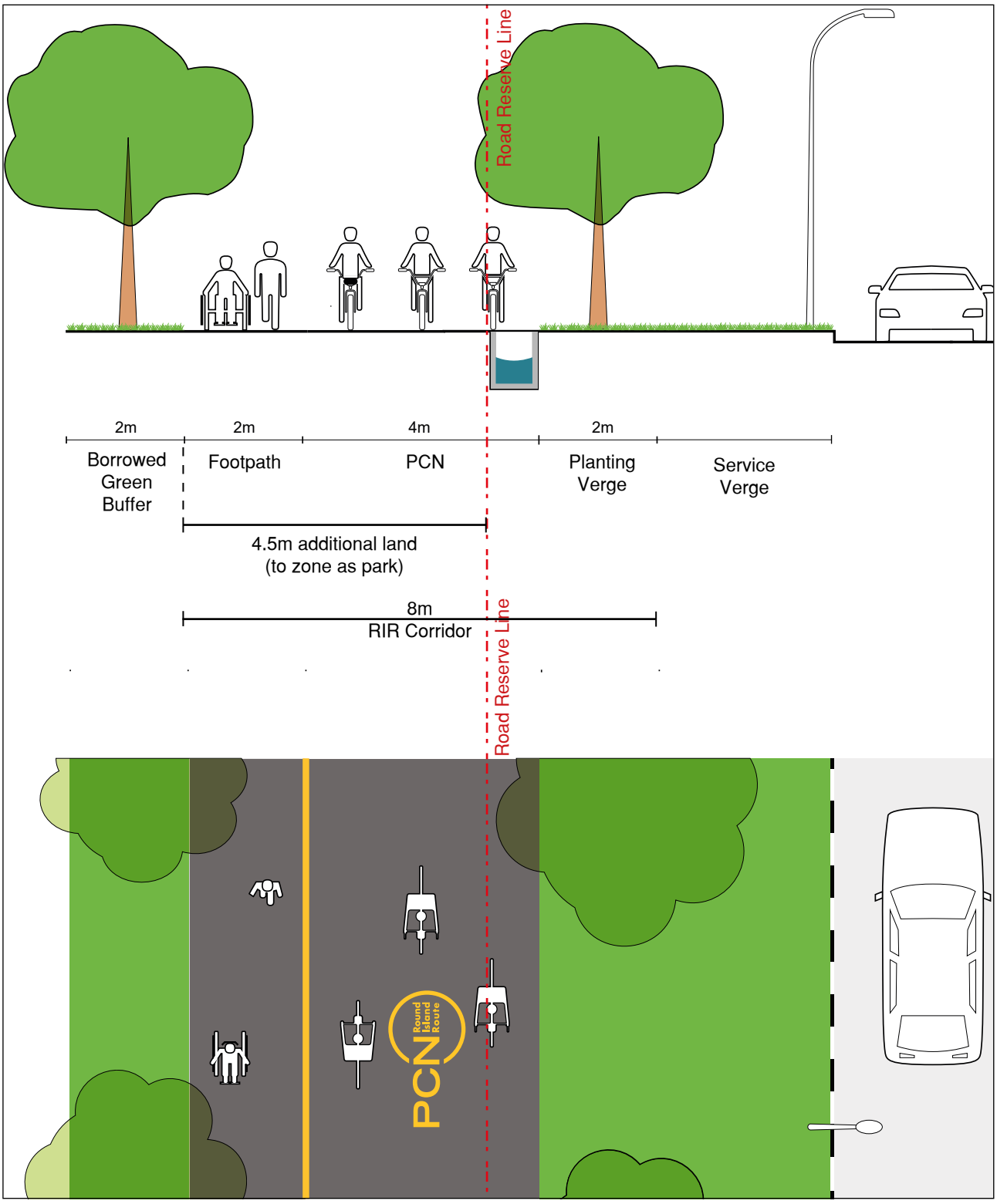
To harmonise with the Cycling Path Network (CPN), the foot-path portion of PCN will be demarcated with a pedestrian logo. While the cyclist logo is used on CPN, the PCN imprint will be used along the PCN portion instead. PCN imprints will be spaced closer at 100m intervals.

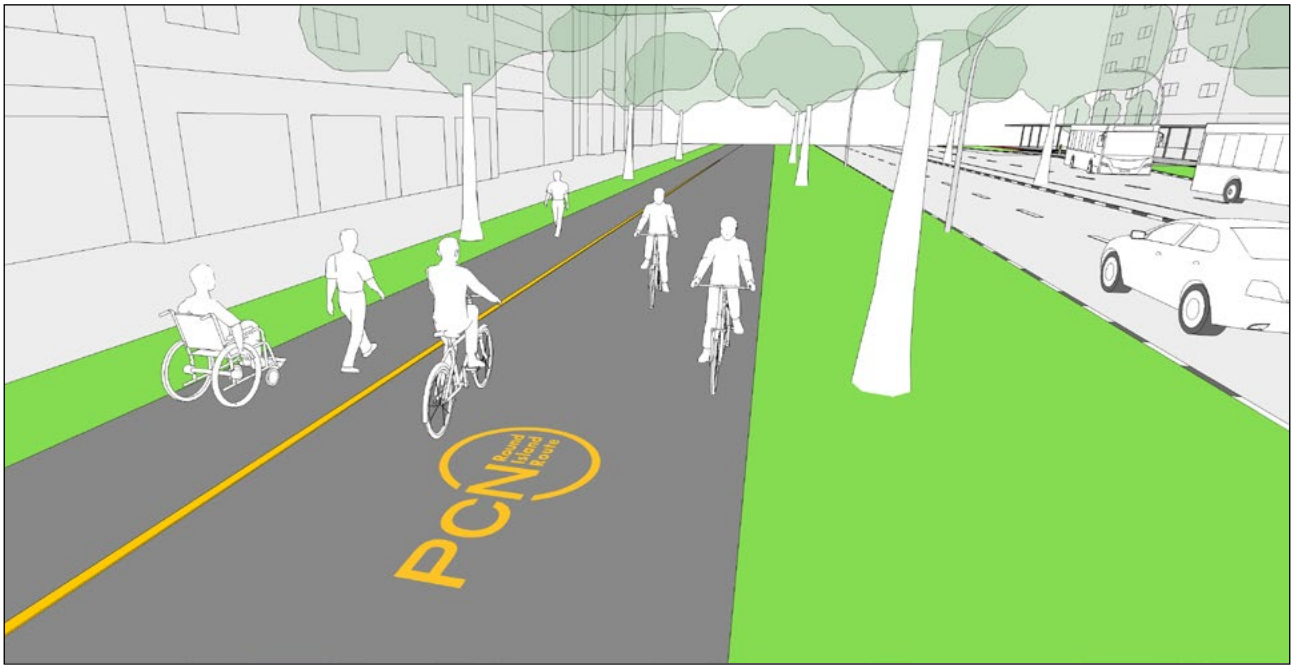


1. Footpath portion
2. PCN portion will be demarcated with PCN imprint instead of cyclist logo in CPN

3.3.4 PCN-RIR Corridor (6m width)

The Park Connector Network Round Island Route (PCN-RIR) beside road reserves will have a 6m path made up of a 2m footpath and 4m PCN path. The adjacent greenery is 4m in width, 2m of which will be the streetscape green buffer and the remaining as the service verge. On the other side of the path, no dedicaated planting will be provided. Any additional greenery will be borrowed from adjacent developments.





ABOVE: Perspective of PCN/RIR Corridor

Non-Roadside Typologies

To provide direct connections and reduce the need to make circuitous routes around large or elongated developments, agencies have developed a set of typologies for non-roadside footpaths and cycling paths to guide agencies and the building industry. Non-roadside footpaths and cycling paths refer to paths located between developments, which are critical first- and last-mile walking and cycling links. They are direct paths from public streets to transport nodes (e.g. bus stops, MRT stations) and amenities.

This chapter illustrates the non-roadside typologies that capture the placement of walking and cycling paths, and their supporting elements (e.g. drain & lighting) that cut across private and/or industrial lands. Public housing estates are porous, which might not be necsesary to have such dedicated connections as they are integrated as part of the design of public housing precincts.

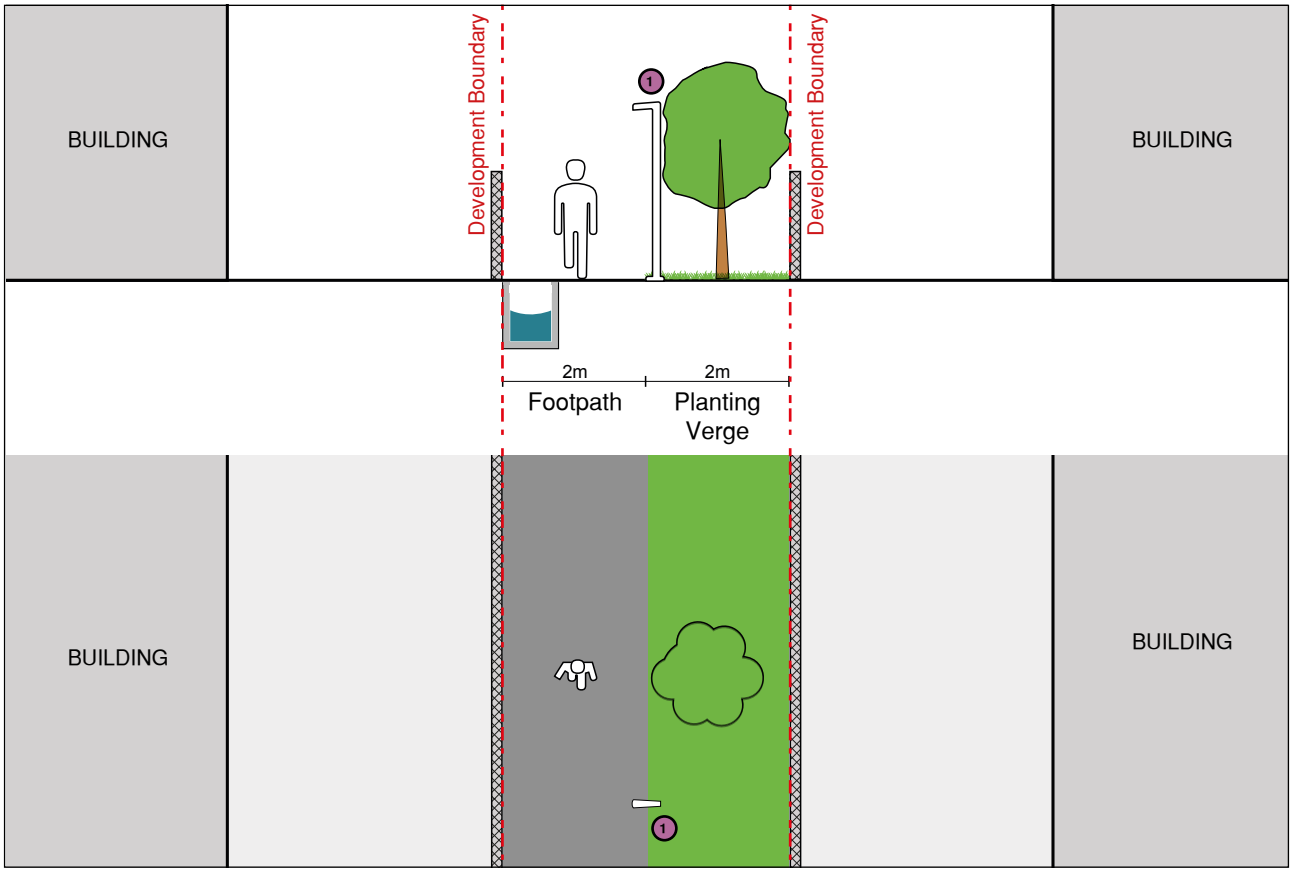
4

4 NON-ROADSIDE TYPOLOGIES

4.1 Where Both Abutting Developments Are Non-Porous*

We recommend providing a dedicated planting verge for visual relief in view of the confined space and shade for users where both abutting developments are non-porous. Below are four scenarios under such a situation.

4.1.1 Footpath & Dedicated Planting Verge

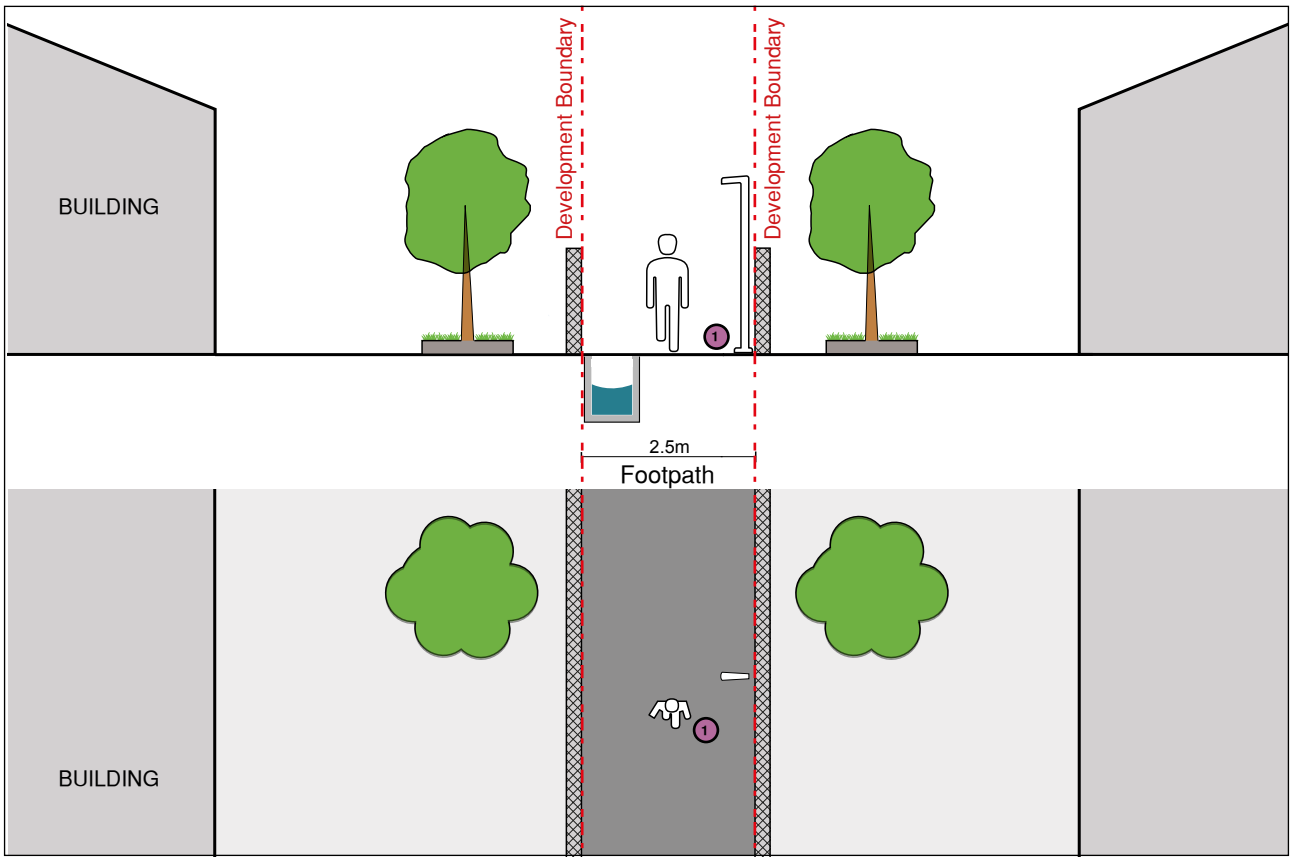


(1) Path lighting is located outside of the path, for example, on planting verge between tree intervals.

* Developments are non-porous if they are bounded by boundary walls/ fencing, regardless of the materials used.

4.1.1a Short Footpath With No Dedicated Planting Verge (Exception)

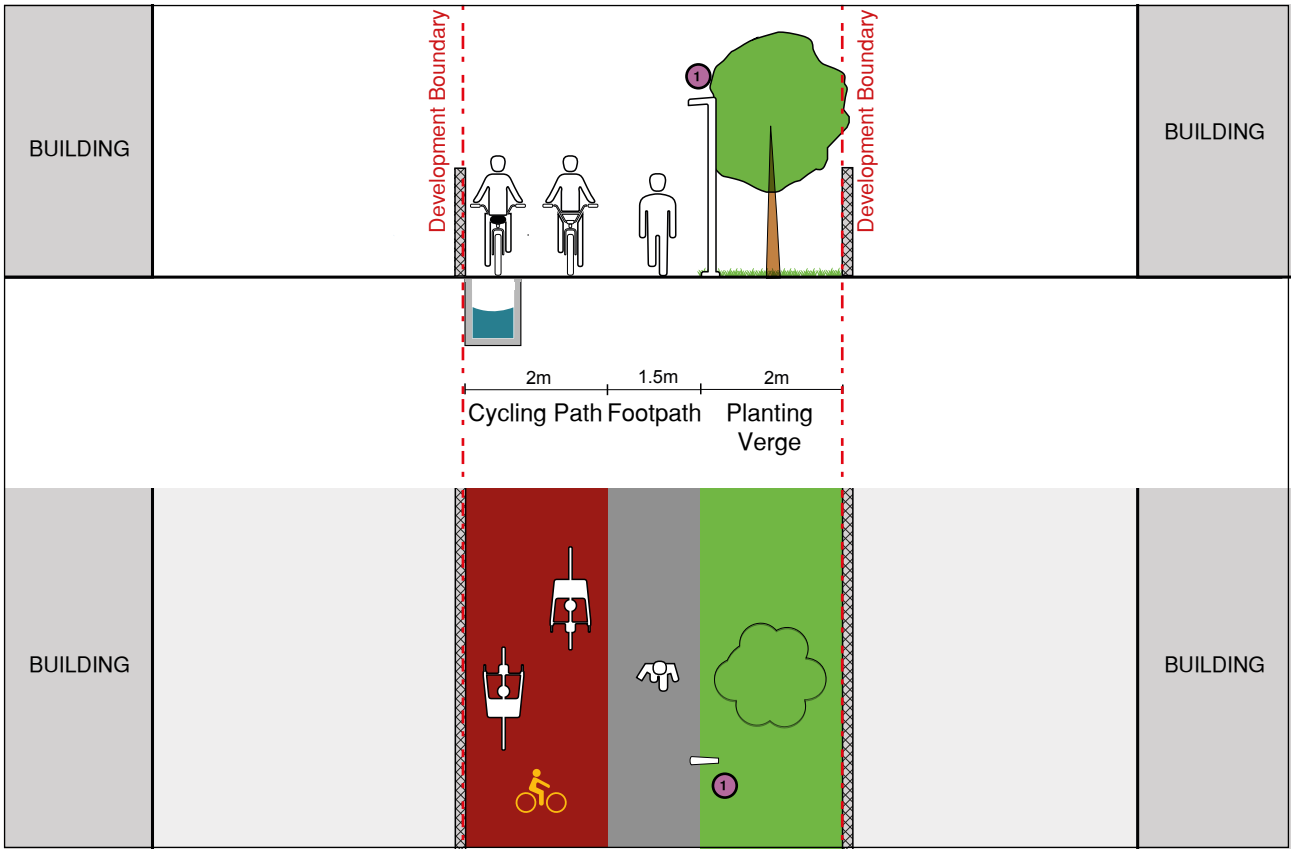
In low density areas or areas with low pedestrian flow, a standalone 2.5m footpath with path lighting and no dedicated planting verge may be considered. This can be applied in industrial and landed housing areas for a length of not more than 30m.



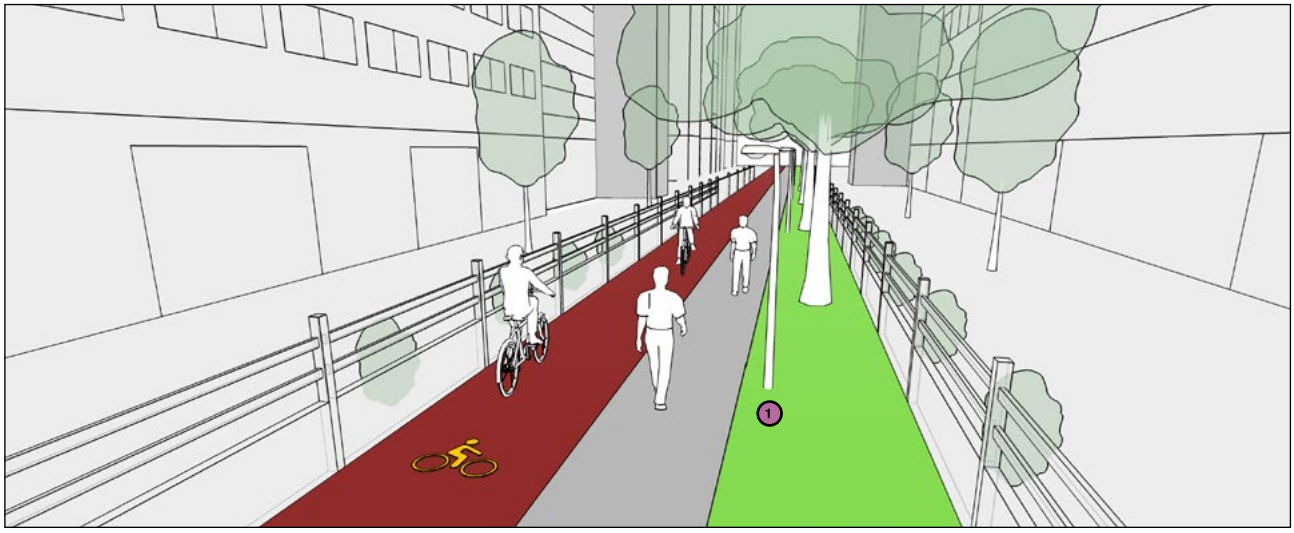
1 2.5m footpath is recommended (typical non-roadside footpath width is 2m) as the additional 0.5m space is needed for path lighting.

