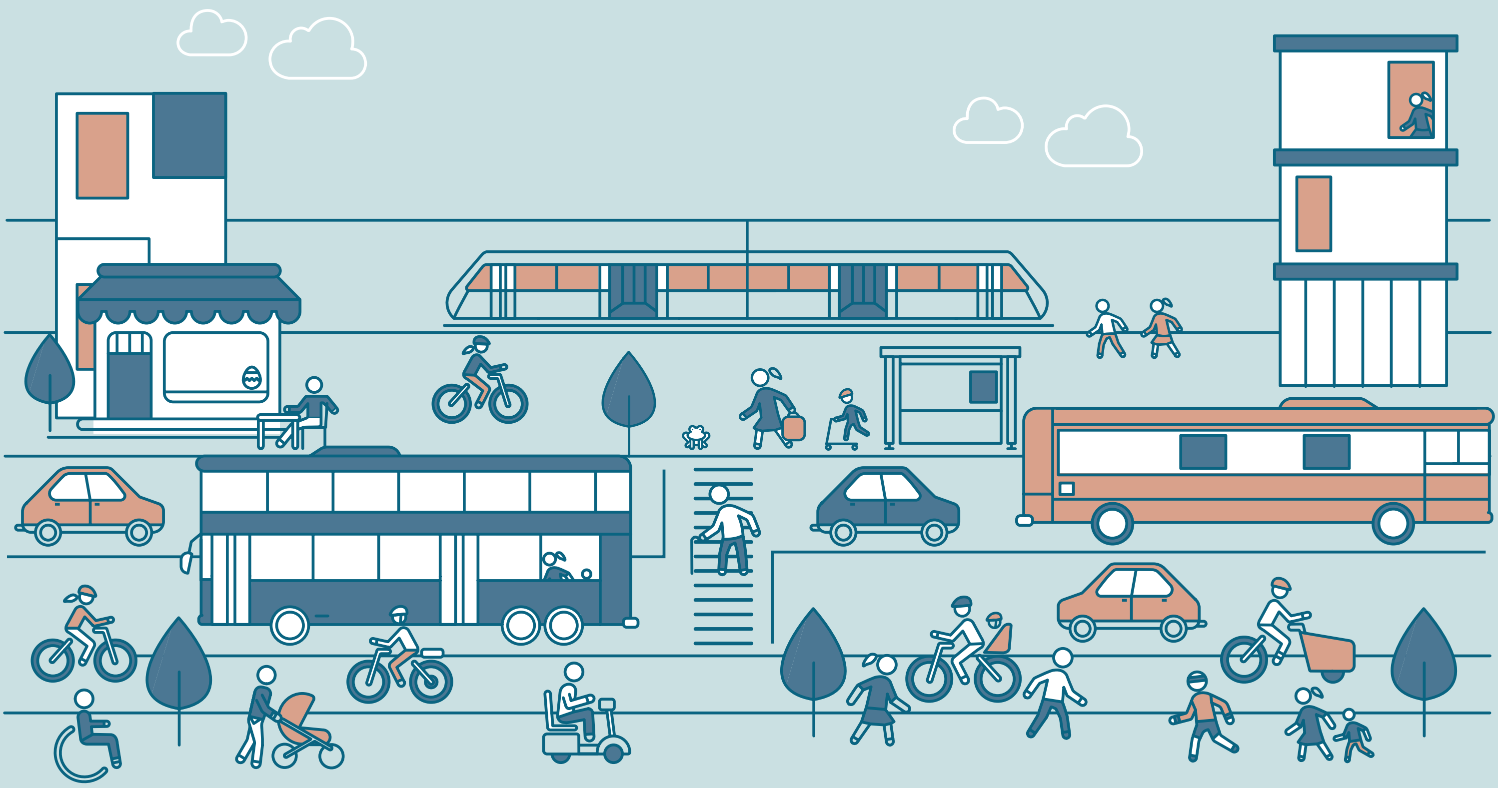
Urban Street and Road

Design Guide



Content

Introduction

Shane Ellison

CHIEF EXECUTIVE

I am pleased to present Auckland Transport's new Urban Street and Road Design Guide.

This guide provides a 21st century approach to designing urban streets to be safer, healthier, greener, and more enjoyable for all. It provides meaningful tools to deliver the goals set out in Auckland Transport's recently adopted Sustainability Framework and Roads and Streets Framework.

The Urban Street and Road Design Guide supports the network classifications from the Roads and Streets Framework that supports a rapidly growing, diverse and changing city. The network classifications respond to, and support, the vision of a safe, compact and quality city, and provide specific tools to advance the transformational shifts outlined in the Auckland Plan.

The guide takes a people-first approach, in recognition of the fact that the design of our streets is about maximising people's access to the opportunities available in the city. The choice to walk or to use public transport is related to both the structure of neighbourhoods and the design of our streets. Importantly, safe and walkable neighbourhoods and streets have a positive influence on our activity levels, health, and mental wellbeing.

Auckland Transport's Vision Zero goal for the city is that our streets and roads do not cause harm. Vision Zero says no traffic death or serious injury is acceptable.

The guide provides tools and examples to help re-imagine our city streets to meet the growing demands on transport services and street space, and design streets to be truly safe and healthy places. It provides clear advice and methods to prioritise active transport modes and public transport that unlock street space, increase safe accessibility, and provide a multitude of wider economic, environmental, and social benefits.

I urge leaders, practitioners and the wider public to explore the designs here and begin imagining the opportunities possible through better street design.

The Urban Street and Road Design Guide sets a new vision and approach to urban streets, one that is focused on people, safety and increasing the choices and opportunities of Aucklanders. The Guide is a practical tool to help transform Auckland's streets into more efficient and welcoming spaces that accommodate all users and meet the demands of a growing city.

Shane Ellison CHIEF EXECUTIVE

Policy setting

Auckland is projected to grow by over one million new residents by 2040. In November 2010, Auckland Council became a unitary authority through the amalgamation of one regional council and several territorial authorities. This amalgamation has enabled the development of integrated region-wide Plans. These plans support integrated transport and land use development through co-ordinated planning, timing, funding. This integrated approach is to be used to achieve the outcome of an accessible transport system.

AUCKLAND PLAN 2050

The Auckland Plan sets the direction for how Auckland will grow and develop over the next 30 years. It responds to key challenges that are faced today – high population growth, sharing prosperity among all Aucklanders, and reducing environmental damage. It provides a growth and development strategy that sets out how Auckland will grow and change over the next 30 years.

Auckland 2050 sets out six key outcome areas:

1. Belonging and participation
2. Māori identity and wellbeing
3. Homes and places
4. Transport and access
5. Environment and cultural heritage
6. Opportunity and prosperity.

AUCKLAND UNITARY PLAN

The Auckland Unitary Plan is the key statutory document for developing and managing activities in the Auckland Region and for implementing Auckland Plan's development strategy.

The Unitary Plan

- describes how people and communities will manage Auckland's natural and physical resources while enabling growth and development and protecting the things they value;
- provides the regulatory framework to help make Auckland a quality place to live, attractive to people and businesses and a place where environmental standards are respected and upheld.

It provides for appropriate development, controls the adverse effects of activities and manages the use of natural and physical resources. The following are aspects of the plan that are relevant to the provision of infrastructure such as the transport network.

- **Objectives and policies** – These identify the outcomes sought such as an integrated, safe and efficient transport system and policies for how to achieve them at the local (site) level and regional scale.
- **Zones** – Zoning is used to manage the types, location and scale of activity provided for in different areas, such as residential and business. These activities create a range of transport needs and can have an impact on the operation, development and management of the transport network.
- **Rules / Standards** – Along with those relevant to development sites, the Unitary Plan includes provisions relating to the transport network and transport-related activities such as:
  - Construction and operation of the road network
  - Requiring transport assessments for development proposals
  - Vehicle access to and from public roads servicing development sites
  - New or upgraded transport infrastructure required to support land development and subdivision
  - Parking, walking and cycling facilities
  - Managing stormwater runoff and quality on roads
  - Managing environmental effects of transport infrastructure
- **Designations** – Designations for public works such as transport projects or facilities are identified in the Unitary Plan.

AUCKLAND REGIONAL LAND TRANSPORT PLAN

The Regional Land Transport Plan (RLTP) is a statutory document that sets out Auckland's transport challenges, and the strategic responses to those challenges. It specifies the investment programmes for Auckland over the next ten years, including the capital programmes for Auckland Transport, the New Zealand Transport Agency (NZTA) and for rail infrastructure. As such, it also guides funding and is aligned to Auckland Council's Long Term Plan and feeds into the National Land Transport Plan.

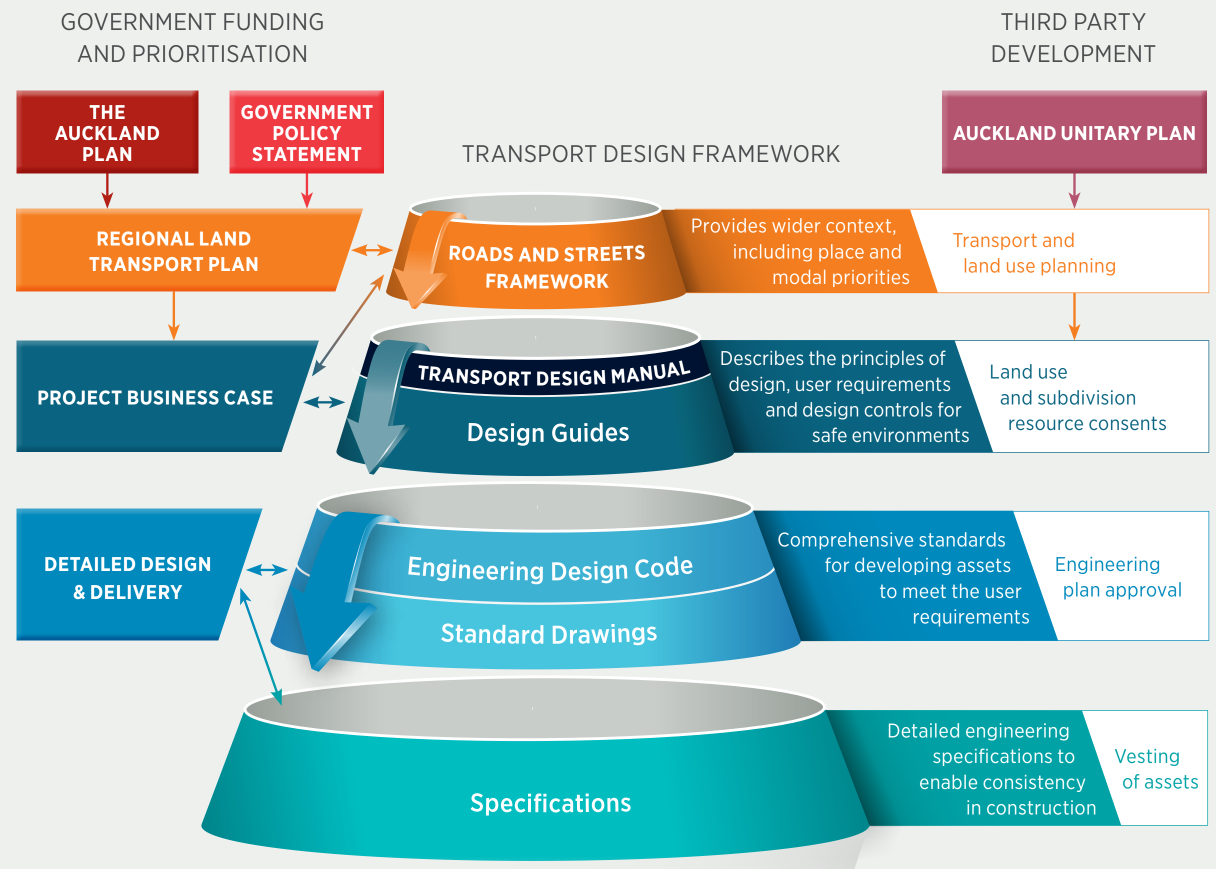
REGIONAL PUBLIC TRANSPORT PLAN

The Regional Public Transport Plan (RPTP) is a statutory document that sets out Auckland Transport's vision for public transport within Auckland, and includes objectives and policies which detail how we intend to achieve it.

The RPTP's vision is for Auckland's public transport system to have seamless end-to-end customer journeys that are safe, accessible and reliable. In order to realise this, the RPTP includes several key focus areas. One focus is on the expansion and prioritisation of the rapid and frequent network of services, which are the core of the public transport system. In order for these services to operate reliably so that customers can depend on them, they must have appropriate priority to ensure they are not caught in congestion. Another key focus is on access to public transport. The RPTP acknowledges that every public transport journey involves 'first and last leg' components, of getting to and from the service. The transport network must also ensure these legs are safe, convenient, and accessible to everyone.

These focuses flow through to the standards for the design of public transport infrastructure as an integrated part of the wider transport network, to ensure that this vision for public transport can be achieved.

OTHER RELEVANT DOCUMENTS: Auckland Long-Term Plan



Better incorporation of high-level policy and strategic guidance from central government and Auckland Council, applied through the RASF, enables greater realisation of the vision for the city as set out in the Auckland Plan.

GPS Government Policy Statement
NLTP National Land Transport Programme
RLTP Regional Land Transport Plan
RASF Roads and Streets Framework
TDM Transport Design Manual
OPS Operations

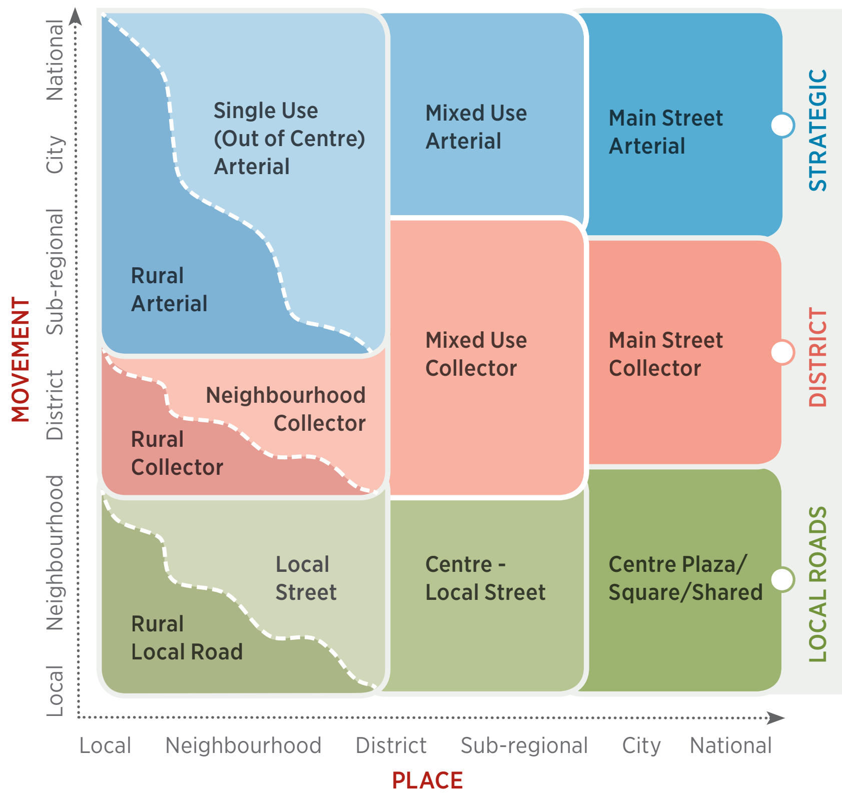
The Roads and Streets Framework

The Roads and Streets Framework transforms the conventional road classification system, recognising that roads and streets fulfil a variety of functions. The framework moves beyond the simple functional classification system of arterial, collector and local roads and re-imagines what they can and should be, looking at both current context and desired future outcomes.

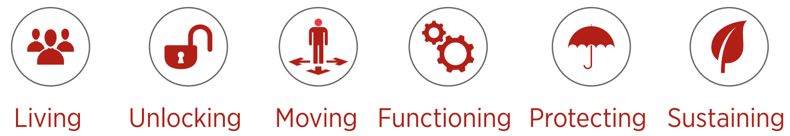
The Roads and Streets Framework includes a family of street types.

Note: The Roads and Streets Framework is under review by Auckland Transport and this Guide will be amended in due course.

ROADS AND STREETS FAMILY



It has provision for the diversity of the strategic functions:



It also sets future modal priorities and service priorities and has a toolbox of local and strategic measures to help resolve conflicts between the functions.

The framework is applied at both the regional and local levels. At the regional level, the framework assesses key strategic corridors, typically arterials or collectors within a defined network, to determine how a road or street can function optimally. At the local level, the framework identifies issues and opportunities, unique aspects of place (environmental, cultural, social and economic) and the desired mode priorities and operational regimes that collectively support balanced place and movement outcomes.

The result of a Roads and Streets Framework assessment is a strategic planning mandate of the functional requirements for street design, whether looking at an arterial network or a single local street.

For a more detailed account of the framework, please refer to the Roads and Street Framework Strategy (2018).

Who undertakes the assessments?

A Roads and Streets Framework assessment can be undertaken by Auckland Transport or a private entity who intends to produce infrastructure that interfaces with the public road network.

Auckland Transport is responsible for any assessment of the existing network and the assessment will be led by Planning & Investment. This assessment will ensure that the current and future strategic needs of the network are considered and that the right modal priorities are selected that are aligned to the long-term direction of the transport network. This assessment can then be used to define project mandates for new or alterations to existing roads and streets that Auckland Transport will deliver.

Private entities looking to connect in to the existing road network, either through subdivision or the connection of private accesses, must undertake a Roads and Streets Framework assessment for their developing networks early on in the land use stages. Assessments of the networks being connected to can be sought from Auckland Transport to aid in understanding the boundary conditions and what connections should be appropriate. These will be reviewed in the consent process.

What is the Transport Design Manual?

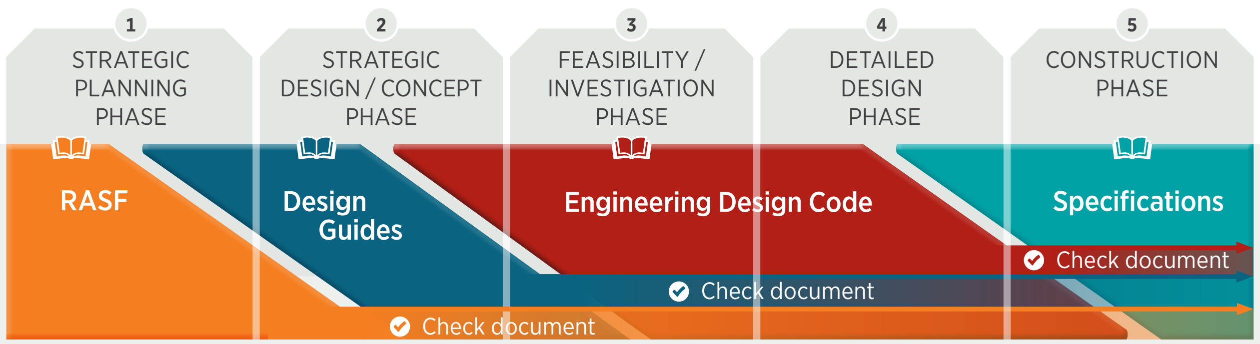
The Transport Design Manual is a set of Guides, Codes and Specifications that are specifically created for the Auckland region based on international best practice and robust common engineering theory.

Its purpose is to show how transport infrastructure should be designed and constructed, to manage change to introduce international best practice for Auckland, and to assist with transforming outcomes within the Auckland Region.

THE SYSTEM CONSISTS OF THE FOLLOWING ELEMENTS:

- Design Guides
- Engineering Design Code
- Specifications for Infrastructure Works

Each part of the system acts in an overlapping manner, cascading from the top down to ensure consistency of approach and outcome throughout the planning and design process.



Design Guides

The purpose of the Design Guides is to outline the guiding principles that all designs should use; who the expected users of the space are and how the various activities in a transport corridor can fit together . It defines the design vehicles for each user, the elements necessary for them to function and design considerations for matching them together. In some cases, not everything will be utilised as financial or planning decisions may limit elements in the guides from being used.

Ultimately, they explain how to design a transport corridor from the perspective of the most vulnerable user first and the design controls used to achieve that.

Engineering Design Code

The code is laid out in a series of documents that describe the engineering parameters and minimum standards for compliance. The various code documents are components that fit together to achieve the overall vision for the transport environment that is defined by the Roads and Streets Framework street typologies and the considerations of street or road design represented by the Design Guides.

The code consists of the minimum dimensions and requirements to achieve the correct design for each user.

Design Tools

This section contains web-published CAD tools, calculators, figures and design charts that will enable designers to produce design solutions in compliance with the Engineering Design Codes.

Quality of service

Once the assessment of place and movement has occurred and a quality of service (QoS) rating for the route established (if applicable), the next piece is to use a design guide relevant to the area of work, e.g. urban areas should use the Urban Street and Road Design Guide, to understand the following:

- Safe design principles
- Appropriate guiding principles
- Network design considerations in relation to the strategic network functions from the earlier RASF assessment
- User requirements (based on RASF mode functions)
- Design controls to meet functional and QoS requirements

Until other QoS tools are available, designers should define a quality or level of service objective derived from the design guides. Network Operating Plans may include Level of Service evaluation that gives appropriate levels for each user type.

For cycling projects, the Cycle QoS tool can then be used to determine the road quality as a direct relationship to the modal priority, e.g. a high cycle priority would generally indicate that a route QoS score of 1 is required. Other QoS tools are being developed to support the quality of services for other modes.

Specifications for Infrastructure Works

The Specifications are the engineering requirements for the supply of materials and products, as well as any specific construction methods required to deliver them. These specifications form the basis of Auckland Transport's construction contracts and are mandatory for all public road reserve works constructed by Auckland Transport or vested in Auckland Council for management by Auckland Transport.

The specifications are aligned with the Auckland Transport method of measurement for construction activities. This allows for a seamless experience when designing, specifying, scheduling, constructing, measuring and finally paying for the construction of the asset.

How to use the Transport Design Manual

This section deals with how the Transport Design Manual (TDM) works as a system and how it responds to the direction of the Roads and Streets Framework, as well as the other policies defined earlier.

The system responds to the planning requirements of the RASF by establishing the design principles; understanding the place context; which users are present, and their requirements, before considering the design controls needed. Each user has a specific Engineering Design Code chapter associated with them which details further the engineering requirements to achieve the outcomes sought.

It is commonplace to find that the constraints of a site, whether topographical features of a greenfield, or land constraints of a developed area, limit the measures that can be taken to deliver the planning outcomes set through RASF. Also, constraints on expenditure may affect what facilities can be provided at any one time, with others staged.

Once the preferred elements and street types have been chosen, constraints may be identified that require planning and funding decisions. The RASF iteration process will help to determined revised or staged outcomes that can be achieved by alternative designs.

RASF PLANNING

The start of the design process begins with an understanding of the transport network in relation to the importance of place. This assessment is done using the principles and process defined in the RASF and should include capacity analysis of both the required intersections and the streets between them.

This includes use identifying the quality of service required for each user type.

Once all of the above have been understood, the development of the street/road plan layout can occur, noting the requirements of the place and surrounding land use activities.

At a first concept design level, this will not define dimensions, but show what types of features need to be present, in which locations, to meet the defined requirements.

RASF/TDM ITERATION PROCESS

If it is necessary to reduce outcomes for some functions in a street below the objectives set, it becomes necessary to review the objectives. RASF then provides the means to look at wider networks to identify changes elsewhere that allow changes to the requirements at the project site. For example, capacity for one mode (freight, public transport, private vehicles) might be transferred onto other streets to enable a design solution for the project site. RASF is then used to understand the impact of such a transfer, and ensure that the streets affected can accommodate the transfer and still meet their own planned functions.

Iterations of planning with RASF and design with TDM will ensure that decisions on what to construct are based on sound planning and design principles to produce acceptable outcomes for people and places.

Note: The Roads and Streets Framework is under review by AT and this Guide will be amended in due course.

HOW THE RASF FEEDS THE TDM

The RASF is used to define the functions of a street, both as a place and for movement through it. It defines the network significance for each user type, provides indications of the measures that can be applied to the street in the future, and may include a timeline for progressive changes to the street. It indicates the characteristics of the street type. It provides the means for planning what capacities, especially at intersections, are required for each user.

The TDM provides the means for translating these planning requirements through design into physical features that deliver the desired outcomes. Design guides set principles and allow selection of elements, and how they can be assembled together. Engineering Design Codes enable preliminary and detailed design to be carried out. Initially, they will identify the limits of size and shape that will determine how elements can fit into the constraints of a site.

RASF/TDM AND THE BUSINESS CASE PROCESS

The business Case Process is used for Auckland Transport initiated projects predominately once a planning decision has been made and a project has commenced. The process ensures that a decision maker receives consistent information about the project and is able to assist in refining a solution to the problem. It is important to note that while the network planning elements of the Roads and Streets Framework are generally undertaken prior to the business case process, the identification and evolution of the solution using either the Roads and Streets Framework or the Transport Design Manual at the project level will be subject to the Business Case Process and the solution subject to the standard business case approvals and funding requirements.

How to use this Guide

UNDERSTAND PRINCIPLES

CHAPTER 1

Design Principles

All designers must understand these principles as the basis for decisions, and the approach to be taken in the design process. In particular, this sets out how safety must be incorporated in all design work.

IDENTIFY SYSTEM ELEMENTS

CHAPTER 2

Neighbourhood Design

focuses on design aspects of planned networks, either as a means of designing the relationship between land use and movement, or for evaluating the local design context for a specific street or place within a neighbourhood. It also includes guidance on environmental design within a neighbourhood.

CHAPTER 3

Street Users

takes each user group in turn, and describes their needs, specific design principles and the features that can be provided for them. Having understood principles and context, this chapter guides the choice of elements for each user to meet the planned function.

CHAPTER 4

Design Controls

deals with the issues of geometric design that need to be considered to ensure that drivers of vehicles in particular are guided to behave reliably in the way planned for them, safely and efficiently.

PUT ELEMENTS TOGETHER

CHAPTER 5

Street Types

can then be used to put the elements together in accordance with the design principles to deliver street and intersection layouts that will effectively deliver the planned outcomes. Typical layouts are shown, not as finished designs, but to illustrate the design considerations required to fit elements together into the design of a whole place.

CHAPTER 6

Intersections

can then be used to put the elements together in accordance with the design principles to deliver street and intersection layouts that will effectively deliver the planned outcomes. Typical layouts are shown, not as finished designs, but to illustrate the design considerations required to fit elements together into the design of a whole place.

Resources

are cited at the end of the Guide, as definitions, sources, design tools and case studies from around the world, to support use of this Guide.

1

CHAPTER

Design principles

IN THIS CHAPTER

Auckland is rapidly emerging as a global-scale city, with a growing reputation for its urban amenities and its spectacular physical setting.

The region is experiencing population growth and urbanisation at an unprecedented rate, placing new challenges on our existing infrastructure as well as requiring significant additional infrastructure. Addressing the physical, social, and spatial challenges of this population growth requires a closer look at the city's urban roads and streets, which make up both the largest component of the transport system as well as the places where we live and conduct business. Re-imagining our streets through street design provides a solution by unlocking street space to provide for more spatially efficient modes of transport.

This chapter sets out principles founded on safety, design for people and Te Aranga Māori Design. These are summarised in twelve guiding principles.

These principles must be understood by all designers as the basis for decisions, and the approach to be taken in the design process.

Why street design?

The words road and street are often both used in urban areas. "Road" has a specific definition in the Local Government Act 1974, but "street" no longer has a legal definition. In common language, the words refer to slightly different functions: roads convey people, goods and services while streets join together land uses within urban centres and areas of living.

Road and street design to support the complex life of a city must enable safe and effective transport of people and goods and the delivery of services. For roads with a high movement focus, this will mean considering the priority of modes of transport and the allocation of space to move people and goods efficiently. For short trip lengths, active modes may offer the greatest productivity. For longer trips, priority for public transport and freight may be more economically productive than private car use.

Roads with a dominant movement function such as expressways may be similar to rural roads and highways, but still have an effect on adjoining urban land and movement across the line of the street.

Streets with a high place value may generate economic and social benefits by a focus on active modes and access to land uses alongside the street, whether commercial or residential.

Where both movement and place are of high importance, the design task is difficult, but a good result can offer the greatest economic and social benefits. Streets also have an environmental function, where rainwater management, air quality and noise must be considered.

Progressive street design recognises the urban street as a complex phenomenon that is distinct from a road. It is in this domain of urban streets that perform multiple functions where state-of-the art guidance is required.

O'Connell Street, after being converted to a shared space

Quay Street

Audience

The Transport Design Manual aims to support policy by providing design guidance and engineering standards to governmental organisations, developers, community groups and consultants on the design. Therefore, the Transport Design Manual is intended primarily for Auckland-based professionals who are concerned with the built environment, our transport system, and with the way our city's and region's streets are experienced on an everyday basis. This includes a wide range of professionals who are involved in shaping Auckland's future, including planners, engineers, (landscape) architects, developers, and policymakers. Public officials, opinion leaders and influencers, advocacy groups and public health practitioners might also find elements of the Transport Design Manual useful.

The Transport Design Manual may equally be of interest to community groups and Auckland residents who are interested in the way their streets are designed and functioning, and who expect more from their streets.

Vision Zero & urban street design

Safe transport is vital to our city's success and is a primary objective in street design. Creating streets that protect and improve conditions for walking, cycling and public transport can lead to a more vibrant healthy city and better street design can also contribute significantly to the prevention of deaths and serious injuries for all road users. A multi-modal Vision Zero approach responds to the increasingly ambitious goals for a transport system free of death and serious injury in the Government Policy Statement on Land Transport 2018 and the Auckland Plan 2050. Auckland is part of a global community of cities (such as OECD Safer City Streets group) working to improve the design of roads and streets through a Vision Zero approach. Urban Street and Road Design Guide outlines international best practice to reduce actual harm.

Humans are vulnerable and make mistakes and we must design our streets with that in mind. We need to create an environment which is survivable for all road users, including those who are most vulnerable. Reducing speeds, reducing conflict points, and changing the geometry of our streets are all proven to provide safe urban streets. By emphasising an integrated and holistic approach to safety, risk of injury and death will be reduced and the vibrancy of our streets can be restored.

Origins of Vision Zero

Vision Zero was first launched in Sweden more than twenty years ago. Since establishing this goal, Sweden has continually reduced its road trauma. Critical insights for designers can be gained from Sweden's experience, and also the Sustainable Safety programme in the Netherlands. More recently, many cities have picked up the Vision Zero mind-set, including New York City, London and Edmonton.

The Vision Zero aim to eliminate transport death and serious injury is similar to health and safety approaches in other sectors. It is a return to first principles for harm minimisation.

VZ

Throughout this document you will see a Vision Zero icon highlighting key areas for understanding Vision Zero in design.

An ethical and moral imperative for street and road design:

"EVERYONE SHOULD HAVE THE RIGHT TO USE ROADS AND STREETS WITHOUT THREAT TO LIFE OR HEALTH"

Tylösand Declaration

VISION ZERO IS IN SWEDEN, NETHERLANDS, NEW YORK AND MANY OTHER CITIES

No death or serious injury is acceptable

Vison Zero and urban road safety

In urban areas, the road environment is complex. The safety context includes the ever-growing diversity of mode types of various mass and speed; the high number of people of diverse agility and mobility moving about every day and the necessity of vibrant street activity. Recognition of the importance of Place has a strong influence on enabling safety. It is not just the people travelling who are effected by traffic, residents and people going about their day in a place also stand to benefit from calmer street environments.

Urban arterials are some of our most dangerous roads in Auckland. While rural crashes are notable for being severe, the large majority (4/5) of Auckland's fatal and serious injuries occur in urban areas. Of these urban injuries two thirds are happening on main urban arterials. These streets often

provide mixed messages about hazards and are not built for survivable impact speeds. Traffic management features will be more common on arterial roads in future. Urban roads through commercial and other centres should emphasise design for people and opportunities to engage with place. Busy roads next to schools, public transport stops, stations, local stores or other neighbourhood features also require more thought to reach new safety goals.

Safety applies regardless of street type and must be considered in terms of likely conflicts, especially for the more vulnerable users who will be present at all urban destinations.

Perceptions of safety affect the liveability of places, and can add to traffic stress or comfort, but note that perceptions are not enough to achieve Vision Zero design goals, the underlying safety principles must also be applied.

A shift in thinking

There has been a shift in thinking in the transport sector, starting with designing streets for people. This thinking has evolved to using everything we know about human behaviour, our choices and mistakes, and about human bodies and what they can recover from. We know more about how to eliminate risk of fatal forces and create different outcomes for crashes to avoid whole families losing someone unnecessarily or suffering pain and lost ability for years. Blaming the user for making predictable mistakes does not stop crashes. Instead, we look at the whole transport system in terms of design for human use.

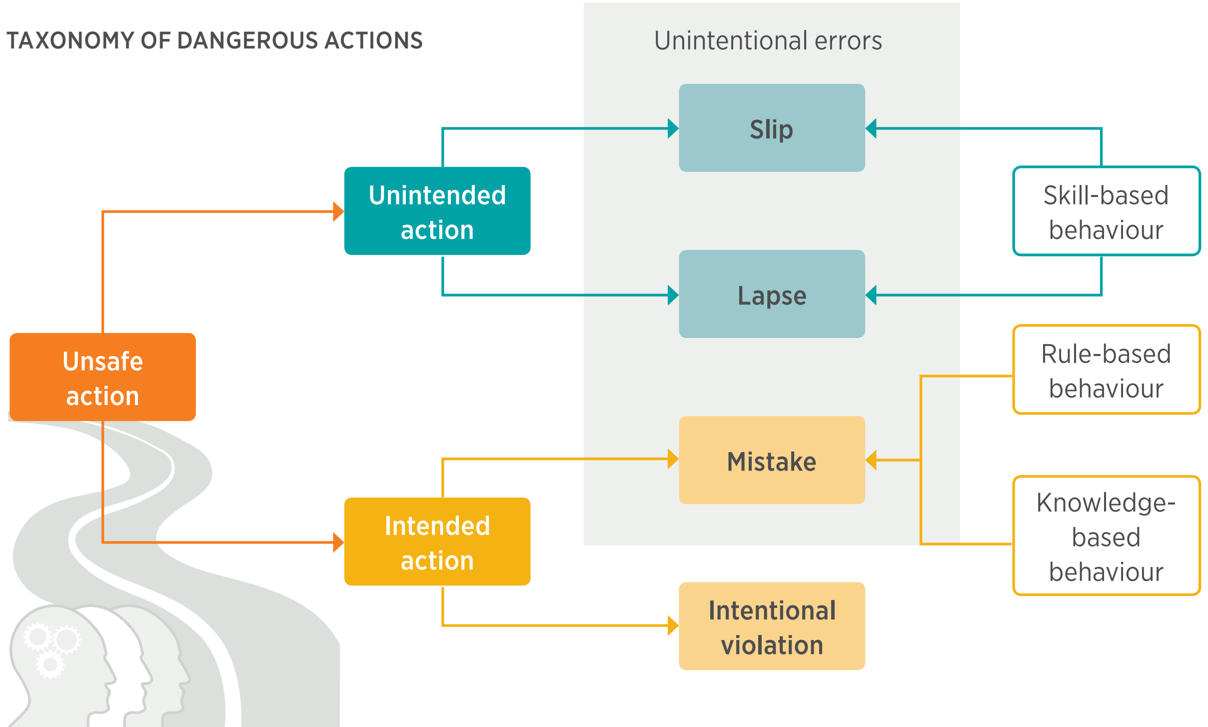
System wide action addresses the inherent risk of exposure to impact forces (from vehicle speed and mass) and treats these as a hazards to be eliminated or managed. For busy urban streets, unsafe options that create or ignore this risk are no longer acceptable. Design for place influences safety outcomes in a broad way, via mode choice and reduced vehicle trips, as well as design for awareness, attention and recovering from lapses and mistakes. Environment, vehicle and user behaviour all contribute to safe outcomes.

From knowledge of behavioural and biomechanical science, crashes and mistakes are inevitable. However, fatal and serious outcomes of crashes are avoidable even where humans are frequently in control of fast and heavy machines. Most serious crashes are not a result of extreme behaviour but of issues within the whole system.

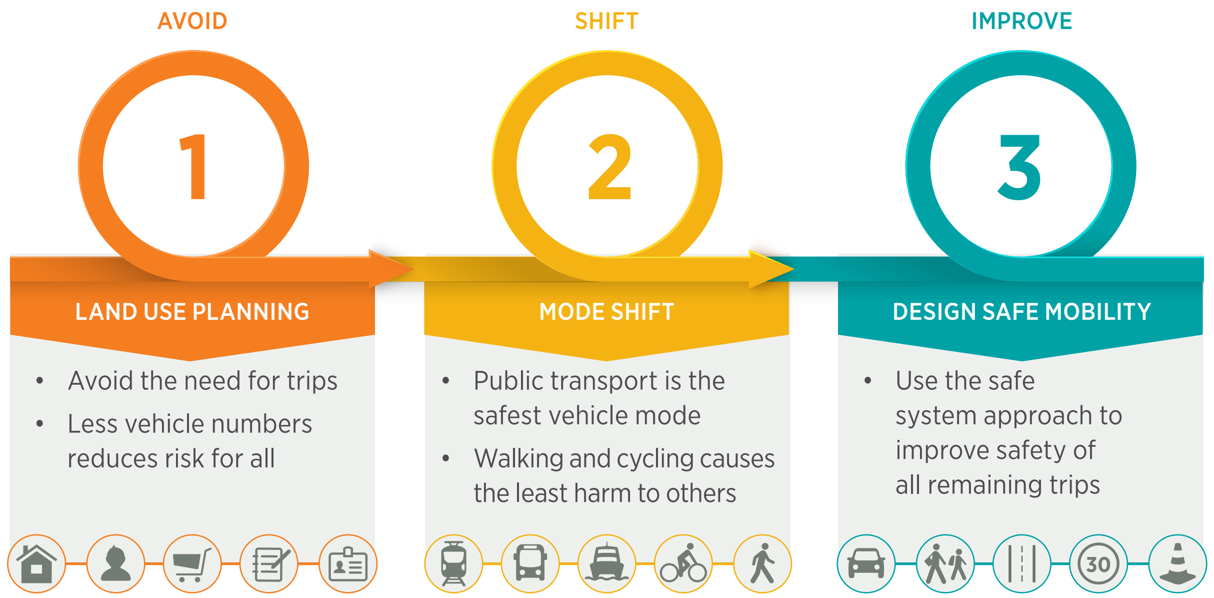
There is a growing body of evidence around designing for human psychology specifically related to road safety. For instance, people think about things other than their driving task 90% of the time on familiar trips, a common activity that does not always lead to crashes, but is an important aspect to remember in design to prevent injury. Design that acknowledges real human behaviour can address it, and prevent lapses, slips and mistaken interpretations from leading to serious outcomes. (See diagram below.)

Biomechanics or the human capacity for absorbing crash forces is another area of detailed research. Crash studies are increasingly sophisticated. Vision Zero does not focus only on death, but instead sets a conservative goal to reduce serious life-changing injury as well.

TAXONOMY OF DANGEROUS ACTIONS



SAFE, HEALTHY AND SUSTAINABLE MODELS GO TOGETHER



Addressing human fallibility and fragility requires a broad approach, the diagram above shows three scales of action for Vision Zero. Safety is a result of all the environmental, vehicle and behaviour aspects of the whole system.

For more on land use planning and mode shift, see the Auckland Design Manual and Roads and Streets Framework, and see TDM section on neighbourhood design in Chapter 2.

MAXIMISE SAFE, HEALTHY, SUSTAINABLE TRIPS, AND CREATE NO MORE MOBILITY THAN CAN BE TAKEN UP SAFELY

Vison Zero design principles

Design needs to consider severity, likelihood and exposure to avoid death or serious injury as a result of a crash

RISK	=	SEVERITY	X	EXPOSURE	X	LIKELIHOOD
		IMPACT SPEED (delta V) The speed and mass of each road user changes the force of impact Survivable speeds = #1 goal		**NUMBERS OF PEOPLE** = risk of event, number of vehicles = hazards **TIME AND DISTANCE** not separated from harmful forces		**DESIGN LAYOUT** Primary focus is on instinctive design that nudges drivers at key points for alertness or frequently for slower speeds (vertical and horizontal shifts of the driving path)

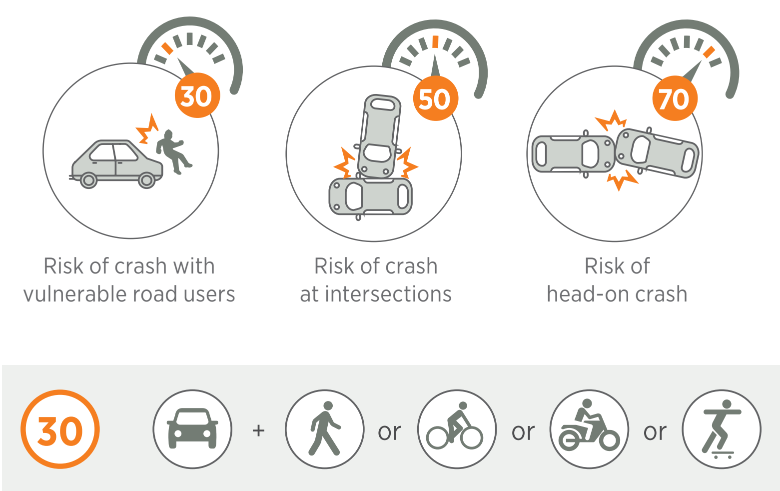
SURVIVABLE SPEEDS

Reducing severity or ensuring survivable impact speeds is a key goal for Vision Zero design. There is more on this under design speed in Chapter 4.

Survivable speed is to be used as a design objective in all situations or a strong justification must be given.

Humans are not very good at judging the risk of speed. Impact forces are more readily understood in terms of falls from a height, e.g. 30km/h impact is similar to falling from the first floor of a building, whereas 50km/h impact is similar to falling from the third floor. As a result, we often don't notice that the speeds we travel at regularly are as hazardous as they are.

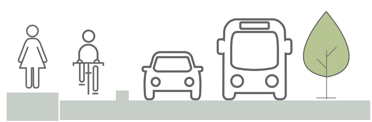
SURVIVABLE IMPACT SPEEDS



EXPOSURE

Exposure is simply about the numbers of people at risk, but can also be expressed in terms of the number of hazards, the time exposed or the distance. Exposure can be a high-level measure across a network or corridor, or specific to a particular site of conflicting movements.

Reducing the number of vehicle trips reduces exposure. Maximise safe people movement, e.g. increase walking, cycling and public transport and decrease or separate private car use.



DESIGN TO REDUCE THE LIKELIHOOD OF SERIOUS INJURY IN A CRASH

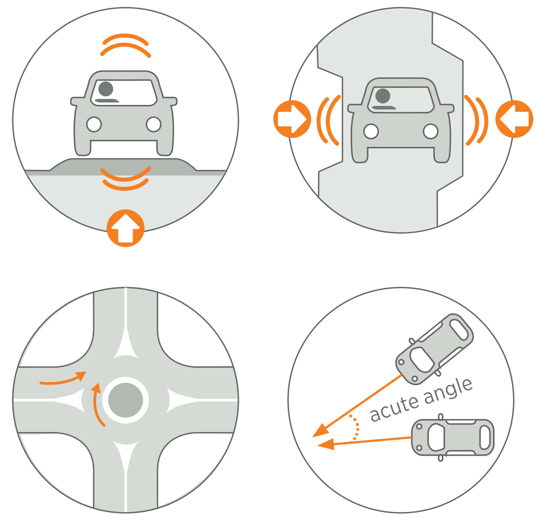
Design features vary from treatments that convey risk instinctively, to symbolic and cognitive messages (e.g. picture and text signs). The Safe System Assessment Framework is a tool for calculating risk of death or serious injury, and includes practical treatment options, from 'Primary Treatments' to less preferred options that still have some effect in constrained sites.

How design features create safe streets

For vision zero, if elimination or separation from non-survivable forces is not a complete option, the primary details of a street need to first address the instinctive response of human beings to space and movement.

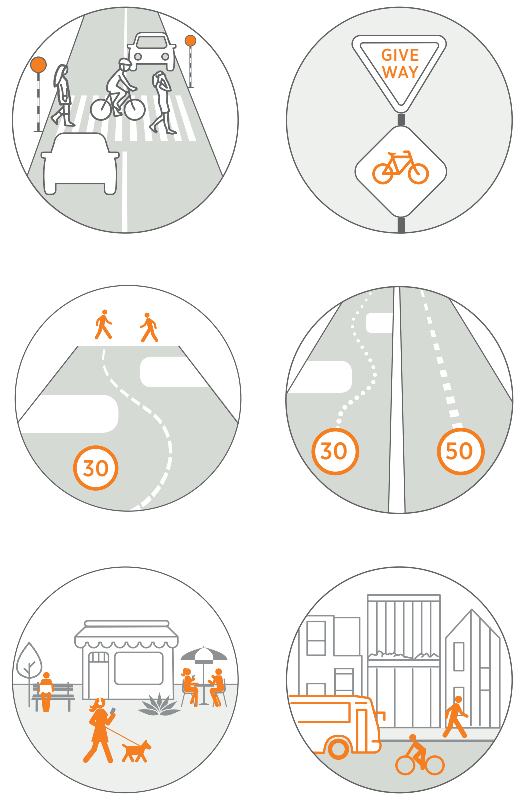
Control impact forces and attention

- Instinctive design creates physical "nudges" for attention in complex urban environments and alertness near conflict points. Properly designed vertical and horizontal shifts in the vehicle path also slow vehicles down to survivable speeds for people outside and inside the vehicle at conflict points, so that if attention is lacking, the risk is still low.
- If vulnerable user safety is not the constraint, review review impact angles for vehicle safety, as vehicle occupants are most vulnerable from right angle side impact forces. The survivable speed for vehicle-to-vehicle crashes changes with the angle of impact. Modern roundabouts and on-ramps make use of this life-saving feature. This is important for intersections in areas that are 50 km/h or higher. Note that this side impact risk is the main reason why vehicle users are still not safe from serious injury in urban areas.

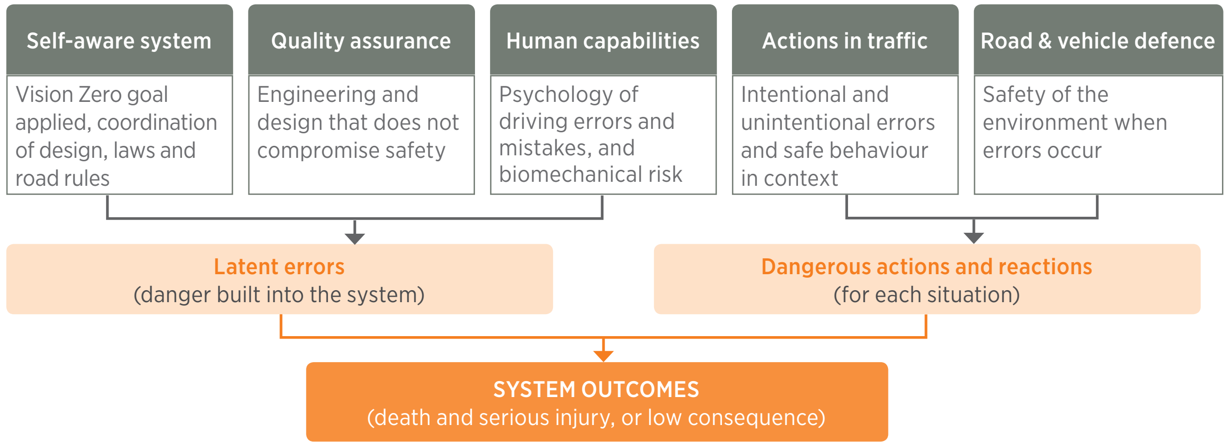


Communicating the risk

- Care should be taken to make safe behaviour the easy choice. Use devices and appropriate street typology to give advance warning of a risk to self or other people. The microseconds needed for thinking tasks are important when travelling faster than a human can naturally run, and with heavy masses. Design to make the most of well-known safety rules, habits and symbols where these already support safety and create new instinctive or self-explaining urban road types where existing rules are not enough to prevent serious injury.
- Environmental cues or context is another form of communicating risk, not quite as strong as safe habits or deflection. Visible movement and flashing lights can attract attention to influence behaviour. Communicate the general urban context (mixing and variety). Speed limits are fully effective only where they match the messages coming from the rest of the road environment. Many of our existing streets give conflicting messages about appropriate travel speed, or do not give adequate warning of potential hazards or risk – aim to avoid surprises.



A SAFE SYSTEM HAS LAYERS OF REDUNDANCY



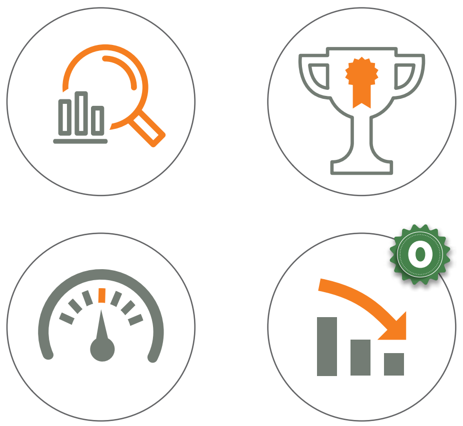
Design works with other parts of the system to defend people in a dangerous moment. Injury outcomes in a particular context result from all parts of the system supporting or undermining each other.

The aim is to have design that prevents errors and is forgiving - design that increases user awareness of risk and the likelihood of successful safe actions, but also creates a fail-safe system so people are able to walk away when mistakes happen. Unintentional errors and failure of the system to provide protection is common in our high numbers of serious injuries. Vision Zero design acknowledges that humans are prone to distraction, fatigue and misreading of a situation, as well as having fragile bodies, and creates layers of support so that if one thing goes wrong it will not lead to fatal or traumatic results. Redundancy across design, speed limits and laws, user knowledge and skill, and vehicle design is necessary. A system approach is similar to any other modern industry or transport sector. This is also known as cognitive ergonomics.

Ongoing refinement, same components, new outcomes

While we have a number of examples of safe system design here and overseas, it is important to note that there is no cookie cutter solution for all situations. Design details need to be worked out in context – including the local culture and diversity within that. There is strong evidence that applying the principles for Vision Zero save lives, but designers have the opportunity to apply the principles in innovative ways. Designs that can show how Vision Zero principles have been applied and assessed via a safe system assessment framework are more likely to be approved than something taken out of context.

As this is a paradigm shift, there is a need for monitoring of safety indicators and fine-tuning of design examples locally. There is a need to build on what has been demonstrated already. Vision Zero design features are not new, but the ethical priority is. Road and street design needs to step up to the challenge of Vision Zero, and no longer trade off people's health and wellbeing for other goals.

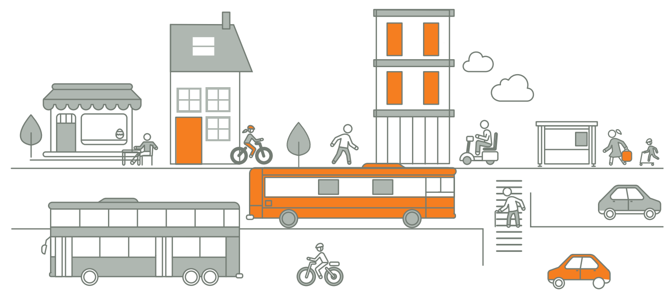


This process will require greater coordination across all decision makers to make the most of lessons from research, demonstrations and trials. Monitoring is not just about waiting to see if injury occurs, although that is the final test. There are several interim measures that indicate reduced risk, such as operating speed, mode choice, exposure numbers and infrastructure safety ratings, etc.

Old and new – what is the difference?

A crash that leads to serious injury or death is a system failure, not a road user failure, as humanity is a given design constraint. Fatal crashes still happen even when users are in full compliance with the road rules. Often multiple factors fail - the user, the vehicle, or non-survivable speeds. However, road design is very common as something that could have saved a life but didn't. Studies in New Zealand and elsewhere indicate that fatal crashes involve a number of failures across the four safe system pillars. With strong, safe road design that includes speed management, there are only two pillars to potentially fail, reducing the likelihood of severe outcomes.

Key Question	Traditional approach	Vision Zero approach
What is the problem?	Crashes	Fatalities and serious injuries
What causes the problem?	Humans should know better, be infallible, and defer to machines	Humans make mistakes, humans are fragile
What is the public demand for road safety?	People don't want safety	People want safety
What is the appropriate goal?	Optimise the number of fatalities and serious injuries	Eliminate fatalities and serious injuries
What is the system approach?	Parts of the system considered in isolation, with limited responsibility for safety outcomes	Consider how all parts of the system work together to control harmful energy to eliminate risk
Who is responsible?	Individual road users	System designers have ultimate responsibility for the systems, design, maintenance and use, and are ultimately liable for the level of safety in the entire system. Road users should continue to be under obligation to show respect, good judgement and follow rules. But, if injury still occurs because of lack of knowledge, acceptance or ability then system designers must take further action to prevent people being killed or seriously injured.



The idea of separate system pillars can lead to a fractured approach to safety. Vision Zero has a much stronger moral anchor to the overarching goal of zero deaths and serious injury and increased responsibility.

Typical unsafe road environment	New decisions for safe road environment	
• zebra crossings without a raised table (high risk) • right angle approaches to intersections for vehicles over 50 km/h (high risk) • new speed limits of 100 km/h on unseparated rural roads (high risk) • local street design with mixed traffic and activities at 50 km/h	Auckland Transport is making new decisions about what provides safe movement on our streets These can look different to how our streets are currently. Our focus is on highest risk areas and situations, with prioritisation of investment, resources and speed of delivery.	• zebra crossings with a raised table • close angle approaches to intersections for vehicles over 50 km/h, or slower speed design • speed limits of 80 km/h on unseparated roads, 100 km/h on separated roads • local street and town centre design with 30 km/h design speed • more separation of cyclists

Integrated design – the art of street design

It is impossible to design streets well using only standardised templates or metrics. Street design requires the consideration of many factors that often span various levels of spatial scale.

Understanding the relationships between users, site conditions, transport systems and the urban context is critical to developing appropriate context-sensitive designs. Considering the various levels of spatial scale means that transport design must extend beyond the project itself. Holistic solutions require looking at wider transport networks, the surrounding community and civic systems.

This integrated design approach also recognises that a combination of characteristics can work together, sometimes counter-intuitively, to achieve the desired outcome. While it is important to understand the relevant user elements and geometric design, the art of street design is the practice of putting everything together. This is particularly important, as street design occurs in physically constrained space where a combination of minimum standards is neither possible nor, in many cases, desirable. Only by first understanding the context can design for movement be integrated into design of the place. Context includes topography, hydrology, ecology, land use and transport networks. These should be determined from planning objectives, including multi-modal networks. Integrated design will then show how best to lay out streets to meet all functional objectives.

DESIGN FOR PEOPLE

The street network is the fundamental framework for safe, liveable communities, where the human scale of the individual and the act of walking represents the basic unit of design. Everyone is a pedestrian, even the motorist who walks to and from their car. Because streets also are public spaces, designing them with people in mind is key. This goes beyond merely providing a footpath, it means that careful attention must be given to providing a comfortable, safe, interesting and engaging experience to those who use the street on foot, and making sure the most vulnerable people (children, the elderly and people with disabilities) can travel safely within the road reserve.

DESIGN FLEXIBILITY

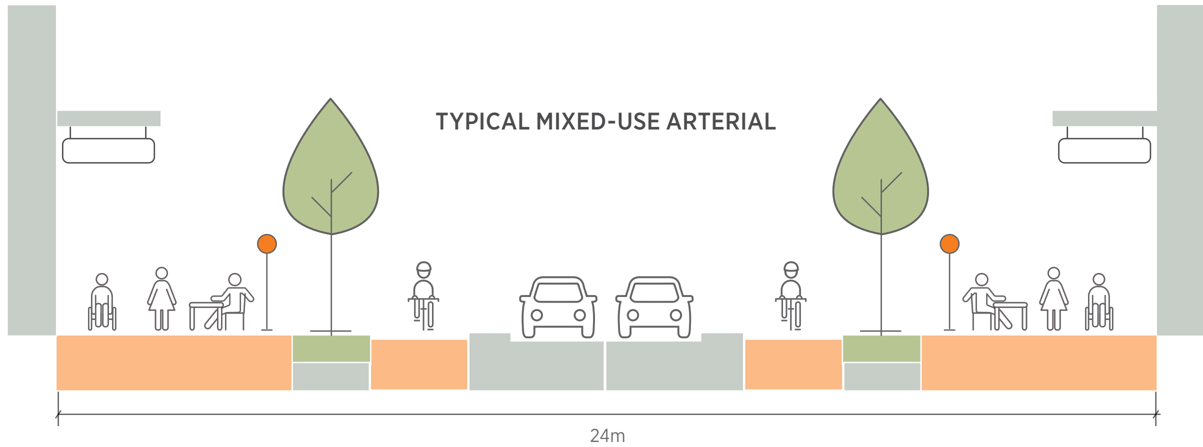
The Guide is intended to help designers consider the trade-offs and compromises to reach the desired outcomes. In many cases, the final designs require solutions that do not meet the prevailing design orthodoxy (which is primarily concerned with standardisation, vehicle flow, larger street geometry, and nominal safety). It is here where the Street and Road Design Guide recommends a principles-based approach that is focused on outcomes rather than focusing on one particular design element. Design flexibility is a fundamental tenet of the Guide, as street design requires new tools to achieve the city's priorities.

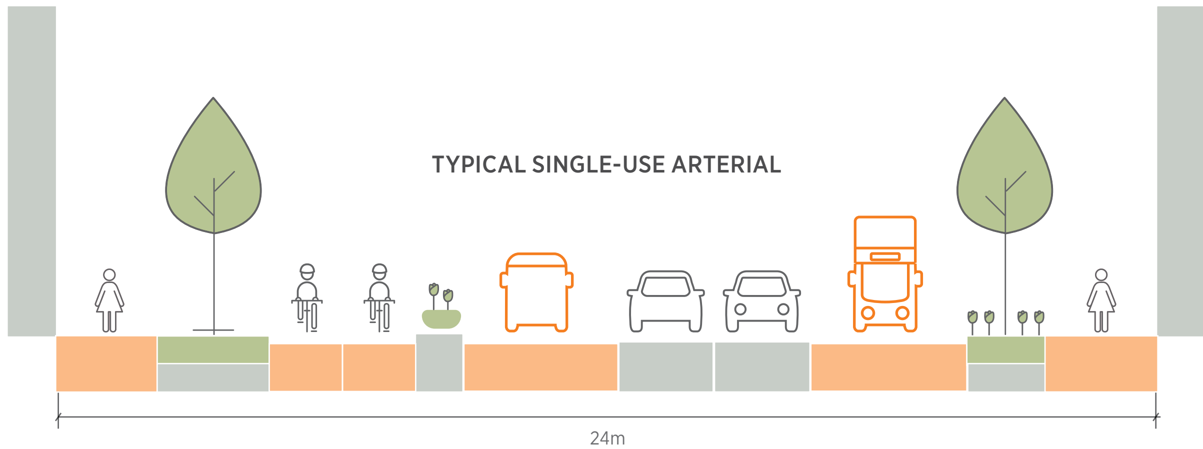
Implementing designs that depart from convention, however, requires justification and duty of care. In practice it is easier to do business as usual then it is to develop designs that challenge norms.

Delivering better street design requires a proactive culture of innovation, testing and documentation. Not only should street design be based upon extensive observation and benchmarking, but it should also be evidence-based, using the variety of datasets and metrics available.

MULTI-MODAL

Most major streets should have enough space to accommodate a form of public transport such as buses or light rail, in addition to offering vehicle access. Space for pedestrians must always be provided, in the form of a footpath or a shared street. Most streets should also be able to provide for cyclists. If one street cannot provide fully for all modes, then other nearby streets may provide the network functions for some modes with it. When the various modes of transport work together in interconnected networks, access to many destinations is provided.





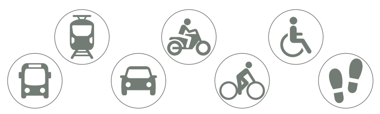
System design: Movement through places

System design requires the designer to understand the components of a system and how they interact to result in an outcome.

Conventionally, design has focused on places and the constraints of vehicles operating within them. This does not lead designers to consider the whole human system, which is what this guide seeks to address.

The designer should think of the choices people can make – how they will use a place, where and when they will travel and how long their journey will be. This should determine what constraints to set on how various vehicles may be directed within the place, and how the place should be laid out to provide for people's actions.

PEOPLE
looking, deciding & acting



VEHICLES
to carry out their actions

PLACES
that they act within

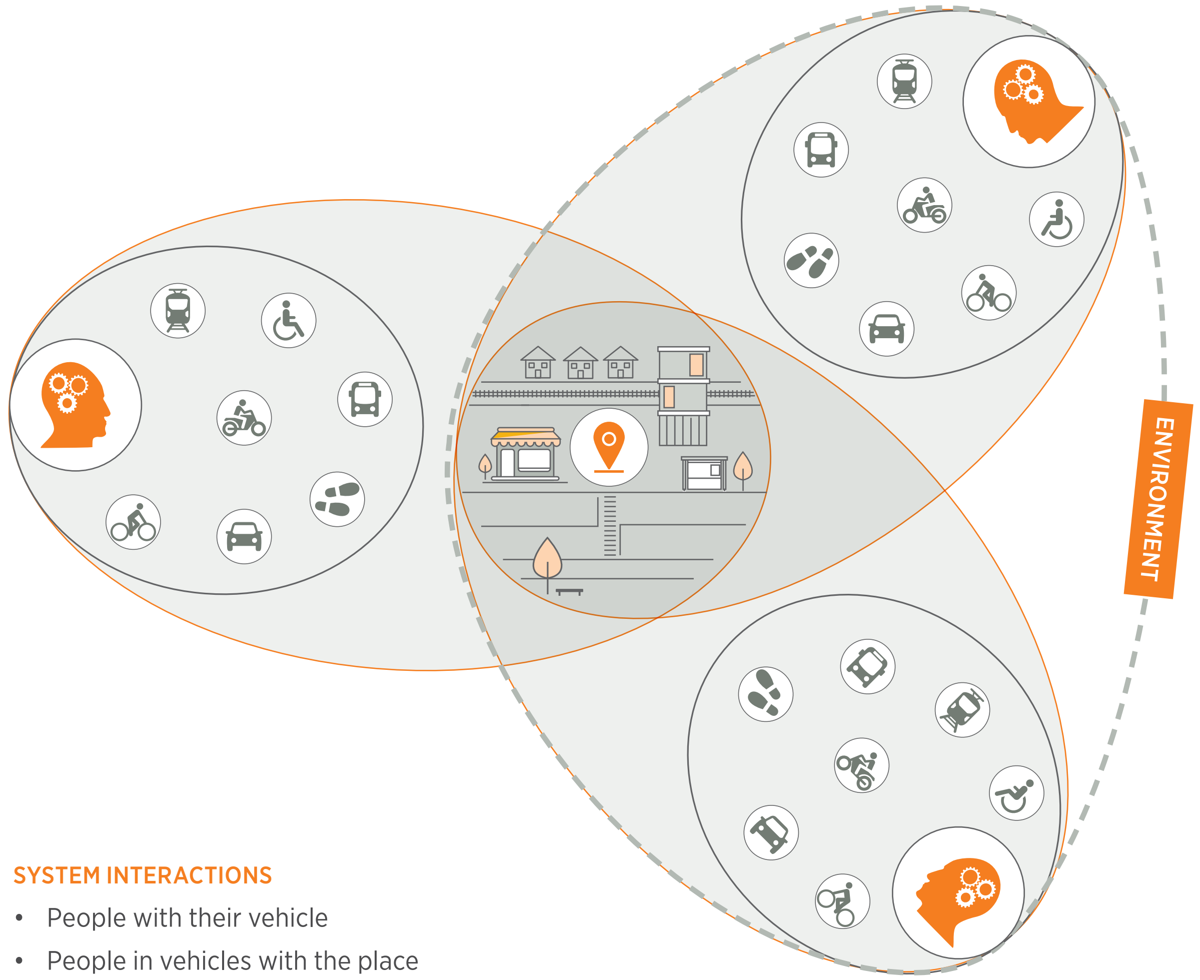
People vary, and their actions depend on what they want to do, where they want to go. Design must consider the full range of people and behaviour that can be expected.	Vehicles are chosen by People – train, bus truck, car, bike, scooter, wheelchair. We include shoes as "vehicles", for people on foot – slips, trips and surface water are important design considerations.	Places provide opportunities and constraints for what People may do, and how their chosen vehicle may operate.

ENVIRONMENT

For any one of the people, the environment includes all the other people, their vehicles and the place that they share. How they see and understand the environment affects how they decide to act.

SAFE ACTIONS COME FROM A WELL-BALANCED SYSTEM

People have enough time to observe, decide and act	Their vehicles can respond to their actions	The place can guide their actions



SYSTEM INTERACTIONS

- People with their vehicle
- People in vehicles with the place
- People in vehicles with the environment

PLACES

People need to recognise each street type easily, and understand the behaviour that is right for them. This includes seeing where they want to go. Each streets type should be distinct, and consistent with streets of the same type, so that people will choose similar behaviours that are safe and appropriate. "Self-explaining streets" is one way of describing this.

OBSERVE, DECIDE AND ACT

People need to be given enough time to look around, see where they should go, see what other people are likely to do, decide what they should do, and act. Speed affects the distance that people move while observing, deciding and acting and is a key factor in designing a place for safe movement.

CHOOSING SAFE ACTIONS

People should be clearly presented with one hazard at a time, to enable observation, decision and action. (An exception may be in busy pedestrian areas, where all people move slowly and mix together.)

Safe path
Guide people to choose a safe route and speed to move though the environment.

Safe to go
Allow people to make a good choice when to move into a space that may conflict with other people in their vehicles.

Safe avoidance
Allow people to see unexpected stationary or moving hazards that may be in their path, or about to cross their path, in sufficient time to respond and avoid collision.

The design of place, and the system as a whole, must provide for the range of mistakes that can be expected by rendering the consequence of mistakes harmless. Choosing a safe speed is a final means of avoiding harm.

Emerging practice

Good streets are those that achieve a good balance between their function as a transport link and as a public space, as a place to linger and to interact, a place to see and be seen. These two functions require a very different design treatment. Depending on which one of the two is prioritised, streets end up looking and feeling very differently. For decades, street design in Auckland has leaned towards the transport function of streets, which why so many of our streets cater primarily for vehicles. This has come at the expense of the other function of streets, namely as public spaces. At the same time, transport modes other than driving have been largely disregarded.

In cities around the world, a transition is underway. After decades of designing streets primarily with the automobile in mind, streets are being redefined as public spaces, and as transport links for all modes. Gradually, planners and engineers are abandoning the paradigm of designing for a maximised vehicle throughput, and are catering instead to people walking, improved public transport, and people on bikes. Emerging practice does more than just redefine the street, it also incorporates street stakeholders and technology into the process.

HOW STREETS SHAPE THE CITY AND OUR LIVES

Streets are the realm where public life is played out. They are places where we share a common experience with our neighbours and fellow citizens. Where the public realm is diminished, the common good is equally diminished. Opportunities to connect with one another are lost. This leads to isolation, decreased social capital, decreased walking and cycling and associated negative effects on public health.

REDEFINING STREETS

The emerging understanding that a single focus on design for private car use is unfit for all of a city's streets has coincided with the global shift to re-make our cities, towns, neighbourhoods and streets as places for people. Wherever streets are re-made, evaluation is key. It measures a project's impact, and helps determine whether an investment is having the envisioned economic and social outcomes. It also informs decision makers and communities on a project's impact on the local community. Take care to ensure that metrics that are used are directly relatable to the street or its function.

STREET STAKEHOLDERS

Many people have an interest in street reconstruction projects. Stakeholders that could be involved in such projects include government agencies (particularly the road controlling authority), residents, local community groups, emergency services, local businesses, advocacy groups and transport professionals.

TECHNOLOGY

Technology is dramatically altering the way we travel and our relationship with streets. Mobile phone applications can facilitate the access to transport services and they can also provide users with better information about their travel choices through real-time technology.

Transport service companies are becoming part of a diversifying multi-modal transport system that includes car-sharing and bike-sharing. Parking management technologies can contribute to the economic and social success of streets by increasing kerbside efficiency and ease of use.

Multi-modal access and interchange will increasingly require consideration in kerbside management and street design. Technology should optimise the functionality of a street, while remaining sensitive to the character of the street. Technology should facilitate the desired urban outcomes of the streets, not define them.

INNOVATION

Street design often requires designers to think outside the box. This guide contains elements and design suggestions that are labeled as innovative and require trial and approval for use by the New Zealand Transport Agency (NZTA). These elements should not be ignored, but actively pursued with the support of Auckland Transport.

Māori values and the Treaty of Waitangi

While Auckland is home to many cultures, Auckland's distinctive Māori identity and the special relationship Māori have to the region is what makes us unique.

Mana whenua of Tāmaki Makaurau (Auckland) have a unique relationship with the region and as kaitiaki play a leading role in shaping it. This responsibility is inter-generational, based on tikanga Māori and embodied in the Treaty of Waitangi.

The Treaty of Waitangi gives rise to obligations to Māori and statutory provisions such as decision-making and participation in statutory processes.

Transport projects can impact on the ability of kaitiaki to undertake their responsibilities. We can pro-actively mitigate these effects in a tangible way by using innovative design and technology. The Sustainability Framework and work programme with mana whenua will provide opportunity to better reflect the Māori world view in a practical way by ensuring that resources are protected, enhanced and sustained across our business.

Te Aranga Māori Design, a Māori design philosophy process based on Māori Values provides guidance to all, reflecting the unique Māori identity of Auckland in our roads, streets and across the public network.

Te Aranga principles

MANA RANGATIRATANGA AUTHORITY

The status of iwi and hapū as mana whenua is recognised and respected

WHAKAPAPA NAMES AND NAMING

Māori names are celebrated

TE TAIAO THE NATURAL ENVIRONMENT

The natural environment is protected, restored and/or enhanced

MAURI TU ENVIRONMENTAL HEALTH

Environmental health is protected, maintained and/or enhanced

MAHI TOI CREATIVE EXPRESSION

Iwi/hapū narratives are captured and expressed creatively and appropriately

NGĀ TOHU THE WIDER CULTURAL LANDSCAPE

Mana whenua significant sites and cultural landmarks are acknowledged

AHI KĀ THE LIVING PRESENCE

Iwi/hapū have a living and enduring presence and are secure and valued within their rohe.

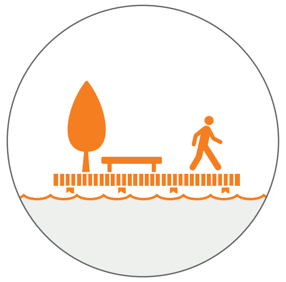
Guiding principles

DESIGN FOR PEOPLE

People are the basic design unit for cities and liveable streets. Designing for people requires the understanding of how fast people move, how far they can see, and how they feel in different environments. In addition to transport considerations, designing for people takes into consideration the spatial scale, activities and interesting things that make places safe, attractive and lively.

DESIGN FOR SAFETY

The safety of all street users, especially the most vulnerable users (children, the elderly, and disabled) and modes (pedestrians and cyclists) should be paramount in any street design. The safety of streets can be dramatically improved through appropriate geometric design, facility design and transport operations. Safe System Assessment Framework must be used in design.



DESIGN FOR CONTEXT

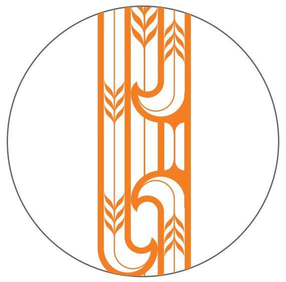
For several decades, streets had been defined by their functional classification, which relates primarily to car flow. Today, streets are expected to reflect and support adjacent land uses. Well-designed streets promote appropriate speeds, modes and footpath activities. This context-sensitive approach considers and enhances the existing built, natural and heritage elements, seeking to reveal and celebrate a place's identity.

STREETS INFLUENCE OUR HEALTH

Aucklanders suffer from a deficit of physical activity, which plays a part in growing levels of chronic disease and obesity. Street designs can help people make healthy decisions by supporting walking, cycling and public transport. Street and neighbourhood design play a role in how people move around safely, in their exercise and activity levels, and personal wellbeing.

STREETS AS ECOSYSTEMS

Street design, including street trees and other green infrastructure, can improve water quality and improve watershed health. Green infrastructure can retain and reduce stormwater, which extends the life of the aging sewer system and makes it operate more efficiently. Green infrastructure brings nature into the city, which can improve both mental and physical health, increase amenity, improve air quality, conserve energy, and enhance habitat in urban areas that are increasingly intensified.



TE ARANGA PRINCIPLES

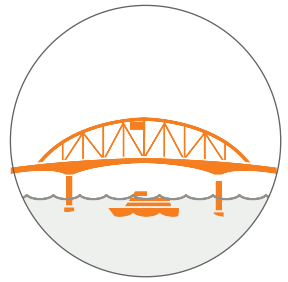
Te Aranga Māori Design Principles are founded on intrinsic Māori cultural values. They have arisen from a widely held desire by Māori to enhance their presence, visibility and participation in the design of the physical realm.

STREETS ARE PUBLIC SPACE

Street design should encourage and enable recreation, social interaction and business activity. Designs should maximise the road reserve space that will be used for social, economic and environmental purposes. Streets should be designed to create an attractive, comfortable, pedestrian-scale environment with a range of amenities, including street trees and other vegetation.

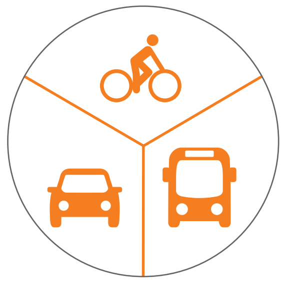
BETTER STREETS ARE GREAT FOR BUSINESS

Streets serve as the key platform for economic exchange in cities. Improved accessibility and a more welcoming street environment attract more people and more activity, thus strengthening communities, the businesses that serve them and the overall city economy.



STREETS IMPACT OUR QUALITY OF LIFE

Streets influence our ability to move around, connect to wider transport networks and access the opportunities of the city. Streets also shape our local environment and neighbourhoods. Streets should support wider accessibility as well as local activities and social interaction.



STREETS ARE MULTI-MODAL

Streets design must support safe, comfortable and attractive multi-modal transport for all users, including elderly, children and mobility-impaired users. Every mode should be integrated, as appropriate, across the transport network. Any particular street may have a different mix of modes to achieve these network objectives.