4.1 Where Both Abutting Developments Are Non-Porous*

4.1.2 Footpath, Cycling Path & Dedicated Planting



1 Path lighting is located outside of the path, for example, on planting verge between tree intervals.

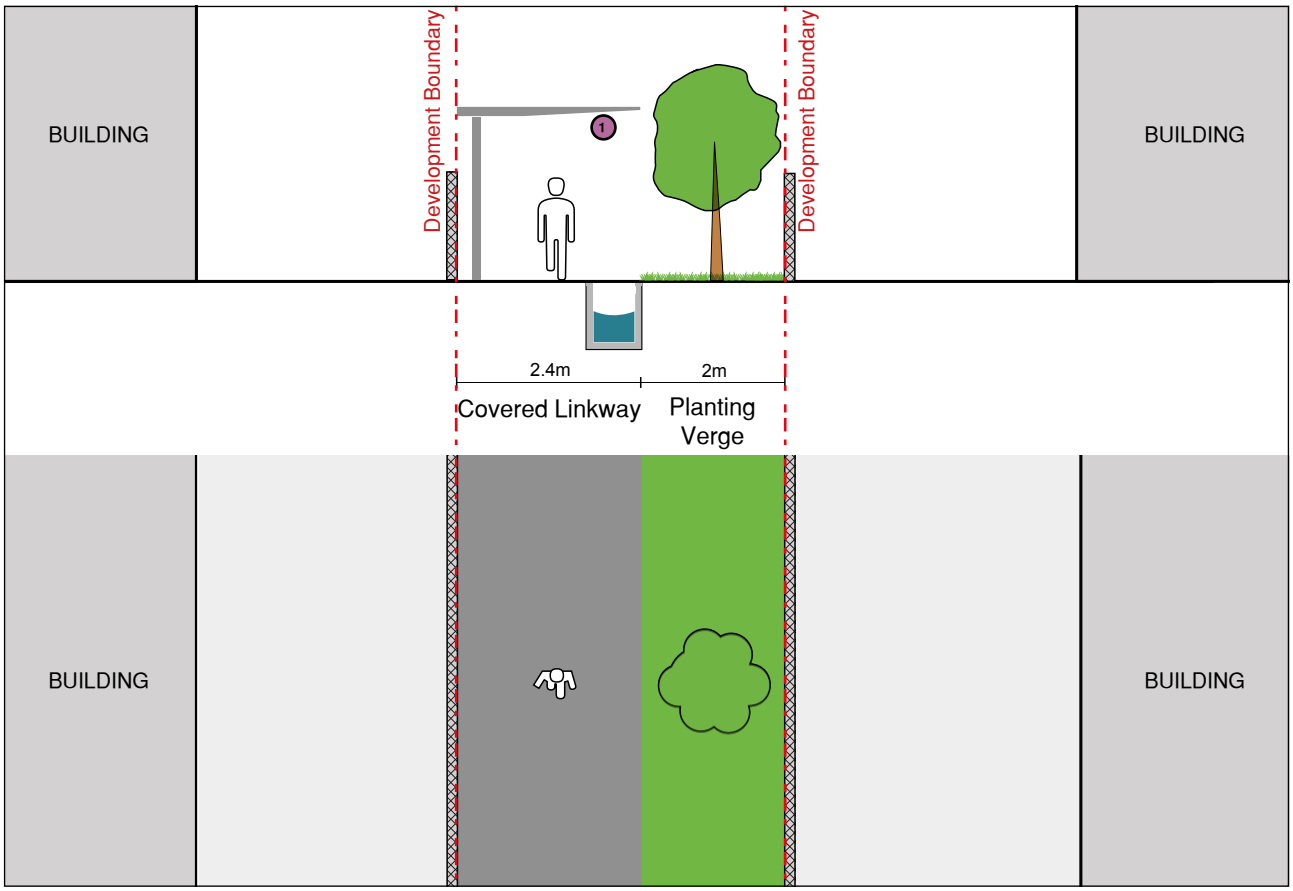


* Developments are non-porous if they are bounded by boundary walls/ fencing, regardless of the materials used.

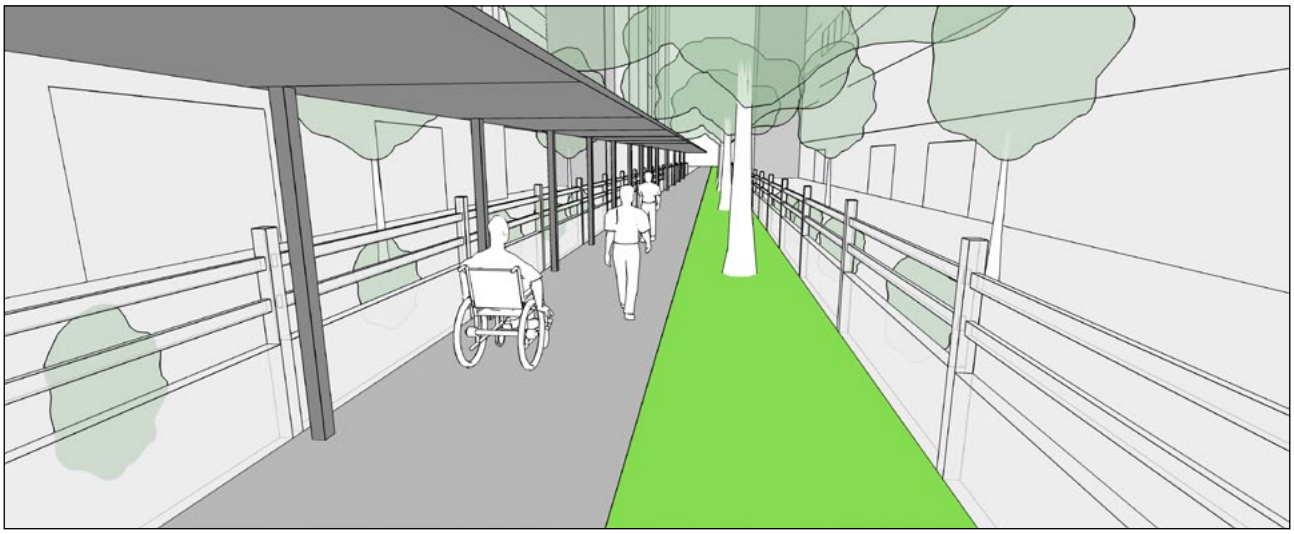
4.1 Where Both Abutting Developments Are Non-Porous*

4.1.3 Covered Linkway & Dedicated Planting

It is not recommended to implement covered linkway next to landed residential area due to security concerns, unless necessary depending on the site context. Wider covered linkway width (standard width: 2.4m) can be assessed based on site context (e.g. areas with high pedestian traffic).



1 Covered linkway lighting can be shared by pedestrians and cyclists, hence, no additional land is required for path lighting.

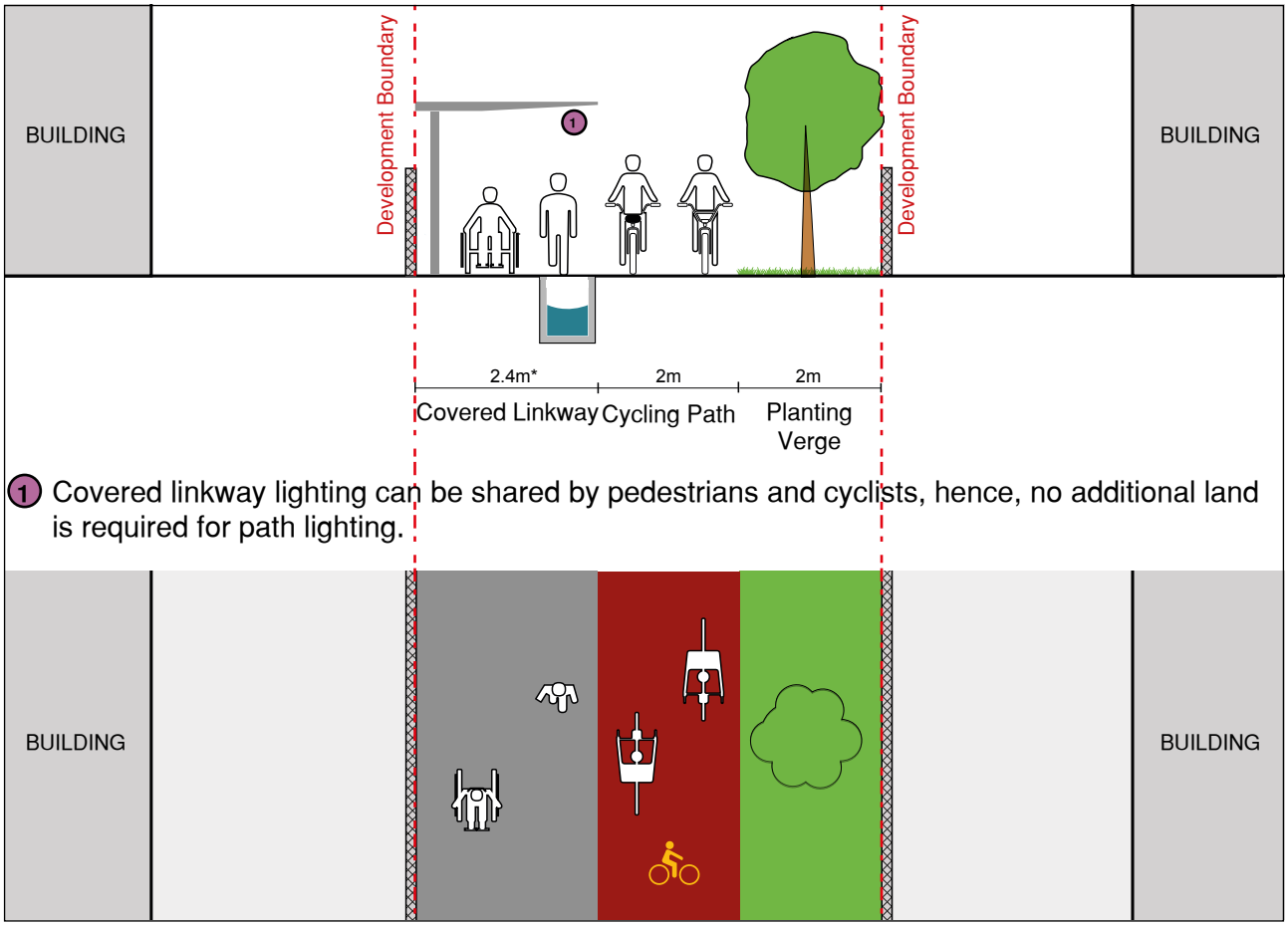


* Developments are non-porous if they are bounded by boundary walls/ fencing, regardless of the materials used.

4.1 Where Both Abutting Developments Are Non-Porous*

4.1.4 Covered Linkway, Cycling Path & Dedicated Planting

It is not recommended to implement covered linkway next to landed residential area due to security concerns, unless necessary depending on the site context. Wider covered linkway width (standard width: 2.4m) can be assessed based on site context (e.g. areas with high pedestian traffic).



1 Covered linkway lighting can be shared by pedestrians and cyclists, hence, no additional land is required for path lighting.

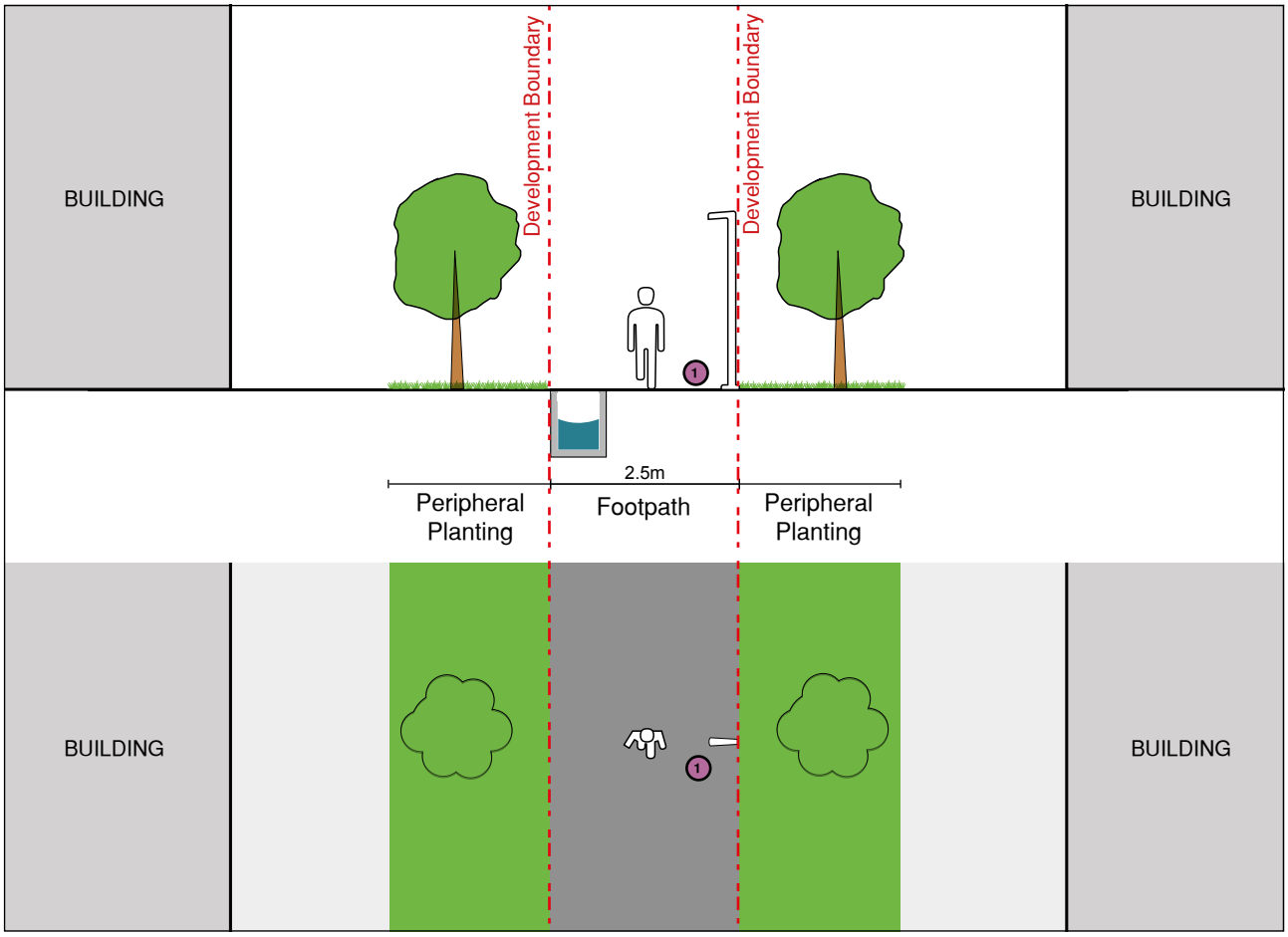
* Developments are non-porous if they are bounded by boundary walls/ fencing, regardless of the materials used.

4.2 Where At Least One Abutting Development Is Porous*

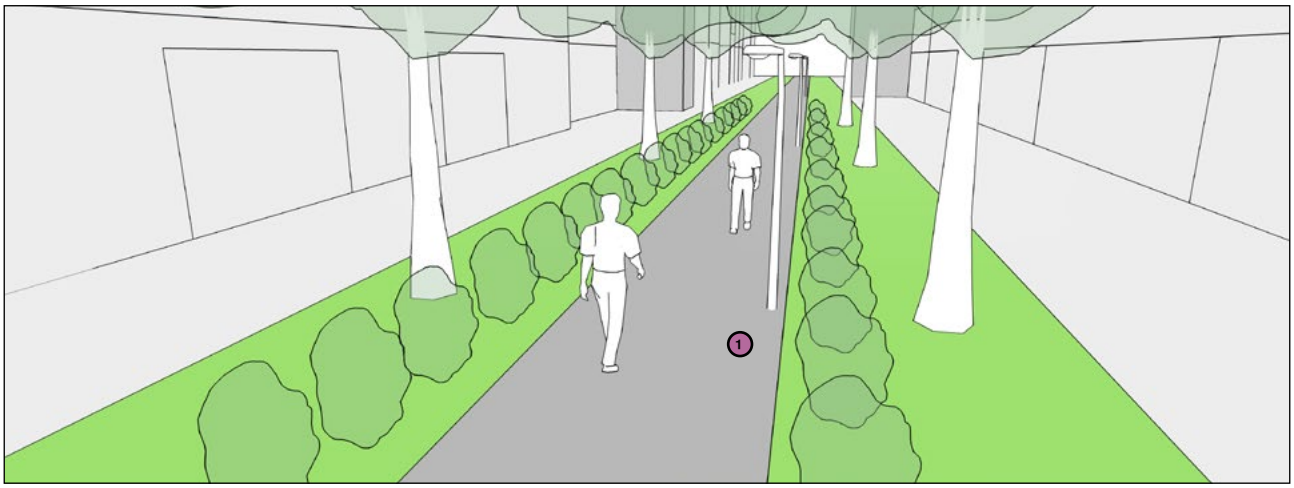
Under this situation, greenery can be tapped from the peripheral planting from the development/s, hence planting verge may not be required. There are four scenarios under this situation.

4.2.1 Footpath With Peripheral Planting

This typology may not be applicable to footpaths within HDB precincts as HDB will integrate the necessary pedestrian connections as part of its precinct design.



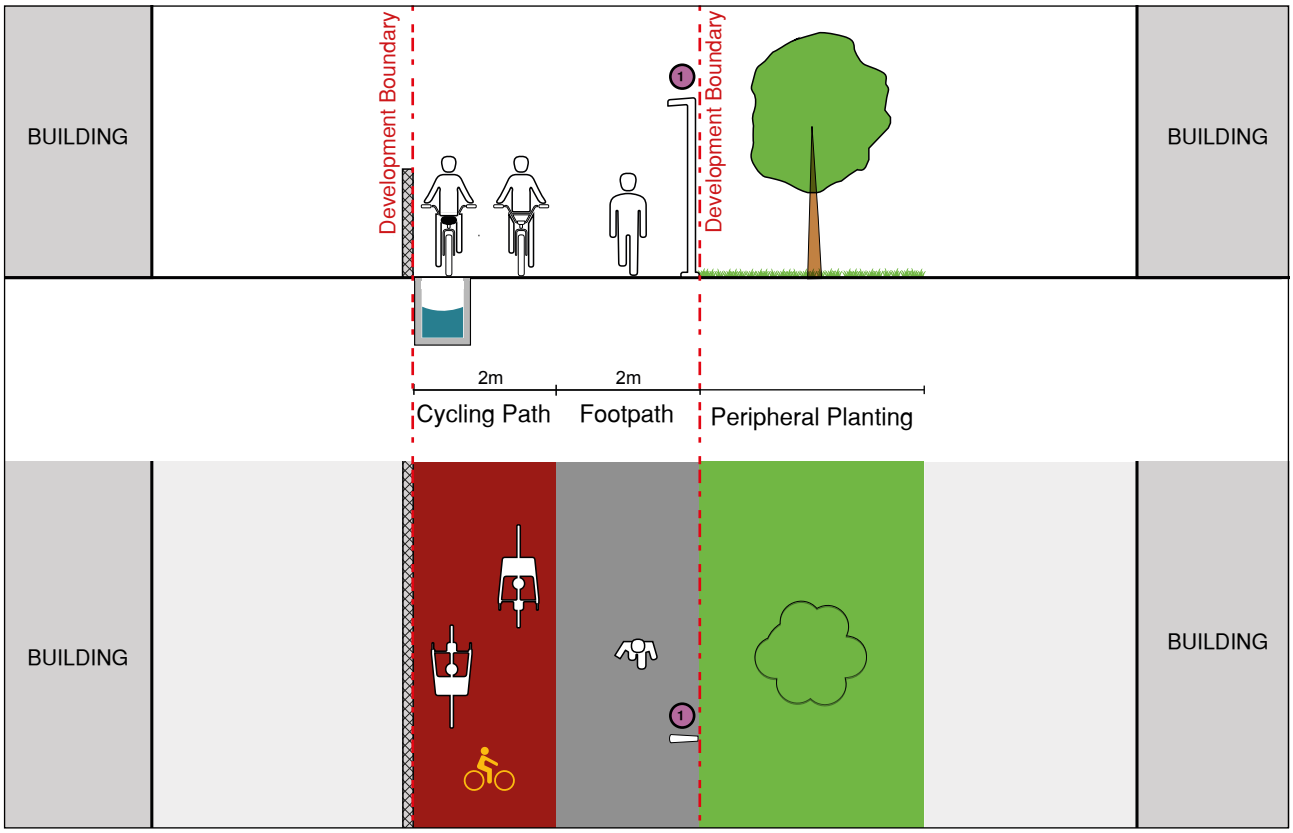
1 2.5m footpath is required (typical non-roadside footpath width is 2m) as the additional 0.5m space is needed for path lighting.