STREETS CAN CHANGE

Many streets today reflect the priorities and practices from the time they were first built. As Auckland changes and adopts different priorities, the street designs should reflect these new conditions and priorities. Streets can change through major interventions and capital improvement projects, and they can also change systematically through road renewals and ongoing maintenance. Street designs can also be strategically implemented through quick, low-cost interventions that can serve as interim stages to more long-term visions.

STREETS CARRY PEOPLE AND GOODS

Productivity of movement of people should be ensured. Consider the length of the various end-to-end journeys any street is intended to carry. Modes that support these outcomes should be enabled, to give appropriate performance. Movement of freight and servicing land uses must be balanced with the ways people move in the street.

2

CHAPTER

Neighbourhood design

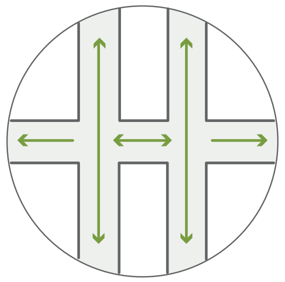
IN THIS CHAPTER

Streets cannot be designed in isolation. Street design occurs at varying scales and includes multiple systems that have interactions and influence over one another.

This Chapter looks at the neighbourhood level of street design, where the level of design is set from a high altitude. It includes consideration of how streets connect to form neighbourhoods; how street networks support access to transport options and local communities; and how network design influences street level characteristics and informs street type choices.

Principles

The shape of the network within a neighbourhood or town centre can increase or decrease walking, cycling or public transport use, which affects the efficiency of the whole network. The goal in neighbourhood planning should be to create a network that makes walking, cycling and public transport the easiest and most appealing choices. The following principles should be considered when designing at a neighbourhood scale.

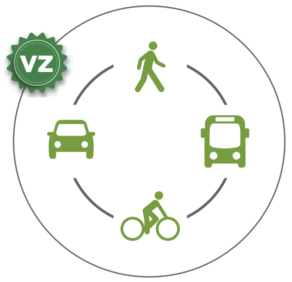


CREATE A STREET NETWORK THAT SUPPORTS COMMUNITIES AND PLACES

A collection of streets form and define the structure of neighbourhoods and places. They set and influence the long-term patterns of development. They connect people to each other and to destinations. Street networks are not just about transport and infrastructure, but also about the movement of people, goods, ideas, and wealth. They foster economic activity and provide public space for human interaction.

PRIORITISE WALKING AS THE FUNDAMENTAL UNIT OF MOVEMENT

Our most valued urban places are those principally designed for the use and enjoyment of people on foot. This requires a closely spaced network of streets and blocks that offer direct, safe, varied pedestrian routes made interesting through careful design.



MAXIMISE TRANSPORT CHOICE

A well designed street network supports a choice of transport modes and routes. People can walk, bicycle, take public transport, or use a private vehicle. Each mode is integrated, as appropriate, within each street.

INTEGRATE TRANSPORT NETWORKS

The street network is a foundation for the design and evolution of other transport systems. An effective street network integrates these multiple transport systems, including other non-street based transport networks such as rail. It provides flexible mobility, easy and legible movement between modes, and helps to turn public transport meeting points into attractive and valuable civic places.

INTEGRATE THE STREET NETWORK WITH NATURAL SYSTEMS AT ALL SCALES

A sustainable street network protects and enhances the natural features and ecological systems of its urban environment, creating a balanced and symbiotic community. It integrates stormwater treatment into street design and incorporates stormwater flow and detention. The sustainable street network responds to natural features, resources and systems by adjusting street density and connectivity. It considers a broad spectrum of relationships, from the human system where low energy and low emission transport options are encouraged, to natural systems, including those that are site specific and regional. It also considers its global impact on climate change through the use of sustainable materials, water efficiency and transport choice.

RESPECT THE EXISTING NATURAL AND BUILT ENVIRONMENT

The scale and orientation of streets in the network reinforces the unique local and regional characteristics of the natural and built environment. These include cultural features, architectural features, climate, geography, topography and history. New street connections need to integrate with the existing (and planned) transport network.

Designing car-optional places

VZ This neighbourhood design guidance is based on the need to create walkable neighbourhoods. Cars do the most harm to people, so enabling people to move around without the need to use a car solves many environmental, health, economic, social and equity challenges facing Auckland.

CIRCULAR RADIUS OF A BUS STOP

Green represents 8 minutes walking distance

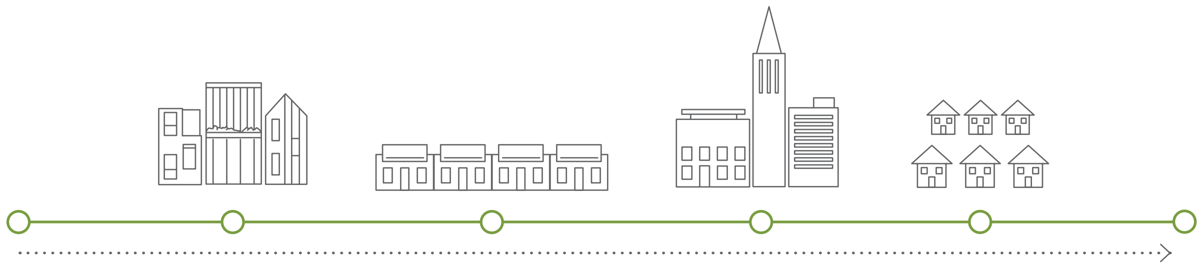
Transport structure

Enabling people to get around without a car requires a street network that supports transport, and a suitable size and density of population and mixture of land uses. It is also important to consider the wider regional public transport network and how local neighbourhood design can leverage existing and future public transport networks.

Together with the population density, the street network structure determines the viability of providing public transport. The integrated planning and location of appropriate land uses for good access to the public transport network can further enhance this.

A fine grid of streets allows more users to access public transport stops/stations and straight streets, in particular through the middle of residential areas, allow public transport vehicles to reach more people per kilometre travelled, as illustrated in the diagram below.

A fine grid should be made up of small block sizes to support a variety of building and housing types, as well as a variety of land uses and a walkable public realm.



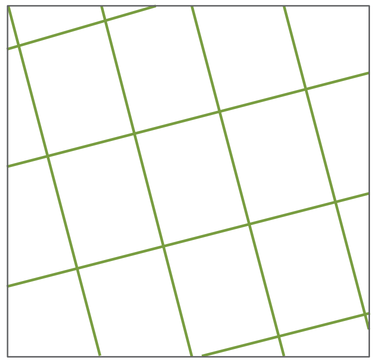
ABOVE: MOST EFFICIENT GEOMETRY FOR TRANSPORT STRUCTURES

ABOVE: INEFFICIENT AND COSTLY GEOMETRY FOR TRANSPORTATION STRUCTURES

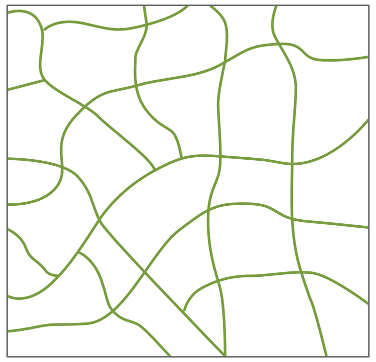
Street networks

Planning and designing effective street networks may be the most important part of urban design, as it has a large influence on people's quality of life and the opportunity to provide active transportation systems. Unlike buildings, which can be adapted and replaced, street networks are difficult to change or improve once in place. Street networks also nest into wider networks, influencing the viability and success of adjacent neighbourhoods.

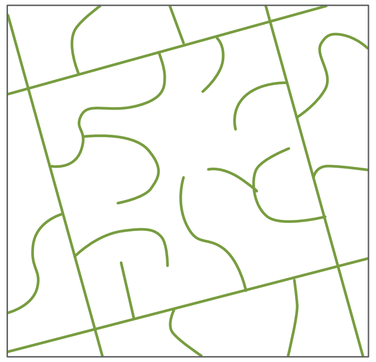
COMMON NETWORK TYPES



Orthogonal grid



Organic grid



Dendritic

NETWORK TYPES

Street layouts should feature a rich array of street and route types. This diversity of streets determines a community's character, and whether it functions as a coherent whole. Street layouts can take a variety of forms, but in terms of shape and configuration, the two main network typologies tend to be either gridded or dendritic (branched form resembling a tree).

A dendritic or suburban hierarchy is designed where local streets only flow to collectors and collectors only flow to arterials. This approach tends to concentrate vehicles onto the congested arterial system and encourages high speeds throughout, and should generally be avoided.

The desired gridded street network connects all types of streets with one another. Individual streets can be more diverse, vehicle speeds can be reduced, and the network can function more efficiently, supporting a range of transport modes. Good patterns of urban street networks support a diverse set of street types and a dense pattern of streets and intersections, facilitating the efficient use of land.

NETWORK STRUCTURE

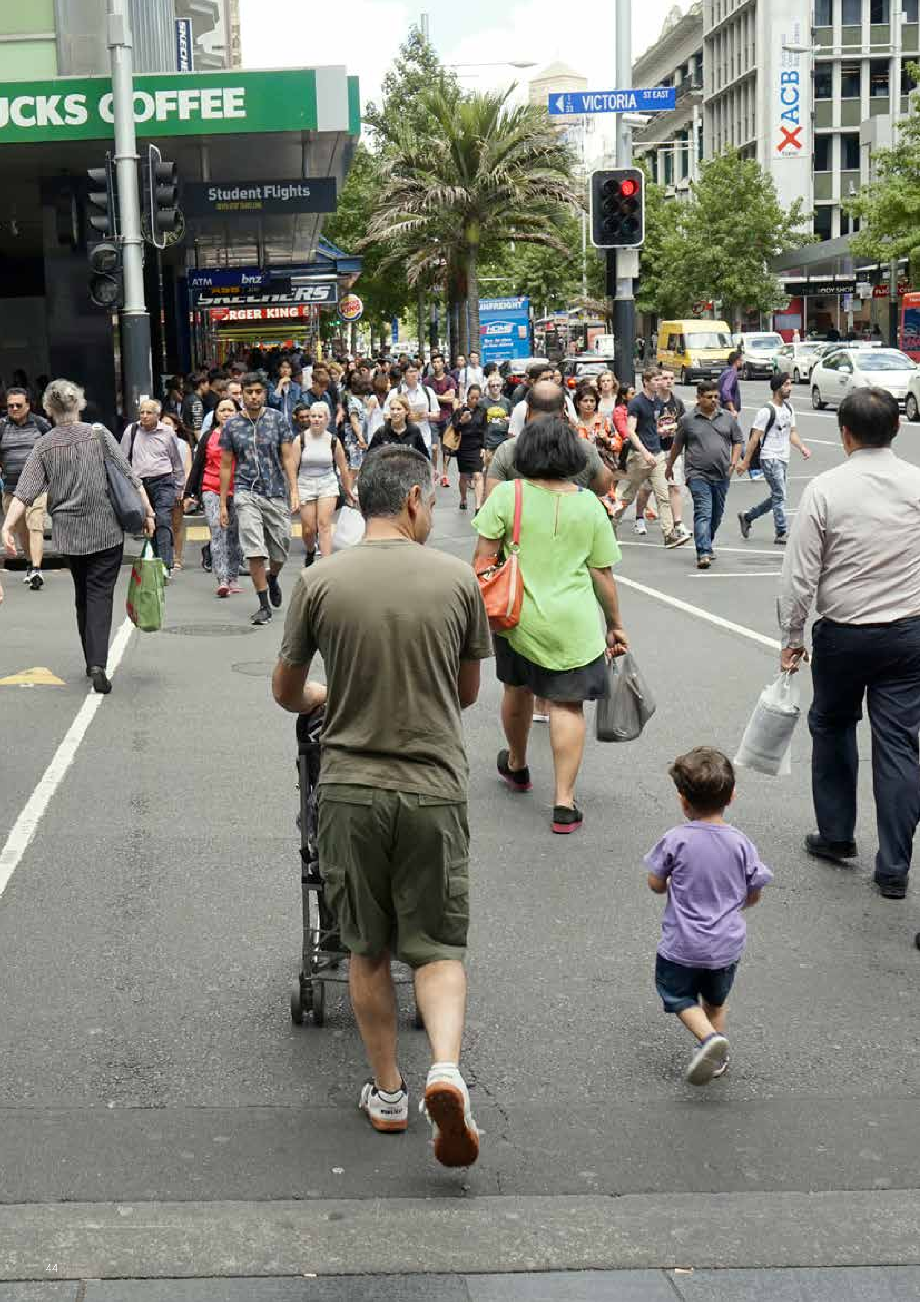
The layout of any neighbourhood or unit of development should contribute to an urban structure of interconnected neighbourhoods and centres. The urban structure of new developments should enhance the structure and connectivity of existing networks. The connected street structure should support several scales of movement – from accommodating pedestrian movements along and across a street to connecting to the local destinations and centres. It should also enable and support the viability of local and regional public transport systems. The length of each leg of a journey, on different street types, and the concentration or dispersion of vehicle numbers on each street, can affect driver behaviour. The safety of the network must be considered, by the design of streets and by encouraging safe behaviour.

INTEGRATION

Permeable and connected movement networks provide choices for people walking and cycling, reduce land consumption, and improve overall network efficiency.

Public spaces such as parks and plazas should be integrated into these networks, further encouraging walking and community activity. Where networks overlap for a variety of uses and users, places become better used, safer, encourage shorter distance and multi-purpose trips and are more appealing.

Designing streets both as valuable public realm and as the structure of the movement network requires that car use is balanced with other modes and priorities. This results in a street space that accommodates all users and treats the street as a positive, pleasant space.



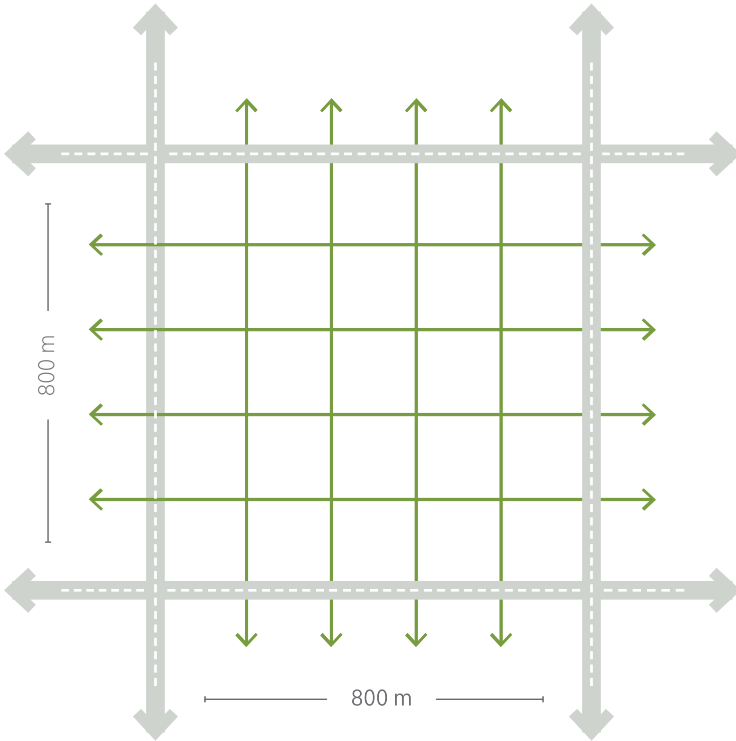
Major streets

Major streets can be "Great Streets", not only facilitating transport, but also creating welcoming public places.. Many of Auckland's most loved streets are classified as arterials which are multimodal and serve established adjacent neighbourhoods. These streets have the greatest potential for large-scale placemaking and for improving the physical space for social, civic, and commercial activity. Major streets also provide the greatest opportunity to accommodate multimodal transport options.

Spacing and aligning major streets is a critical consideration of neighbourhood design. Major streets should be contiguous through the neighbourhood and connect up to other logical main routes. Where new major streets meet adjoining streets, they should meet in a + (cross) intersection, as close to 90 degrees as possible.

By the nature of the catchments they serve and the various modal requirements, some major streets will be wider than others. It is important that these streets do not divide neighbourhoods. Major streets should reflect and support the local context, including frequent safe crossing options to retain local connectivity.

Major streets need to be properly spaced about 800 m apart. When major streets are spaced too far apart, they are required to have additional lanes to carry higher levels of traffic. Inadequate street spacing also causes traffic to encroach on neighbourhood routes designed only for lower traffic volumes. This compromises their potential for pedestrian and cycling use and severely erodes their place quality.



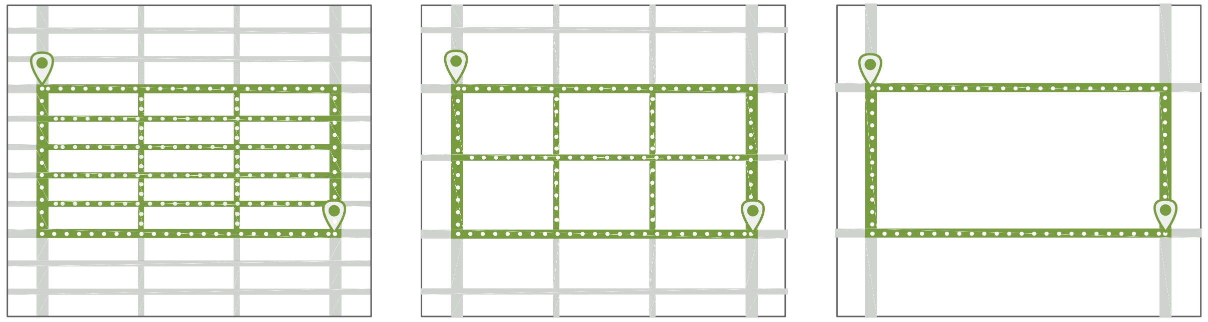
MAJOR STREETS AND LOCAL NETWORK

Block size

Block sizes have a large influence on the walkability of neighbourhoods. Small blocks offer more route choices and greater ability to filter through built-up areas. Block sizes should be small and designed to absorb a variety of building and housing types. Block sizes in centres and commercial areas should support a variety of land uses and a walkable public realm. Permeability for pedestrians can be made higher than for cars by having mid-block alleys or covered arcades specifically for people on foot.

Blocks that are longer north-south than east-west may provide better for solar access. Mid-block rear lanes may be particularly useful in supporting higher density housing types and other types of land uses.

Smaller block sizes and rear lanes may require a larger investment in linear roadway. This increased length of streets (and associated paths and lanes) can be offset in overall road reserve area by utilising a diversity of street types, including narrow streets.



Pedestrian options for different block sizes

Intersections and intersection density

Intersection density (which is related to block size) may be the most important predictor of walkable neighbourhoods and increased public transport use. Intersection density reflects the ease of moving around and the options that people have for doing so.

Cross (+) type, or four-way intersections, are also associated with high levels of walkability. Four-way intersections are associated with grid-shaped street networks and their utility reflects the ease for pedestrians to cross the street, and the likelihood (if associated with short blocks) for lower vehicles speeds.

1500 Intersections/2.6 km²

150 Intersections/2.6 km²

15 Intersections/2.6 km²

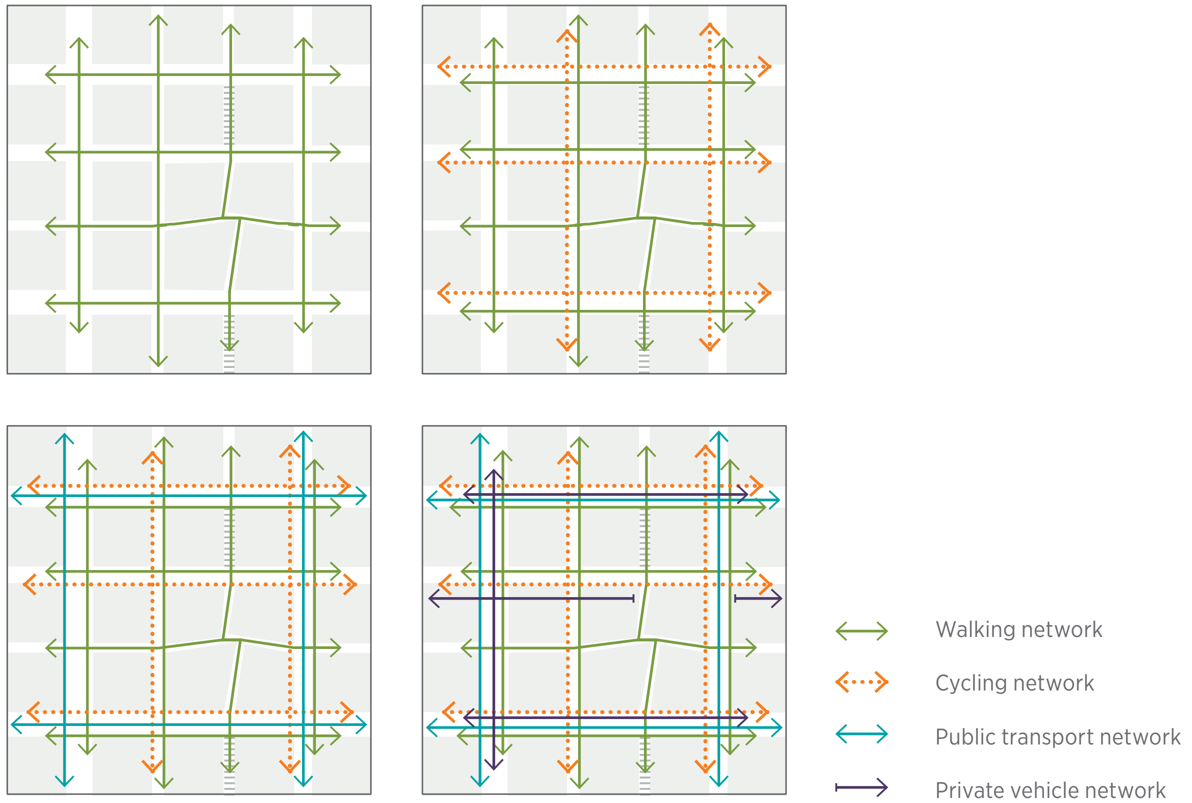
Permeability vs. connectivity

Street networks with a high intersection density and short block lengths have high levels of connectivity, as there are many route options. As street connectivity increases, there are more opportunities to manage permeability differently for various transport modes. Filtered permeability can retain high connectivity, while creating environments that achieve their strategic objectives.

Strategies can be developed that prioritise desired modes along direct routes. For instance, Local Paths (also known as Greenways or Bicycle Boulevards) can prioritise walking and cycling by having walking- and cycling-only links or by restricting vehicle traffic by filtering. Similar techniques can be deployed for public transport routes, where new or designated routes allow for public transport vehicles only. These designs favour the public transport routes with more direct journeys.

The Local Path Design Guide describes how neighbourhood street networks can be retrofitted to prioritise walking and cycling. These same strategies can be applied to greenfield neighbourhoods.

The diagram below illustrates how multiple networks overlap, creating corridors with focuses on different modes.



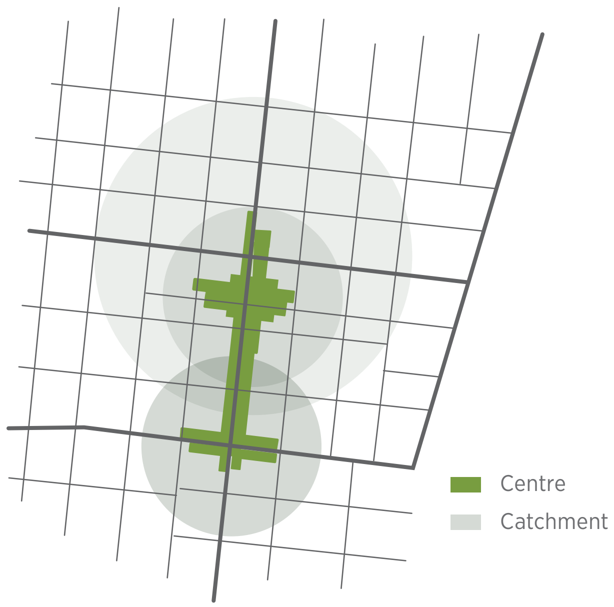
Transport catchments

The movement economy

Interesting and successful places accommodate multiple modes across multiple scales of movement without introducing burdens or displacing local activities. Utilising this movement for various activities is known as the 'movement economy'. Designers can use strategies to maximise the advantage of this movement economy by understanding the various scales of movement and how they can contribute to urban outcomes.

Strategies to strengthen centres that serve their surrounding catchments include accommodating and improving access for a range of local users and for people travelling through. Where dense population areas and movement networks overlap, there is an opportunity to reinforce the economic role of centres and support the viability of a range of commercial activities and activated public places.

VZ It is also important to consider the effects of different modes. Public transport is the safest way of making long trips. Walking has the least risk of harm to others, followed by cycling. Private vehicles have the highest risk of harm, and the worst environmental impacts per person.



PEDESTRIAN CATCHMENT

Pedestrian catchments represent the range that people can walk over a given time period. Common barriers to range include busy streets with difficult pedestrian crossings and paths in areas that feel unsafe. Maximising pedestrian accessibility is a key strategy to supporting local businesses, public transport services and other destinations. Designing for access requires the consideration of the movement network structure and the barriers that limit movement. Strategies to improve the walkability of neighbourhoods includes introducing more connections and links in the network, as well as removing barriers.

BIKE RIDING CATCHMENT

People on bikes have a larger range of travel than people on foot. Planning and designing for people who cycle for daily activities such as commuting and recreational purposes is important for public transport connections and centre vitality.

Bike riding catchments can be increased with the introduction of cycleways and low-speed, low volume local streets. The Local Path Guide aims to create conditions where walking and cycling is safe and attractive by slowing and limiting vehicle traffic in neighbourhoods.

Separated cycle paths can be provided along busy streets where vehicle volumes and speed warrant separation to reduce people's interaction with and exposure to traffic.

On-site cycle parking is a requirement for office and retail activities in the Auckland Unitary Plan. Bike parking should be located in prominent places in centres, major public transport stops, local shops and large commercial destinations. Bike parking can be incorporated into the furniture zone along the footpath, or in bays on the carriageway.

PUBLIC TRANSPORT CATCHMENT

Public transport catchments are the extent to which people can comfortably and safely walk to services. Catchment analysis can reveal optimal locations of stops and identify the paths used by users.

In planning for access, the first consideration should be pedestrians crossing the street at the immediate stop location. Should preferably be located close to intersections where formal pedestrian crossings can be provided. Locating stops near intersections also extends the catchment reach. Stop locations will vary, however, according to intersection spacing. Where stops need to be located away from intersections, controlled or uncontrolled crossing can be provided.

Key paths leading to stops should provide for access for people of varying ages and physical abilities. Paths should be universally accessible, direct, and well-lit. Particular attention should be focused on areas that may be deemed unsafe by a range of users, particularly at night.

While evidence shows that people are willing to walk up to 1 km for high-quality public transport services, access improvements may be most beneficial close to the stop/stations and along main paths and routes.

PARK AND RIDE

In low-density rural areas, public transport catchments can be enhanced by Park and Ride access to the rapid Transport Network.

This can also occur informally, where on-street parking in low-density neighbourhoods close to stops can be managed safely. Provision of formal Park and Ride facilities is determined on a case-by-case basis in accordance with Auckland Transport's strategic guidance.

PEOPLE MOVEMENT

While traditional methods of measuring a street's performance have focused primarily on vehicle volumes, this fails to capture the movement potential of other modes in constrained environments. Measuring the number of people moving through a street provides a more complete picture of how people get around a city and the efficiency and productivity of the transport network. As street space becomes scarce and more is expected of streets as places, shifting to spatially efficient transport modes can unlock street space. Public transport has the highest people-moving capacity in a constrained corridor, followed by walking and cycling. While an urban traffic lane may only move 600 to 1,600 people an hour, a dedicated bus lane can carry up to 8,000 passengers an hour.

PRIVATE VEHICLE CATCHMENT

Private vehicle catchments can contribute to the vitality of centres, but their impacts must be managed. If places can only be accessed safely by car, car parking and vehicle circulation can dominate and compromise the success and vitality of a centre.

Surface car parking should be minimised. Kerbside parking should be carefully allocated and managed across the different times of the day. Adjacent to public transport stops/stations in particular, kerbside space should be made available for pick-up and drop-off ('kiss and ride') trips.

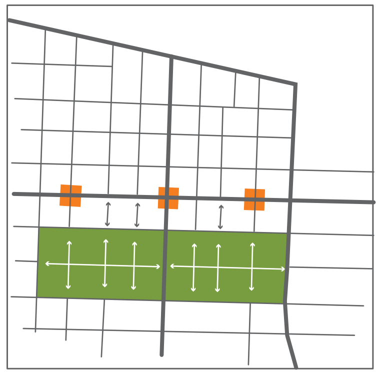
Neighbourhood structure

Connecting streets

While internal permeability is important, neighbourhoods must also be connected with adjacent street networks. A development with poor links to the surrounding area creates an enclave which encourages movement to and from it by car. New neighbourhoods and alterations to existing street networks should be designed with multiple access points that connect with, and complement, existing street patterns.

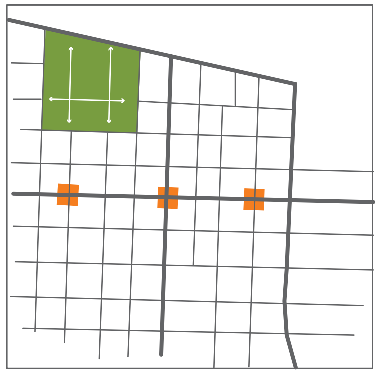
Organising strategies

Larger scale neighbourhood development can make positive contributions to the existing street networks and transport systems.



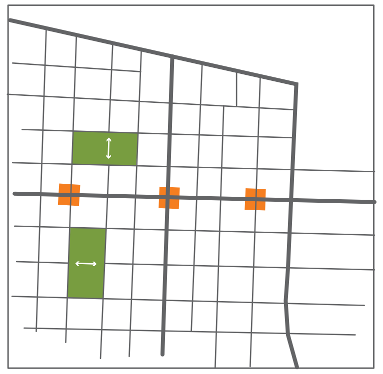
CONSOLIDATING

New development contributes to existing urban areas by the provision of new amenities and new transport structure.



EXTENDING

New development contributes to existing urban areas by creating wider connected catchment to support improved (existing) transport structure.



INFILLING

New development is based on existing transport systems and street structure.

Neighbourhood composition

Density

Designing streets and neighbourhoods to support density is critical to deliver upon the goal of creating places that are walkable and support public transport. Density provides a population base to support local services and nearby centres, so that a larger proportion of daily activities can be conducted closer to home. Higher density development within walking distance of public transport stations/stops can reduce car dependency, help to create local businesses and help to support busy, interesting centres.

Density (and a diversity of housing choices) gives people the opportunity to live in neighbourhoods that meet their lifestyle preferences and economic means. The goal should be to provide residents with the choice to live in amenity-rich neighbourhoods where they are a short walk or bike ride away from shopping, parks, schools and cafés, and take public transport or drive to work and regional destinations. Density allows for more options for more people.

Prioritising investment in frequent, high-capacity public transport to support density is a mutually supportive strategy that can rapidly shift people from private cars to public transport and active modes.

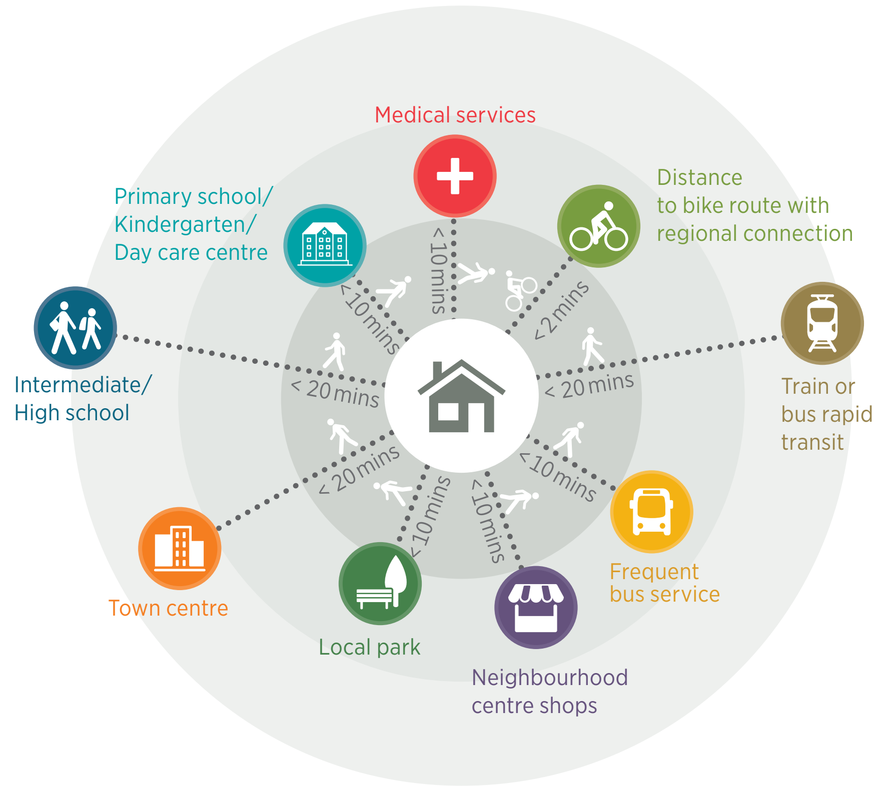
Destinations

VZ While block size and connectivity create a network structure for walkability, destinations are a critical component of neighbourhood design. Local destinations allow people to access community services, retail offerings and even jobs without the need for a long-distance trip. Ensuring the viability of local destinations should be considered during the neighbourhood planning and design phases.

Increased accessibility by active modes and public transport reduces the number of private car trips, reducing the risk of harm.

It also provides economic and social benefits.

ACCEPTABLE TRAVEL TIMES



Land use composition

Encouraging an appropriate mix of land uses can help enliven streets with activity, keep streets in centres active and safer after business hours, keep commute distance and times shorter and provide opportunities to access key destinations within walking distances of home or work places.

In greenfield development, it is important to plan and design for a mix of land uses. Land use informs who uses a street and when, the width of sidewalk or footpath needed for the volume of pedestrians, and decisions on the geometry and elements within the street.

- Mixed Use
- Terraced residential
- Urban residential
- Suburban residential
- Open Space
- Business or Education

HOMOGENEOUS LAND USE PATTERN

VARIED LAND USE PATTERN

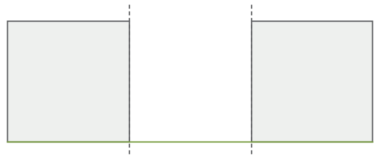
Building edges and street activity

STREET ENCLOSURE

Designers should seek to promote a sense of street enclosure.

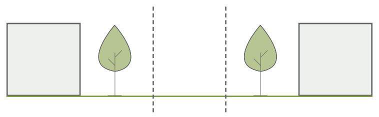
Enclosing streets with buildings and trees helps define them as urban public places and promotes them as pedestrian friendly spaces. A sense of enclosure can also have a traffic calming effect, as it can help the street to look narrower than it actually is. Street enclosure is generally described as a ratio where the height of a building is measured against the width of the street. Ratios can be context specific.

1:1 – Strong enclosure



1:2 – Moderate enclosure

1:3 – Generally effective ratio but trees can help



A strong sense of enclosure should be promoted in larger centres where an ideal ratio is greater than 1:2.

A good sense of enclosure can also be achieved with a ratio of 1:3, provided there are frequent large trees planted along the street, as this can make up for the lack of building height.

ACTIVE STREET FRONTAGES

The block, building and street layout should provide active street frontages. This helps to create a positive, engaging and safe public street environment.

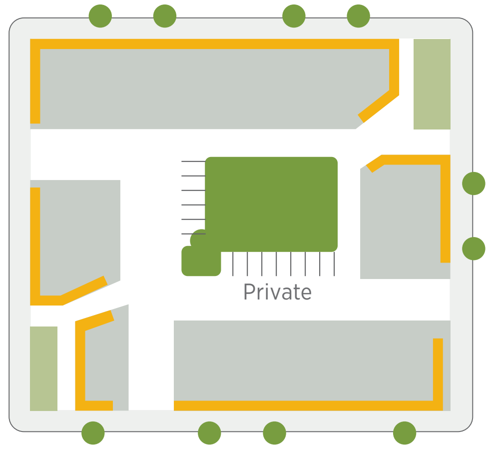
Blocks should

- Have clearly defined public 'fronts' and private 'backs'
- Have limited vehicle access and crossings
- Maximise continuous building frontages
- Locate car parking to the rear.

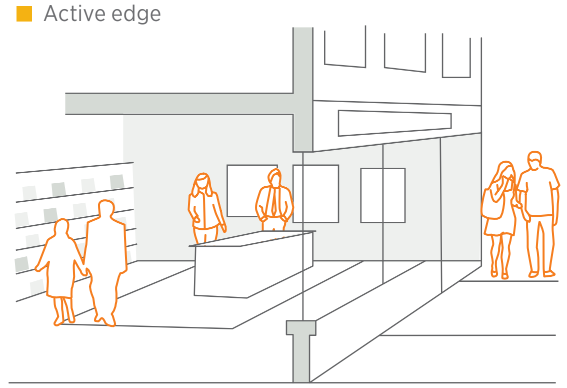
Building should

- Front and positively address the public street
- Have clearly identifiable entrances with direct pedestrian access from the street
- Have glazing at ground floor to enable views into and out of the building
- Incorporate active land uses fronting the street, or habitable rooms in residential environs.

BLOCK LAYOUT



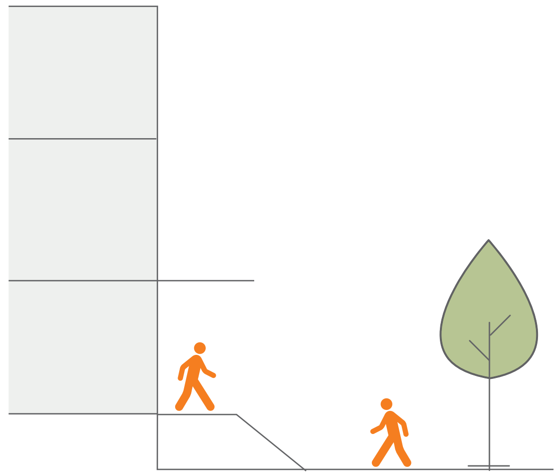
Active edge



PRIVACY VS SURVEILLANCE

Active street frontages facilitate passive surveillance of public spaces and streets. This can help make them be safe and feel safe. However, it can be difficult to maintain a degree of privacy in some cases, where buildings front directly onto the street.

One possible solution is to incorporate a slight difference in height between the street and the ground floor of the building. This changes the field of vision and means people in the building have more privacy, while maintaining eyes on the street. Where accessibility is an issue, ramps could possibly be used.



Level changes can promote surveillance, while retaining privacy

Parking location and supply

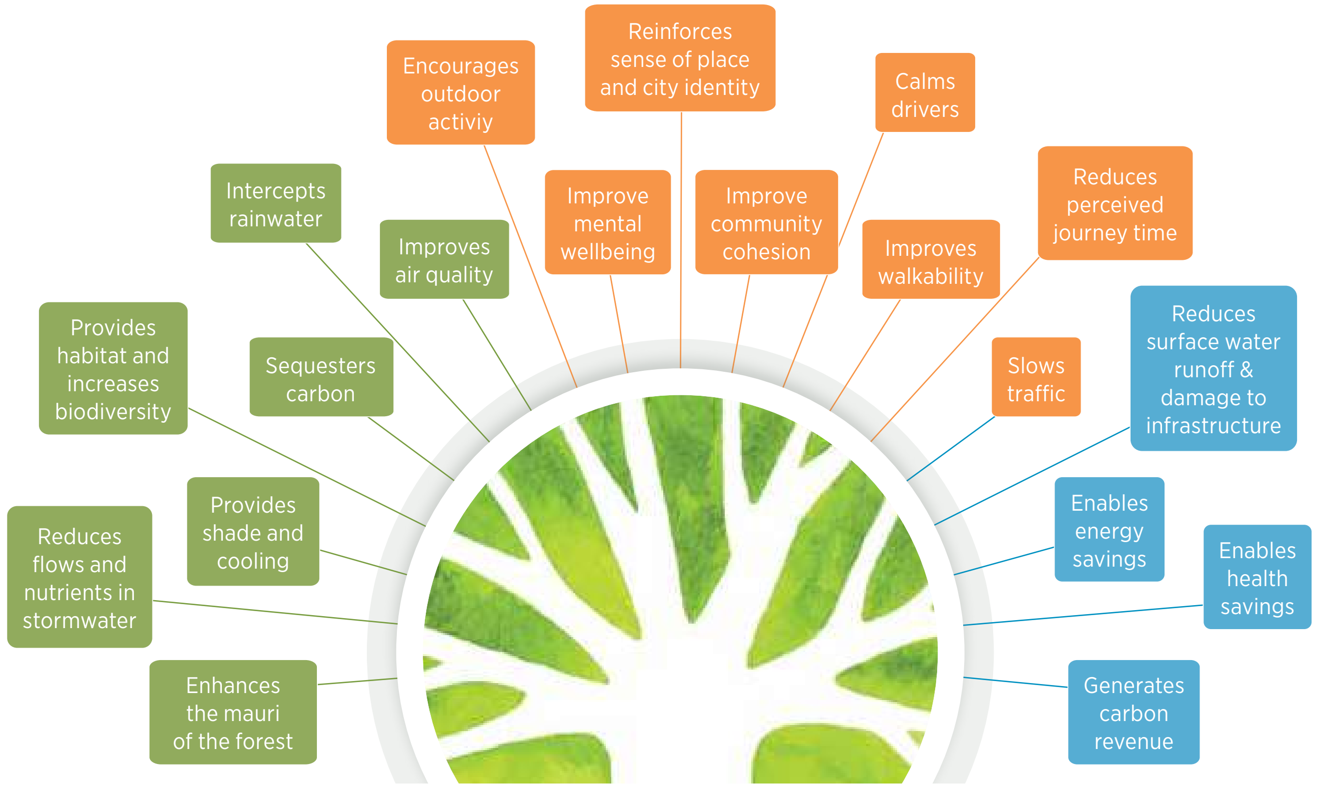
Where a new street network is being created, streets should be designed with an overall concept for on-street parking, taking into account adjacent land uses and off-street parking provided as part of new development. The design of streets should include strategies such as providing parking bays, space for car sharing, loading spaces, mobility spaces, space for motorcycles, cycles and terminals for electric vehicle charging stations.

New developments fronting streets should minimise vehicle access ways, using rear laneways for services and access functions. If parking is not provided on the street, entrances to buildings should still be from the street (with secondary access from private parking if necessary).

Street trees

Street trees fulfil multiple functions in street design and are an indispensable component of neighbourhood design. They give definition and shape to the public realm, and when executed properly, give the street the feeling of an outdoor room. Trees create a pleasant environment for pedestrians and provide physical separation and buffering from moving traffic. They can break down the scale of tall buildings along the street and be a useful tool in resolving transitions between private and public space. They can provide order and legibility to a neighbourhood, which can assist with both orientation and neighbourhood identity.

Street trees should be regularly and closely spaced, ideally not more widely spaced than 15 - 20 m. To maintain a visual connection across the street and maintain the integrity of the street as a whole, trees should not have dense foliage below the eye level. Among the urban forest benefits shown, it is important to understand that the leaves of trees and shrubs capture particulates, to improve air quality, intercept rainwater and reduce air temperature.



URBAN FOREST BENEFITS

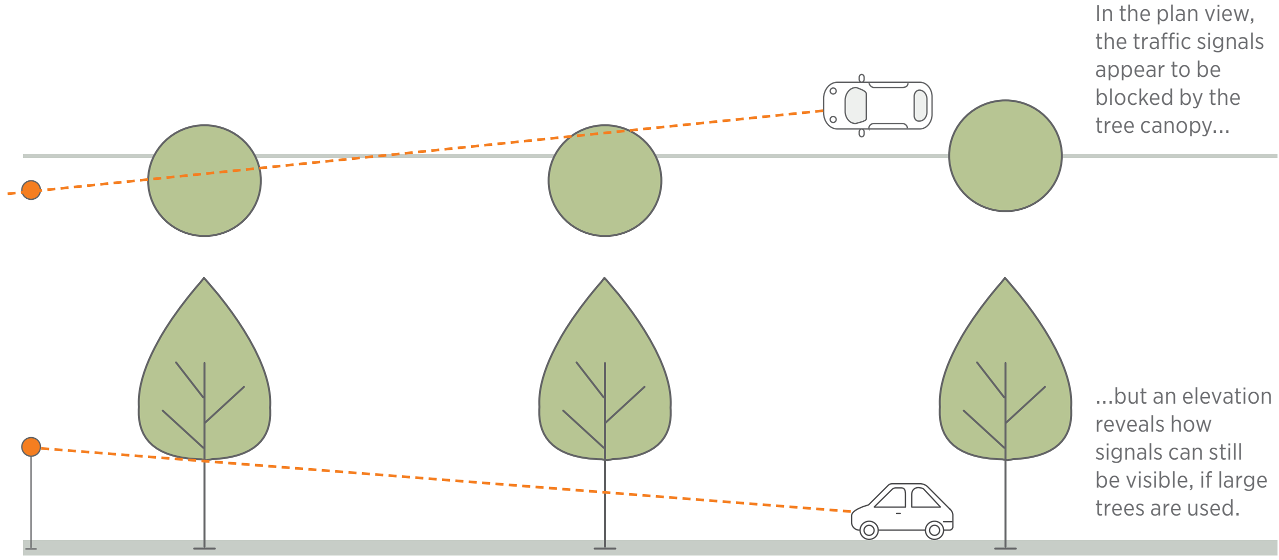
Auckland Transport supports the principles outlined in Auckland's Urban Ngahere (Forest) Strategy. We are aiming for canopy cover of 30% across the region. The road corridor is an important area for tree planting to take place to help deliver longer term improvements and an increase to regional tree canopy cover.

PRINCIPLES FOR DELIVERING TREES IN AUCKLAND'S ROADS AND STREETS

1. All public roads and streets should have trees, except in specific circumstances. Trees contribute to a high-quality urban environment, benefitting all road users. The larger the trees, the greater the benefits that they provide. Roads and streets are the largest category of public space in Auckland. Trees should therefore be included in street designs as a matter of course. Every new road should retain mature trees of value and scale, plant new trees where appropriate and introduce green infrastructure. Exceptions to this principle should be clearly justified.

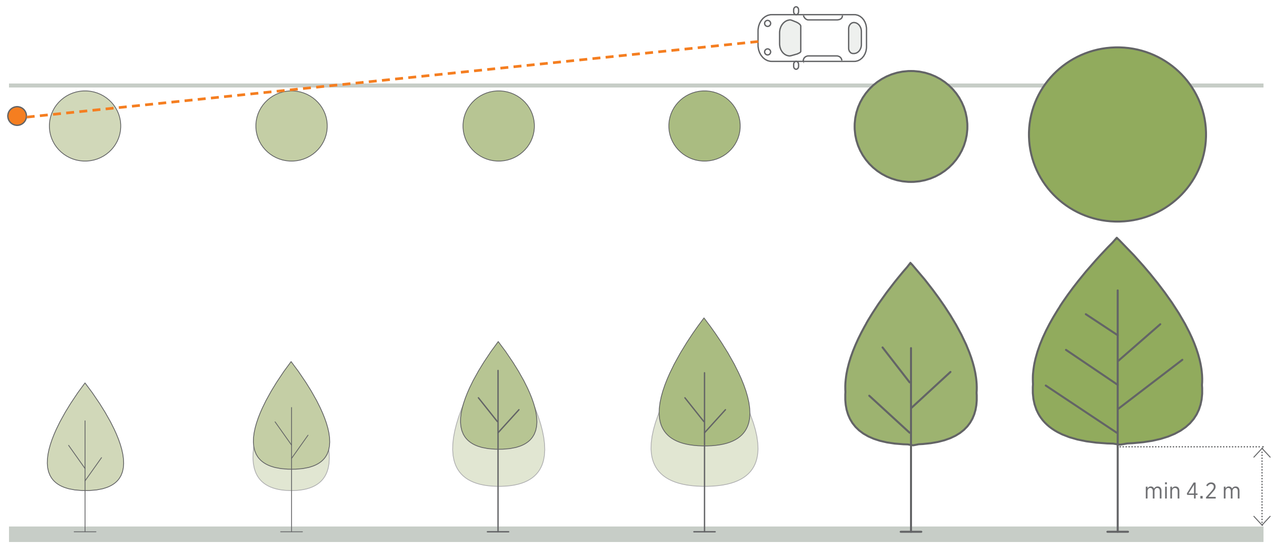
2. Native trees should be the first choice. New Zealand's native flora is unique. 80 per cent of the country's trees, ferns and flowering plants are endemic. Native trees contribute to our sense of place. When the opportunity exists to plant more trees, natives are preferred. Species should be appropriate to the location and function; the right tree in the right place. Large mature trees should be preserved. If native trees are not suitable and/or exotic trees are better, clear reasons should be provided. In some situations, exotic trees may give better outcomes for winter solar access, heritage landscapes, or providing a better environmental service. Reasons for their use should be given.

3. Trees should be regularly spaced along roads and streets A continuous row of trees provides a regular rhythm to the street. It also has a visual narrowing effect, which has been shown to reduce traffic speeds while calming drivers' behaviour. Where existing tree planting is sporadic, new trees can be added to fill the gaps. This delivers continuous canopy cover, providing shade and shelter. Exceptions include clustered planting or single specimen trees suitable for the design context. Plazas, small squares and non-linear spaces are examples of this.



LARGE AND FAST-GROWING TREES FOR ROAD VISIBILITY AND AN ACTIVE BUILDING FRONTAGE

At signalised junctions, street trees need to provide adequate visibility of traffic signals. This can be managed by using large, fast-growing trees that can be limbed up to have a high canopy. This provides clearance for vehicles below, good road lighting, and visibility for motorists, pedestrians and cyclists. Smaller trees obscure shopfronts, signage and lighting. A larger street tree is generally a better choice



MAINTAINING VISIBILITY AS TREES GROW

When the trees are young, the canopy spread is narrow: visibility to signals is maintained.

As the trees grow, the lower branches are removed - keeping the spread of the tree narrow.

Once the tree canopy reaches target heigh (min 4.2 m), removal of the lower branches ceases and the canopy is allowed to spread.

With a fast-growing tree species, the height of the tree's lower canopy can be raised relatively quickly by canopy lifting or removal of lower branches. In streets with close-spaced trees, a narrow tree species may be a good choice. When planting street trees, building frontages should remain visible to help street-level business. Safe and vibrant street life fundamentally depends on the interactions possible between the buildings and the street. The most important principle is to choose the right type of tree for the right place. For further advice, please contact Auckland Council's Urban Forest Advisor and/or the urban designers at the Auckland Design Office.

Natural environment

NATURAL SYSTEMS

Neighbourhood design should start with the understanding of existing natural systems such as mature vegetation, soils, aquifers, watercourses and wetlands. The intrinsic landscape and natural systems should be incorporated positively into the overall neighbourhood design.

An established tree can provide instant prominence in a park or plaza. Creeks and watercourses can inform street orientation and block patterns. Visual links between a landscape feature and key buildings can be used to create view corridors, in which open space uses, pedestrian routes, or a new street can run.

A cohesive landscape structure can shape neighbourhood design on multiple scales and make a positive contribution to the sense of place. Adjustment and iterations between the natural features and movement structures can shape block structure, development forms and types, and the wider movement network.

TOPOGRAPHY, ASPECT, VIEWS AND VISTAS

Working with the grain of the landscape in topology, hydrology and solar aspect, can have economic benefits and reinforce the individuality of a place. Design blocks, streets, and building footprints to follow slope contours. This minimises cut and fill and enables natural gravity-flow drainage.

Site design, including blocks and street layout, should take advantage of existing views. Building size and arrangement can be organised to reveal or frame views as vistas.

GREEN AREAS AND CORRIDORS

Open space is an important part of neighbourhood design. Green areas and corridors can enhance the legibility of a place and they can contribute to ecology and public amenity. Open space networks can be part of the public or private realm and can provide an additional layer in the wider movement network for people, reducing the need to duplicate footpaths and cycleway links.

Giving people access to green space and allowing movement along green corridors allows them to gain benefits to health and wellbeing.

Stormwater integration

From a regional perspective, the best way to reduce stormwater impacts is to create well-designed neighbourhoods with compact centres and streets. This is based on the reality that much of the city's impervious coverage is used to provide space for cars; parking lots, driveways, roads and motorways.

Stormwater systems should reflect and support the desired urban context. Some surface-level stormwater designs may be inappropriate in areas where there is a high level of pedestrian or public realm use.

Larger developments may have more opportunities for stormwater solutions that span property boundaries or even streets. To save space, it may be beneficial to seek off-site mitigation solutions.

Stormwater management should be considered as early as possible in the planning and design process. Stormwater management should be integrated into the street design, open space, and landscape design of subdivisions and neighbourhoods.

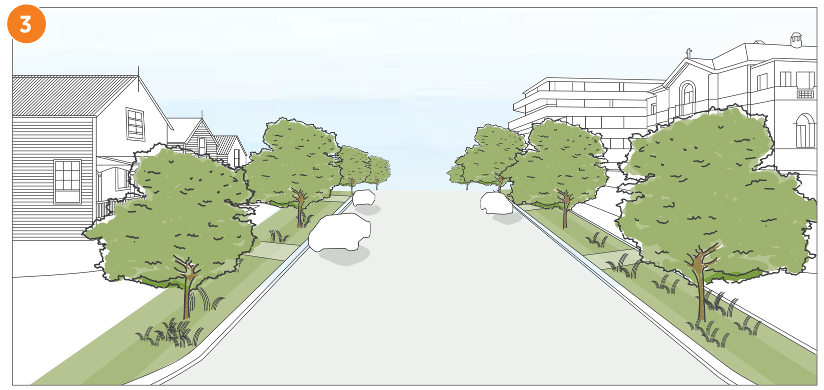
Main swales and streams
Local treatment and collection
Overland flow paths

1 Centre streets
2 Green streets, rain gardens
3 Swale street
4 Green alley

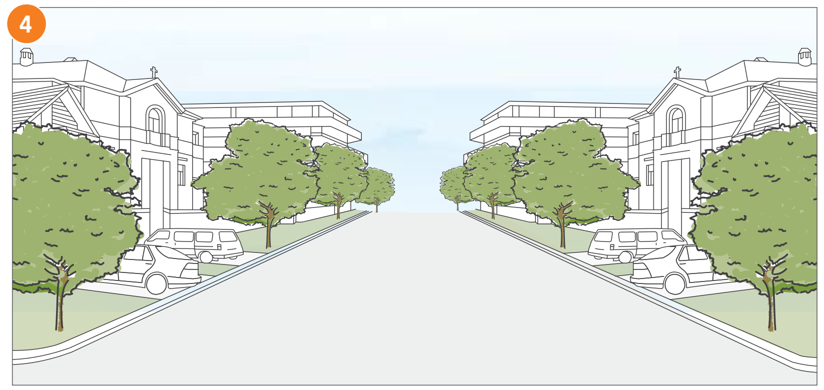
INTEGRATED STORMWATER MANAGEMENT ELEMENTS

Centre streets

Green streets, rain gardens



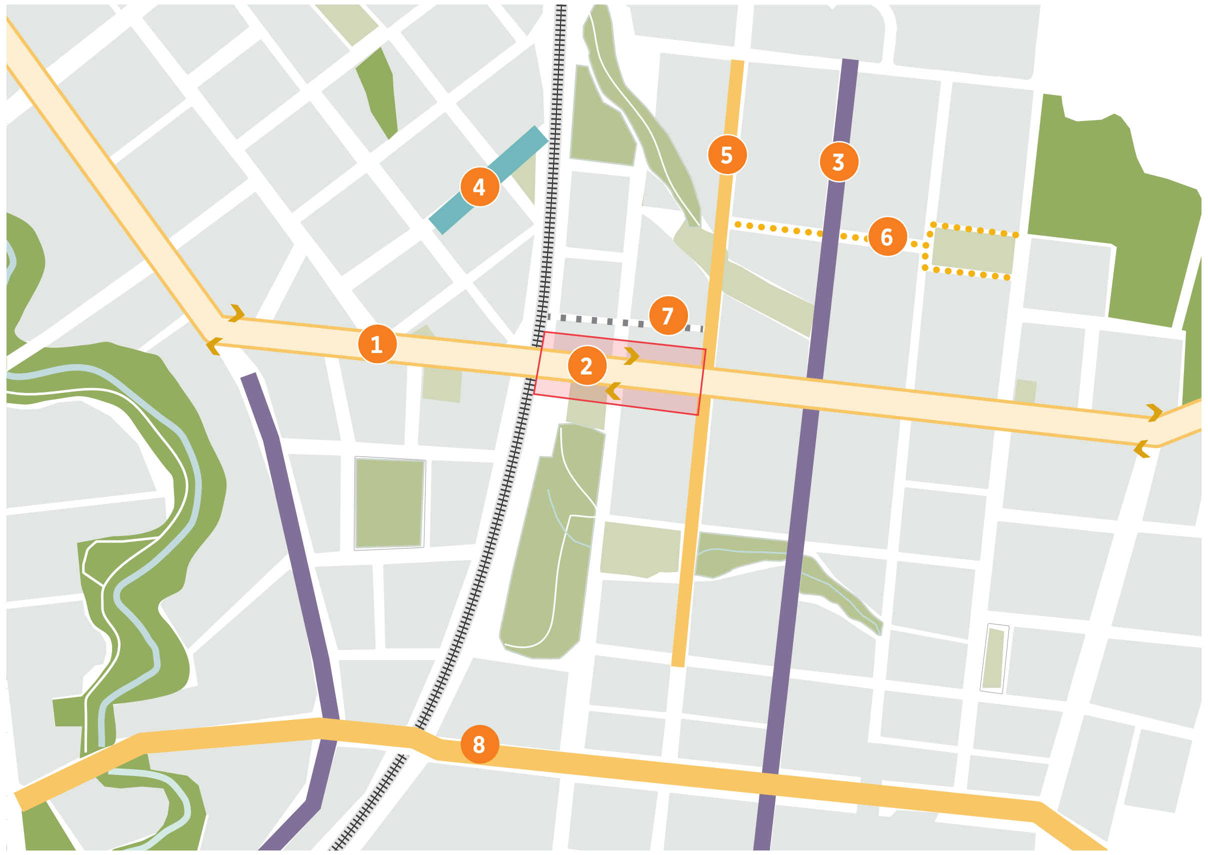
Swale street



Green alley

Street types in a neighbourhood context

A variety of street types must work together to create a lively and thriving neighbourhood, balancing the needs of movement and place in close proximity to each other. Chapter 5 will outline the necessary design responses to these street types, but it is important to note that they do not operate in isolation. For instance, a public transport street may become a public transport mall for a few blocks where the context requires a strong through-movement and place amenity. A public transport street may then intersect with a variety of streets, from a main street with bikes to shared streets. A thriving neighbourhood provides examples of many types of streets serving the multitude of needs of the neighbourhood. For further explanation on Street Types, see Chapter 5.

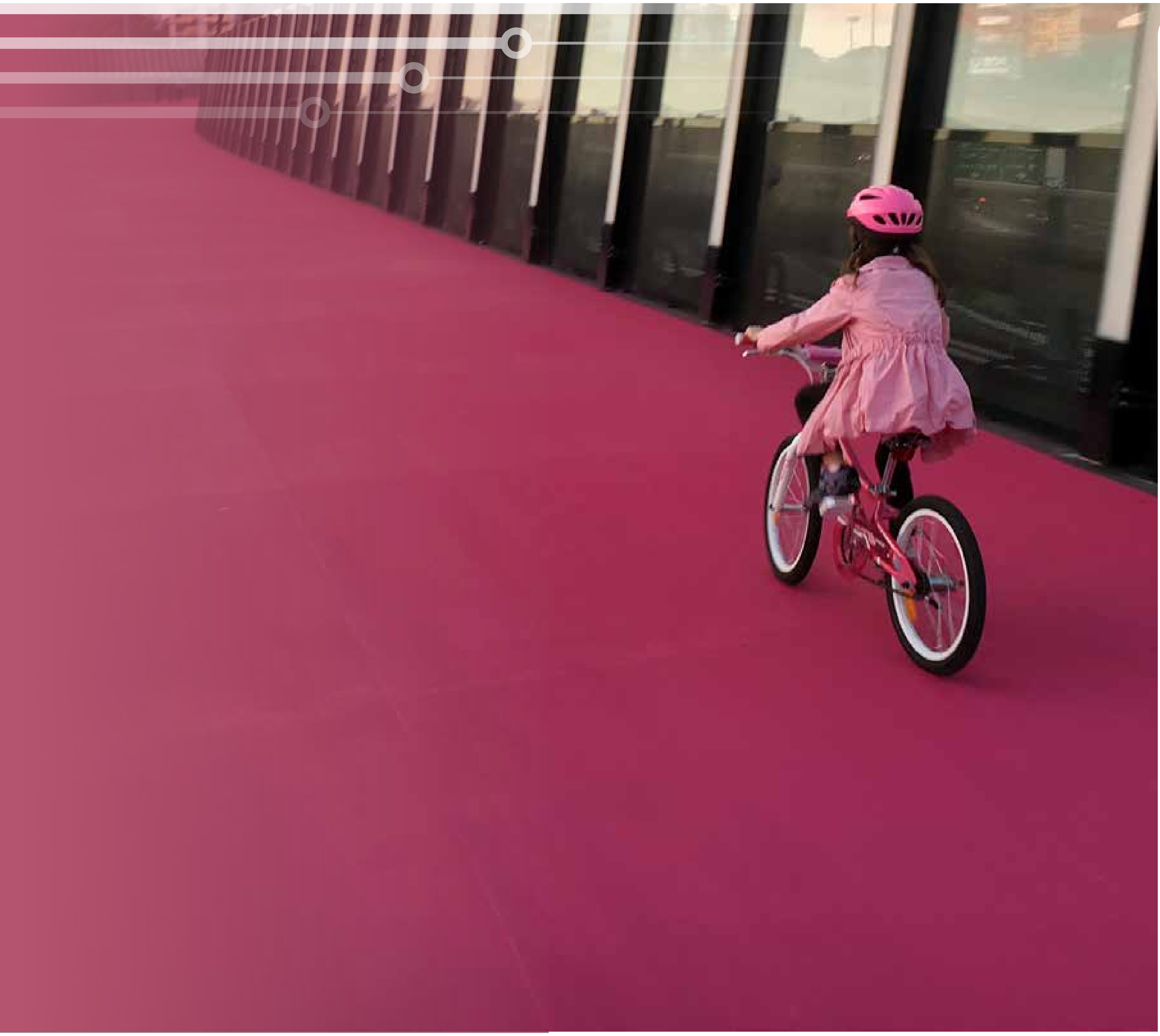


1. **Mixed Use Arterial**
   Public transport street
2. **Main Street Arterial**
   Public transport mall
3. **Main Street Collector**
   Main street with cycling provision
4. **Local Street**
   Home zone
5. **Centre - Local Street**
   Residential street - high density
6. **Centre Plaza/Square/Shared**
   Shared streets
7. **Centre Plaza/Square/Shared**
   Shared streets
8. **Neighbourhood Collector**
   Neighbourhood collector

3

CHAPTER

Street users



All types of people use streets. These include people on foot or small wheels such as scooters and skateboards, people on cycles, people using public transport, people in cars, as well as city services and freight.

A user's spatial requirements greatly impact street design. In order to create a successful street, it is imperative to ensure that the human scale forms the starting point for all street design.

This chapter provides an overview of the types of facilities that form the network, as well as information on the guiding principles of network design and geometries for each of the facility types.

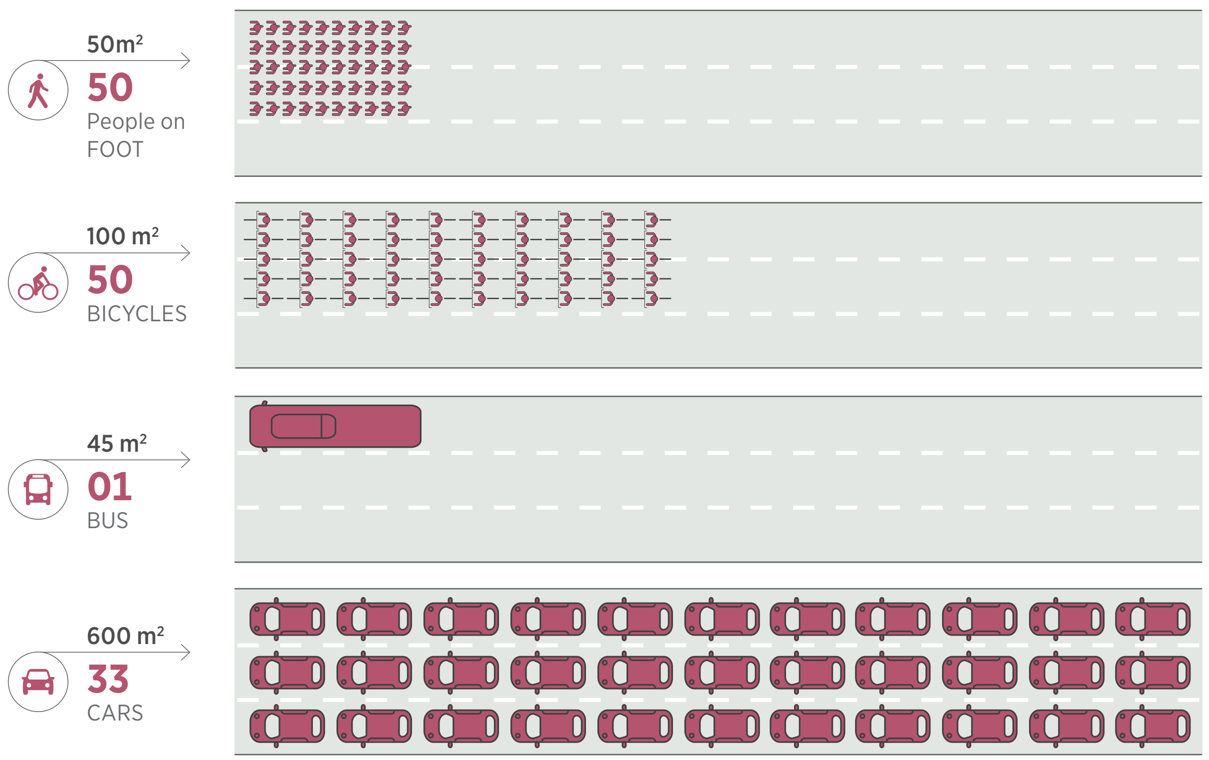
IN THIS CHAPTER

Comparing street users

Most streets must accommodate several different types of a street users at any given time. The needs and spatial requirements between different street users differ greatly. This chapter discusses these different requirements in depth. Comparing these users brings to light the significant advantages prioritising spatially efficient modes in constrained environments. For instance, while a bus needs three times as much space as a car, its capacity over longer distances is unrivalled, as demonstrated in the diagrams opposite. It is important to note that, as land becomes increasingly scarce, the road space must serve the most amount of people.

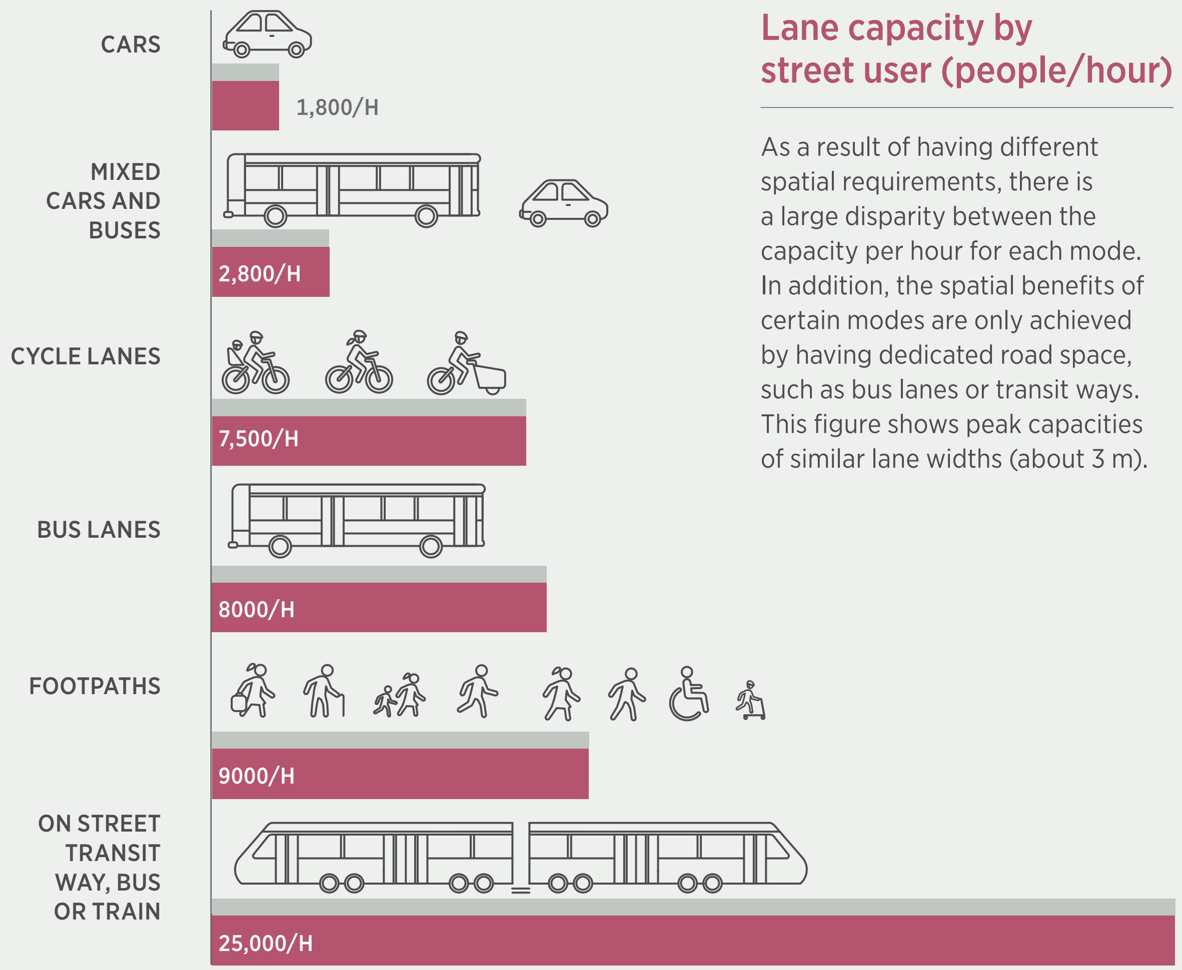
VZ When considering safety, 33 private cars have much more risk of causing harm than one bus. People on foot or bike have negligible risk of causing harm.

Space occupied by 50 people queuing



Lane capacity by street user (people/hour)

As a result of having different spatial requirements, there is a large disparity between the capacity per hour for each mode. In addition, the spatial benefits of certain modes are only achieved by having dedicated road space, such as bus lanes or transit ways. This figure shows peak capacities of similar lane widths (about 3 m).



People on foot

Walking is the most accessible, affordable and equitable form of transport. This implies that people on foot are given consideration first in street design. Priority must be placed on designing with the city's most vulnerable users in mind; the elderly, the young and people with mobility impairments. That is the core principle of universal access: every street must be accessible by people of any age and any ability.

Walkable cities are places that are easily and safely navigable on foot, and offer a sense of equity and independence. A person walking with crutches, a person in a wheelchair and a young mother with a pram all have an equal right to reach any destination that is served by public streets in a city.

The numbers and types of people walking along any urban street will differ depending on several factors. These include the land uses and densities

found along the street, the number of crowd-drawing destinations along it, and the time of day. In turn, the amount of space available to people and the overall attractiveness of a street, together affect how people choose to use the street: do they rush through it trying to get somewhere, or do they stroll along and enjoy the street?

Walking has the capacity to promote equality and reduce social exclusion. As a free means of transport, walking can provide access to a range of facilities, and socio-economic status does not limit opportunity. In addition to equity, walking has public health benefits as well as environmental benefits.

From a public health perspective, walking can contribute to a healthier society. Physicians recommend that adults take up moderate physical activity for at least 150 minutes per week. This could be 30 minutes per day for at least five times a week (it is equally effective when spread out over three ten-minute sessions)[1]. Most people can attain this through simply walking for shorter trips and combining walking with public transport for longer trips.

Walking has the least external environmental impacts of all forms of travel. The most effective way of curtailing the impact of travel on the environment is to cut down on the number of motorised vehicle trips. Short, local trips of up to 2 km disproportionately add to air pollution. In a diverse, mixed urban environment such as Auckland, there is great potential to create more walkable environments, with good local pedestrian connections and links to public transport.

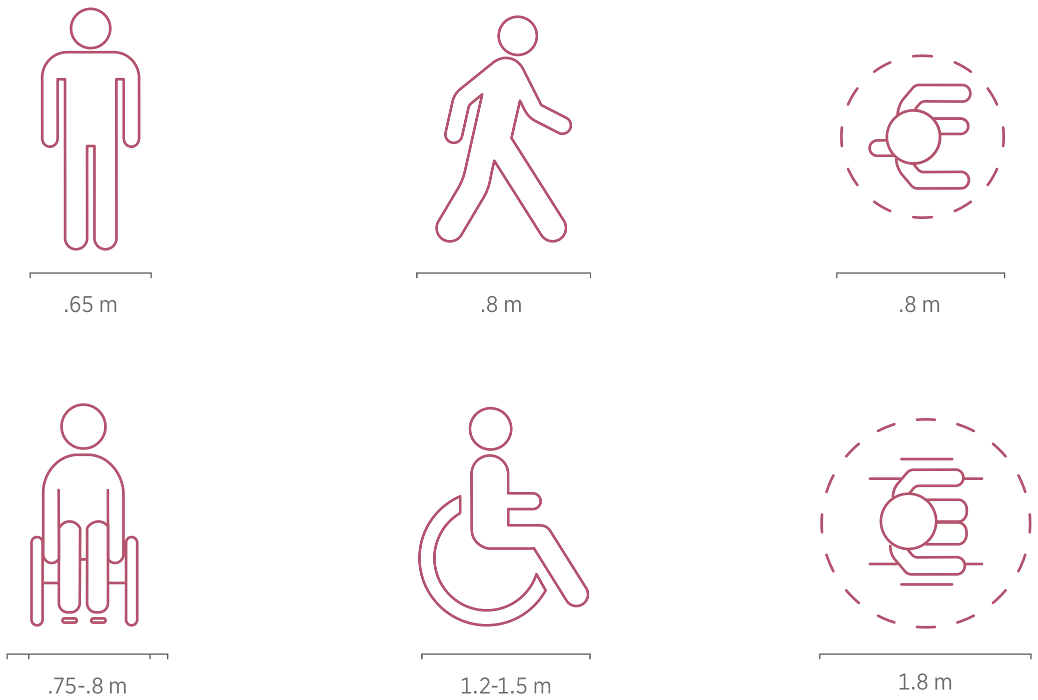
Street design should enable many trips, especially shorter ones, up to 10 or 20 minutes, to be made by walking rather than vehicle.