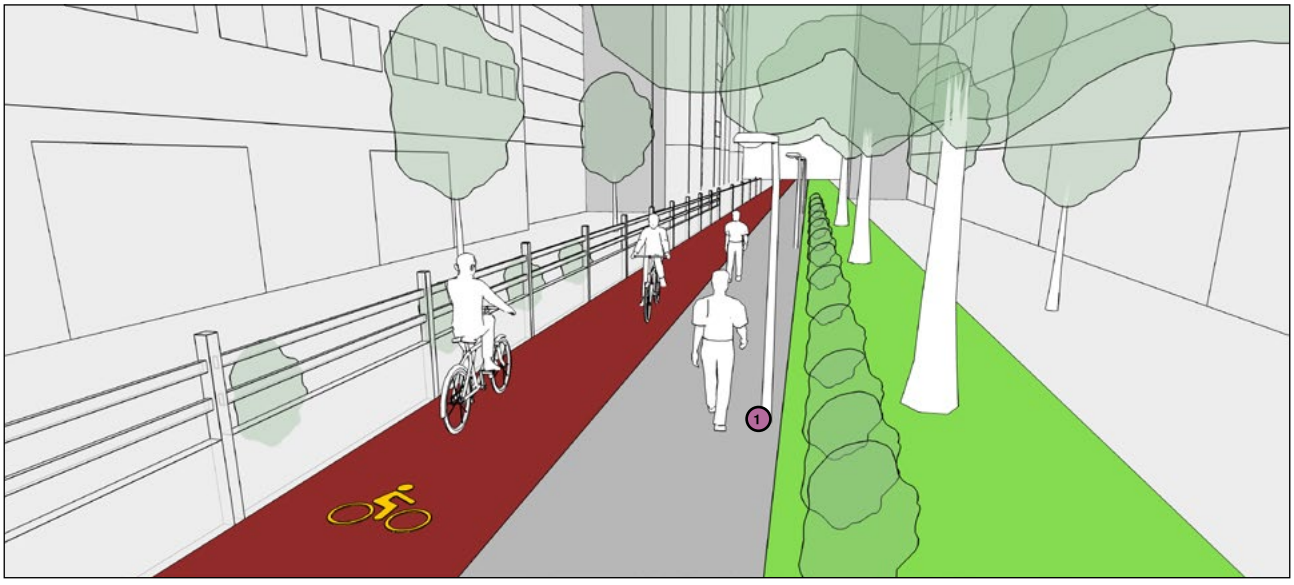
* Developments are porous if they are not bounded by boundary walls/ fencing, regardless of the materials used.

4.2 Where At Least One Abutting Development Is Porous*

4.2.2 Footpath, Cycling Path & Peripheral Planting



(1) Path lighting is located within the footpath, as it is not possible to be sited on abutting development's green buffer. Additional 0.5m land is not required for the lighting pole as pedestrians can share the cycling space when necessary, for example, when two wheelchair users bypass each other.

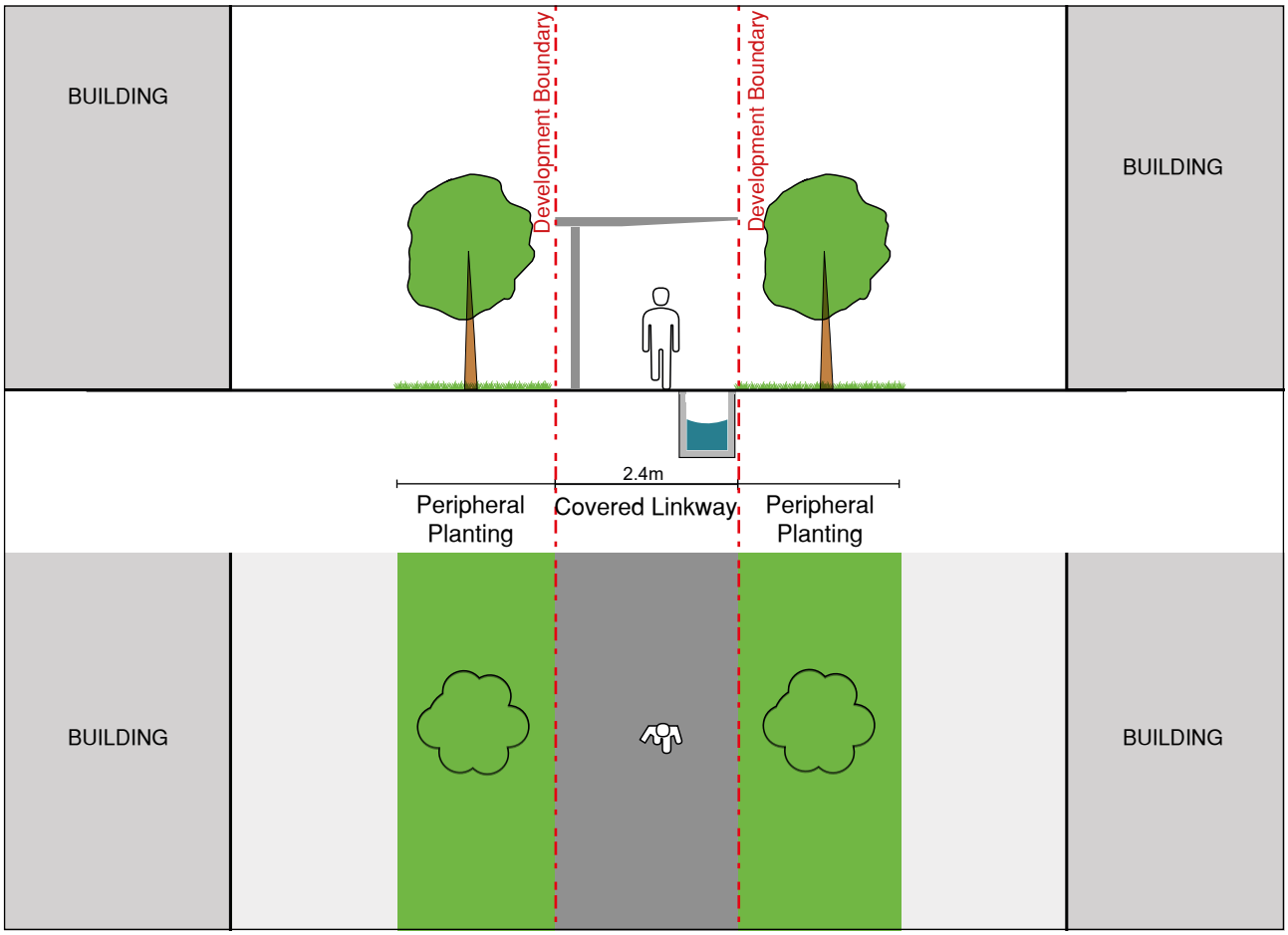


* Developments are porous if they are not bounded by boundary walls/ fencing, regardless of the materials used.

4.2 Where At Least One Abutting Development Is Porous*

4.2.3 Covered Linkway & Peripheral Planting

It is not recommended to implement covered linkway next to landed residential area due to security concerns, unless necessary depending on the site context. Wider covered linkway width (standard width: 2.4m) can be assessed based on site context (e.g. areas with high pedestian traffic). This typology may not be applicable to paths within HDB precincts as HDB will integrate the necessary pedestrian connections as part of its precinct design.

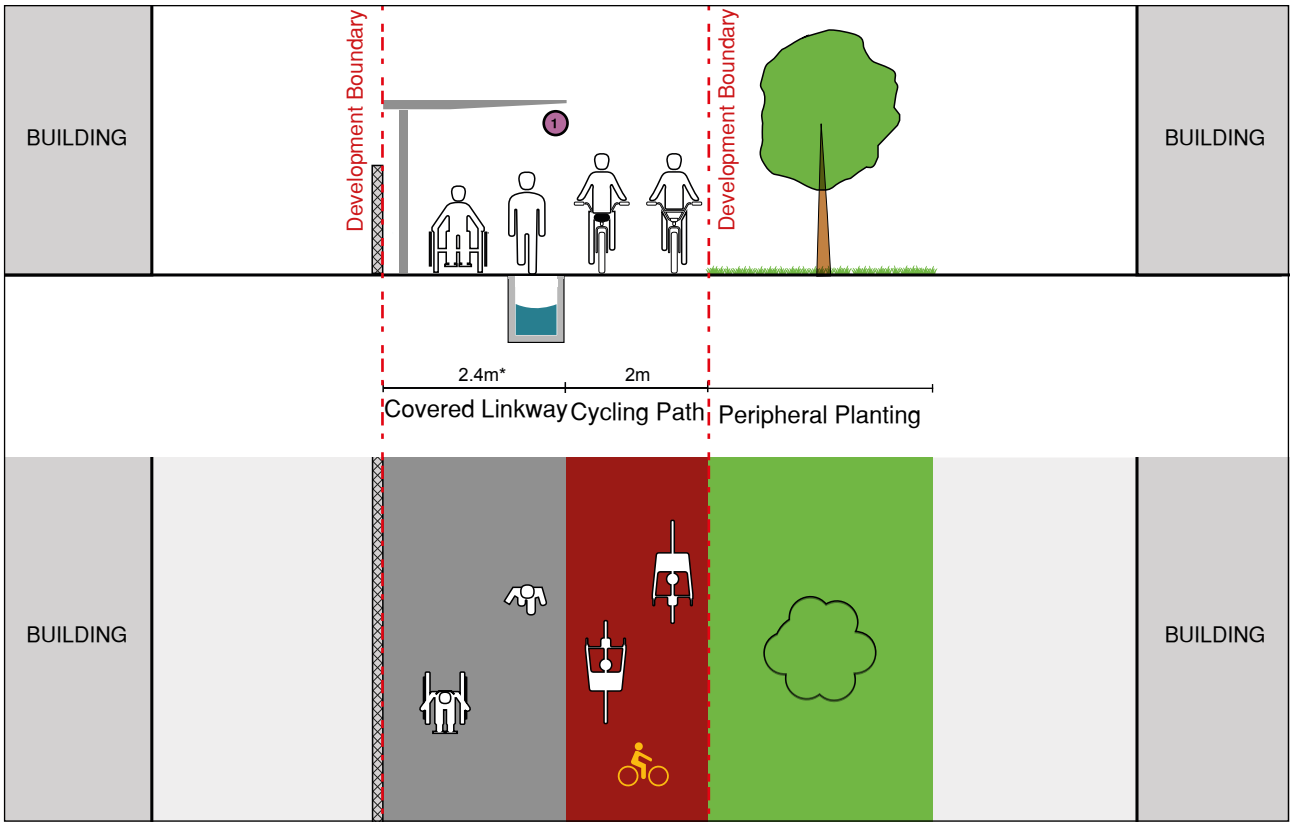


* Developments are porous if they are not bounded by boundary walls/ fencing, regardless of the materials used.

4.2 Where At Least One Abutting Development Is Porous*

4.2.4 Covered Linkway, Cycling Path & Peripheral Planting

It is not recommended to implement covered linkway next to landed residential area due to security concerns, unless necessary depending on the site context. Wider covered linkway width (standard width: 2.4m) can be assessed based on site context (e.g. areas with high pedestrian traffic).



1 Covered linkway lighting can be shared by pedestrians and cyclists, hence, no additional land is required for path lighting.

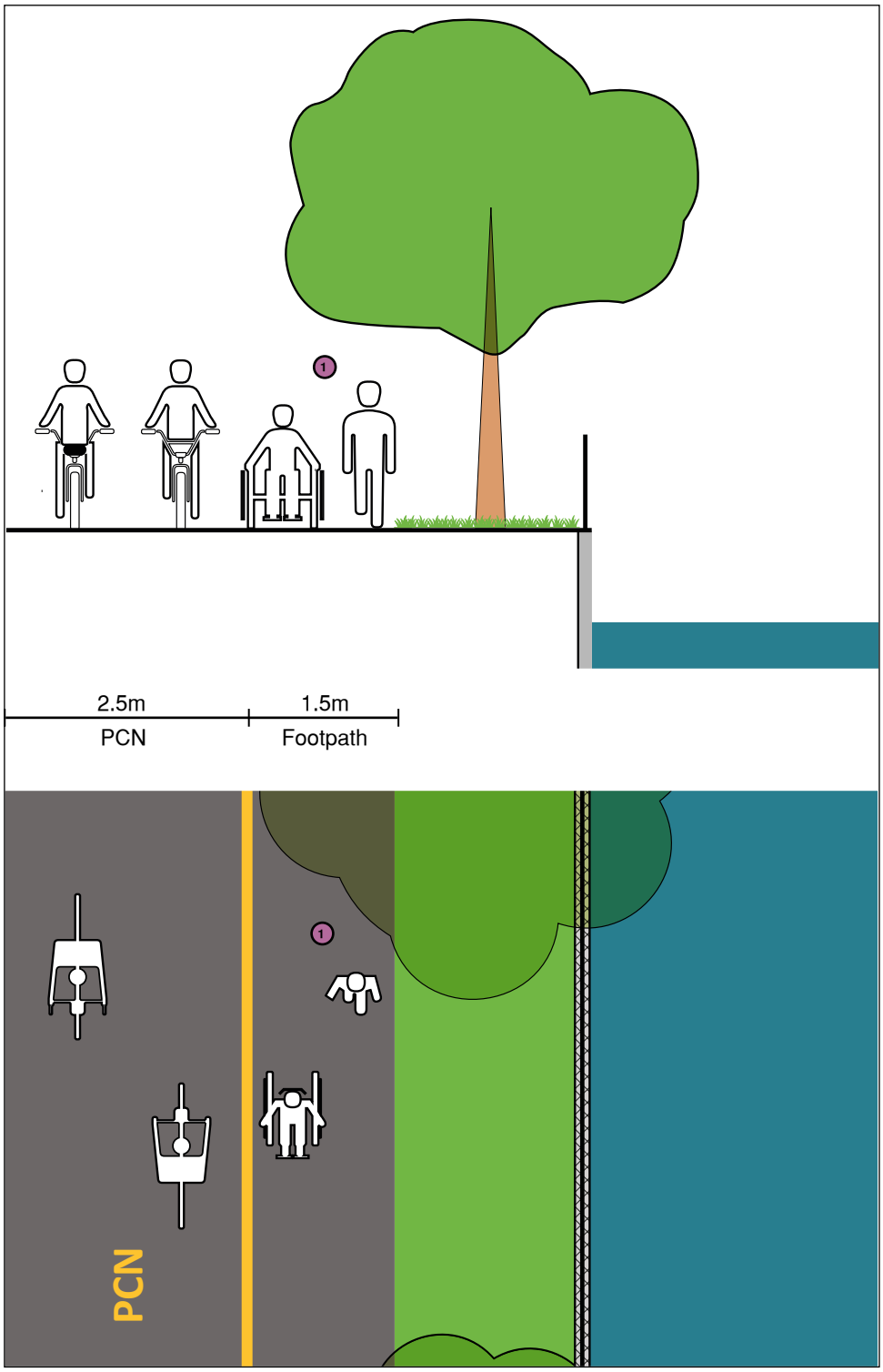
* Developments are porous if they are not bounded by boundary walls/ fencing, regardless of the materials used.

4.3 Park Connector Network (PCN) & Round Island Route (RIR) Typologies

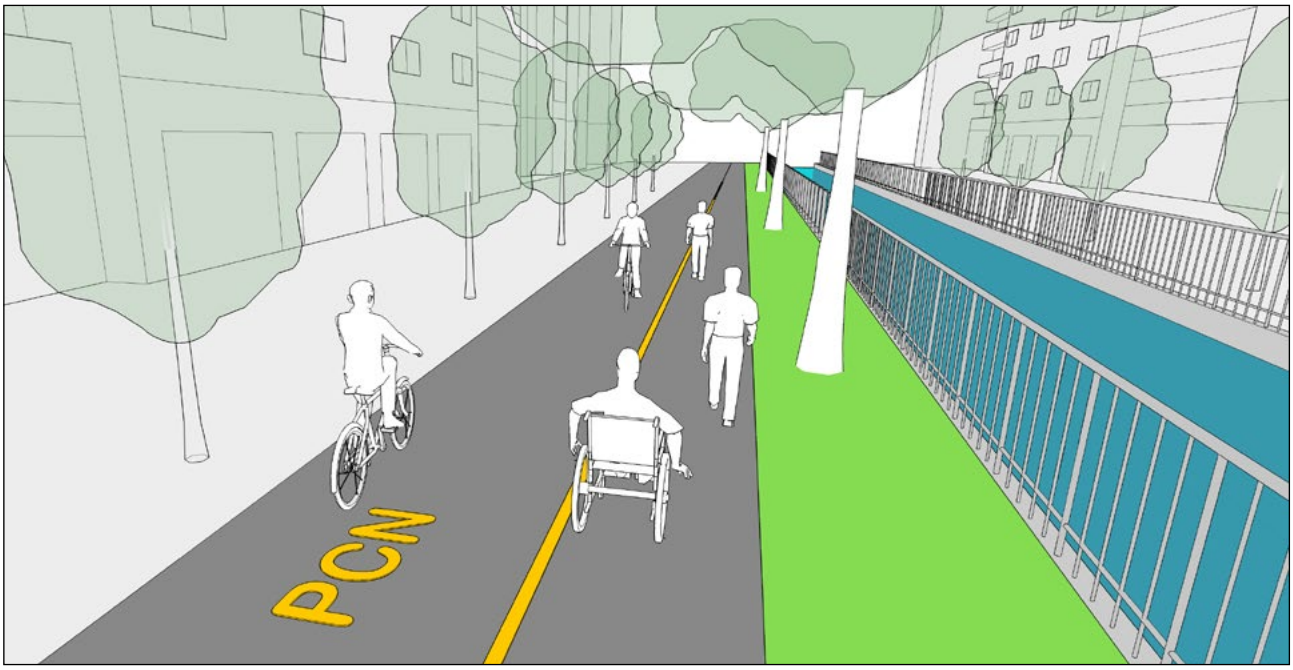
Similar to Chapter 3.3 for roadside typologies, non-roadside PCN paths are 4m in width where 1.5m will be labelled as footpath, and 2.5m as PCN. Should the track be less than 4m, the PCN portion will be reduced.

PCN follows two standard typologies dependent on the path width: 1) 4m segregated path and 2) shared path for those with less than 3.5m width. For the types of plantings to be planted along the waterway, please refer to the chapter on 'Waterway Planting' in Sustainable Landscapes, a publication by NParks' Centre of Urban Greenery & Ecology (CUGE), for more infomration.