For more technical guidance, please refer to the Engineering Design Code: *Footpaths and the Public Realm*

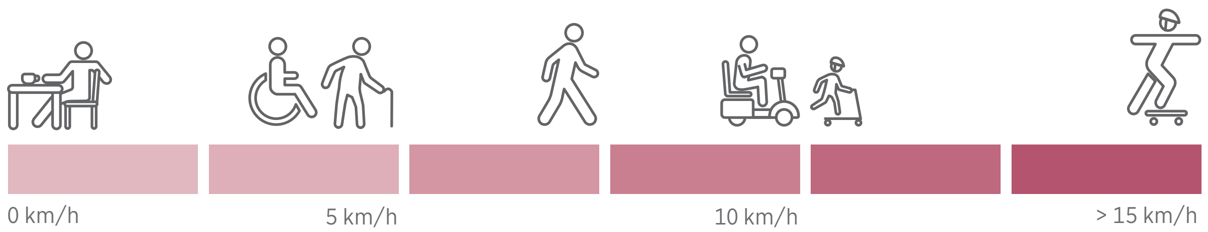
[1] World Health Organization, Global Recommendations on Physical Activity for Health 18-64 years old, 2011

Dimensions and speed

There are a variety of people on foot, each with different needs, and traveling at different speeds. Walking speeds depend on a person's age, ability, their purpose for walking (or jogging) and the length of their route. Furthermore, site conditions such as topography, pedestrian engagement and accessibility also influence walking speeds. Ideally, each type of pedestrian will be catered for in a street's design, allowing for a wide range of walking speeds. Designing to allow for a range of activities, whether undertaken alone or as part of a group, is key to accommodate a variety of pedestrian experiences in the city. Three groups of people have higher requirements, and should be given careful attention in street design: the elderly, children and the disabled and/or injured. The following illustrates user dimensions in space[2].



SPEED RANGES



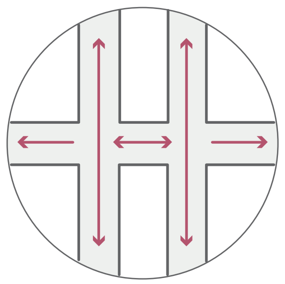
[2] All dimensions are taken from the Global Street Design Guide

Network principles

Urban streets have two primary functions: as corridors of movement and as places. To design a network of connections for people on foot as well as places, it is imperative to look at the smallest scale of the urban fabric. People who are walking experience the street most intensely because they move the slowest of all modes and are able to have all senses engaged due to the absence of an enclosing vehicle. People on foot also have a smaller range than other forms of transport. Responding to the pedestrian experience by allowing for social interaction, with spaces to sit, wait, meet and spend time, will determine the place function of a street. The amount of time people spend on a street directly relates to the safety, level of activity, attractiveness and amenity of the space. These and other considerations present a number of general principles which should be regularly referred to when designing streets for people on foot.

DESIGN FOR PEOPLE

Pedestrian connections should have clearly defined and engaging edges. Clear through paths should be easy to follow by all ages and abilities, with a gentle gradient and places to wait or rest at intervals. Colours, light, patterning and furniture should be chosen to guide movement and avoid confusion or anxiety.



CONNECTIVITY

To provide a feasible and attractive alternative to other modes of transport, pedestrian connections need to offer clear, continuous, direct paths and maximised route choice. Pedestrians use more energy per kilometre travelled than other modes of transport, so people on foot will always seek out the shortest path possible. Street networks should minimise block sizes and maximise pedestrian connections. The attractiveness of walking versus other modes of transport increases over short trips and where quality pedestrian connections are provided, particularly where a more direct path is provided for people on foot than for other modes.

STREET VEGETATION AND GREEN INFRASTRUCTURE

Street trees and low planting provide amenity to city streets. Street trees visually define the continuous path, slow traffic down, form a barrier between vulnerable users and moving vehicles, and provide shade. All vegetation provides oxygen, filters air pollution, reduces rain run-off, cools the air and visually softens the public realm.

Street vegetation should be considered as an integral part of the design of pedestrian connections. Vegetation can be accommodated in berms, in kerb build-outs between carparks or in raised planters.

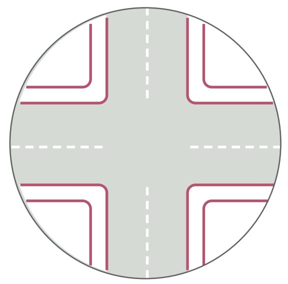
PERSONAL SECURITY

Footpaths are safe especially where there are sufficient 'eyes on the street' to provide passive surveillance, including having active building frontages facing the street, and having a sufficiently lively street atmosphere. For example, closely spaced doors and windows along a street allow physical and visual exterior to interior connections; and outdoor seating at restaurants, kiosks and food trucks encourage people to spend time on the street.

SAFETY

Streets should be safe for all users and at all times of the day. Key contributors to safety are protection from high-speed traffic, appropriate lighting and passive surveillance. A low risk of collisions with vehicles can be designed by encouraging low vehicle speeds, visual contact between street users and appropriate infrastructure.

Survivable impact speeds are essential for reducing the severity of any crash and lowers the risk of road trauma. Survivable speeds of 30 km/h are especially valid around schools, town centres, bus services and neighbourhoods.



QUALITY

Consistency of quality is important - the network is only as good as its weakest link and people will avoid routes where footpaths are uneven, obstructed or end abruptly, even if the interruption is for a short stretch. Route choice allows flexibility for different users, for example where some streets are steep, other continuous, low-gradient routes can provide an alternative.

PEOPLE MOVING THROUGH STREETS

Footpaths on main streets and near major destinations and interchanges need ample width to cater for peak hour volumes of pedestrians to pass each other comfortably, including in groups. Footpaths in residential areas can have a narrower clear path and be surrounded by landscape amenity that is more fitting for this context.

Streets with a focus on movement of people or goods by vehicles may provide for less people on foot, but those who need to walk along them must be able to do so safely.

ACTIVE FRONTAGES

Visual interest makes walking a more enjoyable experience, and buildings along a route should feature a level of detail and ornamentation that is appropriate to the low speed of walking, which allows people to absorb their surroundings. In addition to architectural detailing, varying building height and entrance spacing, window and landscape interest and signage make for a more engaging walking experience.

HUMAN SCALE

Streets should be designed according to the scale of the human body and to function according to the senses. Scale is determined by spatial design and detailing, including building massing, street furniture design and wayfinding. Streetscapes should be comfortable rather than intimidating.

DESIGN FOR CONTEXT

Main streets near employment and interchanges need a focus on movement at peak times. Centre streets that see lower volumes of pedestrians can accommodate more activity on the street, such as outdoor seating and food carts. In popular tourist centres, separate spaces for people to linger and congregate outside of the direct walking paths of other users could be provided. In residential streets, school zones and in areas surrounding playgrounds and parks, space should be designed for children moving and playing.

Network infrastructure types

A city-wide network of infrastructure for people on foot encompasses two groups of linear facility types: footpaths and shared spaces or pedestrian zones. These vary in form according to their specific function and context, but are distinguished based on the level of exclusivity for use by pedestrians.

FOOTPATHS

VZ Footpaths are linear paved surfaces within the street corridor separated from and parallel to the carriageway. Footpaths and crossings form the core of the pedestrian network, facilitating access to lots and connecting to standalone off-street pedestrian and shared paths. They allow universal access for pedestrians when designed to best practice standards. Footpaths provide a dedicated space for people to move on foot and using a variety of small wheeled, low-speed vehicles including mobility scooters and kick scooters. Pedestrians have legal right of way on footpaths, including over driveway crossings.

Footpath design varies according to the land use type, residential densities and adjacent traffic conditions, particularly with regard to width and surface materials. Within Auckland's urban area, footpaths are required on both sides of the street almost everywhere. Depending on context the roadside is divided into zones as shown in Chapter 5: Street Types.

The pedestrian through route must provide a clear accessible path of travel for all footpath users.

The street furniture zone and the frontage zone may be paved continuously with the pedestrian through route, but street furniture or uses must not obscure or obstruct the pedestrian through route.

The full pedestrian network includes footpaths, walkways and stairs, and open public space such as parks. Frequent safe crossings are a vital part of the pedestrian network. For more on crossings, see Chapter 6 Intersections.

SHARED STREETS/PEDESTRIAN MALL

Shared streets and pedestrian malls are streets where pedestrians share the entire width of the street corridor with other street users or have priority within it. These spaces are important parts of the pedestrian network, functioning as corridors of movement as well as places in their own right. Well-designed shared spaces and pedestrian malls are rich and diverse in public life, encouraging people to stroll, pause and spend time and engage in a range of passive and active social interactions. They mostly exist in town centres and inner-city areas where pedestrian volumes are sufficiently high to justify shared or exclusive use of the whole street.

Shared streets are designed to be recognisable as pedestrian-priority streets, where vehicles are treated as guests. The design of the street must ensure very low vehicle speed, even when few pedestrians are present. The street is level from building to building without a grade-separated footpath. The lack of separation by mode compels road users to carefully negotiate shared spaces, and rely on eye contact to determine who yields to whom. For pedestrians, shared streets provide an inviting walking experience, where they can use the full width of the street and are yielded to by motorists.

Pedestrian malls are streets that closely resemble shared streets, though they are more restrictive to vehicular access. Regular private vehicles are prohibited, though access to emergency and maintenance vehicles is maintained, as well as limited access to delivery vehicles. Pedestrian malls must be declared under the Local Government Act Special Consultative Process. Design parameters for shared streets and pedestrian malls are less well defined. These spaces should be designed according to the context.

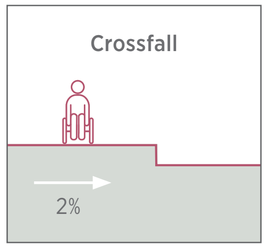
Geometry

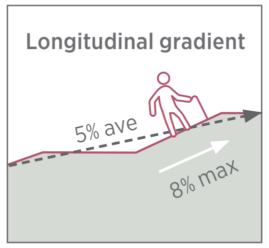
The geometry of streets and of footpaths and other kinds of pedestrian facilities, depends on the physical dimensions of people and path users. Hence it is important to take note of the average dimensions of a person, to ensure that pedestrian facilities remain human-scaled. The average pedestrian is about 0.65 m wide, and will generally require a 0.8 m-long space to manoeuvre when walking. In order to walk safely, a diameter of 0.8 m around the pedestrian is seen as the minimum space needed.

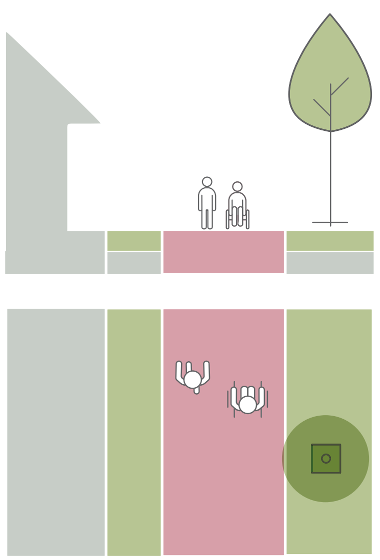
These dimensions are different for people in wheelchairs, who require slightly more space. Wheelchair users require a space of around 1.2 to 1.5 m long to manoeuvre while moving forward. The recommended space around a wheelchair user is at least 1.8 m. When designing streets for people, the requirements of people in wheelchairs should always be seen as the minimum dimensions of any facility.

GRADIENT

Footpaths should have a crossfall of 2% and a mean longitudinal gradient of no more than 5%. Maximum grade is 8% for no more than 9 m. Many footpaths in Auckland have been constructed to a historical standard of 1.2 m wide or less. Best practice now requires a clear path width of 1.8 to 3.0 m, depending on the context, to allow different types of footpath users to pass one another easily.

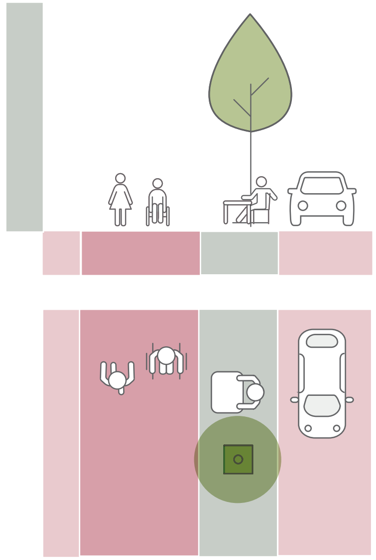






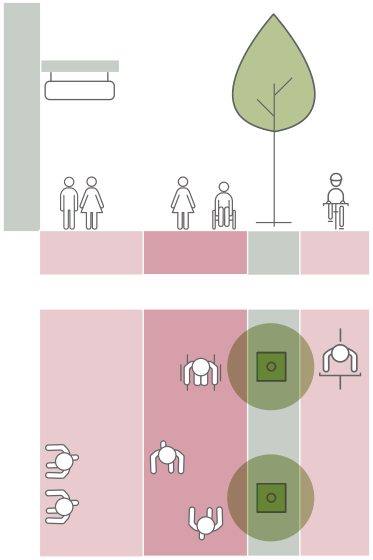
RESIDENTIAL STREET FOOTPATHS

Footpaths in residential neighbourhoods vary in width, depending on their context. A clear path width of at least 1.8 m must be provided. Footpaths may feature a berm or strip of planting on either side of the clear path. For these streets, a strip of 1 metre between the footpath and property boundary is recommended. A planting strip between the footpath and the kerb can accommodate a tree pit (1.5 m minimum width). In denser areas, where the footpath directly borders a building, a clear path width of 2.4 m should be provided. An absolute minimum of 1.8 m should only be considered for narrow streets. A buffer of a minimum of 0.6 m should be provided between the kerb and the clear path, which can accommodate small-footprint street furniture such as lighting posts. Where the buffer zone can be about 2.1 m wide, street trees and larger footprint street furniture, such as seating, can be provided.



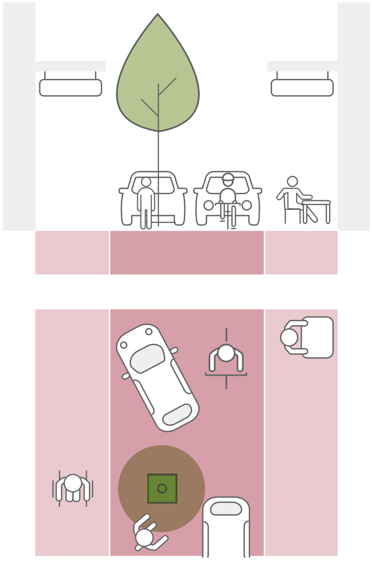
NEIGHBOURHOOD MAIN STREET FOOTPATHS

For neighbourhood main streets, various configurations are possible. Where the clear path sits directly adjacent to the building edge, a width of at least 2.4 m is suggested. Commercial activity (such as outdoor seating), which should be allowed for on neighbourhood main streets, may take up at least 2.1 m. On narrower streets, where it might not be possible to provide tree pits, the buffer strip adjacent to the kerb might be used to provide planters or other landscaping features and should be at least 1 metre wide. Where the clear path is not situated directly adjacent to the building's edge, a small zone (1.5 metre) of commercial activity might be situated directly in front of the building. On busier neighbourhood main streets, a clear path width of at least 3 m is suggested, as are street trees to provide a buffer between higher pedestrian volumes and traffic. This furniture zone might be widened to 2.4 m to provide for bus stops, seating and other uses.



COMMERCIAL/RETAIL STREET FOOTPATHS

On busy commercial streets it is important to allow for on-street commercial activities, a wider clear path width, and a more solidified buffer between pedestrians and traffic. A width of 3.0 m is recommended for commercial activity, which can be situated adjacent to the building's edge, to allow ground floor uses to spill out onto the footpath in a dedicated area. Depending on the total width of the footpath and the street, a clear path of at least 3.0 m is suggested, with 4.2 m being more appropriate for city centre streets that carry higher volumes of pedestrians. A buffer from traffic of at least 1.5 m is suggested, allowing for tree pits. These could be expanded to 1.8 m on wider streets, to allow for public transport stops and additional street furniture such as benches in the buffer between the clear path and the kerb.

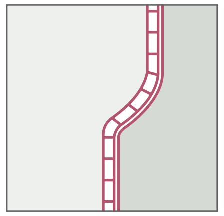


SHARED STREETS AND PEDESTRIAN ONLY ZONES

It is difficult to provide geometry guidelines for shared streets and pedestrian-only zones. On both types of streets, the entire realm between buildings on both sides of the street effectively becomes the footpath, as it is level throughout. Pedestrians can walk freely anywhere on the street, only needing to circumnavigate street furniture and street trees. The geometry of shared streets and pedestrian-only zones depends greatly on the total width of the street. It is recommended that shared streets and pedestrian-only zones are designed on a case-by-case basis. However in all cases, the footpath spatial zones still exist and it is important to provide a clear and accessible path of travel that is safe and protected from vehicles.

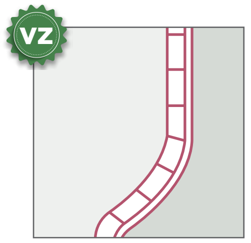
Elements

FOOTPATHS



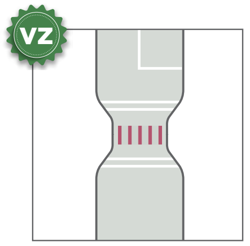
Footpaths make up the majority of the network of pedestrian facilities. The clear through route on any footpath should never be less than 1.8 m wide. Footpaths should have hard, even paving and crossfall of 2% (not more than 3%). Footpaths should include a buffer between the clear path and traffic; presenting a good place for street furniture, utilities and service covers and tree pits. Space for commercial activity should be provided in commercial, retail and mixed-use areas.

KERBS



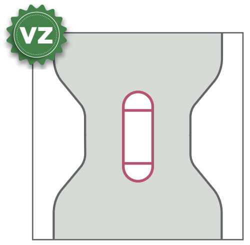
Kerbs provide vertical separation from the roadway, protecting pedestrians from vehicle encroachment. Kerb height should be 150 mm from channel to top of kerb. Kerb alignment and design has implications for use by pedestrians, notably with regard to kerb crossings and kerb extensions. Kerb crossings mediate the transition from the footpath to the carriageway at pedestrian crossings. They are critical for people in wheelchairs and people with prams or trolleys. Any ramps should be at a 90-degree angle to the kerb, aligned with the crossing facility. Kerb extensions can be used as traffic calming devices, as they physically and visually narrow the carriageway, increase driver awareness and encourage reduced vehicle speeds. They shorten the crossing distance and increase the visibility of waiting pedestrians.

CONTROLLED PEDESTRIAN CROSSINGS



Controlled crossings provide pedestrian priority at specific points, either mid-block or at street intersections. Controlled crossings are a critical part of the walking network, as they allow universally accessible opportunities for pedestrians to cross streets that may otherwise present a barrier to movement. Approaching vehicles should be managed to limit them to survivable speeds at the crossing point. Two types of controlled crossings are used. Zebra crossings should be on raised tables and give pedestrians the right of way at any time and are denoted by a combination of carriageway markings, signage, kerb extensions, pedestrian refuges and/or lights. Signalised crossings are also denoted by carriageway markings and give pedestrians the right of way in dedicated signal phases. The frequency and length of pedestrian crossing phases determine pedestrian delay and have a major influence on the level of service for people travelling on foot.

UNCONTROLLED PEDESTRIAN CROSSINGS

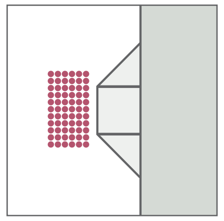


Pedestrian crossings allow movement across streets where no controlled facility is provided. As pedestrians do not have right of way, they rely on a greater level of pedestrian awareness and care, making them unsuitable for some street users.

Crossings occur in two forms. Pedestrian refuges provide a protected place for people to wait halfway across the street and allow pedestrians to look for traffic in one direction at a time. Pedestrian platforms can be used at intersections, in low-speed streets and in town centres to indicate suitable places for pedestrians to cross. They may take the form of raised tables or changes in materials across a street to encourage slower vehicle speeds.

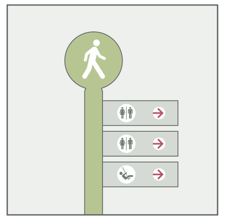
Uncontrolled pedestrian crossing points allow people to cross at unsignalised intersections, roundabouts or mid-block. As no protection is provided, pedestrians must be able to judge when to cross the street, which may not be safe for all street users in all traffic conditions. The pedestrian experience is improved by traffic calming devices such as kerb extensions, narrow vehicle lanes and street trees. Approaching vehicles should be managed to limit them to survivable speeds at any point where people are encouraged to cross a road.

VISION IMPAIRED GUIDANCE



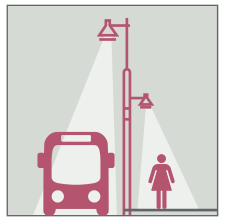
Street facilities that assist people with impaired vision are an essential part of providing for universal accessibility. They function by communicating changes in the street environment at decision points, using tactile and aural means. Two elements are used in streetscapes. Tactile ground surface indicators denote hazards such as changes in level and street crossings and provide directional indication where other tactile or environmental cues are insufficient. Audible tactile traffic signals allow people who have impaired vision to activate and use signalised pedestrian crossings, using a combination of push buttons and audio indications.

WAYFINDING SIGNAGE



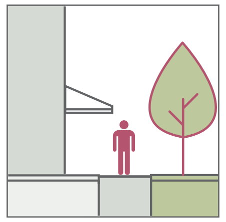
Wayfinding signs help pedestrians to navigate around the city. They should use a consistent, easily understood visual language, and ideally include the walking distances measured both in walking time and absolute distance. Best practice wayfinding also provides information on where to switch modes, aiding those who are using public transport.

LIGHTING



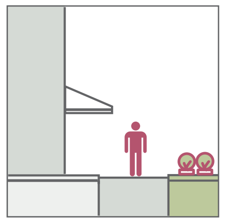
Pedestrian connections should be sufficiently lit to ensure safety, deter crime and create inviting spaces. Lighting should be scaled to the pedestrian, with lighting fixtures placed on all streets at appropriate intervals. Separate fittings will often be required for pedestrians and vehicle traffic. Commercial areas will be lit more intensely, whereas lighting in residential areas should be subtler. Lighting fixtures should not obstruct walking paths.

STREET TREES



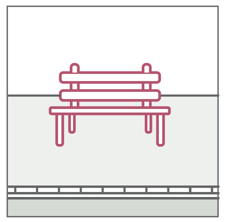
Street trees are a fundamental component of street design. Trees improve the street environment for all street users by improving air and stormwater quality and can contribute to enhanced biodiversity. They give definition to the public realm, break down the perceived scale of the street, provide shade and a reassuring physical barrier for footpath users. Street trees also slow down traffic, contributing to overall street safety.

LOW STREET PLANTING



Like street trees, low planting and lawns areas offer numerous benefits to street users as well as the ecology. Low street planting provides oxygen, filters out air pollution and helps to manage the quantity and quality of stormwater runoff. Areas of planting can be designed to contribute biodiversity, visually soften and add to the sense of place the street corridor. Planting should be designed so that it does not grow to obscure people, especially children, where they may step into the road to cross it.

STREET FURNITURE



Street furniture contributes to public life by facilitating social interaction and catering to the convenience and comfort of pedestrians. Seating should be provided at regular intervals and should be a mix of shaded and non-shaded seats. It is recommended that half of the provided seating has comfortable backrests, and armrests to assist people in standing up. Movable chairs are desirable in public spaces, as they allow people to customise seating arrangements. Water fountains should be provided at suitable locations on walking and cycling routes. Strategically placed litter bins are convenient for pedestrians and help maintain a clean and pleasant public realm. Other amenities may be considered for inclusion in the street corridor, including opportunities for play, public toilets and kiosks. These elements improve the vitality and encourage people to spend time and interact socially on the street. All street furniture should be located outside the pedestrian clear path.

People on bicycles

Riding a bike is an affordable, environmentally friendly and healthy mode of transport that is enjoying a resurgence in cities worldwide. The benefits to public health and local economies are tremendous. E-bikes are also extending the range and speed of cycling, increasing accessible travel choices.

From the 2013 Census 1.2 percent of morning peak time journeys to work were made by bicycle. There still is ample opportunity for the mode share to grow.

Encouraging cycling has numerous benefits in Auckland. The best way to make cycling safer is to increase the number of cyclists. Cycling provides a cost effective and often quicker transport choice as an alternative to driving. As the city grows, there is increasing justification for unlocking city space for more spatially efficient transport modes like cycling. Cycling can increase the catchment of town centres and local centres, helping to support local economies and advance the desire for a compact urban form. Cycling allows access to wider opportunities in the city that contribute to people's quality of life. People use bikes for journeys to work, to study or to shops, or for recreation.

Two types of cycling facilities are discussed in this guide:

- **Separated cycle paths**
  Space is allocated for exclusive cycling use, separated from traffic by buffers, medians or parked vehicles;
- **On-street facilities**
  Including cycle lanes and mixed-traffic streets, these are facilities where cyclists ride in or next to motorised traffic.

People on bikes can be seriously injured in even a minor collision with motorised traffic. In general, new cycling facilities should be separated from motorised traffic where travel speeds exceed 30 km/h, as cycling near fast-moving traffic is uncomfortable for most cyclists. Shared facilities are most fitting on quieter streets with lower speeds and traffic volumes. Where people on bikes have to mix with busier traffic, the competition for space may lead to unsafe behaviour. Conflicts with pedestrians may also arise where people resort to riding on the footpath, in the absence of a cycleway. Adequately designed cycling infrastructure can reduce these conflicts, creating safer environments for the most vulnerable modes.

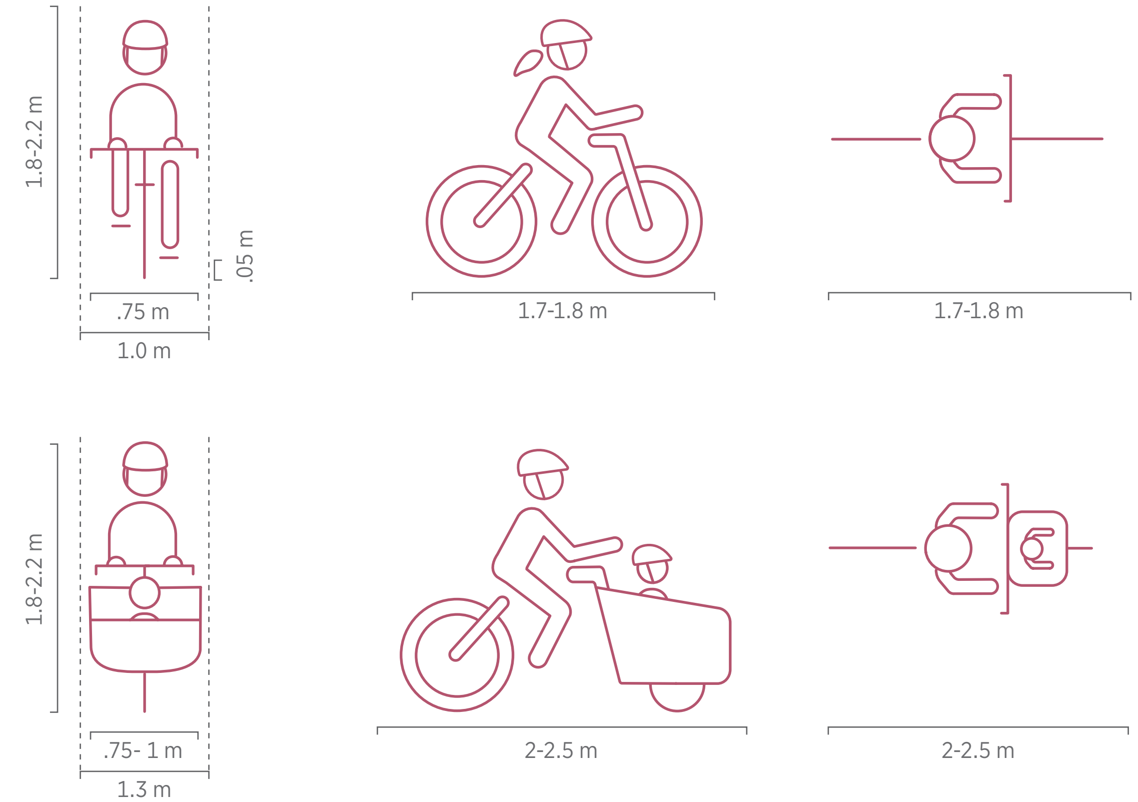
For more technical guidance, please refer to the Engineering Design Code: ***Cycle infrastructure***

Dimensions and speed

The geometry of cycling facilities depends primarily on two factors: the available space or the spatial constraints on a street, and the dimensions of cyclists. Most bicycles are about 1.7 to 1.8 m in length, and about 70 cm wide, with the height of the cyclist generally varying from 1.8 to 2.2 m. Larger bikes such as cargo bikes tend to be wider (up to 1 m) and longer, varying from 2 to 2.5 m. Tricycles can be wider. Recumbent bikes, cycles for disabled users and for children can be lower. This has implications in all infrastructure where a person on a bicycle is present, from refuges and pram ramps to shared paths and separated cycle paths.

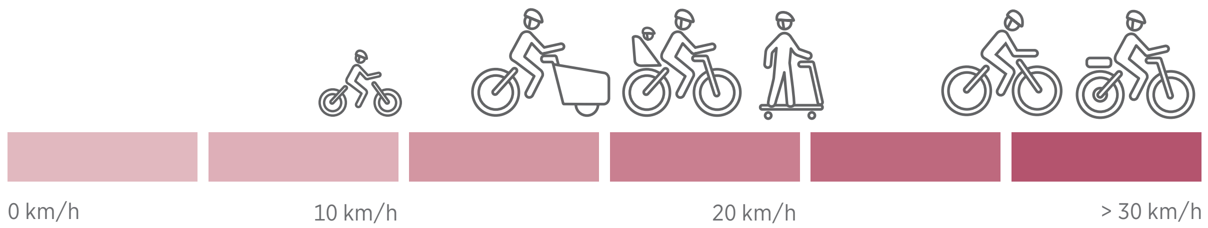
Electric-assisted e-bikes can be faster than unpowered bikes, and can accelerate quickly and maintain speed uphill. This is significant in considering the range of cycling behaviour, and risks of conflict with other user types.

People on e-scooters may also mix with people on bikes, at speeds up to 15 km/h or more.



Minimum envelope for bike users is 1.0 m wide, allowing for some weaving for stability, especially uphill.

SPEED RANGES



Network principles

Creating a safe, city-wide cycling network encourages people to get on a bicycle to meet their transport needs. A cycling infrastructure system adhering to the following network principles will provide optimal conditions for inducing high levels of cycling.

COMFORTABLE

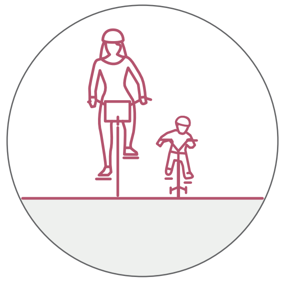
Cycling infrastructure should allow its users to feel at ease through careful attention to topography, geometry, the riding surface, the street environment and provision of amenities.

Avoid steep hills while maintaining directness where possible. Cycleways should provide generous space for moving along a street corridor by bicycle, including through intersections.

The surface should be paved with smooth, slip-resistant materials, avoiding uneven surfaces, utility covers and drains which can cause cyclists to swerve and lose balance.

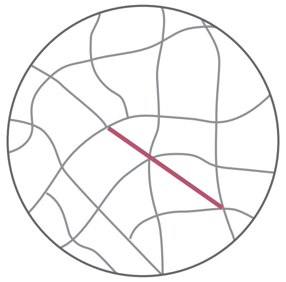
Natural landscape elements enhance the cycling experience, such as street trees which provide shelter from wind, shade and beauty.

Supporting amenity should be included along the network, including bicycle parking, drinking water and toilets.



DESIGN FOR PEOPLE

People on bikes may be of all ages and abilities. A cycle network should have facilities and routes for all. People making longer trips may want to travel faster than those making shorter, local trips. The mix of users must be understood in context to make good design choices.



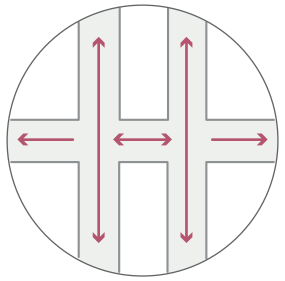
DIRECT

Cycling is a people-powered transport mode, meaning that physical effort required is proportional to distance travelled. A good cycling network will afford users the most direct route between key destinations and likely origins throughout the city, keeping detours to a minimum. Delays at intersections and crossings should be kept to a minimum. This is important, because some people will opt for a different means of transport when a cycling facility is less direct than other modes.

SAFE

People on bikes can be seriously injured in even minor collisions. Perceived safety affects travel choice and therefore the success of the cycling network. Cycling close to fast-moving traffic is unsafe for people on bikes due to the large mass and speed differential from vehicles. Separation of traffic from people on bikes, or reduction of traffic speed, are needed for safe system design.

Safety is particularly important where people on bikes cross the path of other users. Separation from people on foot is also important for their safety, especially where speed and number of people on bikes will lead to conflicts.



CONNECTED

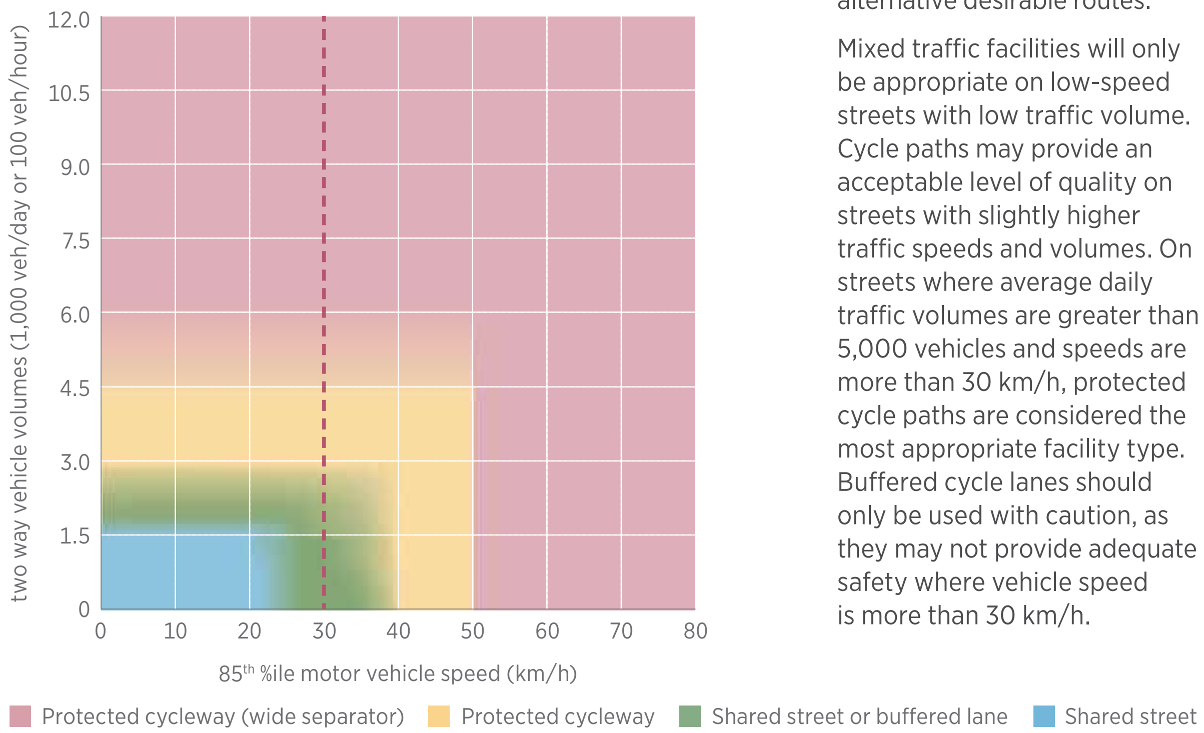
A functional cycle network is connected, and consistent, and provides access to a variety of destinations, making cycling an attractive option. Key destinations should be located with good network access. Continuity of design of cycling facilities along the length of a route is also important, as it helps cyclists identify the route easily. Facilities should be accessible from local streets and land uses on both sides of busier roads.

Cycle facility choice

Determining the appropriate cycle facility type requires an analysis of street conditions, including traffic volume and speed. To attract a broad range of users, a cycle facility needs to be appropriate for the street conditions. The facility type (whether a buffered cycle lane, protected cycle path or facility in mixed traffic) has a major impact on safety and attractiveness. While protected cycle paths are not always the appropriate treatment, they are required on busy streets with fast traffic to provide a safe system facility. In some constrained cases, facilities providing a limited Quality of Service may be accepted. This may be as interim investment as a connected network is developed over time, or where a network provides alternative desirable routes.

Mixed traffic facilities will only be appropriate on low-speed streets with low traffic volume. Cycle paths may provide an acceptable level of quality on streets with slightly higher traffic speeds and volumes. On streets where average daily traffic volumes are greater than 5,000 vehicles and speeds are more than 30 km/h, protected cycle paths are considered the most appropriate facility type. Buffered cycle lanes should only be used with caution, as they may not provide adequate safety where vehicle speed is more than 30 km/h.

GUIDE TO FACILITIES FOR TRAFFIC CONDITIONS



QUALITY FACILITIES

The facility choices and guidance presented here are based on the desire to provide a comfortable experience that is attractive to someone choosing cycling as a means of transport. For most people the key barrier to cycling is interacting with traffic which is perceived as threatening due to mass and speed. Removing the stress of cycling in traffic is the basis for the infrastructure guidance and its suitability in varying contexts and conditions. Evidence shows that cities with high-quality, low-stress cycle facilities have higher cycling mode share.

Where balance is required in facility choice or dimensions, the requirement for removing traffic stress should be of paramount concern. For example, while a cycle path width of 2.5 m enables people to ride side-by-side, this dimension may be reduced in constrained locations as crash severity (and cyclist discomfort) of riding with traffic is of much higher importance than not being able to ride side-by-side.

EVALUATING QUALITY OF SERVICE TOOL

Evaluating Quality of Service for Auckland Cycle Facilities: A Practitioner's Guide should be used as varied in the Engineering Design Code - Cycling infrastructure. The tool consists of a range of criteria and standards that is used to score or compare a proposed or existing cycleway facility. The tool reveals the key considerations required to design a high-quality cycle facility that is useful and attractive to the widest range of people.

Network infrastructure types

PROTECTED CYCLE PATHS

Cycle paths provide a cycling facility that is physically separated from motorised traffic. They are designed for exclusive use by people on bikes. The enhanced separation offers a safer and more comfortable experience of cycling on urban streets. Cycle paths can be one- or bi-directional, with one-directional cycle paths typically provided on both sides of a two-way street, while bi-directional cycle paths are commonly used on one side of a one-way street, in constrained corridors, or along long stretches of continuous land uses such as parks or water bodies.

CYCLE LANES

Cycle lanes provide a facility for people on bikes on streets and roads where physical separation is either not possible (due to space constraints) or not warranted (due to low traffic volumes or low travel speeds, for instance). Using paint, lines and symbols, bicycle lanes are identified on the roadway. They are not protected from traffic by physical barriers. Cycle lanes are intended for one-way travel only, and are typically featured on both directions on two-way streets and in one direction on one-way streets. Contraflow paths or lanes should be provided where possible on one-way streets.

MIXED TRAFFIC

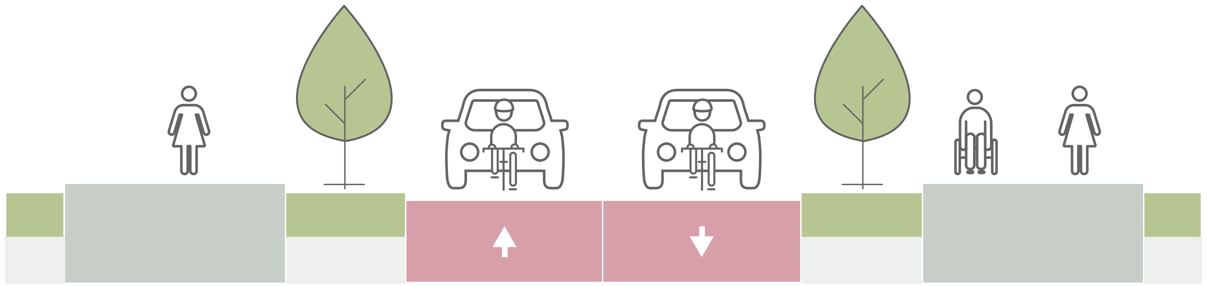
Many streets can be enabled for safe and comfortable cycling where they share the carriageway with vehicles. For example, two-way cycle travel is accommodated on Auckland's shared streets. Designing shared streets for cycling is not limited to kerb-less shared streets or one-way travel patterns. The critical conditions are low vehicle speeds (<30 km/h), low traffic volumes, and a relatively dense urban context.

Local paths

The Local Path Design Guide sets out the network philosophy, design principles, and performance standards for the implementation of local paths.

Local paths are quiet streets, routes through parks and short connections that improve walking and cycling connectivity. They form the local catchment areas of the wider cycleway network.

Streets that form part of a local path network must meet the performance standards for low-stress cycling: low traffic volumes (< 2,000 average daily traffic) and slow speeds (< 30 km/h). In some cases, interventions are required to create streets that are suitable for mixed traffic cycling.



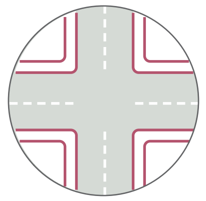
Local path performance standards

VEHICLE VOLUMES

Local paths should be designed, built and maintained for a maximum average of 2,000 vehicles per day.

VEHICLE SPEEDS

Local paths should be designed, built and maintained for a vehicle speed of 30 km/h at most (85th percentile speed).



ARTERIAL ROAD CROSSINGS

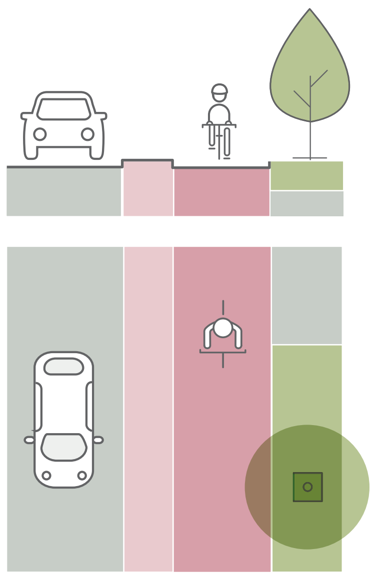
At intersections with arterial or collector roads, local paths should be designed, built and maintained to provide a minimum of 50 crossing opportunities per hour.

Geometry

The geometry of cycling facilities is designed according to the dimensions of moving and stationary cyclists and the nature of the corridor in which they occur. When designing a street with cycling priority, infrastructure should be selected from the following types, based on existing street conditions, its cycling network function, expected volume and type of use and spatial constraints.

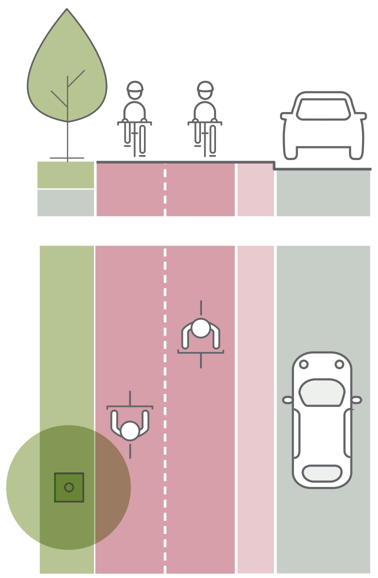
PROTECTED CYCLE PATHS

Where vehicle travel speeds are 50 km/h or higher, protected cycle paths become the appropriate on-street cycling facility. The cycle path can be protected from the vehicle travel lane by a raised buffer and/or parked cars where parking is required. Alternatively, the cycle path can be raised to footpath level or to an intermediate height.



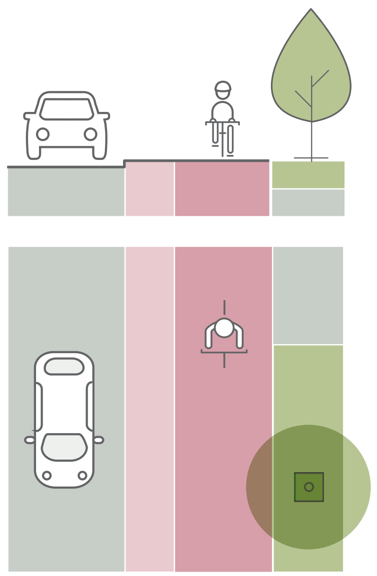
SEPARATED CYCLE PATH

Cyclist movements are protected from vehicle movements by a built kerb-height buffer, which may be paved or contain street trees or low planting. This facility type provides the highest degree of segregation of pedestrian, cyclist and vehicle movements. Buffer width is 0.6 m or more, allowing it to be used to pause by crossing pedestrians where it is paved. Where the cycle path is separated using a parking lane, the buffer will allow vehicle passengers to alight while minimising the risk of having the door of a parked car opened in the cyclist's path.



BI-DIRECTIONAL CYCLE PATH

Due to their spatial efficiency, bi-directional cycle paths are sometimes used where spatial constraints prevent the provision of one-directional cycle paths. They are most appropriate along stretches with minimal driveways and intersections, such as parks and water bodies, as this minimises interaction with turning traffic. Careful consideration must be given to potential for inter-modal conflicts, as drivers of entering or exiting vehicles and crossing pedestrians may not expect, or look out for, cyclists coming from two directions. Design considerations include potentially complex signal phasing and safe access to destinations on the opposite side of the street to the facility.

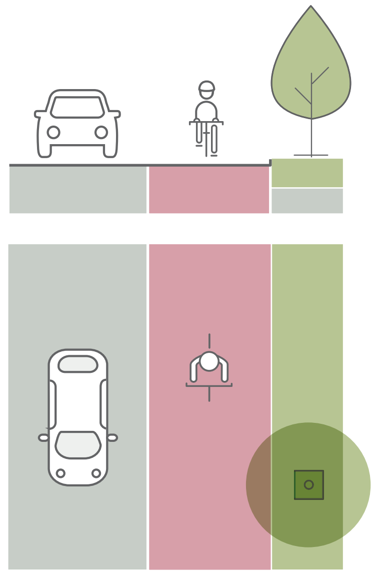


RAISED CYCLE PATH

Cyclist movements are protected from vehicle movements using grade separation. The cycle path is raised to the footpath level and distinguished through use of different materials or raised to an intermediate level between footpath level and the vehicle travel lane level. The degree of separation of movements is less pronounced than separated cycle paths, which may lead to parking compliance issues. The raised cycle path can be used in spatially constrained conditions, as no horizontal buffer is required unless kerbside parking is accommodated adjacent. A width of at least 2.1 m is advised.

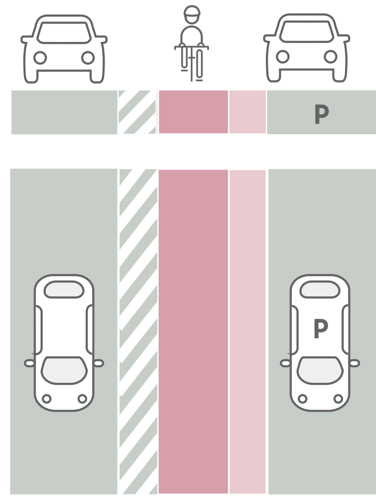
CYCLE LANE

Where vehicle travel speeds are 50 km/h or less, cycle lanes may be a suitable on-street cycling facility type. The painted cycle lane does not provide physical protection for cyclists. Painted buffers should be used.



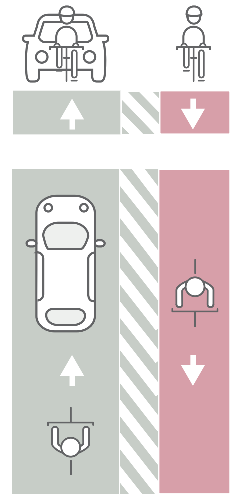
CONVENTIONAL CYCLE LANE

Painted cycle lanes indicate an allocation of road space to cyclists. Due to the lack of physical separation from the vehicle travel lane, they are not an accepted choice for new infrastructure in Auckland. To allow for cyclists to overtake one another, cycle lanes should be at least 1.8 m wide. Maintaining the minimum width is of particular importance where kerbside parking is unavoidable. Where space is available, however, a much safer cycling facility can be provided by switching the parking lane and the cycling lane, placing the cycle lane adjacent to the kerb and using the parking lane as a buffer. This configuration requires an additional buffer space of at least 1.0 m to protect cyclists against open car doors.



BUFFERED CYCLE LANE

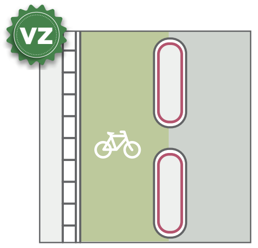
On wider streets, conventional cycle lanes can have a marked buffer on one side. Where a kerbside parking lane in the cycle lane is required, the buffer between the cycle lane and the parking bay should be included in the cycle lane width and not be hatched. Alternatively, the parking lane and the cycling lane can be switched, placing the cycle lane adjacent to the kerb and using the parking lane as a buffer.



CONTRAFLOW CYCLE LANE

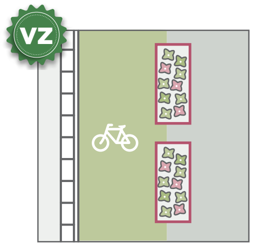
On one-way streets characterised by low volumes of vehicle traffic and low vehicle travel speeds, cyclists can comfortably ride with traffic. Opening up these streets to cyclists who are traveling in the opposite direction can increase the overall connectivity of the cycling network. This is particularly fitting where cyclist volumes are high and blocks are long. To avoid conflicts between oncoming cyclists and other road users, it is critical that a dedicated contraflow lane is provided. The contraflow lane can use (inverted) bicycle symbols and directional arrows and should be buffered where possible. A contraflow lane should at least be 1.5 m wide with 1.0 m buffer.

Elements



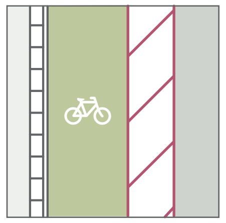
CONCRETE DIVIDER

Concrete dividers can occupy the buffer space to offer a significant form of physical separation. The dividers can be segmented to allow for stormwater movement and driveway access. These should generally be intended as interim measures until the road is reconstructed. Dividers can be widened to allow for crossing pedestrians to pause, to provide space for entering and alighting from parked vehicles and to accommodate bus stops.



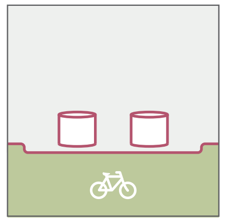
PLANTED DIVIDER

The buffer space is ideally used for the placement of vertical elements that provide additional physical protection from vehicle traffic as well as visual distinction and improved legibility when compared to concrete dividers or at-grade marked buffers. Where possible, the use of planting should be considered to achieve the same goal, as they provide robust separation and additional amenity. Moveable planters can be used for trials.



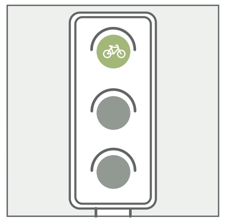
AT-GRADE MARKED BUFFER

The flush buffer zone painted on the road between the cycle lane and a travel lane is called an at-grade marked buffer. An at-grade buffer consists of two solid white lines with diagonal markings and should be 0.6 - 1.0 m wide. They can also be provided between cycle lanes and parking lanes, to help keep cyclists out of the door zone.



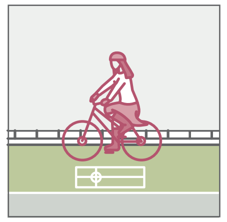
TRAFFIC DIVERTERS

Being of particular use along neighbourhood greenways and bicycle streets, traffic diverters block vehicle entry to a street by closing one lane of traffic or both. A traffic diverter extends out to the centreline of the road from the kerb, or simply across the full width of the road, with a gap in the diverter to permit bicycle entry.



CYCLE SIGNALS

Cycle signals facilitate crossings and make crossing the intersection safer. Signals reduce conflicting vehicle movements. They are placed at standard signalised intersections, and at mid-block crossings where both pedestrians and cyclists can cross. Signage, pavement markings and push buttons may be employed to differentiate signal facilities for cyclists.

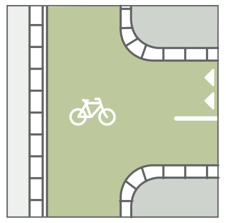


BICYCLE DETECTION

Sensors can be embedded within the asphalt to detect people on bicycles and trigger a green signal phase. Cyclists ride over the sensors as they position themselves to cross an intersection. To maximise their efficiency, the signal phasing can be configured to start a green signal phase for cyclists only moments after the cyclist detection takes place.

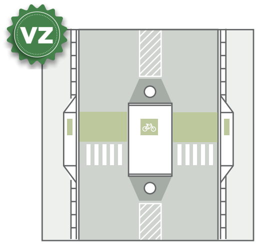
SIGNAGE AND WAYFINDING

Signs advise cyclists of their routing options to districts and major destinations. They should always be posted at decision points, and must include information, including distance and/or cycling time, on the next destinations along a route. Sharrows are bicycle/arrow stencils stamped on the road surface which can be used to indicate a cycle route.



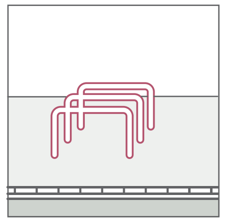
QUEUE SPACES (AND BIKE BAYS)

Queue spaces, including bike bays, are places for cyclists to wait outside of the travel paths of vehicles and other cyclists to perform a turning movement in a direct, guided fashion. They can be painted, demarcated by pavement patterns, or defined by raised kerbs. Queue spaces can help cyclists make right turns mid-block, and diagonal and two-stage crossings at intersections.



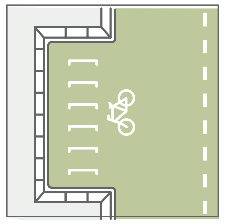
MEDIAN REFUGE ISLAND

A median refuge island allows cyclists to cross in stages when gaps in traffic allow. They can also be used in combination with pedestrian crossings. Median refuge islands should be long enough to safely accommodate a person on a bike (2.0 m or 2.5 m for cargo bikes) and wide enough to accommodate more than one cyclist. Raised tables should be used for crossings where approaching vehicles may exceed survivable speeds.



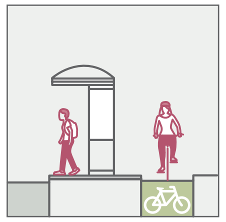
CYCLE RACK

Parking facilities along cycling routes and streets are critical to the success of the network of cycling routes. A cycle rack is the most basic and most prevalent type of parking facility for bicycles. Cycle racks within the street corridor are suitable for short-term parking (a few minutes to a few hours) in areas with low to moderate demand for cycle parking, such as in front of shops and community facilities.



CYCLE PARKING BAY

Cycle parking bays are can be placed along cycling routes to provide storage for numerous bicycles, while taking up relatively little space. They are appropriate for destinations that require medium term parking (a few hours to a whole day) at locations that attract high demand, such as universities or offices. Car parking spaces can be retrofitted for these purposes.



CYCLE LANES AT PUBLIC TRANSPORT STOPS

Streets that accommodate both frequent public transport routes and cycling routes require special design consideration. A conventional way of managing the public transport stop/cycle lane conflict is for the cycle lane to pass behind the stop.

People on public transport

Public transport has experienced a resurgence in recent years, following investments in rail, busways, bus priority measures, the new bus network and improved ferry services. This increased investment is set to continue with the expansion of the rapid transit network. This improved public transport provision has enabled a significant growth in access to the city centre and centres such as Manukau, New Lynn and Newmarket, without a corresponding increase in peak traffic volumes or road capacity.

A properly functioning public transport system is a key component of successful, accessible cities. Public transport services and design can contribute significantly to improving outcomes for residents and the urban environment.

Public transport can improve access to the city for a wide variety of residents, and therefore increase access to employment, services and other opportunities. This improved access especially benefits those who do not have access to a vehicle at all times, and can also increase the number of people for whom vehicle ownership is optional.

Improved environmental outcomes are another benefit of public transport. Public transport offers much reduced carbon emissions compared with private vehicles.

In urban areas, efficient use of limited street space is essential. A medium sized bus takes up the space of three cars but can carry 50 people. This efficiency helps to ensure that urban areas are vibrant by allowing large numbers of people to arrive while not using much space. This is why public transport stops are often described as “people fountains”. This helps improve vitality of streets and also benefits local business by increasing foot traffic.

Public transport facilities need to be carefully designed to integrate and support other functions of the street. Designs must take into account pedestrian volumes, the nature of, and vision for the street, passenger usage and public transport vehicle volume. The solution required will be very different on a busy shopping street compared with a corridor through an industrial area.

Well-designed public transport facilities contribute to the life of the street and the economic success of commercial corridors, while poorly designed facilities can have negative impacts, including severance, displacement of urban activities, and compromised land uses.

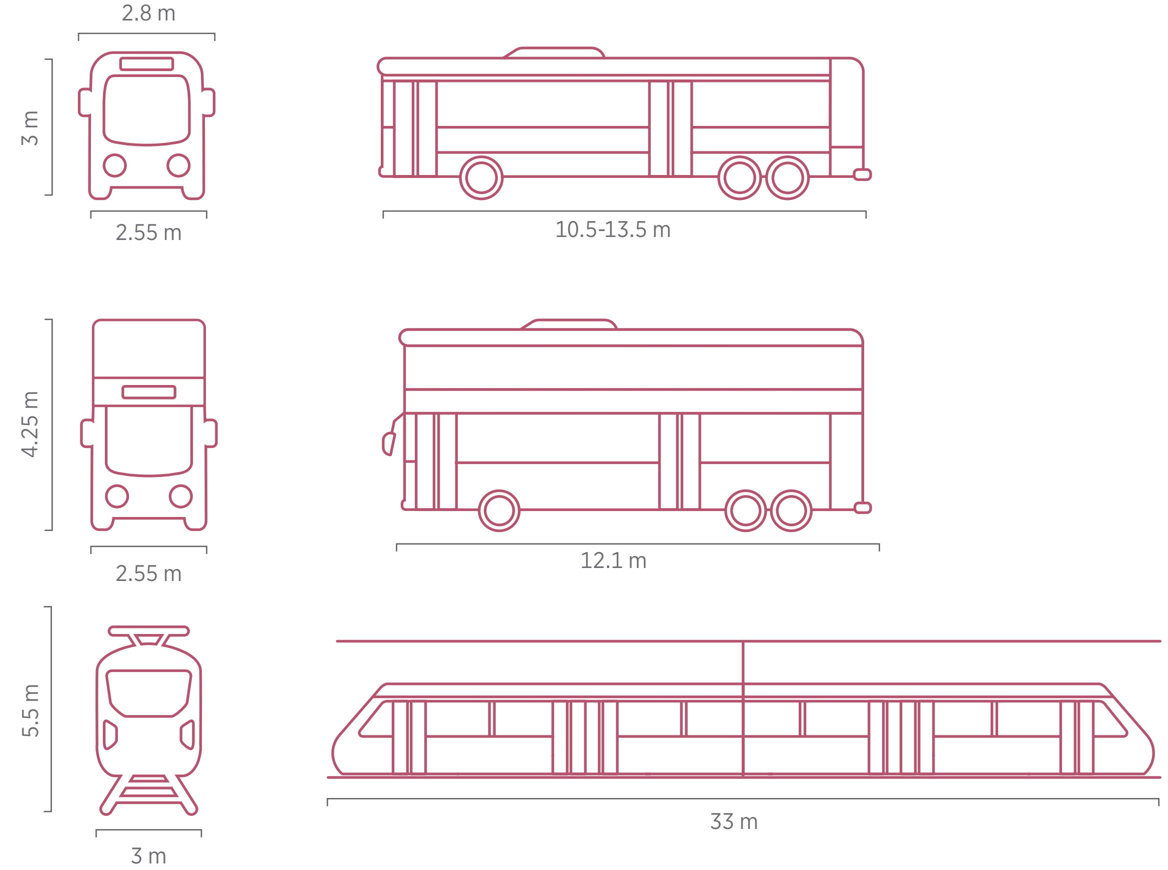
Planning of services can also have an important role to play. Services that consistently operate at high frequencies all day attract customers, as they are easy to understand. The high frequency (and thus short waiting time) allows people to connect easily between services at well-designed interchanges. The service simplicity also helps minimise the spatial footprint by reducing the need for large infrastructure such as indented bus stops.

For more technical guidance, please refer to the Engineering Design Code: *Public Transport - Bus*

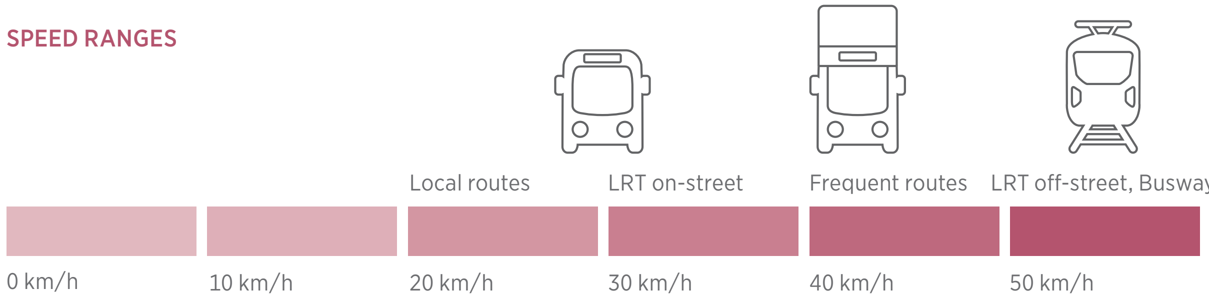
Dimensions and speed

VZ

Public transport can take many forms and sizes. Where public transport is present, streets must accommodate the needs of vehicles that are larger than most others on the street. However, design responses must balance the large spatial needs of public transport vehicles, while minimising the impacts to urban space and activities. All users of public transport are pedestrians first, with journeys on foot that extend past the stop. Maintaining a pedestrian friendly street in stop areas is as important as spatial accommodation between stops. Limiting bus speed to 30 km/h or less in centres and where there are many people on foot should be considered in route and service design, to ensure survivable speeds where risk is significant.

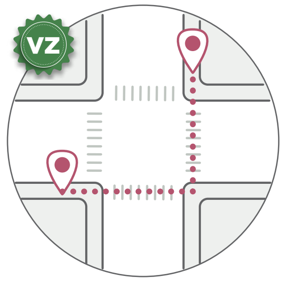


SPEED RANGES



Network principles

Public transport services should be seen as a network, along with walking and cycling trips at either end. Public transport planning needs to look at the entirety of the journey undertaken by users, from door to door, not just where services are running. Permeable street grids and small block sizes around public transport stops can help contribute significantly to patronage, while poor pedestrian linkages can substantially reduce walk-up catchment. Services need to be well integrated with the local area.

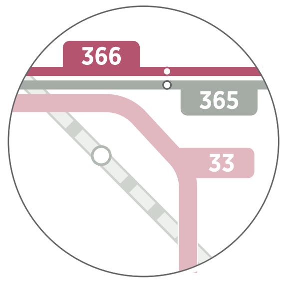


SUPPORT WALKING

The catchment of every stop should be as walkable as possible to support public transport. Public transport must be easily accessible by people on foot if it is to be successful. This means providing safe crossing opportunities at each bus stop, and ensuring that there is a safe and direct walking route to all potential origins and destinations.

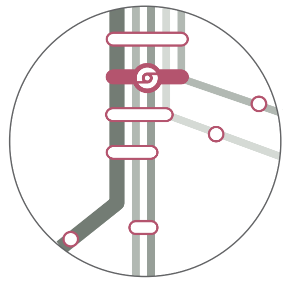
ACCESS TO DESTINATIONS

A good public transport network will provide service to key destinations. Relocating public transport entirely to facilitate place-based aims is counter-productive, as this is likely to reduce usage of the public transport and make the place less accessible. Public transport also needs to be accessible to all citizens, and bus stops and surrounding facilities need to be carefully designed to allow this.



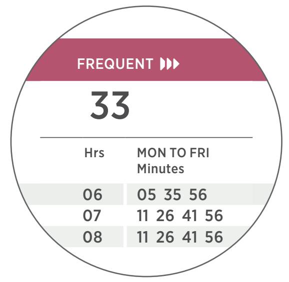
LEGIBILITY

Public transport must be easy for users to find and understand. Many factors contribute to this, including route numbering and naming, timetabling, stop allocation, street selection for public transport routes, and stop location. Bus information needs to be easy to understand, with services that share common destinations being identifiable and sharing route and stop patterns if possible.



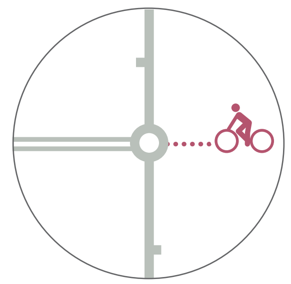
CONNECTED NETWORK

Auckland's bus services have been redesigned to form a connected network. This network significantly simplifies the number of routes, and focuses on providing for transfers at interchanges to increase people's access to all parts of the city. These major stops and interchanges need to be clearly designed and well located near major destinations to be successful. Stops that allow transfers to other routes as part of a journey must be planned and designed to have short, unobstructed transfer routes that are easy enough to follow.



RELIABILITY

Reliability is the most important factor for buses. Unreliability results in the next trip having a delayed start, or adding time to the scheduled service and thus increased passenger waiting time, increased vehicle requirements and cost for the route. Busy services on local and urban streets do not need to run at high speeds, as they are slowed often by stops, traffic signals and other vehicles crossing their path. Journey times can be kept consistent by implementing measures such as dedicated bus lanes. Reliable arrival times at transfer points is most significant, as this can allow the planned delay between legs of a journey to be reduced.



LINK WITH CYCLING

Cycling can be used in several different ways to enhance the public transport system. Cycling can significantly increase the catchment of public transport stops, to around a 4 km radius, rather than a 1 km radius. This amounts to a catchment of 50 km^2, versus one of less than 4km^2. This is especially effective for stops on the Rapid Network. This can be encouraged by providing safe and undercover bike parking at major stops and interchanges. Bike share to expand the catchment at key destinations can also be a good strategy. Allowing bikes on public transport vehicles is another way to expand the catchment of public transport, however this comes with operational challenges on busy routes.

Network service types

Public transport covers a large range of variations with differing effects, impacts and considerations. The following are the facilities that make up a successful public transport network. Streets that carry public transport services must be designed so that they meet the operating standards for each type of service.

A significant factor for services is the overall journey time, which is composed of dwell time at stops, travel time between stops, recovery time for incidents and other delays, and standing time for welfare and shift changes.

Street design, especially stops and intersections, must take account of effects on overall journey time for the services using the street.

LOCAL SERVICES

Local services through rural, suburban residential or employment areas with low traffic volumes can be run by small or medium sized buses at low frequency. They generally act as coverage routes to ensure that most of the population has access to a public transport route. They are likely to stop often and speeds should be appropriate to their street context.

CONNECTOR SERVICES

Connector services can be run by medium or large sized buses upto 60 minute intervals, 7am – 7pm, 7 days a week. Lower frequencies early morning and evening join local centres and major destinations and provide links to Frequent and Rapid routes. They operate largely on arterial and collector streets. Stops should be spaced at medium lengths of around 400m and to maximise accessibility.

JOURNEY TIME – MANAGING SPEED

Bus travel speed makes up only a small fraction of the overall journey time, which consists of traffic and signal delay, boarding delay and travelling time.

The desired speed of public transport vehicles must balance the need to operate a service that is attractive for passengers and appropriate for the context of the street. Public transport journey times need to be competitive with private vehicles to attract patronage. Public transport services on local and urban streets do not need to run at high top speeds where they are slowed by stops, traffic signals and other vehicles crossing their path. Buses travelling at high speeds are not desirable in town centre and main street contexts where street safety, land use activity and passenger access (e.g. crossing the street) are the greatest concerns. On motorway or busway and where stops are infrequent, higher speeds can be achieved, but comfort of the ride and steady flow are important.

FREQUENT NETWORK SERVICES

Frequent services operate at least every 15 minutes, 7am – 7pm, 7 days a week, with lower frequencies early morning and evenings. Convergence of frequent bus routes add up to a frequency of more than 1 per minute in the busiest areas. These frequencies may cause difficulties with stop capacity and sizing. These corridors pass through built-up urban areas with high pedestrian volumes.

Public transport streets provide dedicated bus lanes and other measures to carry high capacity without congestion of buses.

RAPID TRANSIT NETWORK SERVICES CORRIDORS

Rapid transit corridors are run with large buses at a frequency of at least 15 minute headways. They generally have a dedicated right of way and sometimes are grade separated from street level. Stops are widely spaced, generally between 1 and 2 km. They are often run either underground, alongside highways or along major arterial roads.

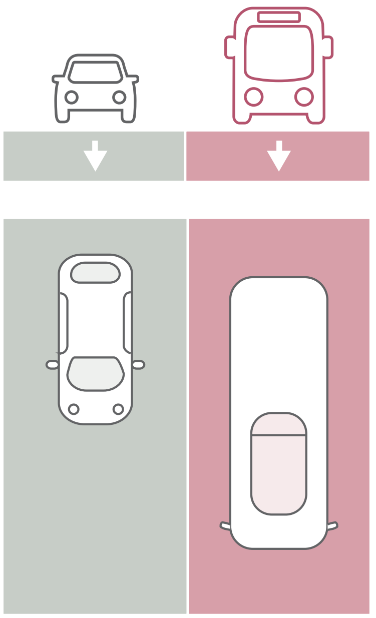
JOURNEY TIME – MANAGING DELAY

The most effective strategy for improving public transport journey times is to focus on reducing delays. Traffic and signal delay can be improved via infrastructural improvements such as bus lanes, transit lanes, bus priority traffic signals and changing traffic signal phasing to favour major bus routes. It can also be improved by location and design of stops, allowing buses to start quickly after boarding. Boarding delay can be minimised by operational strategies.

Removing public transport delay benefits users as it shortens the journey time for users. It also reduces the time and operating costs of each run, making the services more efficient. This efficiency of service allows additional vehicles to be deployed, creating higher frequencies. Higher frequencies reduce passenger waiting time which is considered 2.5 times as significant as time spent in motion. Efficient, high-frequency services create an environment where public transport is reliable and resilient.

Geometry

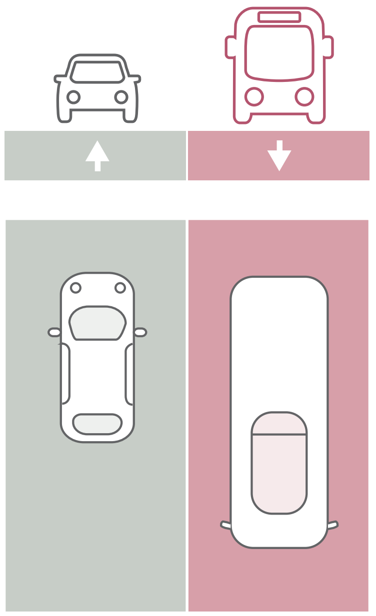
The geometry of public transport facilities depends on the street's spatial constraints and the type of public transport. The following infrastructure types should be considered when designing a street with public transport priority. Edge treatments are important, and may take up width in addition to the lane widths given here.



BUS OR TRANSIT LANE

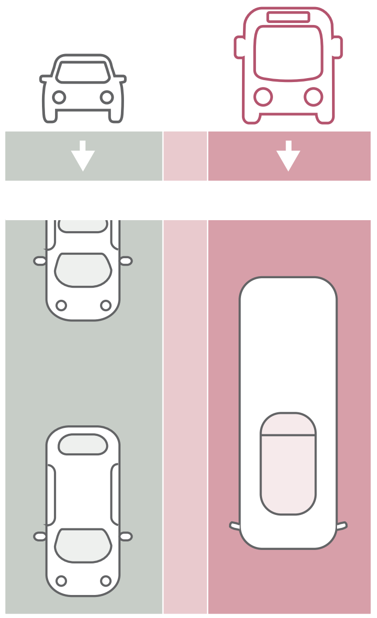
Bus lanes should be provided along frequent routes where buses are delayed by regular traffic congestion. Lane widths of 3.2 m are preferred, as they provide enough space for safe bus operations. Bus lanes are most effective when provided on continuous, long stretches along major corridors. They can operate all day, or at peak times only. Take care to ensure loading and servicing can still take place at appropriate times. On 24/7 bus lanes, loading and servicing will need to be off the bus route and on nearby side streets.

Kerbside bus lanes are the most common, however they can have negative amenity effects. Creation of wider footpaths with street furniture zone buffering can overcome this. Services may also be assisted by bus lanes where frequencies are lower, but reliability is needed. Transit lanes may be used where peak bus services are not impeded. They can be T2 or T3, based in the number of expected vehicles.



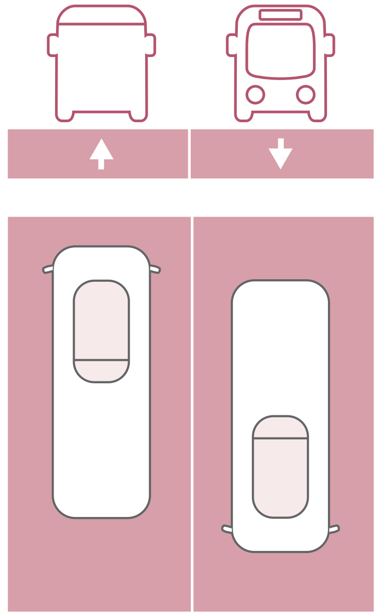
LOCAL STREET

Lane widths of 3.2 m are generally preferable. However, on routes that operate infrequently (i.e. once every 30 minutes or less), on streets with very low traffic volumes, buses can operate in a 6.0 m, two-lane carriageway, where encounters with large vehicles are rare.