4.3.1 Segregated PCN Path (4m width)



1 The footpath within PCN is located closer to the waterway, where possible.

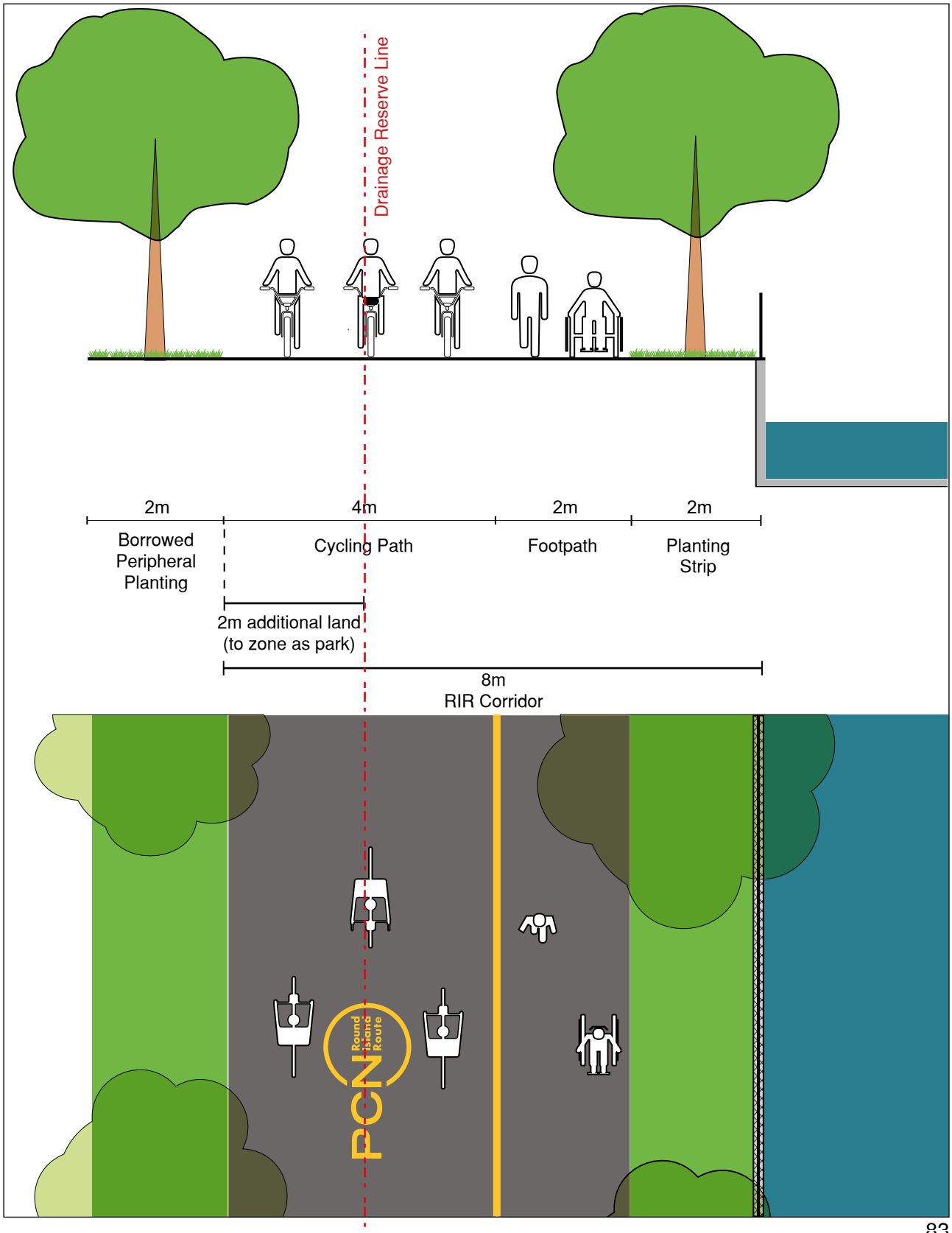


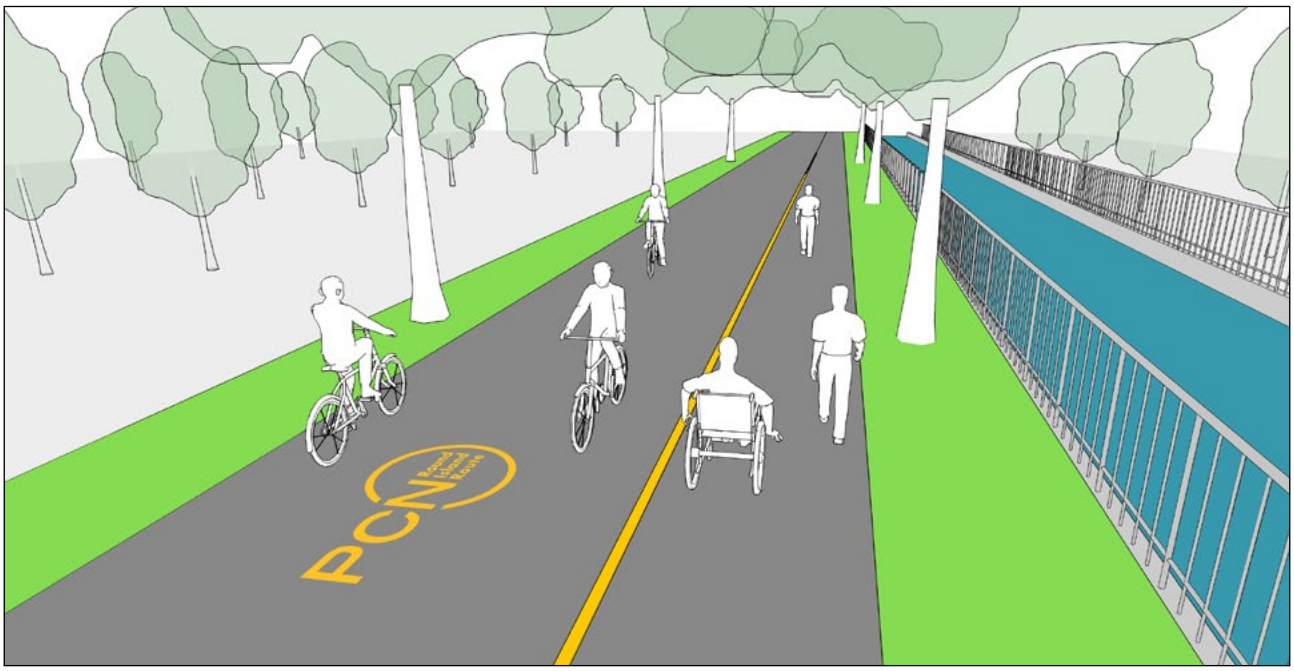
ABOVE: Perspective of segregated PCN path along a canal

4.3.2 PCN-RIR at Drainage Reserve

There are two typical typologies for PCN-RIR paths at Drainage Reserve (DR). For both scenarios, 2m of borrowed greenery will be located opposite the canal but the 2m planting verge for the PCN can be either beside the canal or the borrowed green space. Coastal Areas will have a wider space allocated to the RIR to allow for larger planting space (9m). Boardwalks for RIR will be 5m in width.

PCN-RIR at Drainage Reserve Type A

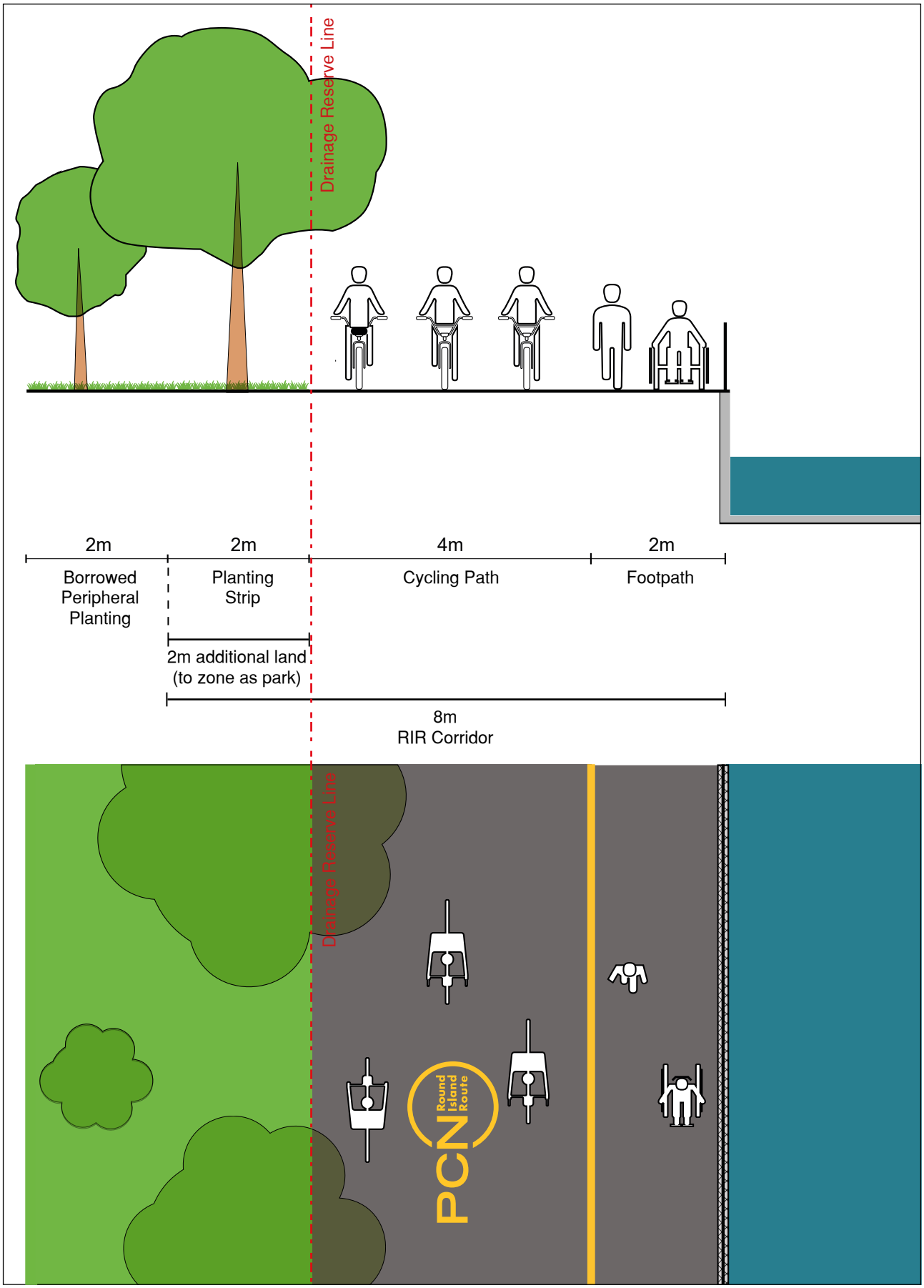


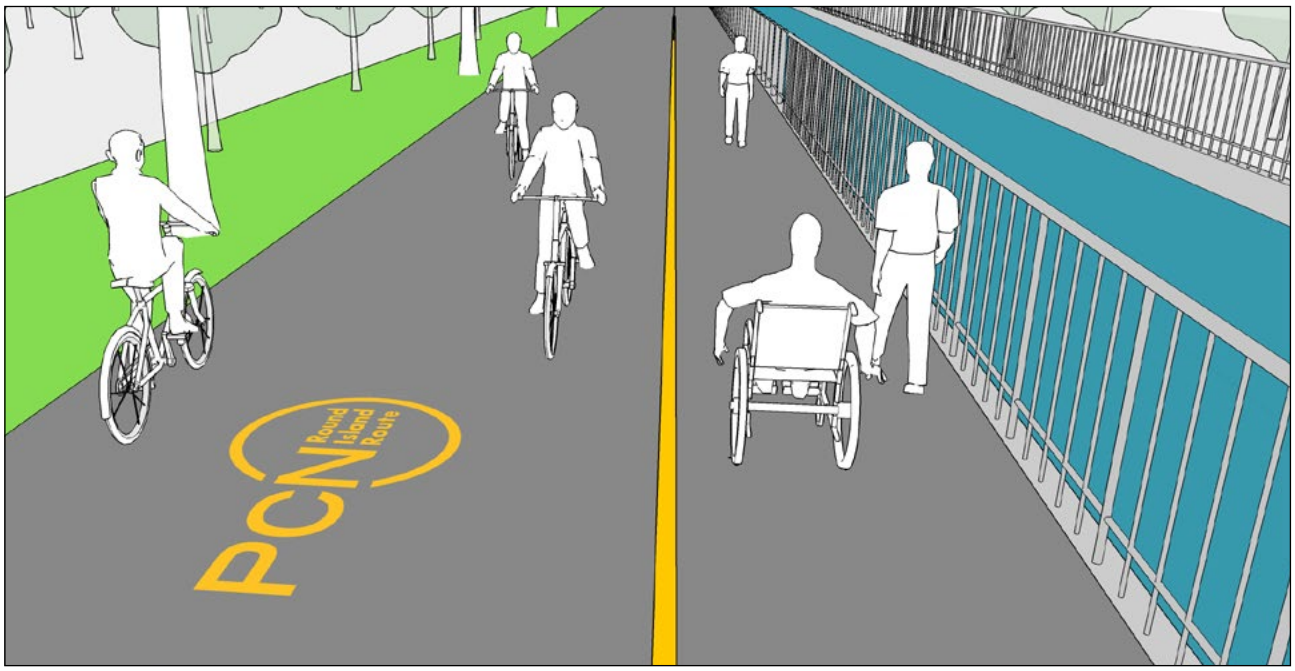


ABOVE: Perspective of PCN-RIR at Drainage Reserve Type A

4.3.2 PCN-RIR at Drainage Reserve (Cont'd)

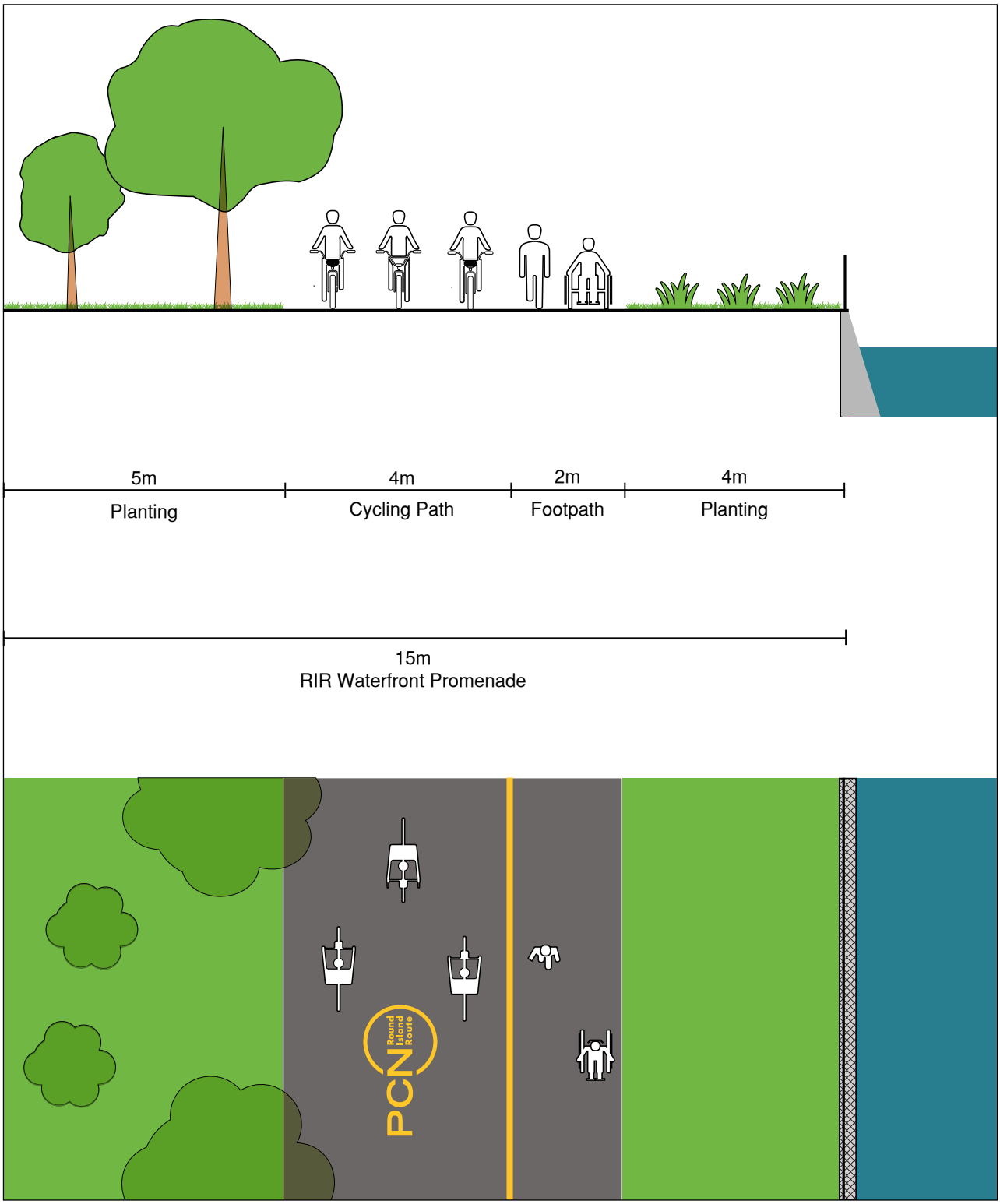
PCN-RIR at Drainage Reserve Type B

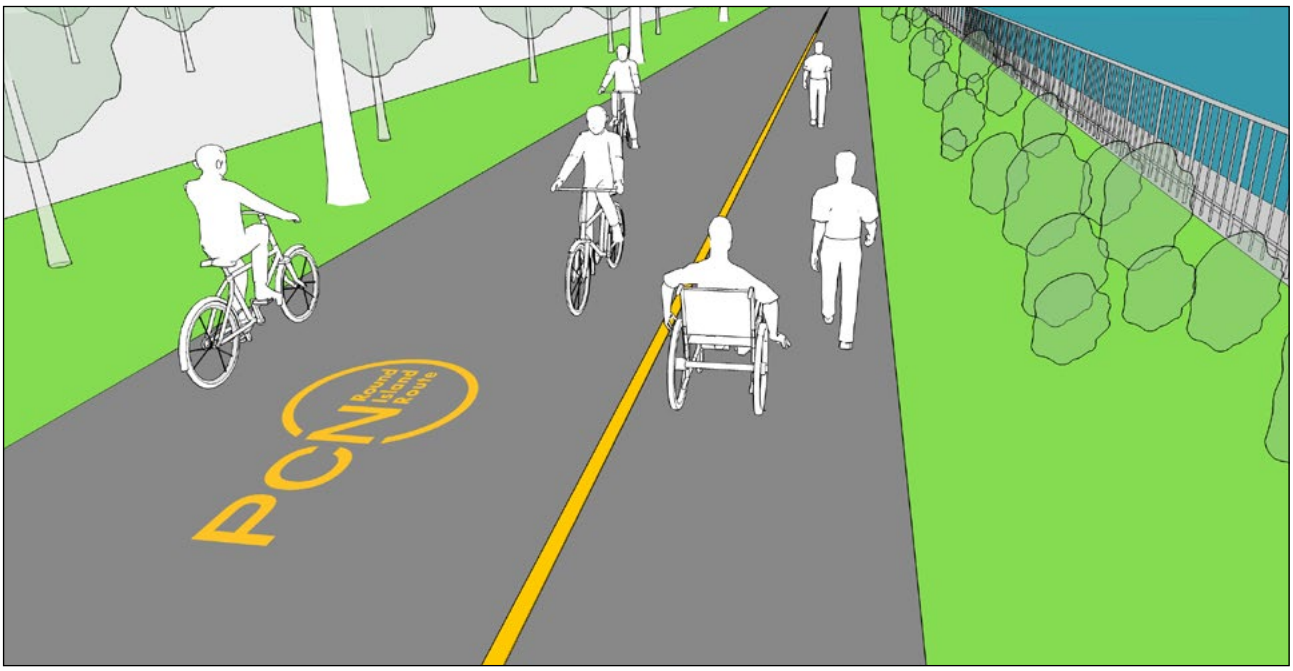




ABOVE: Perspective of PCN-RIR at Drainage Reserve Type B

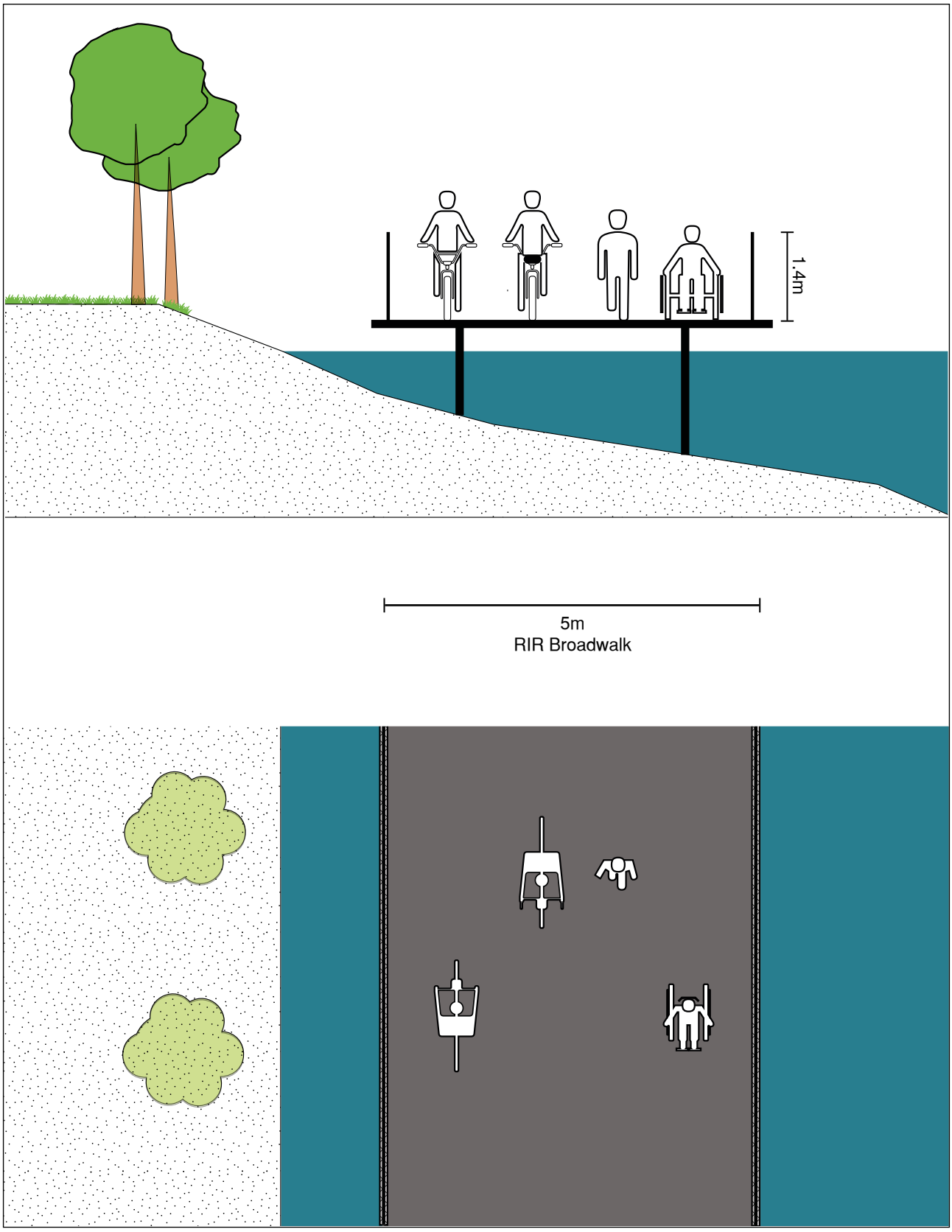
4.3.3 PCN-RIR Along Coast

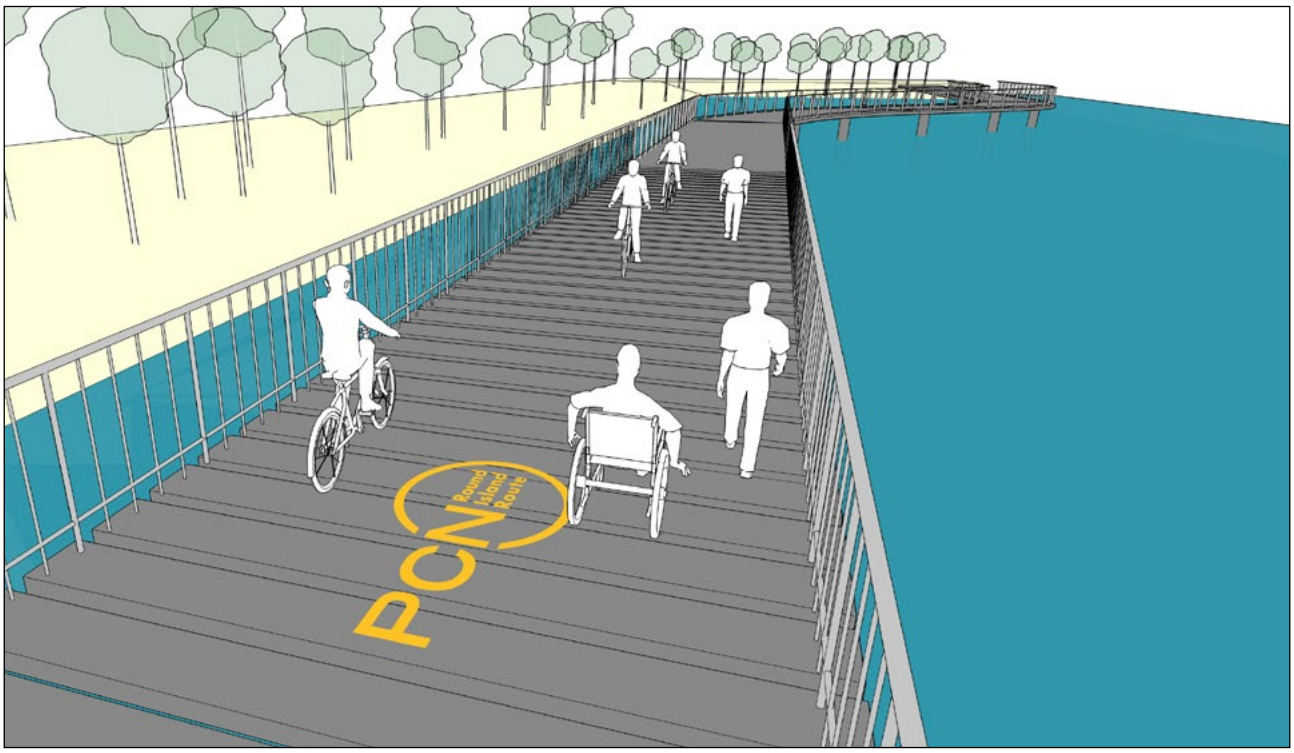




ABOVE: Perspective of PCN-RIR along coast

4.3.4 PCN-RIR Boardwalk





ABOVE: Perspective of PCN-RIR boardwalk

Crossing Features

Crossings are nodes where users of different speeds will interact and conflict may arise. Hence, safety is our top priority when designing for crossing features. A safe crossing should include necessary traffic calming measures to slow down faster oncoming traffic, and elements such as signage, signals and markings to guide the users.

This chapter explains the various types of traffic calming measures, safety features and crossings that can be seen in Singapore's streetscape to make active mobility commuting safer. It also documents special traffic zones such as School Zone and Silver Zone, which are introduced to cater to the needs of users, such as children and the elderly.

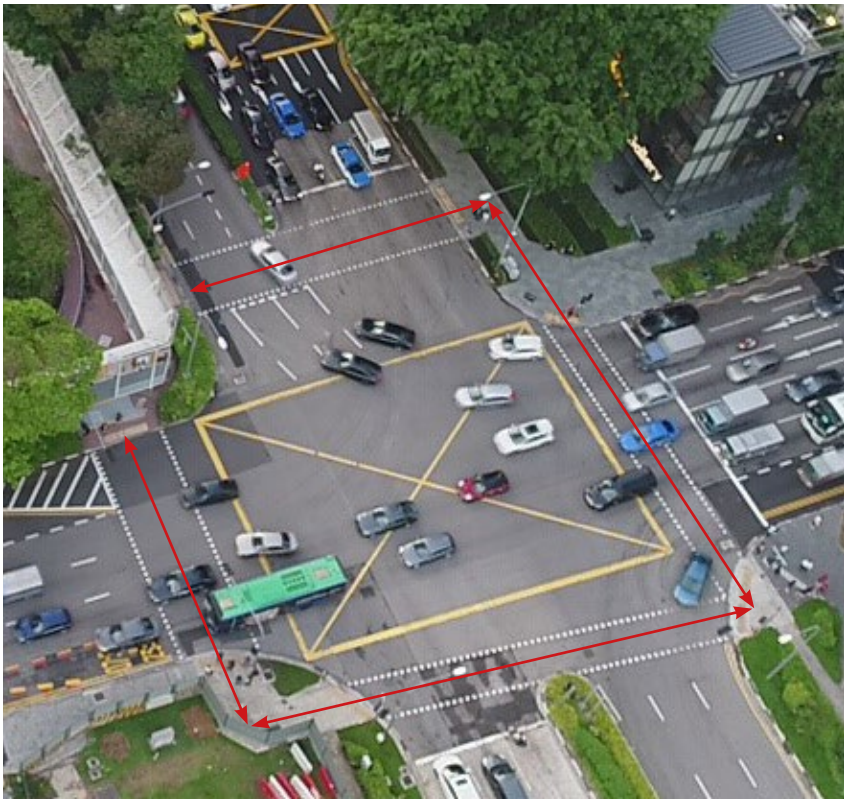
5

5 CROSSING FEATURES

5.1 At Grade Crossings

5.1.1 Junction Crossing

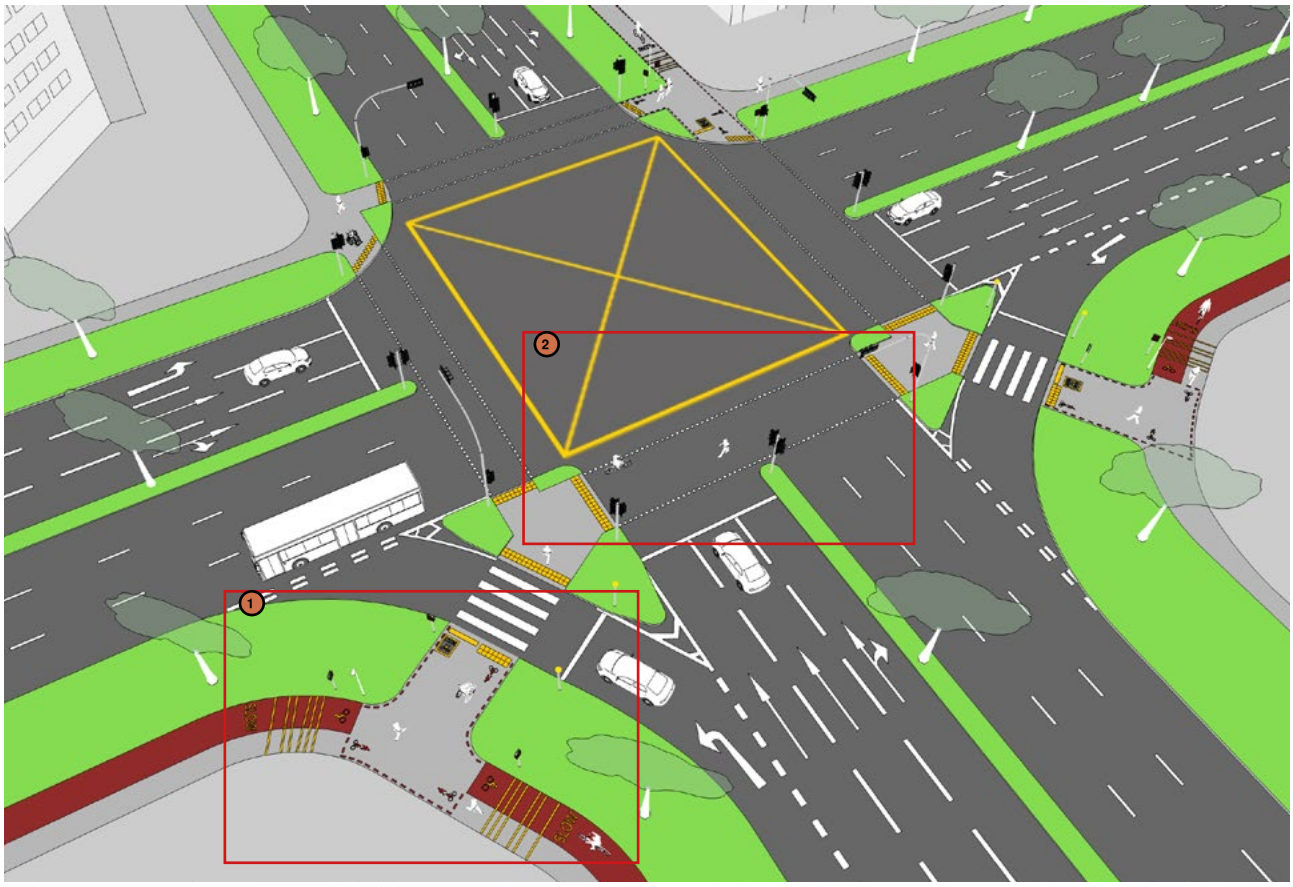
Most of Singapore's signalised junctions are designed with pedestrian crossings to balance the needs of vehicular and pedestrian traffic on the roads. Typically, pedestrian crossings are provided on all sides of the junction unless there are site limitations, traffic or safety considerations.

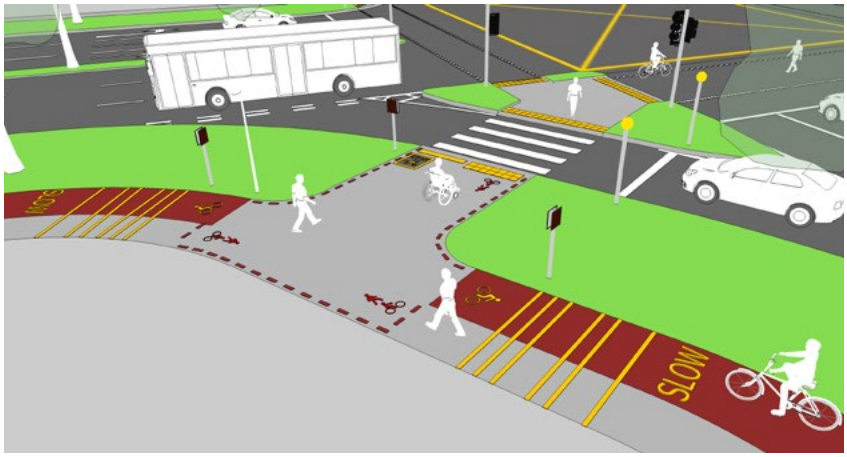


LEFT: Example of pedestrian crossings implemented on all sides at a major junction.

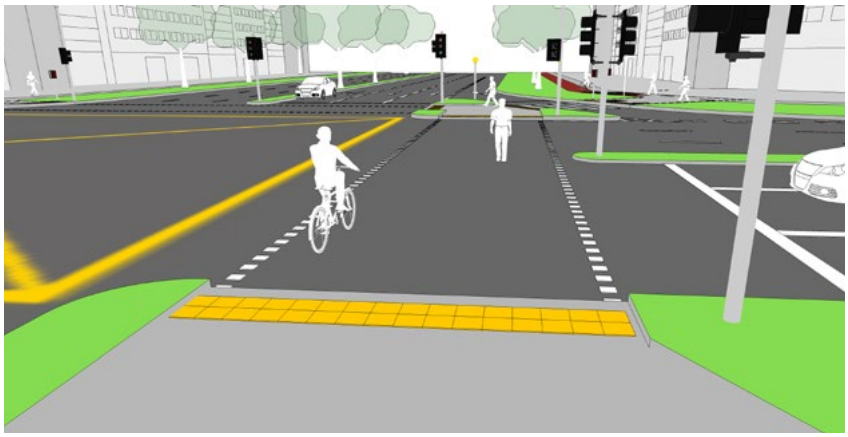
LEFT: Example of a limited crossing leg at a T-junction due to traffic and safety considerations.

Overview: Major Junction With Wider Crossings For Cycling





LEFT: 1 Waiting area/ Pedestrian Priority Zone at the junction



LEFT: 2 Waiting area and crossing at the junction

5.1.2 Mid-block Crossing

Mid-block pedestrian crossings are usually implemented near developments and amenities that generate high volume of pedestrian activity. They can be designed as a one-stage or two-stage crossing depending on the road geometry, traffic volume and crossing span. One-stage design is perceived as more convenient for the pedestrians and cyclists. However, for wider roads with a wide centre divider, two-stage crossing is catered so that the walking distance can be split with a break in between. This helps to accommodate pedestrians with a slower walking pace without overly affecting the delay to vehicular traffic.

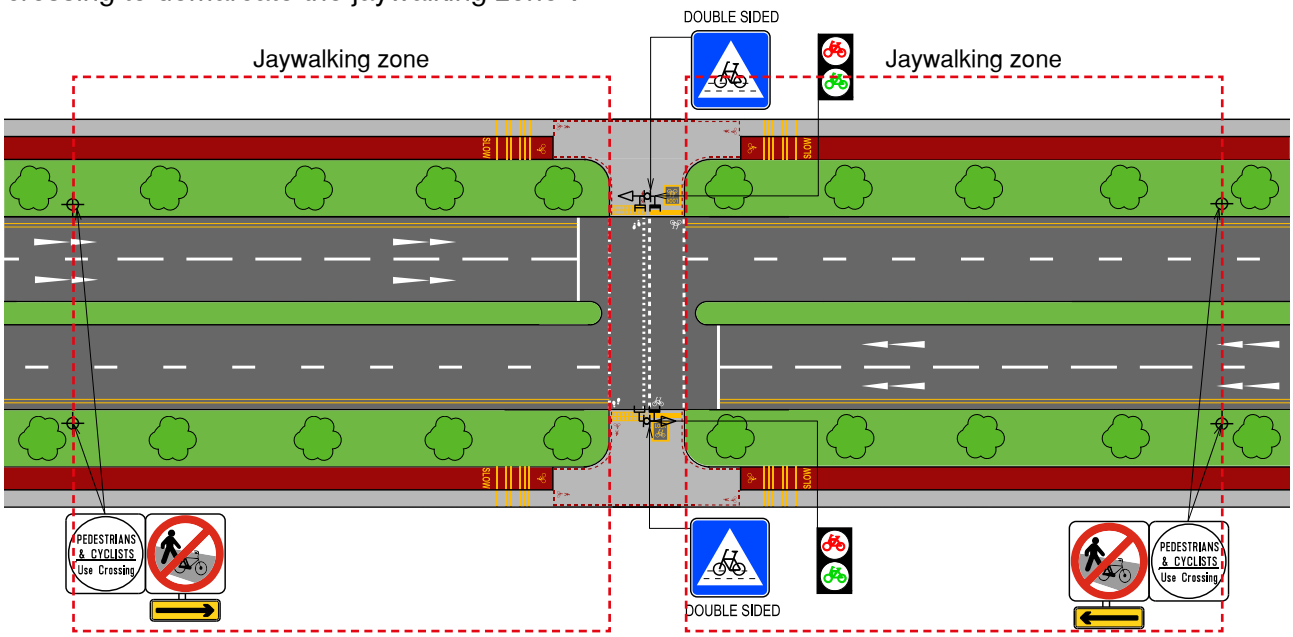
ABOVE: Example of a one-stage crossing

ABOVE: Example of a staggered crossing

5.1.3 Design of Junction and Mid-block Pedestrian Crossing

Pedestrian crossings are minimally 3m wide. Wider crossings are considered at locations with high pedestrian traffic (e.g. near major transport node or amenities). Pedestrian crossing aspects with countdown timers and traffic signal aspects must be provided and not be obstructed to ensure clear visibility.

Pedestrian's waiting area is ramped down and provided with homogeneous tactile tiles for the visually-impaired. Pedestrian and cyclist crossing prohibition signs are provided 50m from the crossing to demarcate the jaywalking zone*.



Distance between Pedestrians Cyclists Prohibition sign and crossing: 50m

* Jaywalking zone: Pedestrians are deemed jaywalking when crossing the road within 50m from a junction.

5.1.3 Design of Junction and Mid-block Pedestrian Crossing (Cont'd)

Pedestrian Crossing Lines are of dashed lines to make the designated crossing more conspicuous. At least 2 sets of arrow markings are provided on the road carriageway before the stop line to guide motorists to slow down as they approach the crossing.

ABOVE: Signalised pedestrian crossing

5.1.4 Zebra Crossing

Zebra crossings are usually implemented at minor roads and on slip roads where pedestrian and traffic volume is lower. Zebra crossings at slip roads are often demarcated with markings, flashing beacons and signs. Alternatively, there are also raised zebra crossings which are elevated in nature and are flushed with the footpath for barrier-free access.

ABOVE: Zebra crossing at slip lane

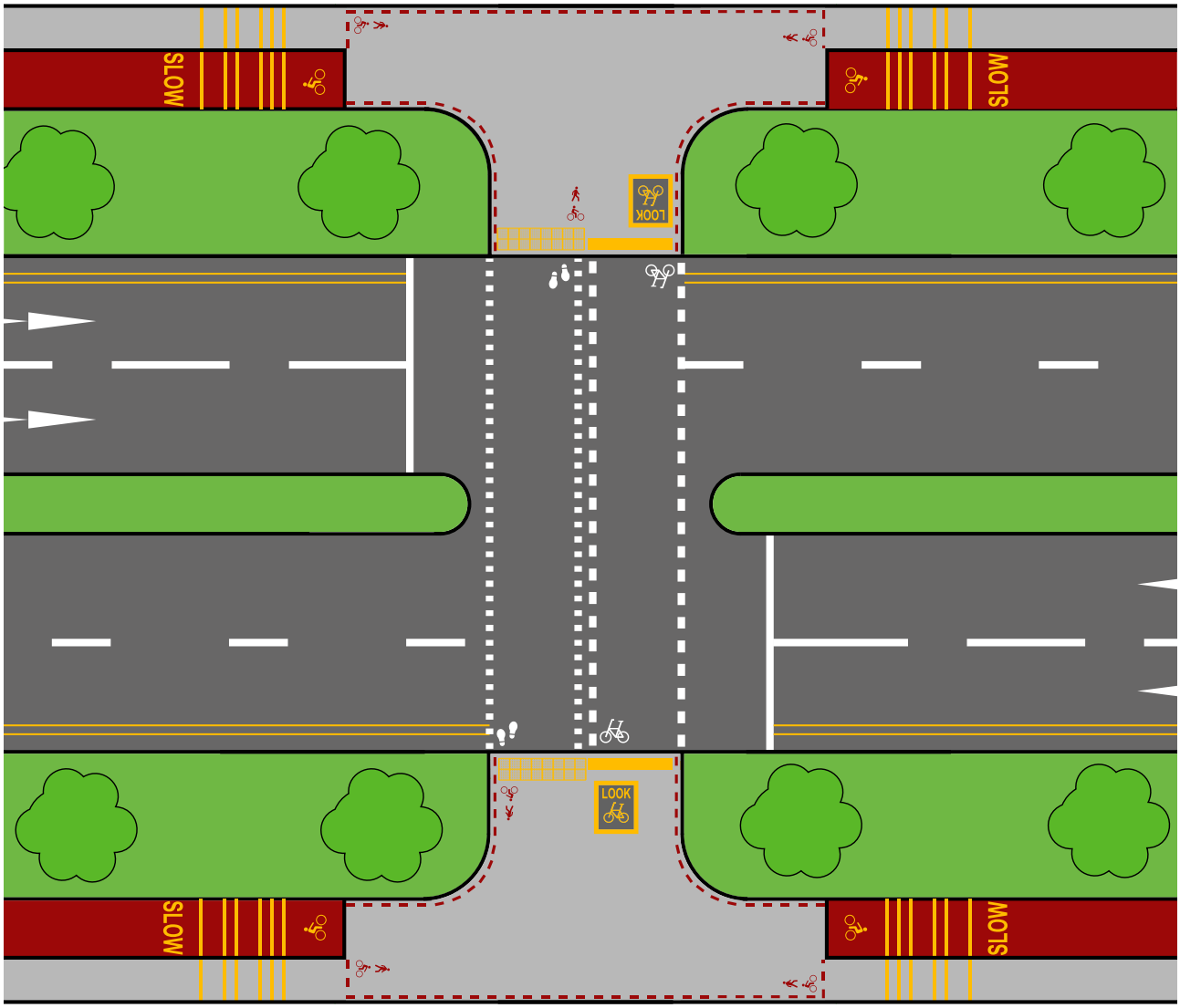
5.1.5 Bicycle Crossing

Bicycle crossing is an additional feature to current mid-block pedestrian crossing. With the legalisation of cycling on footpath, all new mid-block crossings will have a bicycle crossing.