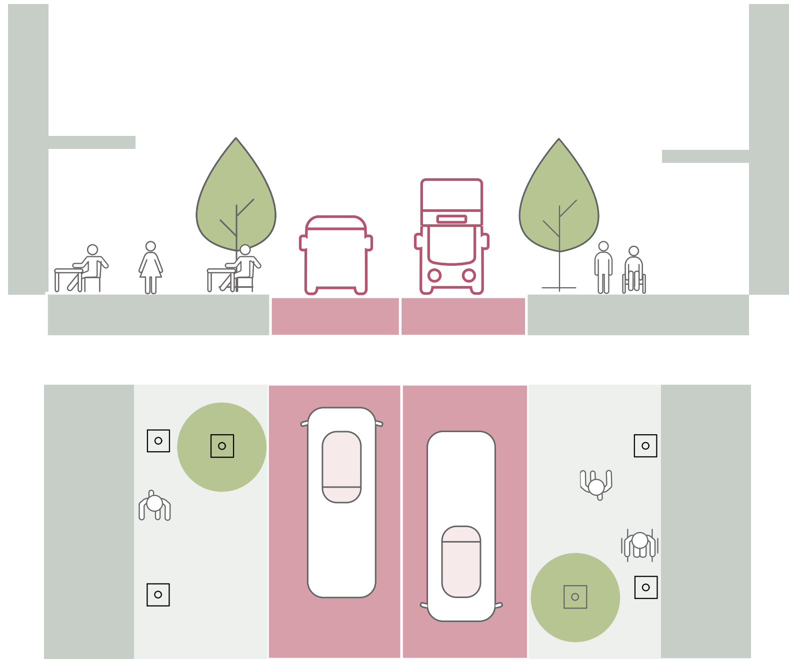
URBAN BUSWAY

On urban corridors with high volumes, ordinary bus lanes may not have enough insulation from general traffic congestion. However, a fully separated busway may not be practicable, because of corridor widths, the need for frequent pedestrian access and crossing, building access and activity density. This creates a need for special urban busways. These busways are characterised by: 30 km/h average operating speeds where stopping is frequent; separation between modes using raised buffers or separators, with breaks for vehicle crossings (as few as possible); buffer or separator between bus lane and cycle or pedestrian through routes. Urban busway design supports urban land uses and pedestrian access. Safety and compliance can be better than conventional bus lanes.



RAPID TRANSIT BUSWAY

Fully segregated busways with limited access provide the highest standard in bus performance, travel time, reliability and capacity. They are appropriate for high-frequency bus corridors serving a large catchment where passengers are using the bus for long cross-city trips. However, they must be designed to suit the local context. Fully segregated busways work best alongside motorways or multi-lane arterials with limited access. Busways in areas with a higher level of pedestrian activity risk adding severance to a street. Common operating speeds on busways outside urban centres are 50 - 80 km/h.



PUBLIC TRANSPORT MALL

On main urban streets with high pedestrian volumes where property access is limited and vehicle through traffic can be diverted, a public transport mall can be an option to integrate buses effectively into the public realm. Public transport malls are suitable for a low to medium frequency of buses. Public transport vehicles should operate at low speeds (**less** than 30 km/h), so pedestrians can freely and safely cross the street. Public transport malls generally need to allow local access for deliveries, though this will generally be restricted to certain appropriate loading times outside of peak hours.

Design of bus stops

WHOLE OF JOURNEY

The location and design of the stop needs to ensure the stop is easy to access by any potential users in the area, and the walking catchment should be maximised.

FOOTPATH WIDTH

Bus stop infrastructure such as shelters and poles should not block the footpath, and a minimum width of 1.8 m needs to be retained to allow unimpeded movement for pedestrians not waiting for the bus.

PEDESTRIAN CROSSINGS

For bus stops to serve the community effectively, pedestrians must be able to cross the road safely close to each stop. Pedestrian crossings should be provided on streets where safe crossing would otherwise be difficult.

FACILITIES FOR CUSTOMERS

The number of boardings at the stop will influence the type and capacity of facilities provided at each stop.

CONSISTENCY

Bus stop designs should be consistent to ensures drivers and customers are familiar with the layout.

LOCATIONAL CONTEXT

The location should influence the style of the bus stop, including graphics on the glass. Wayfinding may be included to highlighted local destinations.

INTERCHANGE

Interchanges between public transport services are a key part of the network structure. Stops that have an interchange function need to be designed to ensure this interchange is as legible, protected and direct as possible.

STEP HEIGHT AND HORIZONTAL GAP

Platform height and width must meet requirements of users in wheelchairs.

TYPE OF PASSENGERS

Stop facilities need to take potential users into account. For example, stops near housing for the elderly have a greater requirement for seating. Stops near shopping areas should be well located for major destinations for shoppers.

BUS OPERATIONS

Stops must be designed so buses can pull in and out of the stop efficiently, and stop close to and parallel with the kerb.

Stop considerations

BUS STOP SPACING

Characteristics of the service, route, location and passenger type need to be weighed up to find the appropriate bus stop spacing.

- **Service frequency and capacity.** Dwell time at stops can add up to be a considerable portion of overall public transport journey time. On routes with high frequency, placing stops farther apart helps to lower overall journey time. This should be balanced with catchment.
- **Topography.** In hilly areas, stops may need to be spaced closer than usual, as some passengers are likely to be put off by walks up steep hills.

BUS STOP LOCATIONS

Factors influencing stop location:

- **Trip generators.** Stops should be located close to major patronage generators.
- **Walking catchment.** Stops should be positioned to increase the walking catchment.
- **Street environment.** Consider the ability to walk safely to the stop from surrounding areas.
- **Likelihood of traffic delay.** Stops should avoid locations or layouts that mean the bus cannot enter or exit the stop readily, especially in busy traffic.
- **Road safety.** Stops need to provide safe sight lines for bus and other vehicle drivers.
- **Social safety.** Stops are best located in easily visible and well-lit areas.
- **Connections.** Bus stops should be located to make transfers between services as comfortable and as legible as possible.
- **Mobility.** Stops should be located close to facilities or destinations likely to be used by elderly or mobility impaired people.

BUS STOP CAPACITY

At bus stops where multiple routes converge, where interchanges take place or where services terminate, stop capacity may become an issue. Stops are over capacity if buses regularly fail to fit in their dedicated stop spaces. Occasional failures are inevitable on busy streets, where bus stop length must be balanced against footpath width and other kerbside activities, but traffic flow consequences and safety must be considered.

Understanding capacity of stops requires a careful analysis of a number of factors:

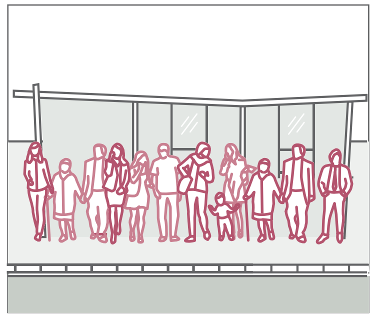
- Number of buses using the stop during peak hours
- Dwell time of buses
- Traffic signal location and cycle time
- Route groupings.

BUS STOP ACCESS AND LEGIBILITY

In addition to the spatial capacity of the bus stop, passenger access must be considered. At stops that can be served by more than one bus, it is essential that customers can identify the bus that they want to catch. Stops should not exceed three buses in length, in particular where passengers are expected to identify unique services. Long stops create a stressful and potentially unsafe situation where passengers have to hurry to catch the last bus arriving at the stop.

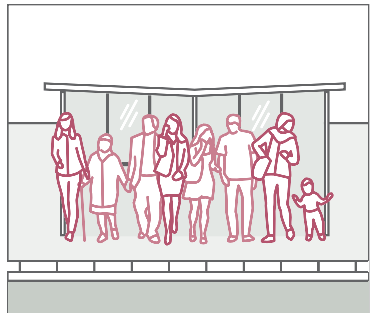
For system legibility and improved passenger access on busy corridors, bus stops should be organised by the common destination(s) of corridor services. It is useful to brand the stop by the core destination that it serves, e.g. “Takapuna” stop. It may also be appropriate to brand or communicate other key (common) destinations that the stop serves, e.g. “hospital”.

Stop functions



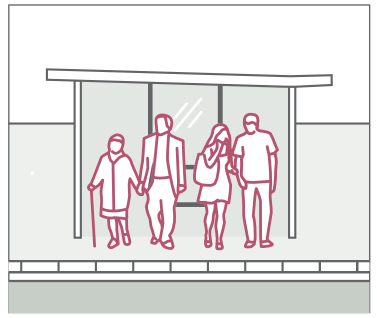
MAJOR

Major stops have high passenger volumes, high-frequency services and are likely to be served by multiple bus routes. Usually space will need to be provided for multiple buses to stop at once. They provide a high level of passenger amenity, often having the largest shelters, wayfinding and larger area route maps. Major stops will also often function as interchange points between services. For interchanges located on cross-roads, multiple stops on perpendicular streets must provide a highly legible interchange facility.



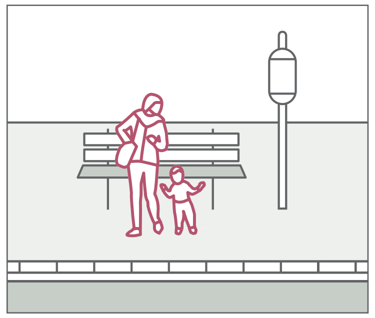
INTERMEDIATE

Intermediate stops are generally located in and around urban town centres. They have moderate to high passenger volumes with services generally running every 15 minutes or less. The shelters should provide a good level of passenger amenity, such as local wayfinding and route maps.



MINOR

Minor stops are located in suburban areas and some town centres. They have moderate passenger volumes with services running every 30 minutes or less and generally consist of one bus route. They must be provided with basic amenities, including shelters, rubbish bins and real-time information signs.



BUS STOP WITHOUT A SHELTER

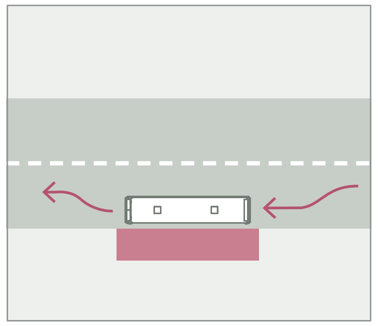
Bus stops without shelters are located throughout the region at stops that have low passenger boarding volumes. However, they may be placed on local or frequent networks where people seldom board, or where the shelter is provided by a building veranda or canopy. Seating, lighting and timetable information must be provided, but further stop amenities are optional.

Stop layout

Good bus stop layouts should be designed to achieve the following objectives:

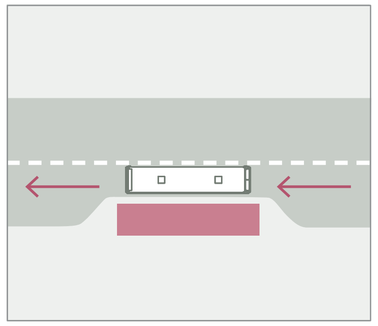
- The bus is able to enter and exit the stop easily
- Bus delay when entering the traffic flow is minimised
- Bus can stop parallel to the kerb.
- General vehicles are dissuaded from parking in the bus stop.

The key elements of this are the bus box, marking “no-stopping at all times” (NSAAT) lines and the design of the bus layout in relation to the street.



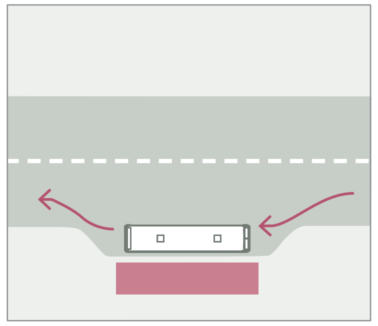
KERBSIDE

Kerbside stops are the most common form of bus stop layout across Auckland, and are suitable for a range of situations and bus frequencies. In-lane kerbside bus stops allow buses to stop and re-enter traffic flow easily. Other vehicles can often pass the bus (especially on lower volume roads), however the traffic will need to slow down to do so safely. Kerbside stops need to be marked clearly to ensure cars do not park in them, or park too close, making entry to or exit from the stop difficult. Kerbside stops also work well where bus lanes are provided, so long as the stopped bus does not significantly delay following buses on high-frequency routes.



BUS BOARDERS

Bus boarders involve building out the footpath to meet the traffic lane. This allows buses to stop in the traffic lane, which further reduces bus delays compared with other stop designs, and also makes it much easier for the bus to park parallel to the stop. They have the added benefit of providing a wider bus passenger waiting area clear of the footpath. Bus boarders should be considered in town centres on high-frequency bus routes where both bus passengers and shoppers will benefit from the added space. This type of stop layout occupies the shortest possible length of kerb, which can be useful in areas with significant demand for kerbside space such as loading bays and parking.

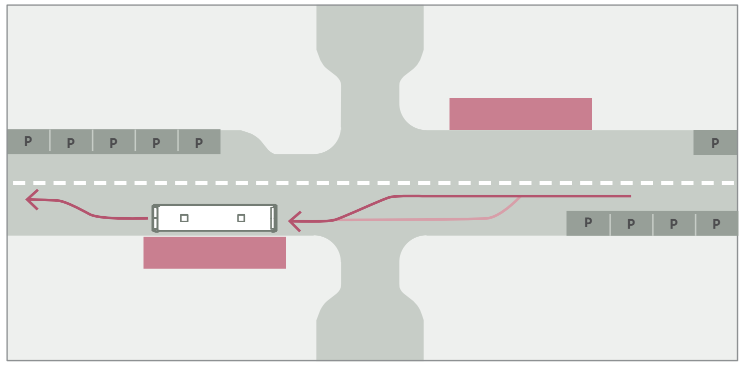


INDENTED STOPS

Indented stops allow a bus to stop clear of the nearside traffic lane. They can be important on high-frequency bus routes with bus lanes to enable buses to pass each other unhindered. However, where general traffic is permitted to use the kerbside lane, indented stops lead to significant delays to buses when attempting to re-join the flow of traffic. They should only be used where special circumstances call for their use:

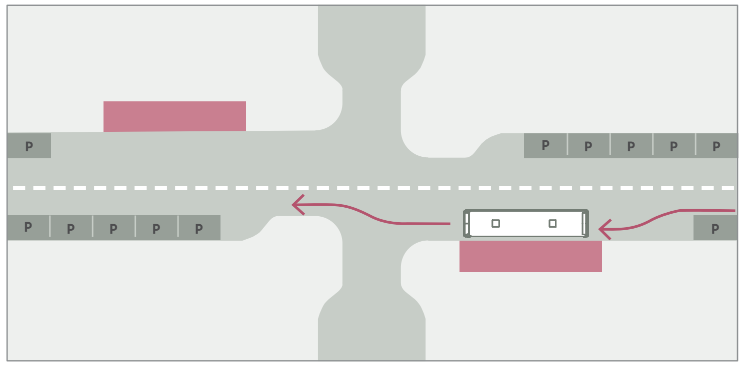
- Safety reasons, such as limited visibility for general traffic attempting to pass; or
- The signposted speed is 80 km/h or over; or
- Places where the bus is expected to stop for long periods of time, such as at timing points; or
- At start or end stops especially, at schools.

Bus stop placement



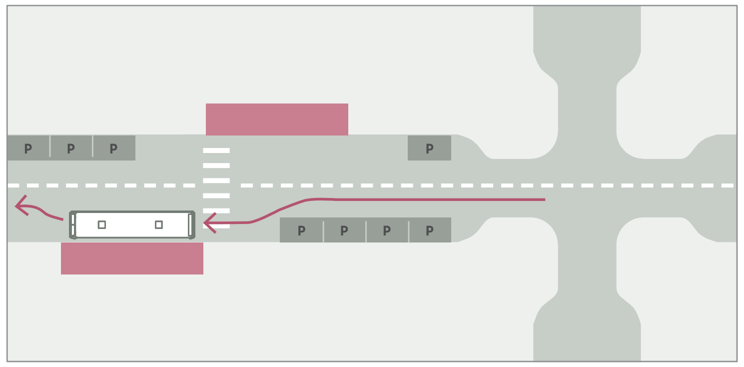
DEPARTURE SIDE

Departure side stops are located on the exit side of a signal controlled intersection. They are generally seen as the preferred location for a bus stop. The key advantages include the ability to use bus prioritisation of the signal cycle by detection on approach. It also removes the risk that a bus will miss the first green of a cycle while loading or unloading passengers upstream of the signals, and will always be able to depart as soon as loading is complete. On routes where time headway between buses is small, there may be need for the stop to have enough space for two or more buses, to avoid a following bus being unable to clear the intersection.



APPROACH SIDE

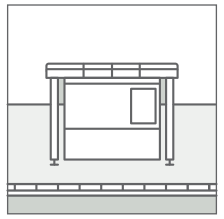
Approach side bus stops are located on the entry to a signal controlled intersection. Approach stops often result in excessive delay, as buses may have to stop more than once. Queuing traffic often blocks bus access to stops located on the approach side of an intersection. This traffic only clears on the green phase, however the bus needs to stop, so misses this green phase and has to wait another full cycle. Over the course of a route, this adds up to significant delay. Approach sides stops may be preferred in some locations where major trip generators are located on the approach side of the intersection, especially where crossing the road offers a poor experience to pedestrians, or where bus routes diverge at the intersection.



MID-BLOCK STOPS

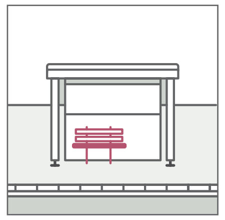
Mid-block stops are common on routes with long distances between major intersections. Mid-block stops should always be located tail to tail, with a pedestrian crossing in the centre, so bus passengers can easily and safely access stops. The tail-to-tail layout reduces issues from pedestrians walking out in front of a bus which may be pulling out.

Elements



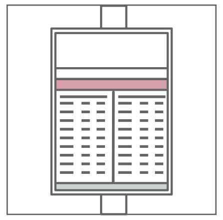
SHELTERS

Shelters at public transport stops provide a much improved passenger experience and help improve public transport patronage. They should be provided at all stops over time, except near ends of routes where passengers seldom board. Take care that they do not block the footpath. Waiting passengers must have a clear view of approaching buses, not obscured by the shelter or any street furniture near it.



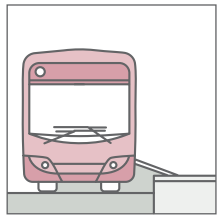
SEATING

Seating improves the experience of waiting passengers. Seating should be provided at most stops, especially where a reasonable proportion of elderly users are expected.



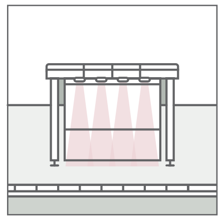
INFORMATION

Public transport stops should always contain clear and concise information about the timetable and destinations reachable by public transport. At larger stops with shelters, maps should be provided of the public transport network, as well as local area maps to help people access their destinations. Interchange stops and other significant stops should be provided with passenger information displays.



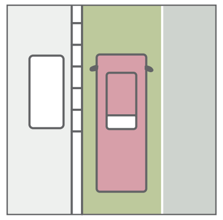
ACCESSIBLE BOARDING AREA

Every stop should have a level and smooth hardstand area at the appropriate height to allow easy access on and off the public transport vehicle. This platform should be continuously linked to the adjacent footpath, preferably at a flush level.



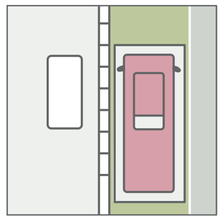
LIGHTING

Lighting is essential both to provide a better sense of security for those waiting, as well as helping bus drivers see passengers waiting when it is dark. Obstructions to lighting should be avoided.



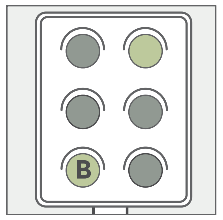
KERBS

Kerbs must be high enough to provide the minimal step heights desired to allow for safe deployment of wheelchair ramps. Kassel Kerbs® should be used to improve accessibility by reducing step heights and gaps. This kerb has a shaped face that guides the bus tyre as the bus comes into the stop.



BUS PADS

Concrete bus pads should be used at bus stops with a high volume of buses (especially inner-city streets with bus lanes) where asphalt pavement regularly deforms. Ruts cause multiple issues, including increasing bus wear and tear, poor ride quality for passengers, and dangers to cyclists.



PUBLIC TRANSPORT PRIORITY SIGNALS

Public transport priority signals should be used on well-patronised bus routes or when buses experience a high level of delay at a localised points or intersection. There are different ways of using signal priority: active priority, passive priority, and signal pre-emption.

Park and Ride

Park and Ride can be used to expand the catchment of rapid and frequent public transport services. Park and Ride is best used to serve areas where it is not feasible to provide a regular feeder bus service, especially rural areas and developing fringe suburbs. It can also be used when starting up a new service to provide an initial level of patronage. However, it can come at a high cost per new rider, so must be carefully compared against other schemes to increase patronage, such as walking and cycling access, feeder buses, land use development and fare policies. In some cases it only provides a minimal increase to public transport use, as a high proportion of users are existing public transport users that are diverted from accessing public transport via active modes, on-street parks, feeder buses or drop offs. Park and Ride can work against walkability, increase localised congestion and compete for space on land that could be used for transport-oriented development, so it is generally not appropriate in town centres and urban areas.

BIKE AND RIDE

Much like Park and Ride, Bike and Rides expand the catchment of public transport in areas with limited services. They are often coupled with Park and Ride, but at a less expensive rate, as they are far more spatially efficient. These facilities often provide secure long-term cycle parking and racks near stations. Any charges for parking are promoted through integrated fares with the public transport system.

People in private vehicles

While the private vehicle affords people with a convenient method of getting around and provides an independent form of transport on-demand, but the widespread adoption of (private) vehicles has come at a great cost to society. While countless public resources are required for roadway construction and upkeep, only a relatively limited number of motorists use them. Then there are further negative external costs that are associated with driving, including a deteriorating air quality, increasing carbon emissions, as well as the public health impact of vehicles. The latter manifests itself both in increased occurrence of diseases such as obesity (due to physical inactivity) and in physical injuries and even deaths that result from crashes.

While the private vehicle has for decades been the main parameter around which our cities and streets have been designed, cities are increasingly shifting to reduce auto-dependency, for instance by scaling back the number of streets accessible to (private) vehicles, creating car-free zones, improving public transport, and enabling people to walk and cycle by redesigning streets. At a larger scale, vehicle-oriented urban development has relatively high infrastructure costs, which results from the need to build and maintain roads, sewers, and roadside storm water management devices. Conversely, compact development requires less public resources for infrastructure.

Vehicles have a place in the city, but the amount of space that is assigned to them needs to be balanced with the needs of other transport modes, particularly in urban contexts, where speeds are preferably kept low. Conflict areas such as intersections must be carefully designed and managed, so that various users of the street can safely navigate around the city.

Design decisions should balance the vehicular requirements with the need to enhance people's experience of streets as public spaces.

For more technical guidance, please refer to the Engineering Design Code:
Urban & rural roadway design

Dimensions and speed

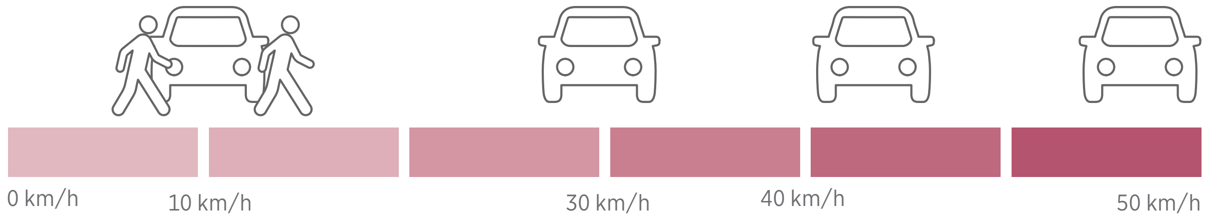
The geometry of travel lanes, motorways, roads and streets, and parking facilities dictate the maximum feasible size of a personal vehicle. Two types of vehicles are considered in the design of streets and roads: the design vehicle and the control vehicle. (See also the section on Design Vehicle in Chapter 4, Design Controls.) Essentially, the design vehicle is the default vehicle across a road or street, which is a standard car or private vehicle. This is the vehicle that a street's design will be based around. Then there is the control vehicle, which is the largest vehicle that uses a street on a regular basis, typically a mid-sized truck such as a rubbish truck or a moving truck. Because the control vehicle will typically only use a street once or a few times per week, it should not form the base of a street's design. Rather, the street should be designed to accommodate it, so that the control vehicle is able to access the street, albeit at a low operating speed.

Traffic delays might occur when a control vehicle accesses the street, but are acceptable, as control vehicles will only very intermittently access the street.

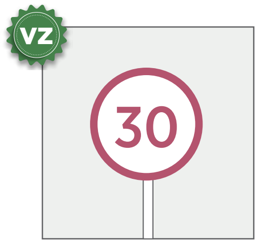
The design vehicle, a standard car or average private vehicle, commonly has a length of 4 to 5 m and a width of 1.8 m. Vehicles usually are no higher than 1.5 m. Private vehicles vary from smaller, more compact cars such as hatchbacks, to large utility vehicles. Large oversized utility vehicles originated in countries where more space is provided for vehicles (in the form of wide motorways, roads and lanes, and ample parking); whereas the micro-sized personal vehicles are a product of countries where roads and parking space is at a premium, streets are narrow and parking spaces are tighter. The assumption here is that the kind of vehicle that is common in any given country or city can be influenced through street design: the more space is provided for vehicles, the more oversized vehicles will become commonplace. By keeping street, road, highway, and parking geometry compact, it is made more attractive for prospective vehicle buyers to opt for smaller and more compact vehicles, which generally have fewer emissions than their larger counterparts.

In addition to the conventional private vehicle, recent years have seen a growth in the number of electric vehicles on our streets. Often used for taxi and ridesharing services, they indicate a cultural shift away from private ownership towards a system where having access to a vehicle is more important than owning one. The popularity of on-demand car services, often ordered via an app on a smartphone, further illustrates this shift. A consequence of this development is that the amount of space dedicated to parking might be much smaller in the future than it is today.

SPEED RANGES

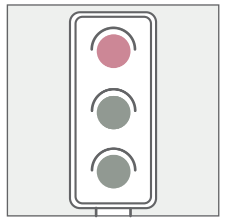


Elements and strategies



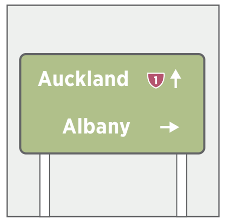
SPEED LIMITS

Set appropriate speed limits, and ensure by design that traffic complies with the limit. 50 km/h limit reduces the risk of harm to car occupants where there are turning movements. 30 km/h limit reduces risk of harm to other street users. These limits are not likely to increase journey times significantly, especially on congested routes.



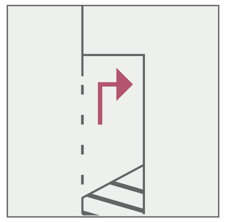
TRAFFIC SIGNALS

Conventionally placed at intersections, traffic signals regulate the use of road space by separating different users by time. Users approaching from different directions are requested to stop, and allowed to proceed when the traffic control signals tell them to. Traffic signals assist in reducing movements by managing traffic flow and directions. However, they introduce delays on streets with low off-peak traffic volumes.



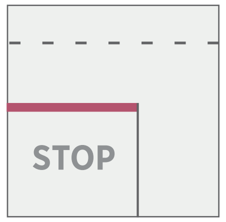
VERTICAL SIGNAGE

Roadside signs are typically used to convey regulatory information to people in vehicles. This includes information relating to speed limits, allowed access, and turning movements. In addition, information on upcoming destinations, place names and street names inform motorists of the context they are driving in.



ROAD MARKINGS

Markings on the road surface inform drivers on required and expected driving behaviour. Surface markings typically are comprised of travel lane dividers, directional arrows (for through traffic and turning traffic) and speed limits. Using a consistent visual language and applying markings with uniformity throughout a road network help to reduce any potential uncertainty on their meaning.



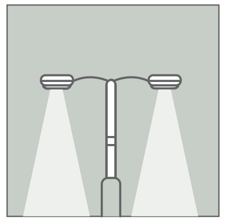
LIMIT LINES

At stop signs and traffic signals, limit lines must be installed. Limit lines are typically 200 mm wide, and must be set back between 1.5 m and 6 m from the crossing, to mark where drivers should stop and to allow them to see the pedestrians crossing in front of them.

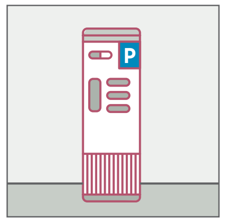
KERBSIDE MANAGEMENT

Kerbside management can optimise the use of valuable street space. Pricing and time restrictions for on-street parking helps to create a higher turnover of parking spaces. Conversely, not using either of these two controls invites people to leave their vehicles parked for extended periods, thereby limiting the use of a valuable resource. Cities have often based their pricing regime on the goal of having an occupancy of 85%, thereby generating some income and maintaining a degree of availability that allows people to find a spot relatively easily. Maintaining a 10-minute grace period allows people and delivery services to quickly do drop offs. Refer to the Auckland Transport parking strategy for more information.

LIGHTING

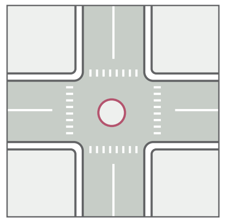


Lighting is provided on urban streets to improve safety at night and allow street users to be clearly seen. Street lights are commonly installed on poles along the edge of the road. Their power is supplied via an underground connection to the power grid, or by solar panels attached to the poles. Street lighting for vehicles is ideally coordinated with street lighting for pedestrians, as the groups have different needs in terms of lighting. All lighting should be directed and only illuminate the required area of the street, not emit light up or out.



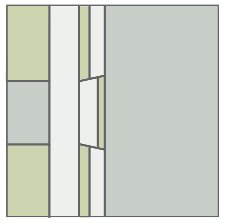
PARKING METERS

Parking meters are used where on-street parking is priced, and are installations where drivers pay for the use of their parking spots, often located at the edge of the footpath. They display the time a vehicle is authorised to be parked in a parking spot, and typically accept payment by cash or cards, though it's a growing trend worldwide to pay for parking with a text message or an app for smartphones. One parking meter will typically serve multiple parking spots. Parking meters can be retrofitted to be reused for a different purpose when parking is removed.



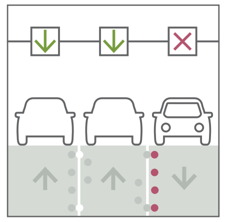
TRAFFIC CALMING ELEMENTS

A spectrum of design treatments exist for slowing down traffic, varying from physically altering the roadway, to changing the way drivers perceive a street. Traffic is slowed down by physical treatments such as speed tables, kerb build-outs, pinch-points and chicanes. Streets can be narrowed down visually by on-street parking, street trees and the absence of centre lines. This helps to maintain safe traffic speeds with low traffic volumes.



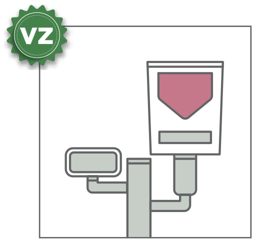
VEHICLE CROSSINGS

Vehicle crossings are interruptions of footpaths and cycle paths, and connect streets with (private) driveways. Their use is best minimised, as they occupy roadside space that could otherwise be used for street trees and on-street parking, and facilitate inactive ground floor building edges, such as parking garages. Vehicles crossing foot and bike paths, especially if reversing, are a risk to path users, and can be unsafe in busy streets. Vehicle access to lots could be provided around the back, so that active ground floor uses can be maintained along a street's edge. Where their use is unavoidable, they ought to be placed strategically.



DYNAMIC LANE CONTROL

Where arterial streets carry flows which are tidal (mostly one way in mornings and the opposite way in afternoons) lanes can be controlled by variable signs, supported by markings and LED studs. Typically, three lanes can be used to provide a capacity that would conventionally require four lanes.



SAFETY OR TRAFFIC ENFORCEMENT CAMERAS

Safety cameras are installed above or beside the roadway for detection of road rule violations. Their most common use is for the automated ticketing for speed and red light safety compliance, or for bus lane compliance. Cameras used to monitor traffic conditions at intersections can also be used to analyse compliance, though not at present for enforcement.

Freight

The delivery of freight into, out of and around our cities is an essential part of keeping our economy moving. However, use of streets for freight can also have significant effects such as noise, emissions, increased general vehicle speeds and increased risk for people walking and riding bikes.

To carry freight around the metropolitan area, large trucks are required. These trucks serve industrial areas, warehouses, ports, railheads and large scale retail centres such as supermarkets, big box stores and petrol stations. Large trucks require a large spatial footprint, especially when turning. This is because the trailer takes a much wider track around corners than the driver's cab. Large trucks require much longer stopping distances than general vehicles, as they can weigh up to 50 tonnes. Trucks also have heavily restricted visibility, so interaction between trucks and active modes (especially people riding bikes) can create serious safety issues.

Accommodating these turning movements requires significant changes to urban street design, such as increased curve radii and wider lanes. The effect of this is to encourage general vehicle traffic to travel faster, as they have a wider space to travel.

Some industries and activities require use of trucks larger than standard vehicles. Over-dimension routes are defined as a network across the country, and special design rules apply to these.

In industrial areas and major arterial roads, where truck movements are frequent and pedestrian volumes are very low, designing for freight trucks does not pose any challenges and traditional design methods of accommodating trucks can be used. However, in suburban areas, where pedestrians are more common, different design methods are required. Allowing large vehicles to use multiple lanes achieves significant reduction in lane width, compared to traditional designs. Mountable kerbs with a dedicated truck track area raised above the road surface and separate from the footpath can allow trucks to take tight turns without encouraging cars to travel at high speeds.

Designating certain streets as freight routes can help ensure that roads are designed appropriately. In many cases, using the same streets as bus routes in suburban areas can make sense, as these streets will already have allowance for larger vehicles. Strategic freight routes may need to make use of Special Vehicle Lanes to provide priority at key points of congestion, to maintain economic productivity.

Network discussion

Networks of roads for goods delivery and services should seek to respond to a number of key concerns, the foremost of which is the safety of all street users. Reliable goods delivery, and minimisation of congestion on urban streets are other key concerns.

VZ Freight routes should be planned to support the economy of industrial land uses. Design speed on freight routes is related to the safety of all road users. Low speeds are needed close to freight destinations where many others use the streets. Speeds also need to be managed at intersections, where risk of harm is high with HCVs present in numbers, by using safe system designs.

The objective of a network of roads for freight movement, is providing access for large and over-sized vehicles. Some transport authorities maintain GIS layers of freight routes, which are at times defined as roads with at least 5% multiple-unit truck traffic.

A freight network should seek to minimise the impact on local neighbourhood streets. Where freight routes cannot be routed to avoid residential areas, buffers and walls that filter noise and air pollution must be considered.

It is recommended that freight routes are strategically planned around residential areas, and not through them. Where possible, cycle routes should be separated from freight routes in order to minimise possible conflicts between users.

Trucks emit higher volumes of carbon emissions. On intensively-used access corridors, air quality can be substantially degraded, which can have serious health impacts. In major cities where access corridors are adjacent to residential areas, there is a significantly higher occurrence of diseases such as asthma

Within urban centres, bulk deliveries can be restricted to early morning with only smaller loads and courier deliveries through the day, when most people need safe access to streets and businesses.

Transfer stations and warehousing could offer a solution to goods delivery that is more appropriate for cities. They should be located at the edge of urban centres, and allow larger vehicles to transfer to smaller ones, or to switch to different modes entirely for the delivery of goods. Alternative delivery methods such as cargo bikes are a way of delivering goods that is more fitting for urban centres.

Consult with AT to determine whether new Over Dimension routes should be created as new road networks are developed for greenfield areas.

Service and delivery

A large volume of traffic on city streets consists of larger vehicles used for supplying goods to local retail and businesses. Trucks are most often used for these deliveries, and are significantly larger than the typical private vehicle. They have a need for routes through the city, so that they can reach their destination, and require space to park, so they can unload their goods and deliver them to their customers. These spatial requirements must be balanced with the needs of other street users. While the expedient and dependable delivery of goods is important to the urban economy, it is important not to over-design streets with only this category of users in mind. When cities design streets with the only the largest users in mind, the human scale is often overlooked and the experience of other users is negatively impacted. It is often possible to use flexible and retractable street elements such as bollards to provide access to large vehicles at an on-demand basis.

It can be beneficial to encourage the use of cleaner vehicles (such as electric vehicles) to minimise the carbon emissions emitted by trucks and larger utility vehicles. This also helps to reduce the impact of trucks on air quality.

The hours during which trucks can access some streets in the city centres for bulk deliveries can be restricted. Loading on streets in the city centre, especially larger businesses, typically only takes place on early mornings and/or late evenings. This way, other street users can be prioritised during the day, and conflicts with other traffic are avoided.

Particularly in areas with a concentration of retail, hotels and businesses, strategically located places for loading should allow trucks to park without causing too much congestion, or adverse noise or smells associated with servicing. These places can be used for other purposes during the day, where truck access is limited to the early mornings and late nights.