Design of Bicycle Crossing

A dedicated bicycle crossing is 3m in width, identical to the dimensions of a pedestrian crossing. Instead of homogenous tactile tiles, a 'Look' box will be provided for cyclists at the bicycle crossing waiting area. At the bicycle crossing area, the traffic signal will also show a bicycle logo.

Standard Pedestrian & Bicycle Crossing Design



Please refer to LTA's Standard Details of Road Elements (SDRE) for more details.

5.2 Grade-Separated Crossings

5.2.1 Pedestrian Overhead Bridge (POB)

Pedestrian Overhead Bridge (POB) is typically built across at least Dual-Two road for safer crossing of pedestrians. To provide barrier-free access (BFA), lifts are now installed at POBs. Also, cycling is not allowed on POB due to safety reasons. Please refer to LTA's Architectural Design Criteria for more detailed requirements on the following.

Structure

ABOVE: POB dimensions

A POB is an elevated structure across the road supporting a sheltered footpath. It is provided with sheltered staircases on both ends. The bridge is provided with a height clearance to allow vehicles to pass below the structure.

Typically, POBs that are intended to provide easy accessibility to the nearest transport nodes, such as bus stops, will have their staircases oriented towards the bus stops either in dog-legged or straight arrangements to route pedestrians to the bus stops.

The typical clear width of the footpath on the structure is 2m and it is determined based on a space for two pedestrians to walk side by side and a third pedestrian to overtake. For bridges with heavier footfall, the widths will be increased accordingly.

Planter boxes are provided on both sides of the bridge as part of our effort to keep Singapore a city in the garden.

ABOVE: Straight-legged

ABOVE: Dog-legged

Staircase

ABOVE: Stairs leading to POB

The width of the staircases is determined based on similar considerations as the width of the footpath on the bridge.

The dimensions of the treads and rises are in compliance with the ambulant disabled staircase requirements in BCA's Code on Accessibility in the Built Environment. The number of steps are established based on the height of the bridge and compliance with BCA's Approved Documents.

The minimum length of the landings are also in compliance with BCA's Approved Documents.

Railings & Tactiles

1 Safety Railing

2 & 3 Hand Railings

Hand railings are provided along both sides of the bridge and staircases. The hand railings consist of a top rail to cater to adults and a lower rail to cater to children. More details can be found in LTA's Architectural Design Criteria and BCA's Code on Accessibility in the Built Environment.

Tactile tiles are provided as detectable warning surfaces to alert pedestrians with visual impairment, in compliance with BCA's Code on Accessibility in the Built Environment.

Shelter

ABOVE: Sheltered POB

The bridge including the staircases are provided with shelter to protect pedestrians from light rain and direct sunlight. Typically, the shelters are connected to the covered linkways. The details of the shelter are similar to those of covered linkway found in Chapter 2.3.

Lifts

ABOVE: A lift serving POB

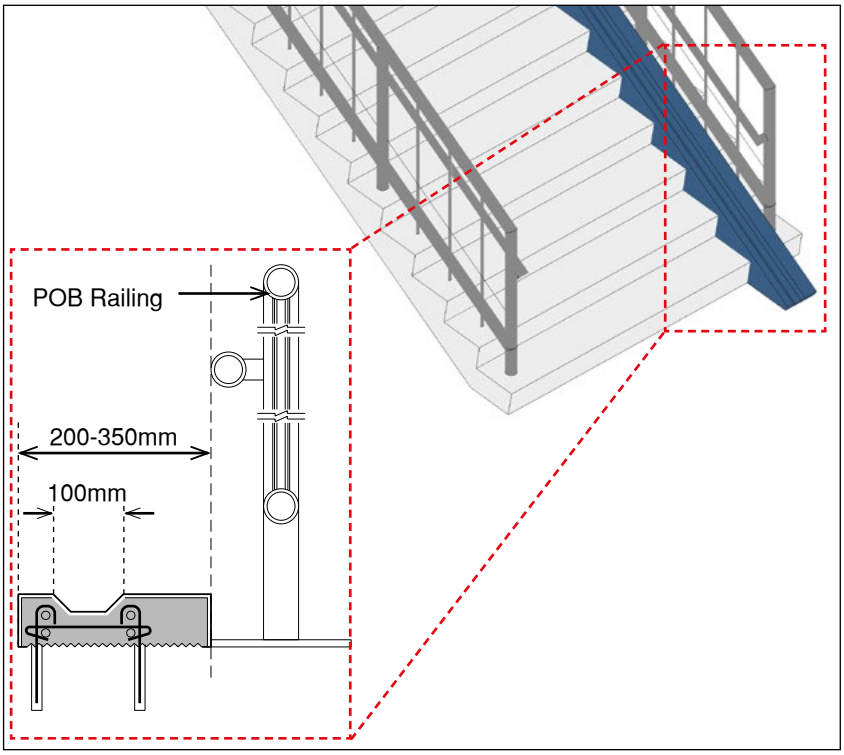
To achieve barrier free accessibility, ramps have been provided and in more recent years, in areas where footfalls are heavier and comprise more elderly pedestrians, lifts have been provided instead.

Typically, if the bridge connects to cycling paths on both sides of the road and there is no pedestrian crossing at grade within a 200m radius of the bridge. The lifts, if provided, are sized to fit two bicycles in addition to pedestrians.

Accessibility requirements (e.g. lift car size and clear spaces) of the lifts can be found in BCA's Code on Accessibility in the Built Environment.

Wheeling Ramp

Bicycle wheeling ramps help cyclists traverse stairs or pedestrian overhead bridges along the cycling path network. They are implemented in locations where there is no barrier-free ramp or lift.



The recommended width of wheeling ramp varies between 200mm and 350mm. The recommended width of the wheeling channel is 100mm and constructed in appropriate distance from the railing/ secondary handrail to avoid the catching of pedals or handle bars. It is recommended to ensure a smooth transition onto and off the ramp.

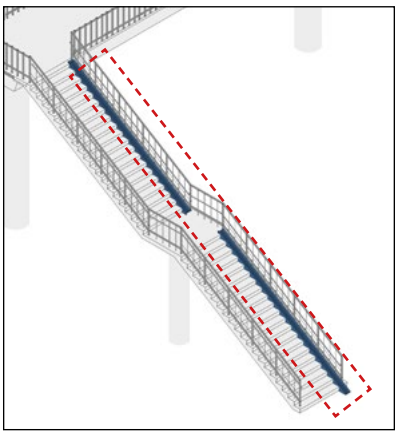
The surface of the wheeling ramp is recommended to have an anti-slip finish of skid resistance within the range of 45 to 60 BPN to ensure sufficient grip on descend. Finishing colour is recommended to be blue RAL5000 or equivalent. Surface water runoff through the wheeling channel should also be taken into consideration to prevent water ponding.

<u>Position of Wheeling Ramp</u>
Straight legged staircases: Recommend placing the wheeling ramp on the right (from bottom). As most cyclists are right-handed, it would be easier for them to push the bicycles up the straight-legged staircase, which requires more effort as compared to going down.

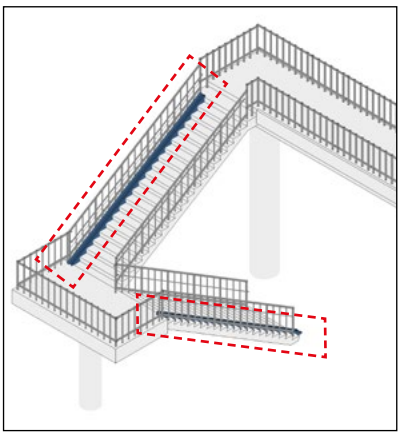
Dog-legged staircases: Recommend placing it on the left (from bottom) since the constraint is the turning point at the inner part of the staircase is shorter as compared to outer part.

ABOVE: Example of wheeling ramp

Straight Staircase Structure



Dogged-leg Staircase Structure



5.2.2 Cycling Bridge

To provide the critical connectivity, cycling bridges are essential to overcome physical barriers, (e.g. canals, expressways and terrain differences). Unlike pedestrian overhead bridges that require cyclists to dismount and push their bicycles, cycling bridges provide seamless commuting for all users - cyclists, pedestrians, joggers, personal mobility device users and persons with disabilities.

Location

Cycling elevated structures are vertically separated from motor vehicle traffic (e.g. expressways, roads, rail tracks) or water bodies (e.g. river, canals).

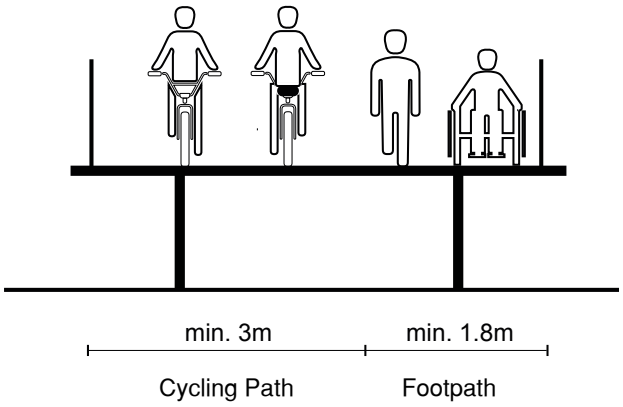
Proper treatment should be provided when the elevated structure merges onto the existing street.

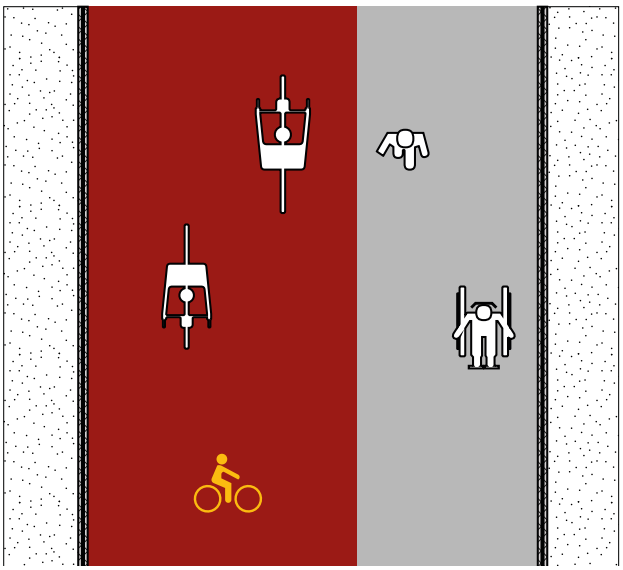
ABOVE: Artist's impression of the future cycling bridge connecting Tampines and Pasir Ris across Tampines Expressway (TPE)

Clear Width

We recommend a minimum clear width of **4.8m** for all elevated cycling structures - **minimum 1.8m** for pedestrian and **3m** for cyclist lane with demarcation, and excluding space allocated for railing. The minimum clearance provides necessary manoeuvring space to minimise conflicts with/between pedestrians and cyclists.

A minimum of 1.8m pedestrian path is recommended to allow 2 wheelchair users to comfortably bypass each other. A minimum of 3.0m cycling path is recommended to cater for cyclists' lateral movement to balance themselves when going up or down the ramp.





Headroom Clearance

1 Headroom clearance is the distance measured from the base of structure to the surface of ground. The minimum recommended headroom clearance of the cycling elevated structure over expressway and road is **5.7m** from the road surface. It also has to design for full collision load on super structures in accordance with the latest National Annex to Eurocode (2011).

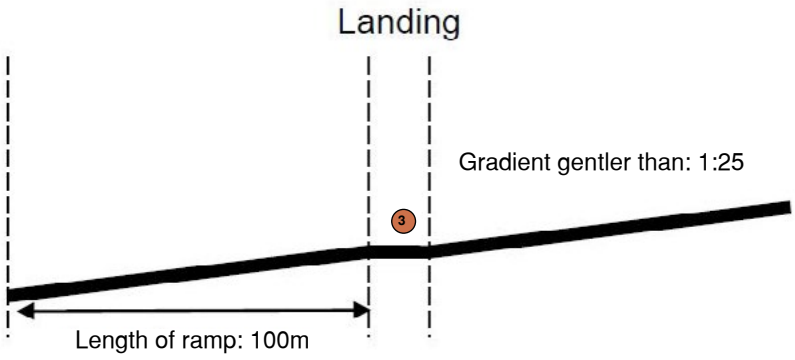
Please consult PUB on further guidelines for cycling bridges across canal.

Vertical Clearance

2 Vertical clearance is the minimum vertical distance from the floor of the cycling bridge to the overhead structures. Taking into consideration the average height of a cyclist and diameter of a bicycle wheel, its recommended minimum vertical clearance is **2.4m** to prevent cyclists' collision with overhead fixtures.

Bridge Ramp

According to international standards, the access ramp of the bridge is recommended to have a **minimum 4.8m** clear width. For ease of cycling up the ramp, its recommended gradient is or gentler than 1:25 (4%). A gradient break in **every 100m** ramp, with a level landing of **minimally 5m** is recommended to allow at least two bicycles to rest abreast of one another.

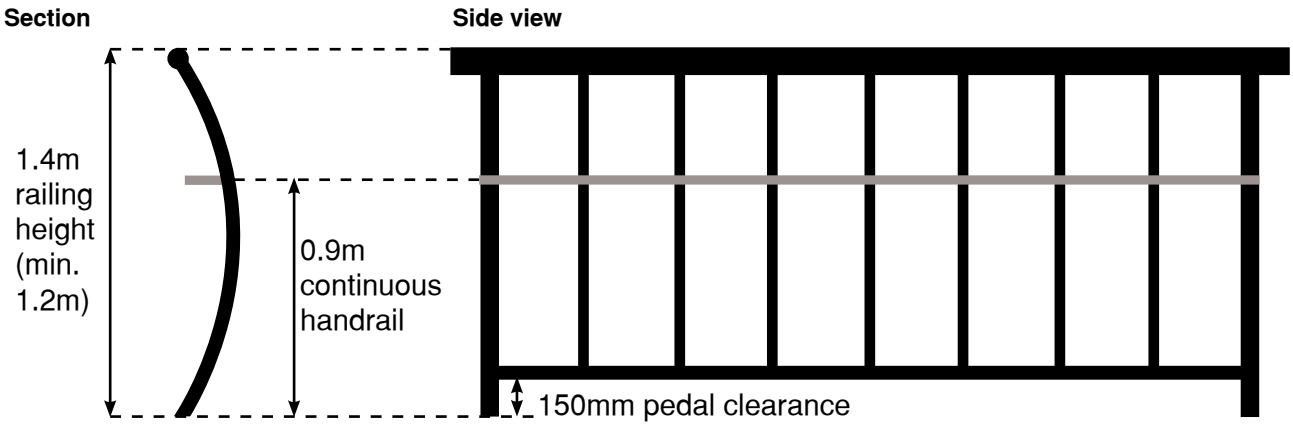


3 Level landing of minimally 5m every100m ramp.

Bridge Railing Height

All railings are recommended to be **1.4m high (minimum 1.2m)** and use stainless steel Grade 316 with a minimum buffer of **150mm pedal clearance at the bottom of the railing**.

A **continuous handrail** shall also be provided along the staircase and ramp at **0.9m high** from the thread and ramp.



Note: Gaps between railings are indicative only

1 Recommended railing height: minimally 1.4m

Turning Radius

The minimum radius is recommended to design according to Chapter 10 of Civil Design Criteria for Road and Rail Transit System, using the design speed of 25km/hr. The radius should be **between 15 to 20m**.

ABOVE: Ulu Pandan Cycling Bridge (Photo Credit: Darric Tan)

Drainage & Lighting

Drainage system shall be designed such that surface runoff is properly discharged to drains to prevent water ponding. Effective drainage shall continue to be provided for the area around and in the vicinity of these crossings.

Please also refer to Chapter 2.10 and LTA's Public Street Lighting Guidelines for the cycling path lighting requirements and technical specifications.

Other Additional Requirements

Planting Troughs
Providing continuous planting troughs on both sides of the cycling bridge along the portions that cross over roads is recommended.

Please consult NParks for more details.

Safety
Measures such as calming devices (e.g. speed regulating strips, humps), curve widening, signage and stopping sight distance should be considered in the design to address potential safety issues.

Please refer to Civil Design Criteria for Road and Rail Transit System for more details.

Wayfinding Signage
To direct users to their destinations, wayfinding signage should be provided near decision points with multiple access or exit points, or when access points are difficult to locate.

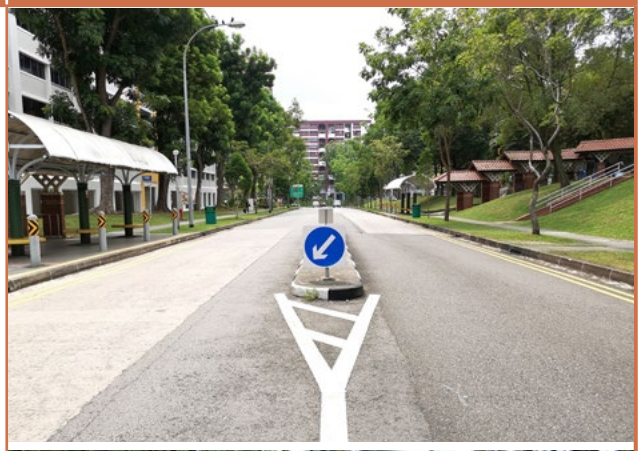
5.3 Traffic Calming Measures

Traffic calming measures are implemented at suitable locations to manage motorists' speed. More measures are implemented at Silver Zones and School Zones to enhance the safety and walking experience for senior pedestrians and students.

5.3.1 Physical Measures

Physical Measures	Purpose	Photo
Road Hump	Road humps slow down vehicles and prevent motorists from speeding.	
Bus-friendly Hump	Normal road humps, or roundtop humps are unsuitable for buses, as they can cause discomfort or even injuries to standing passengers. Hence, bus-friendly humps are placed along bus routes where such speed calming devices are needed.	
Speed Regulating Strips	Speed regulating strips are used to slow down vehicles at locations where it is not advisable to travel at high speed.	

5.3.1 Physical Measures (Cont'd)

Physical Measures	Purpose	Photo
Road Divider	Road dividers narrow lane widths, to encourage vehicles to travel slower.	 

5.3.2 Perceptual Measures

Perceptual Measures	Purpose	Photo
'SLOW' Road Marking	The 'SLOW' markings are to inform motorists to reduce their speed due to the proximity of some danger ahead.	
Chevron Marking	Chevron markings visually narrow lane (at roads that are not advisable to be constructed with physical centre divider), to encourage vehicles to travel slower.	
Your Speed Sign (YSS)	'Your Speed Sign' is a live electronic device that displays the real time speed of vehicles and alerts motorists that they are speeding. It encourages motorists to obey the speed limit displayed and thus improve safety on the roads. YSS is now part of LTA's range of measures used to improve the safety of roads along selected expressway slip roads.	  Solar YSS along PIE (Changi) exit to Tampines Ave 5

5.3.2 Perceptual Measures (Cont'd)

Perceptual Measures	Purpose	Photo
Traffic Calming Markings (TrCM)	TrCM create a visually narrowed lane and the triangles markings can provide an additional "gripping" and funnelling visual effect that encourages motorists to slow down. They also complement other traffic calming measures such as 'SLOW' marking, road humps and speed regulating strips.	

Summary Table: Recommended Applications of Traffic Calming Measures

	Traffic Calming Measure	Location					Environment	Placement		
		E'way slip roads	Major Arterial	Minor Arterial	Primary Access	Local Access	Observed speed reduction efficiency	1 lane per dir	2 lanes per dir	≥ 3 lanes per dir
Physical Traffic Calming Measures	Bus-friendly hump			✓	✓	✓	☆☆☆	✓	✓	
	Speed hump			✓	✓	✓	☆☆☆	✓	✓	
	Speed regulating strips	✓		✓	✓		☆☆	✓	✓	
	Centre divider			✓	✓	✓	☆☆	✓	✓	✓
	Chicanes (kerb/ markings)				✓	✓	☆☆	✓	✓	
Perceptual Traffic Calming Measures	Lane narrowing (markings)	✓	✓	✓	✓	✓	☆☆	✓	✓	
	'SLOW' markings	✓	✓	✓	✓	✓	☆	✓	✓	✓
	Textured pavement				✓	✓	☆☆	✓	✓	
	Traffic Calming Markings (TrCM)	✓		✓	✓	✓	☆	✓	✓	
	Your Speed Sign (YSS)	✓					☆☆	✓	✓	

5.3.3 Silver Zone

Silver Zones are areas with enhanced road safety measures, such as new signs, road features and markings, to change the character of the street, making it safer and more convenient for senior pedestrians. This is achieved by narrowing roads to lower vehicle speeds, reducing speed limits, guiding pedestrians to specific crossing points. Silver Zones are found in selected housing estates with high senior populations, relatively higher accident rates involving seniors and closer proximity to amenities catering to the seniors.

ABOVE: Silver Zone implemented on ground

Silver Zone Gateway

The Silver Zone Gateway includes signs and road markings that indicate the start of a Silver Zone. These features have attention-grabbing bright fluorescent yellow-green signs and yellow rumble strips. They aim to alert motorists to slow down and look out for senior pedestrians. Silver Zones will also reduce speed limit to 40km/h, where possible.

Setback Crossing

Setback kerb cut ramps allow pedestrians to enjoy shorter crossing distances. Motorists also benefit by having sufficient time to look out for potential crossing pedestrians. At kerb cut ramps, motorists still have the right of way and pedestrians should ensure that there are no oncoming vehicles before crossing the road.

Before

ABOVE: Junction of Bukit Merah View and Jalan Bukit Merah

After

ABOVE: Silver Zone Gateway and Setback Kerb Cut Ramps at junction of Bukit Merah View and Jalan Bukit Merah

Two-Stage Crossings

Pinch Points and Eye-Lands provide pedestrians with two-stage crossing so that they can rest momentarily at the pedestrian refuge (centre divider) before continuing to cross the road. Kerb cut ramps eliminate the need to step up and down roadside kerbs so it is easier on the legs. Tactile tiles are provided on the ramps to serve as a reminder to look out for vehicles before crossing the road.

Pinch Point involves pinching of the lane widths so as to encourage motorists to slow down.

Before: Wider lane width along Jurong West Street 52

After: Pinch Point at Jurong West Street 52

Eye-Lands bulge out of the carriageway, creating a widened centre divider as a refuge for crossing pedestrians.

Before: Straight stretch of road at Bukit Merah View

After: Eye-Land at Bukit Merah View

Chicane

Chicanes are horizontal curves constructed along existing straight stretches of roads. They create S-shaped curves that encourage motorists to drive slowly.

Before: Straight stretch of the road at Bukit Merah View

After: Chicane at Bukit Merah View

Mountable Centre Divider

Mountable Centre Dividers, being low in height, allow emergency vehicles to pass over them during emergencies when is it safe to do so. They also aim to narrow lane widths so vehicles travel slower, making it safer for pedestrians to cross the road.

Before: Undivided road configuration at Jurong West Street 52

After: Mountable Centre Divider along Jurong West Street 52

Bollards at Crossing

Bollards fitted with retro-reflective sheeting are installed at zebra crossings. When headlights of approaching vehicles shine onto them, the sheeting reflects the light back to the motorist. This makes the crossing more obvious.

Bus-friendly Hump

Bus-friendly humps slow vehicles down and prevent motorists from speeding. Commuters will have less discomfort when the bus travels over a bus-friendly hump as compared to the road hump.

Before: Undivided road configuration at Jurong West Street 52

After: Bus-friendly Hump implemented along with centre divider at Jurong West Street 52

5.3.4 School Zone

During the start and end times of school sessions, there is usually heavy traffic near schools. As children are inexperienced and vulnerable road users, it is important to keep school zones safe.

Prominent school zone signs are installed at school zones to inform motorists that they are entering a school zone and should drive carefully.

Traffic safety measures

Other traffic measures may be installed in school zones to enhance safety, including:
- Traffic calming measures such as road humps and speed regulating strips
- Raised road surface at pedestrian crossing/signalised at grade crossing
- Parking restrictions
- Railings along the road centre to deter jaywalking

Enhanced School Zones

A school zone with more visible features gets the attention of motorists and reminds them to drive more carefully.

The Enhanced School Zone scheme was introduced to increase the visibility of school zones through the following ways:

- Prominent school zone signs to indicate the start and end of school zones;

- Parts of the road surface near the school gate are covered with a red texture to catch drivers' attention and alert them to look out for children crossing the road;

- 'SLOW' and 'SCHOOL' word markings on the road to further remind motorists that they are travelling within a school zone.

The Enhanced School Zone is implemented at primary schools and special schools, subject to factors such as the road geometry and the type of road outside the schools.

The red textured road surface makes the school zone more noticeable

ABOVE & RIGHT: These traffic signs indicate the school zone clearly

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Bike Parking & Supporting Facilities

While implementing more cycling paths islandwide, we also have to ensure sufficient bike parking spaces and the necessary supporing facilities at trips' origins and destinations to promote cycling as a viable option for first- and last-mile commutes. Again, these will take up additional space in our built-up environment which is why it is important to set guidelines in this chapter to standardise the design and dimensions of bike parking and the supporting facilities.

6

6 BIKE PARKING & SUPPORTING FACILITIES

6.1 Bike Parking Design

With an increasing demand in cycling, it is challenging to provide sufficient bicycle parking lots in our land-constrained Singapore. Hence, a variety of bicycle parking designs is adopted to optimise space, such as U-Bar racks and double tiered racks, amongst others.

ABOVE: Double-tiered bike racks at Ang Mo Kio MRT

To provide secured bike parking facilities, all racks should ideally allow users to lock a bicyle at 3 points: the front wheel, frame, and back wheel.

Water ponding on the facilities is to be taken into consideration as ponding will promote mosquito breeding.

ABOVE: Bike racks should provide 3 points for secured bike parking

6.1.1 Wheel Rack

Wheel racks are basic racks where the front wheel of the bicycle slots in the gap and is chained to the rack.

Wheel racks are usually spaced 0.6m away from each other and can accommodate 1 bicycle per rack.

Pros	Cons
Cost-efficient and require minimal clearance width	Only the front wheel of the bicycle can be chained. Users do not have the option to secure other parts of their bicycle.

6.1.2 U-bar Rack

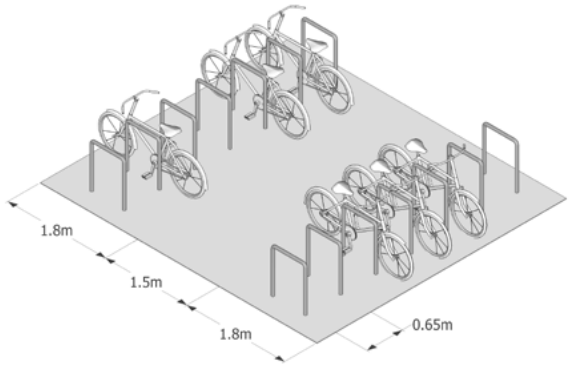
U-bar racks, or Sheffield racks, are shaped in an inverted U anchored on the ground. Cyclists can rest their bicycle on the structure and chain it to any part of the rack.

U-bar racks are spaced 0.6m away from each other and can accommodate 2 bicycles per rack.

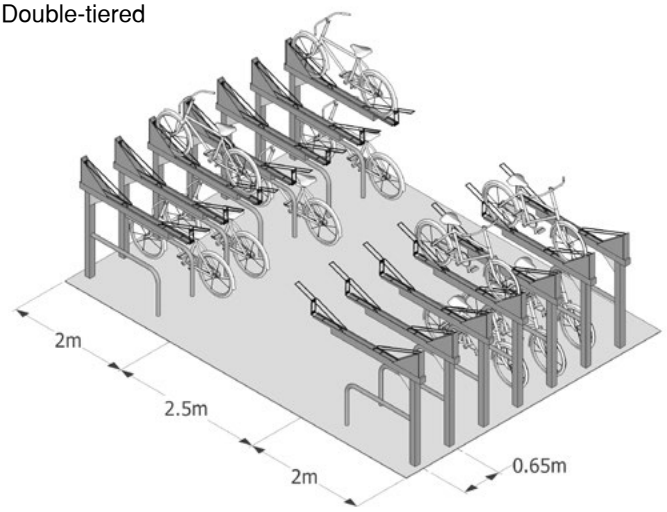
Pros	Cons
Space and cost efficient. Cyclists can lock their bicycle securely at 3 different locations.	Might not be convenient to park and take out the bicycle due to the close spacing of the racks, especially when the racks are full.

Spatial comparison between U-bar and Double-tiered racks

U-bar



Double-tiered



6.1.3 Double-tiered Rack

ABOVE: At Ang Mo Kio MRT

ABOVE: At Tan Kah Kee MRT

Double tiered racks have a second elevated tier to accommodate another bicycle.

Racks are usually spaced around 0.65m apart and can accommodate 2 bicycles per rack.

Pros	Cons
Space efficient: effectively doubles the density of a given space.	More expensive than wheel racks and U-bar racks. Some users may have difficulty when hoisting the bicycle up the upper level.

6.1.3 Double-tiered Rack (Cont'd)

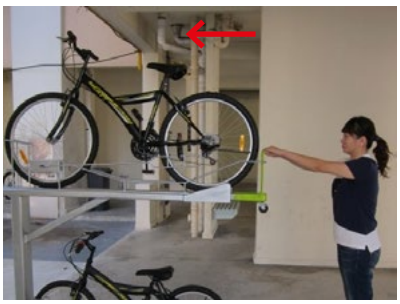
Scan QR code to watch the instructional video of using double-tiered rack

How To Use The Dual Bicycle Rack System

Loading Your Bicycle

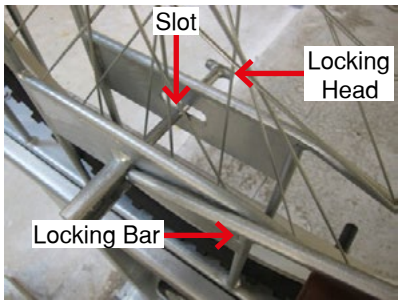
1. Pull the retractable rack towards you until it is fully extended, and push it downwards.

2. Place the front wheel of the bicycle on the rack and guide the entire bicycle onto it.



2. Lift the rack, and push it back to its original position

Locking Your Bicycle



1. Unhook the locking bar. Secure front end of bicycle by tilting locking bar upwards and inserting aligned locking head through the slot.

2. Position locking ring next to the spokes of the back wheel.

3. Thread your own bicycle lock through locking ring and bicycle frame to fully secure the bike. Hook up the locking bar after removing your bicycle.

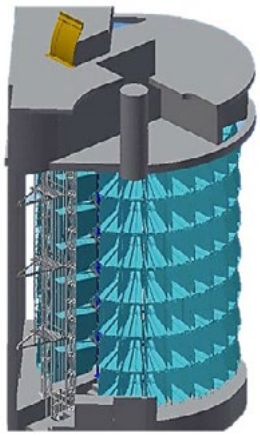
6.1.4 Designated Bike Parking Zone (Yellow Boxes)

Bike parking zone demarcated with a yellow box is a designated bike-parking zone for all cyclists' use. With the popularity of the bicycle sharing scheme in Singapore, this designated bike-parking zone has been introduced to more locations islandwide as one of the measures to address indiscriminate parking of bike-share bicycles.

Currently, the scheme is implemented at locations such as MRT stations, bus stops, void decks and parks. LTA is working closely with agencies like Town Councils & NParks, as well as bike-share operators to draw more boxes within their respective managed areas islandwide.

ABOVE: A Yellow Box in a park

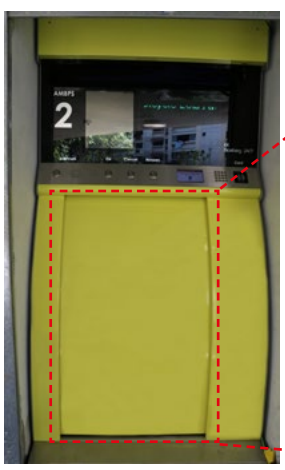
6.1.5 Automated Mechanised Underground Bicycle Parking System



ABOVE: Conceptual design of the Automated Mechanised Underground Bicycle Parking System

Automated Mechanised Underground Bicycle Parking System allows cyclists to store bicycles and cycling gear securely, and protect their bicycles from theft, vandalism, and the weather.

'SecureMyBike' is Singapore's first fully automated underground bicycle parking system. Originating from Spain, this bicycle parking facility can store up to 501 bicycles and will pilot in Kampung Admiralty development.



ABOVE: Bike parking slot (closed)

ABOVE: Bike parking slot (open)

Pros	Cons
Efficient for areas with land constraints to utilise space underground to store bicycles, freeing up more valuable above ground space. The mechanised system allows bicycles to be stacked closer together as well, increasing the density.	Expensive to construct and maintain.

6.1.6 Other Bike Parking Designs

There are different bike parking designs implemented in Singapore and elsewhere, which can make the streetscape more lively and interesting.

New and innovative designs are welcomed as long as they cater to the bike parking needs in the area and fit the site context.

ABOVE: At OUE Downtown

6.1.6 Other Bike Parking Designs (Cont'd)

ABOVE: At Bencoolen MRT

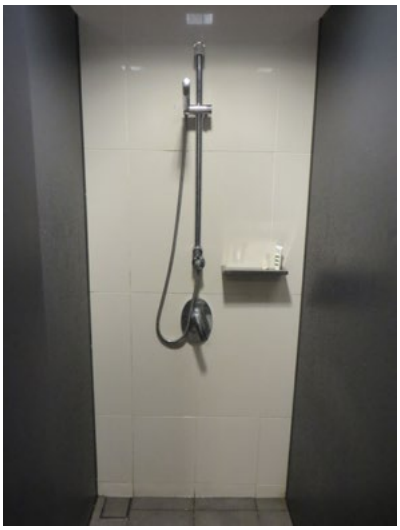
ABOVE: Simple design at Rochor MRT

ABOVE: Interesting design overseas (Photo source: Inhabitat.com)

6.1.7 End-of-Trip Facilities

A series of supporting End-of-Trip facilities is recommended to encourage people to cycle as a form of commute. Below are a few examples implemented in some developments in Singapore.

Changing Room, Lockers & Shower Facilities



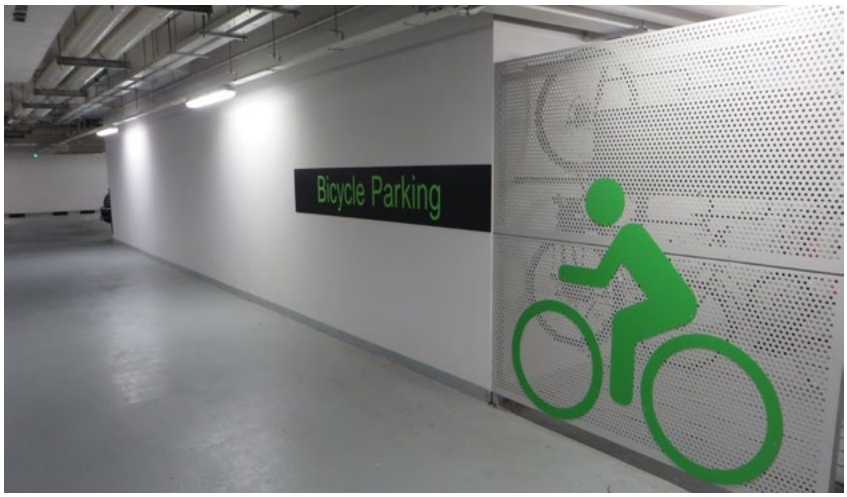
ABOVE: Supporting facilities at Asia Square

Bike Servicing Facilities

ABOVE: Pumping station for flat tyres @ OUE Downtown

ABOVE: Repair tools for a quick fix @ OUE Downtown

Clear Wayfinding Signage



ABOVE: Clear signage at Asia Square

6.2 Bike Parking Provision

Provision of bicycle parking within developments is one key strategy to encourage people to commute via cycling. We have established the minimum bicycle parking provisions for the different types of development (i.e. MRT stations, parks, HDB development, etc.) below.

6.2.1 MRT Stations

Station Class	Range of Bicycle Parking Lot provisions	Remarks
First-mile Station	250 to 800	Aditional 80 lots per foreign workers dormitory within 1.5km from the MRT station
Last-mile Station	130 to 180	- Additional 50 lots per foreign workers dormitory within 1.5km from the MRT station - Deduction of 80 lots if the station has a bus interchange/Integrated Transport Hub (ITH)

Depending on the nearby landuse, MRT stations are categorised as either a predominantly 'first-mile' or 'last-mile' station. Subsequently, the number of the bicycle parking lots is determined based on various factors such as MRT ridership, dwelling units (DUs), and presence of foreign workers dormitory. Based on existing data and surveys, the 'first-mile' stations have higher bicycle parking lots demand as compared to last-mile stations, hence the higher quantum required.

ABOVE: Bike racks along Bencoolen Street

6.2.2 Private Developments

To promote car-lite, the Walking and Cycling Plan (WCP) aims to guide developers to implement active mobility related infrastructure. Under the WCP, developers will provide bicycle parking facilities to encourage active mode of transport. Apart from bicycle parking provision, developers are also recommended to provide long-term and short-term bicycle parking spaces catering to different building users. The recommended bike parking provision are listed in Table 1 & 2 in the following pages.

To encourage people cycle to work, comprehensive End-of-Trip facilities such as showers and lockers provision are encouraged in tandem with bicycle parking provisions for private developments. The recommended End-of-Trip facilities provision standard is listed in Table 3.

Bicycle parking lots and End-of-Trip facilities can be exempted from being computed as GFA if it is provided according to the standards. The exemption is applicable to all bicycle parking lots if the surplus provision (above the minimum requirement) is considered to be reasonable. Please click here for more details.

ABOVE: Examples of bike parking supporting facilities in private developments in Singapore

Table 1: Bicycle Parking Provision Requirement For Developments

<table>
<tr><th>Proposed use</th><th>Developments Located within Zone 1 and Zone 2[1]</th><th>Developments Located within Zone 3</th></tr>
<tr><td>Residential
1. Residential developments
2. Retirement housing</td><td>1 bicycle parking space for every 4 dwelling units</td><td>1 bicycle parking space for every 6 dwelling units</td></tr>
<tr><td rowspan="6">Commercial
3. Cinema, theatre and concert hall
4. Shops and departmental stores
5. Offices
6. Restaurants, night-clubs, coffeehouses, bars, cafeterias, eating-houses and canteens
7. Convention and exhibition halls

Hotel
8. Hotel
9. Boarding houses and hostels[2]

Industrial
10. Factories
11. Business park, science park, computer software development, distribution services, printing, publishing and allied industries and other Business 1 developments
12. Petroleum, petrochemical, chemical and related industries on Jurong Island[3]

Health & Medical Care
13. Nursing homes
14. Clinic, pharmacies, hospitals and other health-care institutions</td><td colspan="2">a) When 1,000m2 =< Development GFA =< 3,000m2</td></tr>
<tr><td>15 bicycle parking spaces</td><td>10 bicycle parking spaces</td></tr>
<tr><td colspan="2">b) When 3,000m2 < Development GFA =< 15,000m2</td></tr>
<tr><td>1 bicycle parking space for every 200m2 of floor area</td><td>1 bicycle parking space for every 300m2 of floor area</td></tr>
<tr><td colspan="2">c) When 15,000m2 < Development GFA</td></tr>
<tr><td>1 bicycle parking space for every 200m2 of floor area, for floor area up to 15,000 m2, and 1 bicycle parking space for every subsequent 600m2 of floor area, for floor area in excess of 15,000m2</td><td>1 bicycle parking space for every 300m2 of floor area, for floor area up to 15,000 m2, and 1 bicycle parking space for every subsequent 1,000m2 of floor area, for floor area in excess of 15,000m2</td></tr>
<tr><td>Place of Worship
15. Churches, mosques, temples, any place of worship and other religious and related institutions</td><td>1 bicycle parking space for every 200m2 of floor area, for floor area up to 15,000 m2, and 1 bicycle parking space for every subsequent 600m2 of floor area, for floor area in excess of 15,000m2</td><td>1 bicycle parking space for every 300m2 of floor area, for floor area up to 15,000 m2, and 1 bicycle parking space for every subsequent 1,000m2 of floor area, for floor area in excess of 15,000m2</td></tr>
</table>

[1] Refer to Zonal Car Parking requirement in Code of Practice Vehicle Parking Provision in Development Proposals for the definition of Zone 1, 2 and 3, via the link below: https://www.lta.gov.sg/content/dam/ltaweb/corp/Industry/files/parking_zones.PDF. Generally, Zone 1: Central Area, Zone 2: 400m within MRT Station, and Zone 3: rest of the island.

[2] The bicycle parking provision standards apply to Backpackers' Hostels; student hostels are akin to Residential use.

[3] The bicycle parking provision requirement for petroleum, petrochemical, chemical and related industries on Jurong Island is based on office floor area.

Civic & Community Institution 16. Community centres, community clubs, welfare houses and other cultural and social welfare institutions **Sports & Recreation** 17. Sports complex, tennis, squash, badminton, sepak takraw courts, soccer, baseball pitches, bowling alley, swimming pool, ice/roller skating rink, recreational clubs, golf range and other sports and recreation facilities **Civic & Community Institution** 18. Foreign workers' dormitories[4]	**a) When 1,000m2 =< Development GFA =< 3,000m2**	
	30 bicycle parking spaces	20 bicycle parking spaces
	b) When 3,000m2 < Development GFA =< 15,000m2	
	1 bicycle parking space for every 100m2 of floor space	1 bicycle parking space for every 100m2 of floor space
	c) When 15,000m2 < Development GFA	
	1 bicycle parking space for every 100m2 of floor area, for floor area up to 15,000 m2 and 1 bicycle parking space for every subsequent 300m2 of floor area, for floor area in excess of 15,000m2	1 bicycle parking space for every 150m2 of floor area, for floor area up to 15,000 m2 and 1 bicycle parking space for every subsequent 500m2 of floor area, for floor area in excess of 15,000m2

Developers are encouraged to locate bicycle parking facilities at different areas in the development to cater to different users (e.g. visitors and occupants of the building).

Short-term bicycle parking spaces cater to visitors. Hence, they should be located at the ground level for easy access by the public. Similarly, long-term parking spaces cater to tenants or residents and could be located at any level of the development with safe internal cycling circulation leading to the facilities. The recommended short-term and long-term bicycle parking ratio is listed in Table 2 below.

Table 2: Recommended Distribution of Short-term and Long-term Bicycle Parking Spaces

Type	Use	Type of bicycle parking spaces	
		Short-term bicycle parking	Long-term bicycle parking
1	**Residential** 1. Residential developments 2. Retirement housing **Commercial** 3. Offices **Hotel** 4. Hotel 5. Boarding houses and hostels **Industrial** 6. Factories	20%	80%

[4] The bicycle parking requirements will also apply to Foreign Workers' Dormitories located on industrial sites.

	7. Business park, science park, computer software development, distribution services, printing, publishing and allied industries and other Business 1 developments 8. Petroleum, petrochemical, chemical and related industries on Jurong Island[5] **Civic & Community Institution** 9. Foreign Workers' Dormitories[6]	20%	80%
2	**Commercial** 1.Cinema, theatre and concert hall 2. Shops and departmental stores 3. Restaurants, night-clubs, coffeehouses, bars, cafeterias, eating-houses and canteens 4. Convention and exhibition halls **Health & Medical Care** 5. Nursing homes 6. Clinic, pharmacies, hospitals and other healthcare institutions **Civic & Community Institution** 7. Community centres, community clubs, welfare houses and other cultural and social welfare institutions **Place of Worship** 8. Churches, mosques, temples, any place of worship and other religious and related institutions recreational facilities **Sports & Recreation** 9. Sports complex, tennis, squash, badminton, sepak takraw courts, soccer, baseball pitches, bowling alley, swimming pool, ice/ roller skating rink, recreational clubs, golf range and other sports and recreation facilities	60%	40%

Table 3: End-of-Trip Facilities That Will Be Exempted From GFA Computation For Various Development Types

Development Type	GFA treatment
Residential 1. Residential developments 2. Retirement housing **Civic & Community Institution** 3. Foreign workers' dormitories[7]	No GFA exemption for bicycle supporting facilities as shower/ changing rooms are to be provided for within the home, or as part of the clubhouse facilities

[5] The bicycle parking provision requirement for petroleum, petrochemical, chemical and related industries on Jurong Island is based on office floor area.

[6] The bicycle parking requirements will also apply to Foreign Workers' Dormitories located on industrial sites.

[7] The GFA treatment will also apply to Foreign Workers' Dormitories located on industrial sites.

Commercial 4. Cinema, theatre and concert hall 5. Shops and departmental stores 6. Offices 7. Restaurants, night-clubs, coffeehouses, bars, cafeterias, eating-houses and canteens 8. Convention and exhibition halls **Hotel** 9. Hotel 10. Boarding houses and hostels[8] **Industrial** 11. Factories 12. Business park, science park, computer software development, distribution services, printing, publishing and allied industries and other Business 1 developments 13. Petroleum, petrochemical, chemical and related industries on Jurong Island **Health & Medical Care** 14. Nursing homes 15. Clinic, pharmacies, hospitals and other healthcare institutions **Civic & Community Institution** 16. Community centres, community clubs, welfare houses and other cultural and social welfare institutions **Place of Worship** 17. Churches, mosques, temples, any place of worship and other religious and related institutions	GFA exemption for bicycle supporting facilities, subject to: - 1 shower stall per 10 bicycle parking spaces (about 1.35sqm per shower stall) - Provision and size of lockers and PMD lockers to be subjected to evaluation - 1 toilet per cluster of facilities - Facilities should be located near the bicycle parking spaces for the convenience of cyclists
Sports & Recreation 18. Sports complex, tennis, squash, badminton, sepak takraw courts, soccer, baseball pitches, bowling alley, swimming pool, ice/roller skating rink, recreational clubs, golf range and other sports and recreation facilities	No GFA exemption for bicycle supporting facilities as shower/changing rooms/lockers should be provided as part of the development

6.2.3 Public Housing Developments

Type of HDB development	Provision Norm
New Public Housing Developments (Since Jan 2014)	1 lot : 6 dwelling units
New HDB commercial clusters (800sqm and above)	- Minimum 30 bicycle lots
New Common Greens and Neighbourhood Parks	- Provide 5 bicycle lots at entrance of the park - If there is more than one entrance to the park, provide another five bicycle lots at one other entrance of the park

ABOVE: Bike parking racks in a HDB estate

[8] GFA exemption for End-of-Trip facilities will only apply to Backpackers' Hostels; it does not apply to student hostels which are akin to Residential use.

Signage

It is important to plan and design places upfront to be legible and easily recognisable to all users including first-time visitors. This will enable pedestrians and cyclists to navigate and easily find their way to their destinations in the built environment.

To complement this, we are also erecting signs along walking and cycling paths and at decision-making points of pedestrians and cyclists where they tend to change course in their journeys or have the need to affirm their directions.

Apart from wayfinding, good signage can also ensure safety for users by prompting pedestrians and cyclists to use the correct path for their journey or activities and reducing conflict between different user groups.

7

7 SIGNAGE

This chapter consolidates the walking and cycling related signage. For the technical details of each of the signs in Chapter 7.1 to 7.3, please refer to LTA's Standard Details of Road Elements (SDRE).

7.1 Advisory Signage

'Give Way to Pedestrians' (600mm x 600mm)

Text Font:
Helvetica/Helvetica Bold

Material:
Aluminium plate 3mm thick

Finishing:
Diamond graded outdoor reflective sheeting (colour to match RAL 8011 - Nut Brown)

Note:
Headroom clearance for all signs is 2.4m

'Stay On Track' (600mm x 600mm)

Same as above: text font, materials, finishing and headroom clearance.

'Shared Track' (600mm x 600mm)

Text:
Helvetica/Helvetica Bold

Material:
Aluminium plate 3mm thick

Finishing:
Diamond graded outdoor reflective sheeting (colour to match RAL 8011 - Nut Brown)

Note:
Headroom clearance for all signs is 2.4m

'Watch Out For Cyclists' (600mm x 600mm)

Same as above: text font, materials, finishing and head-room clearance.

'Watch Out For Vehicles' (600mm x 600mm)

Text:
Helvetica/Helvetica Bold

Material:
Aluminium plate 3mm thick

Finishing:
Diamond graded outdoor reflective sheeting (colour to match RAL 8011 - Nut Brown)

Note:
Headroom clearance for all signs is 2.4m

'No Unauthorised Vehicles' (600mm x 600mm)

Same as above: text font, materials, finishing and head-room clearance.

'Slow' (600mm x 300mm)

Text:
Helvetica/Helvetica Bold

Material:
Aluminium plate 3mm thick

Finishing:
Diamond graded outdoor reflective sheeting (colour to match RAL 8011 - Nut Brown)

Note:
Headroom clearance for all signs is 2.4m

'Caution: Low Headroom' (654mm x 300mm)

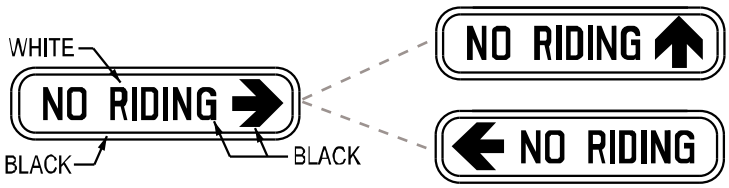
Material:
Aluminium plate 3mm thick

Finishing:
Diamond graded outdoor reective sheeting (colour to match RAL 1018 - yellow, RAL 9011 - black)

Note:
For clear height less than 2.4m

7.2 Regulatory Signage

'No Riding' (320mm x 320mm)



Variations of Signs:

Text:
Helvetica/Helvetica Bold

Material:
Aluminium plate 3mm thick

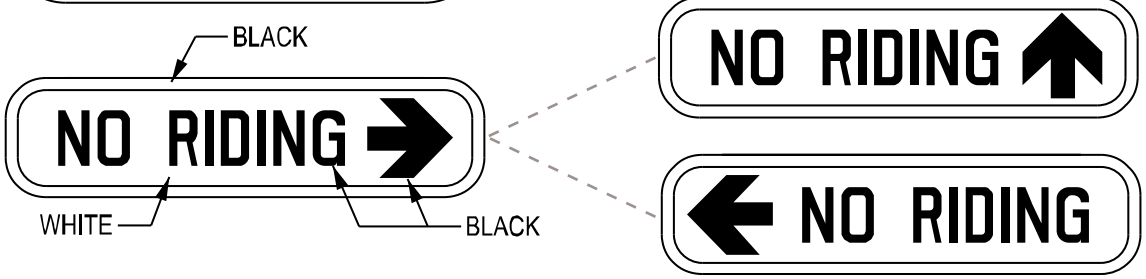
Finishing:
Diamond graded outdoor reflective sheeting

Note:
Headroom clearance for all signs is 2.4m

'No Riding' (600mm x 600mm)

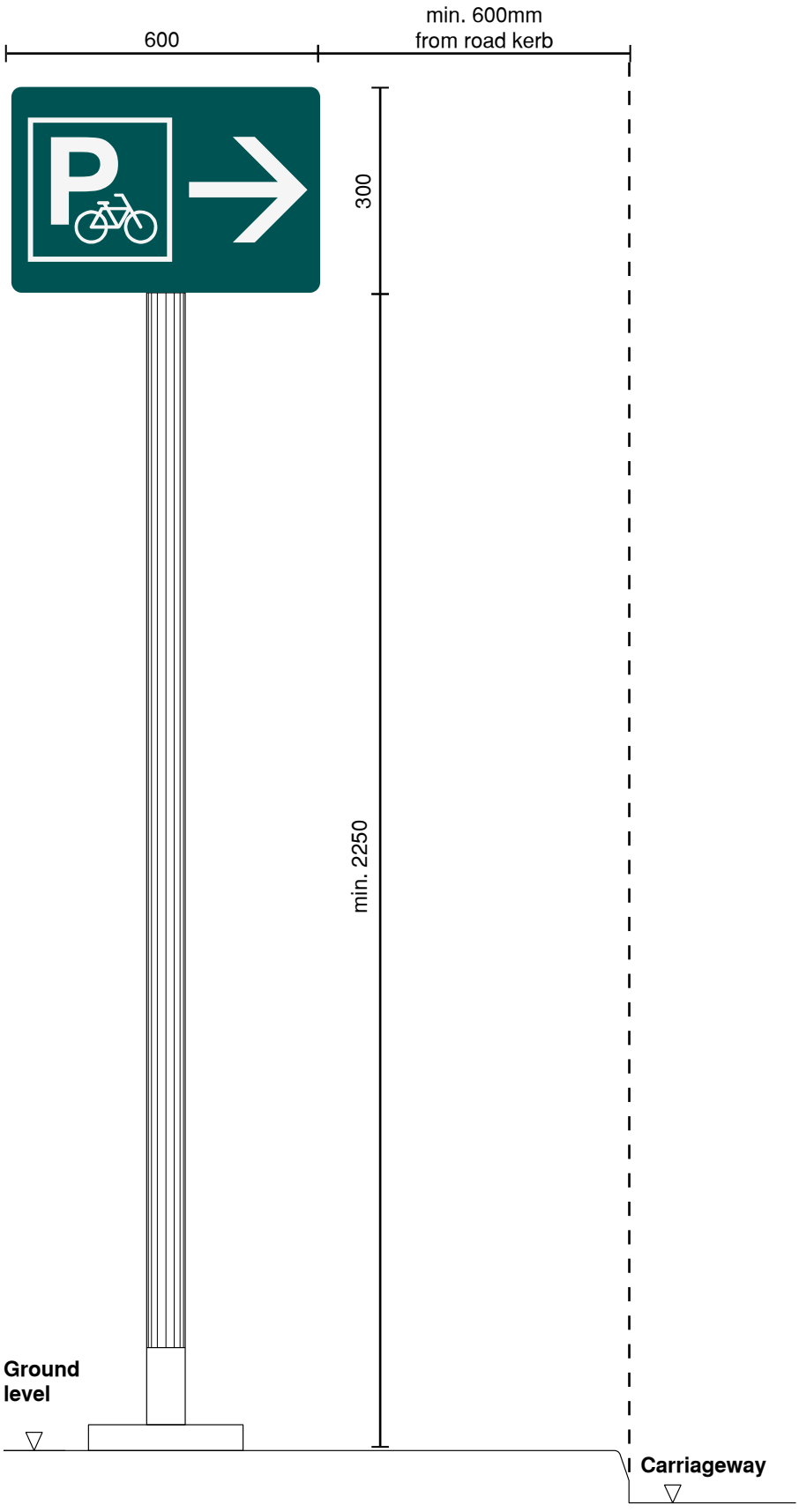
Same as above: text font, materials, finishing and head-room clearance.

Variations of Signs:



7.3 LTA Bike Parking Signage

Bike Parking Signs

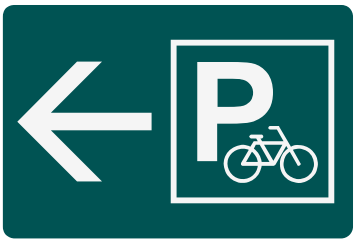


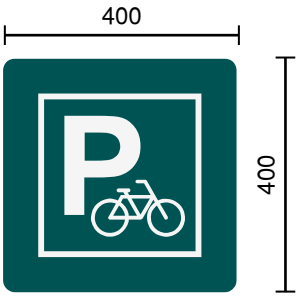
Material:
Aluminium post and plate (3mm thick)

Finishing:
Engineering grade outdoor reective sheeting (colour to match LTA standards)

Note:
Headroom clearance should be minimum 2400mm

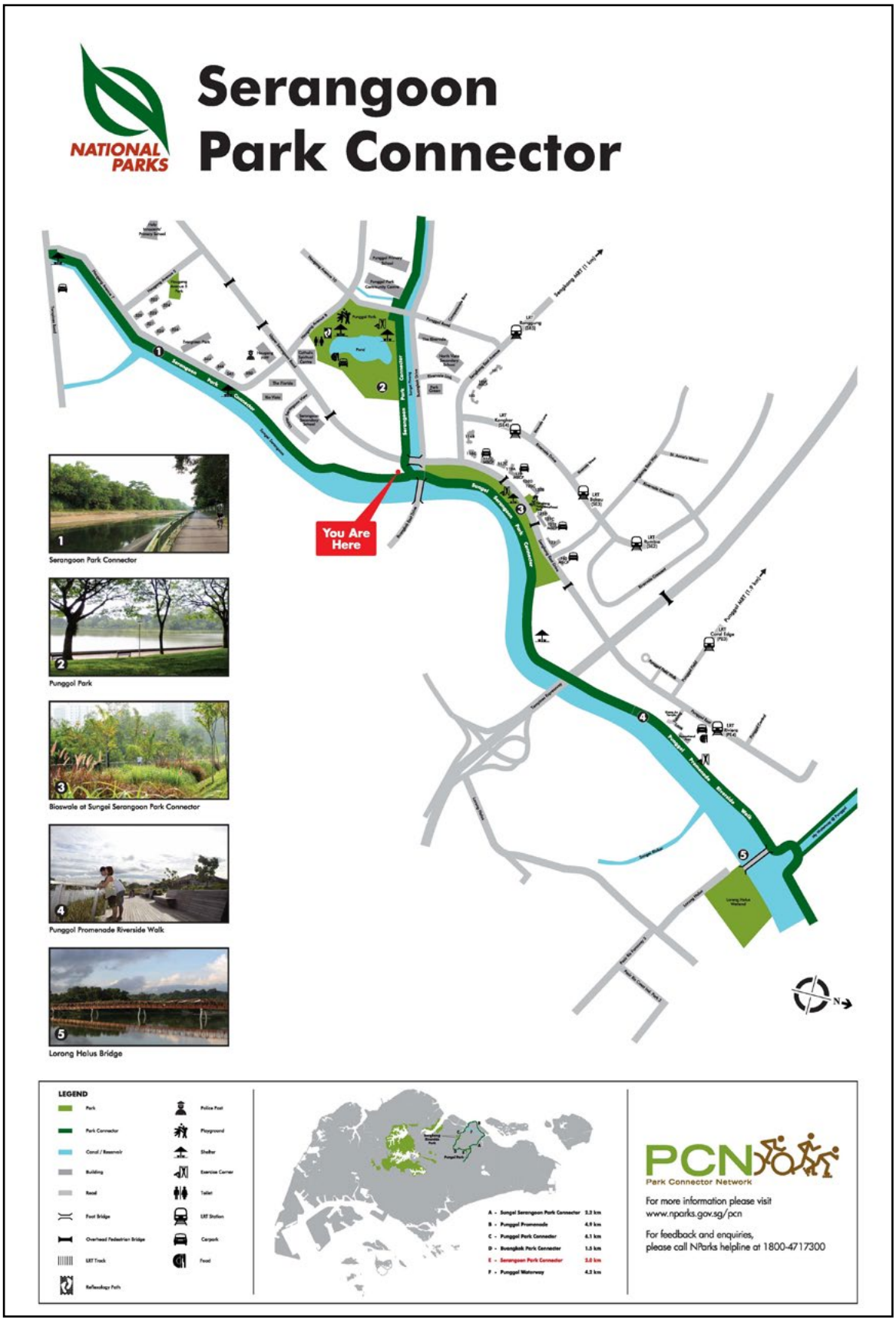
Variations of Signs:





7.4 Park Connector Network (PCN) Wayfinding Mapboard

PCN mapboard is usually placed at key locations to provide users an overview map of the Park Connector Network in the area. Information such as nearby parks and amenities are included.



7.5 Central Area Wayfinding Signage

These signs and mapboards are placed in the Civic District and Bras Brasah-Bugis areas, near places of attraction and at pedestrians' decision-making points (e.g. to go straight or make a turn).

Main Information Totem

Main Information Totem (Cont'd)

Main Information Totem - Mapboard

References

AGENCIES' GUIDELINES

BCA

Code on Accessibility in the Built Environment (2013) Accessible Online: https://www.bca.gov.sg/BarrierFree/others/ACCESSIBILITY_CODE_2013.pdf

Approved Document (2017) Accessible Online: https://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf

Universal Design Guide for Public Places (2016) BCA Publication

LTA

Architectural Design Criteria (ADC) (2015) Accessible Online: https://www.lta.gov.sg/content/ltaweb/en/industry-matters/development-and-building-and-construction-and-utility-works/architectural-standards.html

Civil Design Criteria for Road and Rail Transit System (2010) Accessible Online: https://www.lta.gov.sg/content/ltaweb/en/industry-matters/development-and-building-and-construction-and-utility-works/civil-standards.html

LTA Code of Practice for Works on Public Street (2016) Accessible Online: https://www.lta.gov.sg/content/ltaweb/en/industry-matters/development-and-building-and-construction-and-utility-works/street-proposals.html

Public Street Lighting. Accessible Online: https://www.lta.gov.sg/content/dam/ltaweb/corp/RoadsMotoring/files/LTA%20Street%20lighting%20Guidelines%20-%2005%20Mar%2017.pdf

Standard Details of Road Elements (SDRE) (2017) Accessible Online: http://www.lta.gov.sg/content/dam/ltaweb/corp/Industry/files/SDRE(2014)/Content%20page.pdf

NParks

Greenery Provision for Roadside (2011) Accessible Online: https://www.nparks.gov.sg/~/media/nparks-real-content/partner-us/developers-architects-and-engineers/greenery-provision-for-roadside-(1).pdf?la=en

Greenery Provision within Premises (2011) Accessible Online: https://www.nparks.gov.sg/~/media/nparks-real-content/partner-us/developers-architects-and-engineers/greenery-provision-within-development_4sept15.pdf?la=en

Sustainable Landscapes, Accessible Online: https://www.nparks.gov.sg/-/media/cuge/ebook/sustainable-landscape/sustainable-landscape.pdf

PUB

Code of Practice on Surface Water Drainage (2013) Accessible Online: https://www.pub.gov.sg/Documents/COP_Final.pdf

OTHER SOURCES

AASHTO (2010) AASHTO Guide For the Planning, Design and Operations of Bicycle Facilities: American Association of State Highway and Transportation Officials

Denton (2011) Bridge Design to Eurocodes: UK Implementation

Eurocode (2002) Basis of Structural Design Accessible Online: http://www.cys.org.cy/images/stories/Cyprus_National_Annex_EN_1990.pdf

Sustrans (2014) Handbook got cycle-friendly design Accessible Online: https://www.sustrans.org.uk/sites/default/files/file_content_type/sustrans_handbook_for_cycle-friendly_design_11_04_14.pdf

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