For the last few metres of a delivery, hand and cart movements are more suitable for denser urban areas than trucks. Small electric trolleys, electric cargo cycles and bicycle couriers can assist fast, small-scale deliveries across busy centres. It is best to avoid vehicle crossings where possible and restrict the number of loading bays. Neither of these are appropriate in the context of a commercial or mixed use corridor with high volumes of pedestrians. Instead, side and rear alleys can accommodate loading spaces, taking the pressure off the streets with commercial frontage.

Dimensions and speed

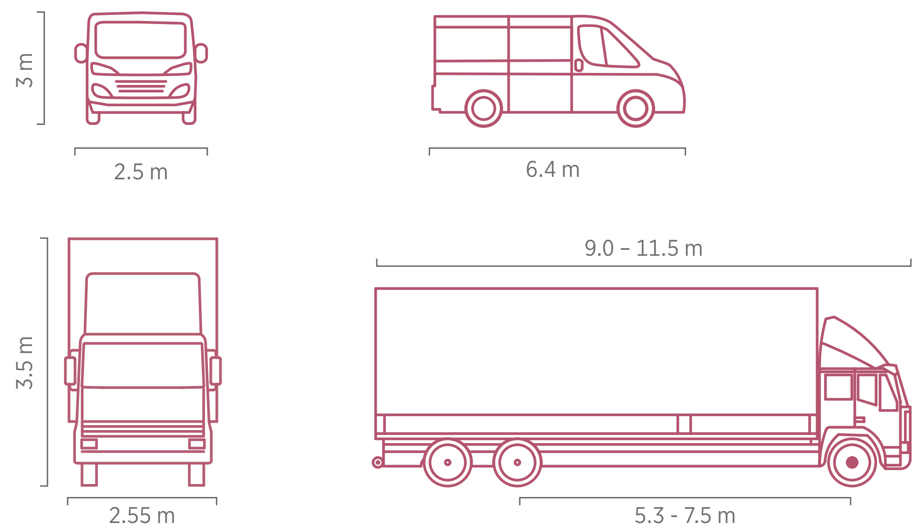
Goods deliveries frequently use a combination of large trucks and other utility vehicles, with hand or push carts for the last metres of a delivery. Vehicles used by city services are typically not much larger than trucks used for goods delivery, but vary greatly in size. Waste collection vehicles are the largest vehicles employed by city services, with vehicles used for street cleaning often being the smaller ones. Urban streets do not have to be designed to allow the largest of vehicles to negotiate turning movements in the same way as frequent private vehicles. Instead, assume that these vehicles can make use of multiple lanes when making a turn. Vehicles used for goods delivery are control vehicles; they access streets only relatively infrequently (waste collection rucks, for instance, require access twice per week), and are not the vehicle around which streets are designed.

Larger trucks are often required to service retail parks, and supermarkets in suburban neighbourhoods. These land uses should be located where they are accessible from freight routes, to avoid introducing large trucks to residential streets.

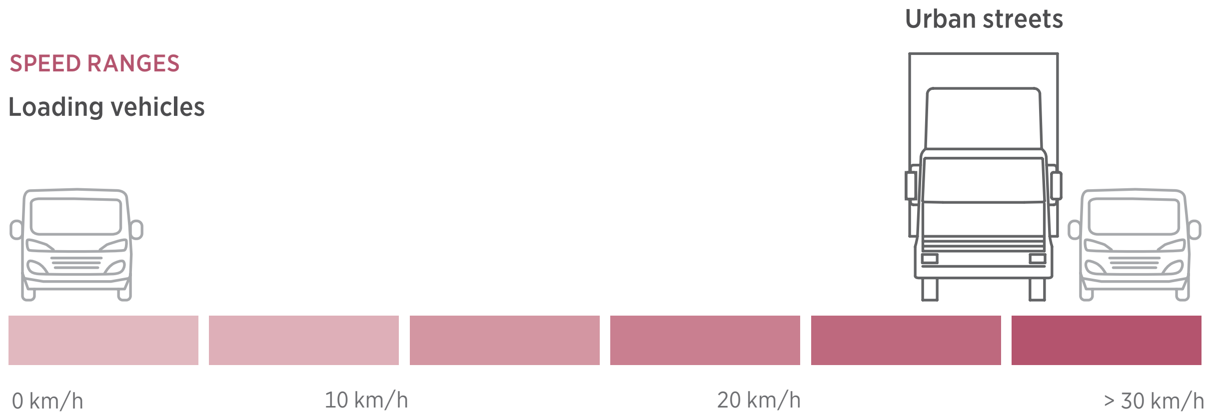
Where efficient delivery and waste collection routes can be organised, smaller vehicles can become economical for tight city-centre streets, reducing the geometric size of infrastructure. However, emergency service vehicles must always be given suitable access where road space is reduced.

City streets must be able to provide for emergency vehicle access, including the length and width of stands for firefighting. Special guidance exists for this.

TYPICAL SERVICE TRUCKS



SPEED RANGES



4

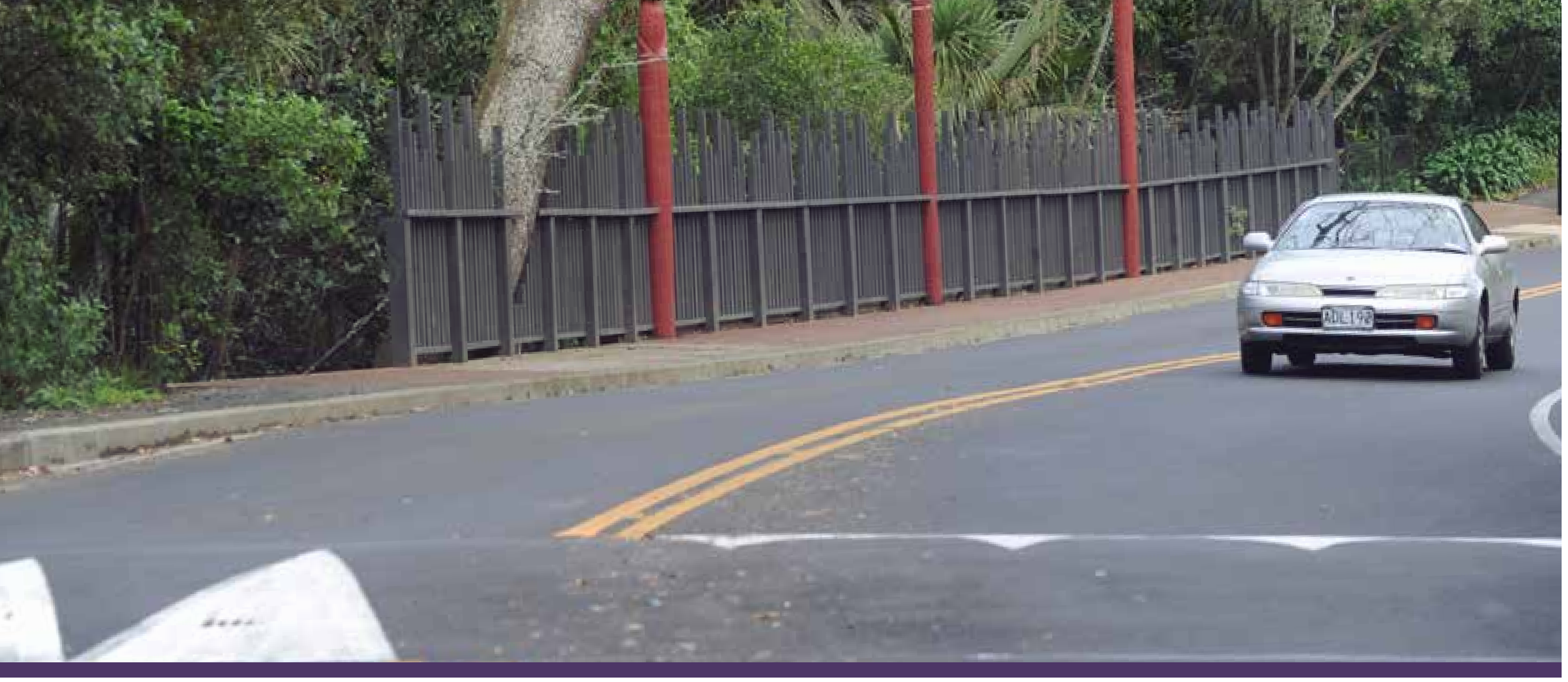
CHAPTER

Design controls

IN THIS CHAPTER

Designing streets to achieve the core principles set out in Chapter 1 requires a new starting point. Design controls, from design vehicle to design speeds, set the basis for street design.

Establishing new design controls refocuses the priority of street design on the diversity of street users and activities on a street. The design controls set the foundation for creating and retrofitting safe, accessible, and high-quality streets and intersections.



Design speed

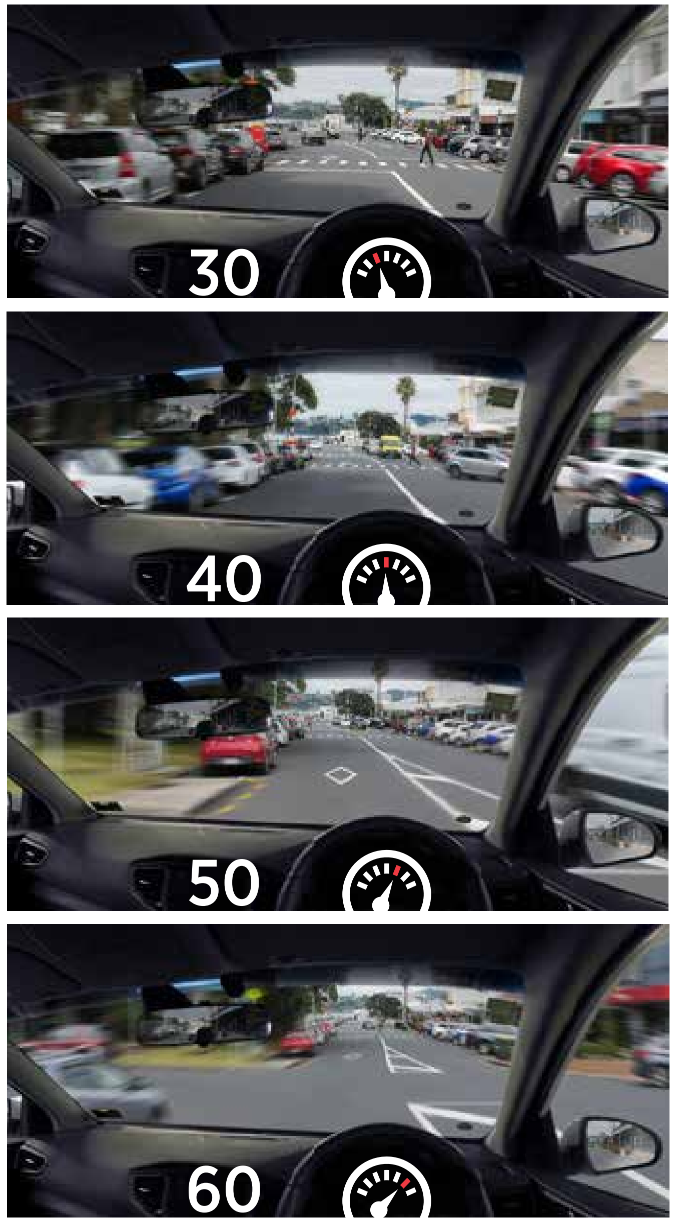
Designing for appropriate vehicle speeds is critical to the safety of street users and significantly contributes to the overall functioning and operation of city streets. Speed should be proactively managed to give clear expectations for drivers, using a range of design, operational and legal tools.

Streets should operate at speeds that create comfortable environments for pedestrians and cyclists, as well as motor vehicles. Street designs should aim to limit excessive speeding and design speeds must be appropriate for the Street Type and the degree to which modes are separated or mixed.

New streets should be designed to feel uncomfortable at speeds above the design speed. This is consistent with the design philosophy of self-enforcing streets. On existing streets with excessive speeds, traffic calming measures should be used to reduce speeds to improve safety and comfort for all users.

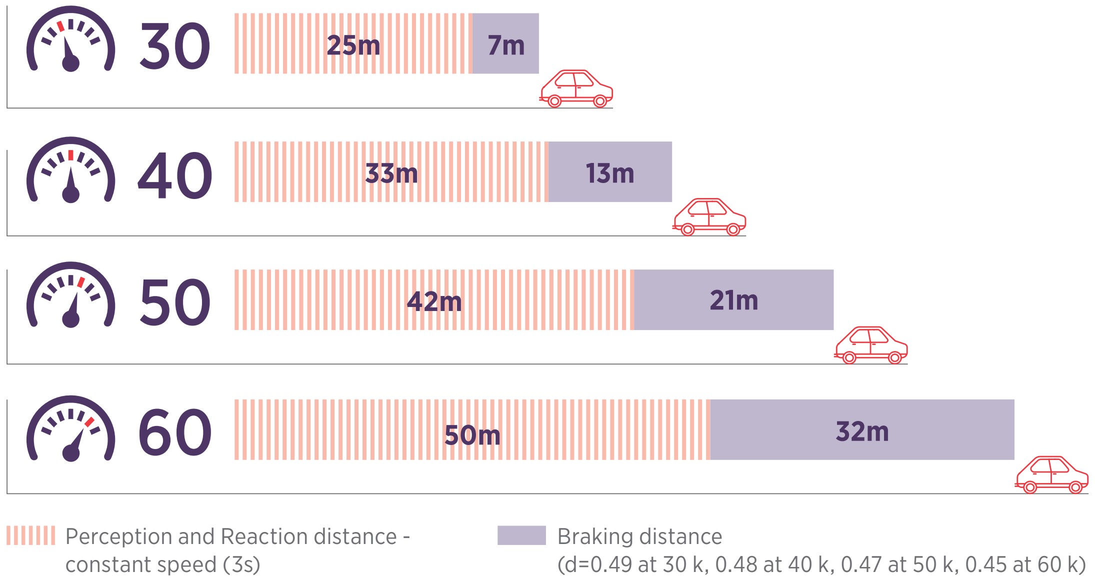
LESS SPEED = MORE AWARENESS

Speed is a primary factor in crash severity and the likelihood of a crash occurring. As speeds increase, our brains process less of what is seen in our peripheral vision, resulting in longer driver reaction times and longer stopping distances, while providing less time for other street users to react. As speed increases, drivers must scan further ahead for hazards.



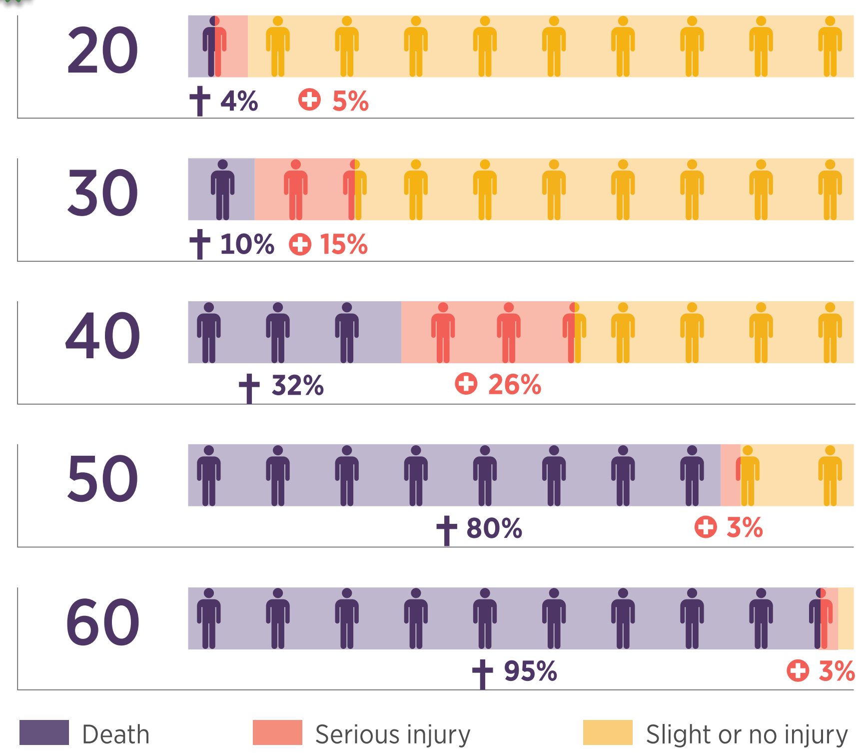
View of pedestrian crossing from stopping distance for speed shown

LESS SPEED = MORE ABLE TO STOP



IMPACT SPEED

LESS SPEED = MORE LIKELY TO SAVE A LIFE

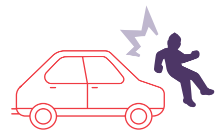


People walking and cycling are particularly vulnerable in the event of a crash. The severity of a pedestrian injury in the event of a crash is exponentially related to the speed of the vehicle at the point of impact. For example, a pedestrian who is hit by a motor vehicle traveling at

30 KM/H = 25% CHANCE
of death or serious injury

whereas a pedestrian hit by a motor vehicle traveling at

60 KM/H = 95% CHANCE
of death or serious injury



† Source: Towards Safe System Infrastructure: A Compendium of Current Knowledge (2018) Austroads

LESS SPEED = MORE AWARENESS = MORE ABLE TO STOP = MORE LIKELY TO SAVE A LIFE

Desired speed

Streets must be designed with a maximum design speed, the speed that designers intend drivers to go. This design speed should be selected to suit all users of the street, the land use context and the degree that modes are mixing. The design features of the street design must ensure that the actual operating speed does not exceed the design speed. Appropriate speeds must reflect the activities expected within the street, including the movement of people across the street. The degree of protection for head-on, passing or cross movements and whether they are spread along the street or at defined points affects the survivable speeds to be considered at possible points of conflict. Speed along the street may be reduced at points of conflict by measures such as roundabouts or raised table crossings, where the general design speed is more than the survivable speed for a predictable conflict. Appropriate design speed will take account of the network function of the street, the users and the physical environment. The following desired speeds are recommended for different network functions.

Desired speed	Appropriate location
10 km/h	Shared spaces
30 km/h	Main street Arterial or Collector. Local Streets. Some Mixed-Use Arterials in centres. Also any type near schools or other major pedestrian destinations. Points of conflict with vulnerable people (crossings, intersections).
40 km/h*	Neighbourhood or Mixed-Use Collectors. Some Mixed-Use Arterials in centres. Any School Zones that have not been reduced to 30 km/h. *Prefer 30 km/h for safety, unless protected crossings provide good accessibility.
50 km/h	Single Use Arterials. Mixed-Use Arterials with extended urban lengths. These streets must be provided with suitable safe crossing points with speed reduced locally.
>50 km/h	Single use arterials with limited access, Urban expressways and motorways. Safe crossings should be grade-separated or at intersections with speed reduced locally.

SPEED LIMITS

While simply lowering posted speed limits can play a role in reducing and enforcing lower speeds, the overall effectiveness is limited if the appearance of the road does not match it. Physical design cues have proven more effective than posted speed limits in lowering overall operating speeds. A combination of design to affect drivers' recognition of safe speed, with setting appropriate speed limits, is most effective.

Technological changes may increase the effectiveness of lowering speed limits where vehicles' systems can regulate speeds, or record speeding with GPS monitoring.

CONVENTIONAL HIGHWAY DESIGN

Operating speed > Design speed > Posted speed

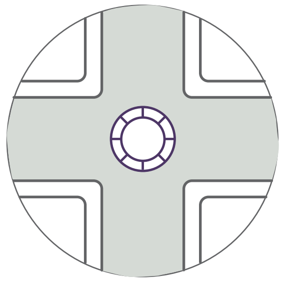
PROACTIVE URBAN STREET DESIGN

Desired speed > Design speed > Posted speed

For more technical guidance, please refer to the Engineering Design Code: *Traffic calming*

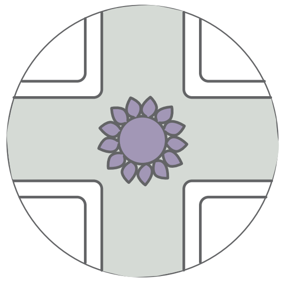
Factors that influence speeds

Several factors outside of the posted speed limit influence driver behaviour. These factors can be broken into physical features and psychological and perceived features.



PHYSICAL FEATURES

Physical features to slow vehicle movement include roadway geometry – block length, lane width and corner radii as well as features associated with traffic calming. Corner radii and driveway ramps are used to influence vehicle turning speeds and transitions between streets. Conventional traffic calming slows drivers by physically limiting vehicle speeds with vertical changes to the roadway (vertical deflection) and horizontal shifts in the vehicle path (horizontal deflection). These affect the comfort of users, and so affect the speed at which they choose to travel. Physical features such as raised table crossings and ramped intersection approaches can also be used on arterial and collector roads where many people will cross traffic lanes on foot, bike or in vehicles.

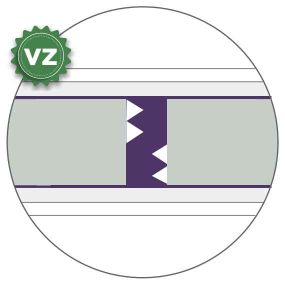


PSYCHOLOGICAL AND PERCEIVED FEATURES

Psychological and perceived features add cognitive complexity and difficulty for drivers. Examples of these features include the use of different materials, visual narrowing and edge friction. Using different materials and colours creates visual interest and signals to drivers that something is different about the street. Visual narrowing makes the street look narrower than it is. Visually narrowing can be achieved through slight grade changes, different surface materials, drainage channels, and lighting. Edge friction relates to the amount of activity and information that the driver must absorb from their peripheral vision. Edge friction can be potential roadway conflicts such as fixed objects (street furniture, trees), other vehicles, or human activity. Edge friction urges drivers to slow down and drive through streets with care.

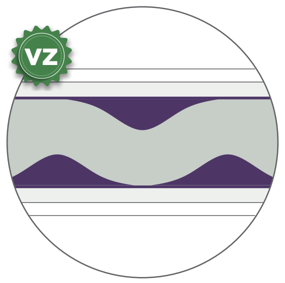
Tools to reduce speed and volume

There are a variety of methods to slow vehicle speeds on a street, both when designing new streets and when retrofitting existing streets. The combination of physical and psychological devices enable street designers to proactively design their environment and encourage desired behaviour. The use and suitability of these measures will often depend on a multitude of factors. The effectiveness of devices to maintain the design speed along a street is affected by the spacing of devices, as well as the design of the devices. It is important to design the combination of devices to produce a safe speed.



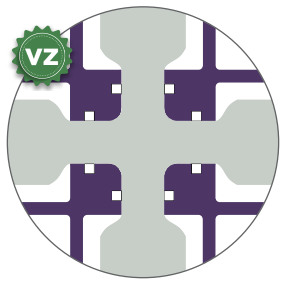
SPEED HUMPS

Speed humps or tables can be added to a street to vertically deflect traffic.



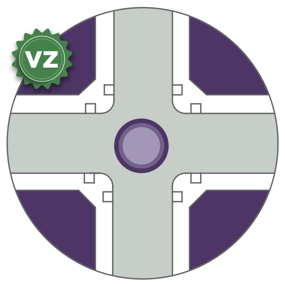
CHICANES/LANE SHIFTS

Chicanes require drivers to shift laterally by alternating either parking or kerb extensions along the street.



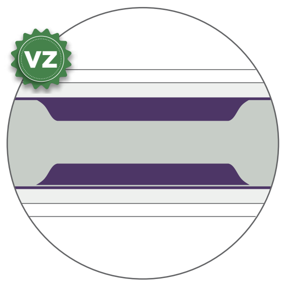
KERB EXTENSIONS

Kerb extensions narrow down the carriageway and increase awareness of drivers, while shortening crossing distance for pedestrians.



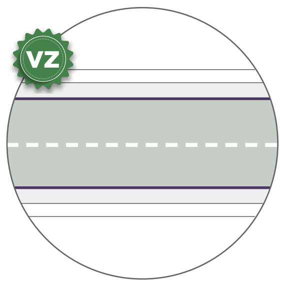
MINI ROUNDABOUTS

Mini roundabouts slow speeds by requiring additional attention from drivers at conflict points.



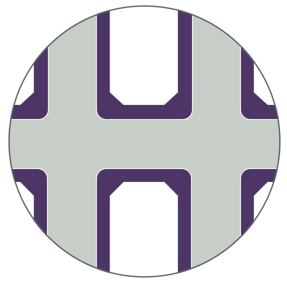
PINCHPOINTS

Also known as chokers, pinchpoints narrow the street, restricting drivers from operating at high speeds.



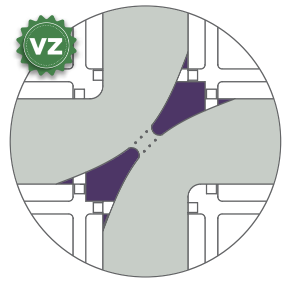
LANE WIDTHS

Narrower lanes correlate with slower speeds. Lane widths should be determined based on the Design and Control Vehicle for any given street.



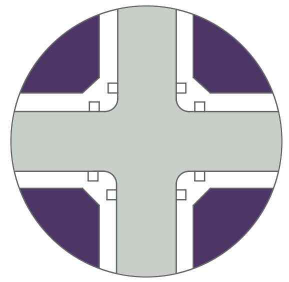
BLOCK LENGTHS

In addition to improved pedestrian connectivity, shorter block lengths limit the time cars can accelerate between stops.



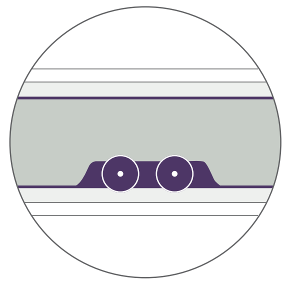
DIVERTERS

Diverters break up traffic and limit access to cars, while maintaining permeability for pedestrians and cyclists.



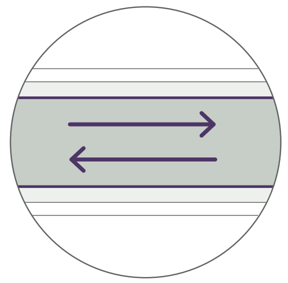
ACTIVE STREET EDGES

Active shop frontage with no significant setbacks not only limits sight lines, but alerts drivers to a change in environment and the likelihood of pedestrians crossing the street.



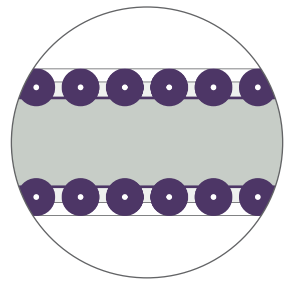
FORWARD VISIBILITY

Reducing forward visibility is an effective way to slow speeds and increase driver attention. Forward visibility can be reduced with plantings and street alignments.



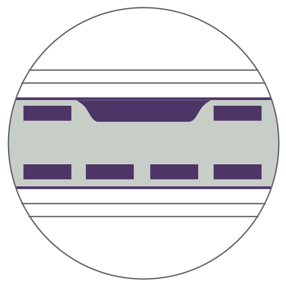
TWO-WAY STREETS

With the added risk of conflicting traffic flow, drivers tend to slow down.



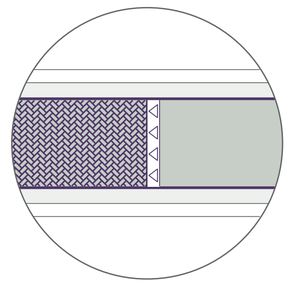
STREET TREES

Among many other benefits, street trees narrow the driver's line of sight and provide rhythm to a street.



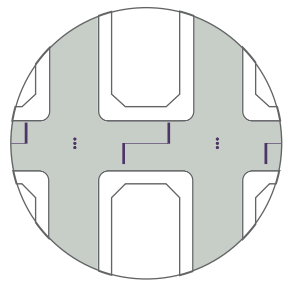
ON-STREET PARKING

On-street parking provides side friction and narrows the carriageway, resulting in slower vehicle speeds. This only works where parking is consistently occupied.



MATERIALS

The visual perception and the physical characteristics of different materials can denote a slower or guest environment for cars.



SIGNAL PROGRESSION

Signals can be timed to achieve the street's target speed.

Design vehicle

The choice of Design Vehicle affects the size and design of the street, as well as how safely it operates and supports the desired land uses and activities.

Designing streets for rare large vehicle movements creates overly wide streets, inducing high speeds. They cost more to build and operate and compromise urban amenity, certain land use activities and transport modes.

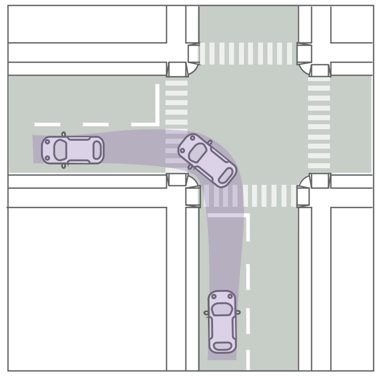
The Design Vehicle is the largest vehicle that frequently uses a street. They are expected to be able to remain within their allotted traffic lane. Depending on the context and type of street, the Design Vehicle could be person on foot, a person on a bike, a car or a truck.

Check Vehicles are larger vehicles that may be expected to use a road from time to time. They may not be able to remain within a traffic lane at all times, but encounters between them and Design Vehicles must take place in a predictable and safe manner. A Check Vehicle should be identified that is based on an emergency vehicle, or other infrequent larger vehicle. Check Vehicles use the street rarely (up to a few times per week). These vehicles may make turns by using multiple lanes, including adjacent or opposing lanes in some types of street.

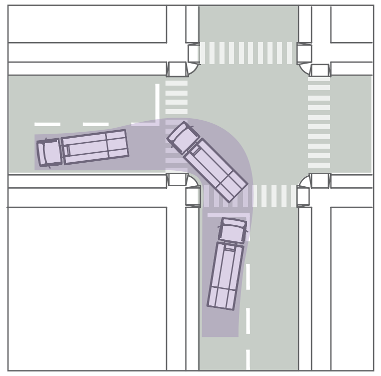
Common Design Vehicles and Check Vehicles are described opposite. Choice will vary with the function of the street type.

> **Further guidance on design controls is given in the Engineering Design Code:** ***Urban and rural roadway design***

DESIGN VEHICLE TURNING



CHECK VEHICLE TURNING



Design vehicle

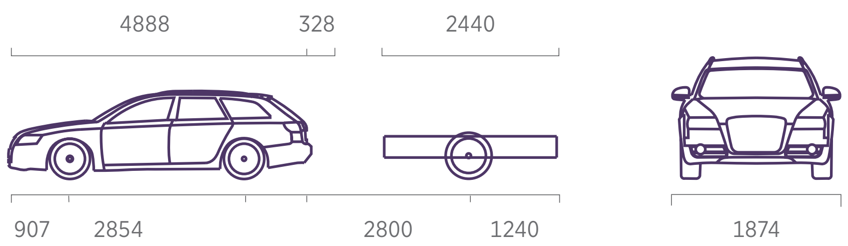
The default vehicle for most local street types is the standard Auckland Transport car and trailer (85th percentile car). This requires space similar to a trade van, and would be driven in a way similar to private cars generally.

A bus or 8.3 m truck is likely to be the Design Vehicle for collector streets.

Most arterial streets are expected to carry freight or large service and delivery trucks, with 19.45 m semi-trailer as the Design Vehicle.

Collector and local streets serving industrial and commercial land uses may need other truck sizes as Design Vehicles.

85TH PERCENTILE VEHICLE



It is critical to select the smallest possible motorised design vehicle that is reasonably expected to use the street.

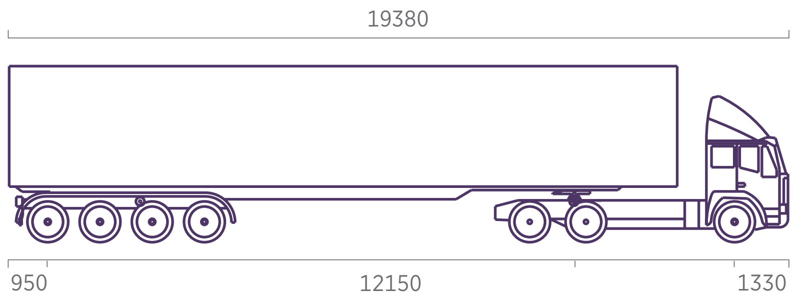
Check vehicle

The rear-steered 10.3 m rubbish truck can be expected occasionally on most city streets. However, it must be noted that on most city streets, this vehicle can be expected only a few times per week. Accommodating this vehicle means designing so it can operate at very low speeds, and occasionally tracking into adjacent and opposing lanes, unless a very high volume of opposing traffic is expected. Traffic delays to, or caused by, occasional vehicle movements are acceptable. Checking for this vehicle will meet most emergency access requirements,

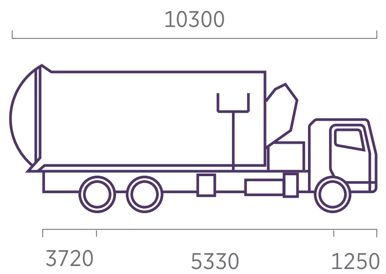
Some streets may also need other Check Vehicles for specific service and delivery or freight access.

An intersection may need to be designed for more than one Check Vehicle, to cover different space each takes to turn.

HPMV SEMI-TRAILER



REAR-STEERED RUBBISH TRUCK



Strategies for regular large vehicle movements

On frequent bus routes and routes with significant freight or truck movements, street geometry may need to be adapted for regular large vehicle movements. Designers must carefully weigh up the design implications of designing for large vehicles as opposed to simply accommodating them. Providing larger roadway geometrics may compromise the safety and accessibility of other road users. In practice, there are many places across Auckland where large vehicles, including buses and high-capacity trucks carefully navigate narrow city streets. Their movements are accommodated by the techniques listed below.

Before increasing intersection dimensions to design for a Large Design Vehicle, the following strategies should be considered to maintain compact intersections:

RECESSED STOP LINES

Recessed stop lines on the destination street can increase the space available for large vehicles to make a turn by enabling them to swing into opposing lanes on the destination street while opposing traffic is stopped.

COMPOUND CORNERS

A compound corner changes the kerb radius over the length of the turn. This technique may be considered where there are high pedestrian volumes, or a desire to make pedestrians visible, but a need to accommodate frequent large turning vehicles such as left-turning buses. Because they allow more sweeping turns, they do not slow turning vehicles, and may not be appropriate.

PAVING TREATMENTS AND MOUNTABLE KERBS

To accommodate semi-regular large vehicles, consider a corner design in which a raised over-run area between kerb and traffic lane is used, to discourage high-speed turns, but allow low-speed use by larger vehicles.

TIME OF DAY

Time of day restrictions can be used for large vehicles.

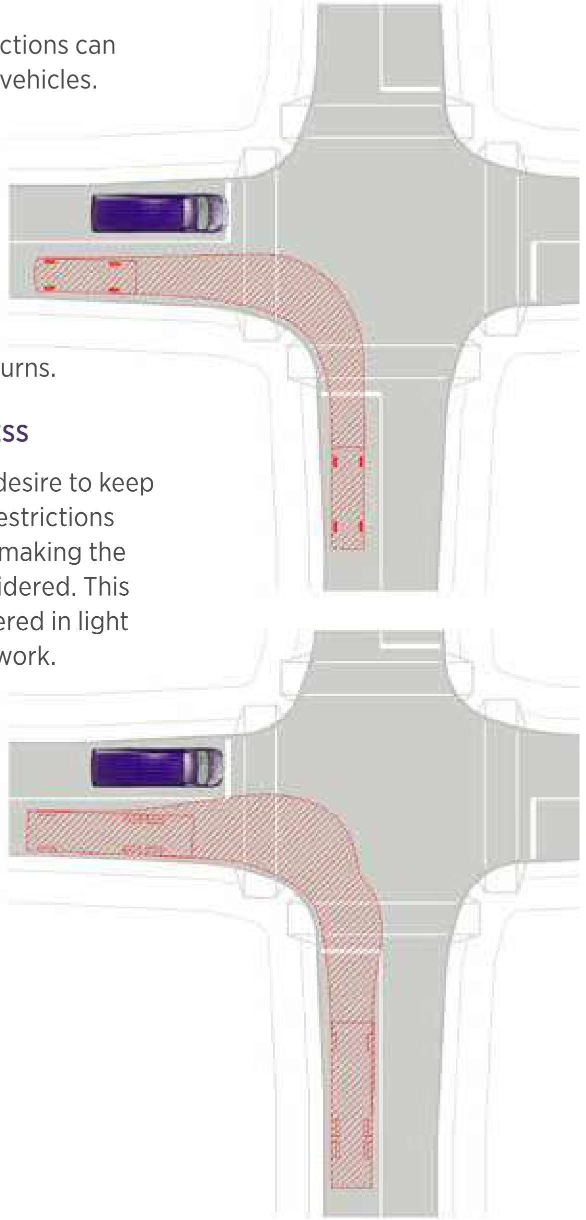
SPOTTING

Require larger vehicles to employ on-road personnel to spot for vehicles through difficult turns.

RESTRICTED ACCESS

Where there is a desire to keep kerb radii small, restrictions on large vehicles making the turn may be considered. This should be considered in light of the overall network.

COMPOUND CORNER



Bus routes

On bus routes, a bus will usually become the Design Vehicle. However, the size and treatment for this design vehicle should depend on the route frequency as well as the local traffic conditions.

On the frequent bus network, larger vehicles and higher frequencies are expected (no less than four per hour all day, and often more at peak times). For these routes, tracking should be generally be done using the 12.6m rigid urban bus, and checked with 13.5 m bus with a rear-steer axle. However, take care not to widen streets unless necessary.

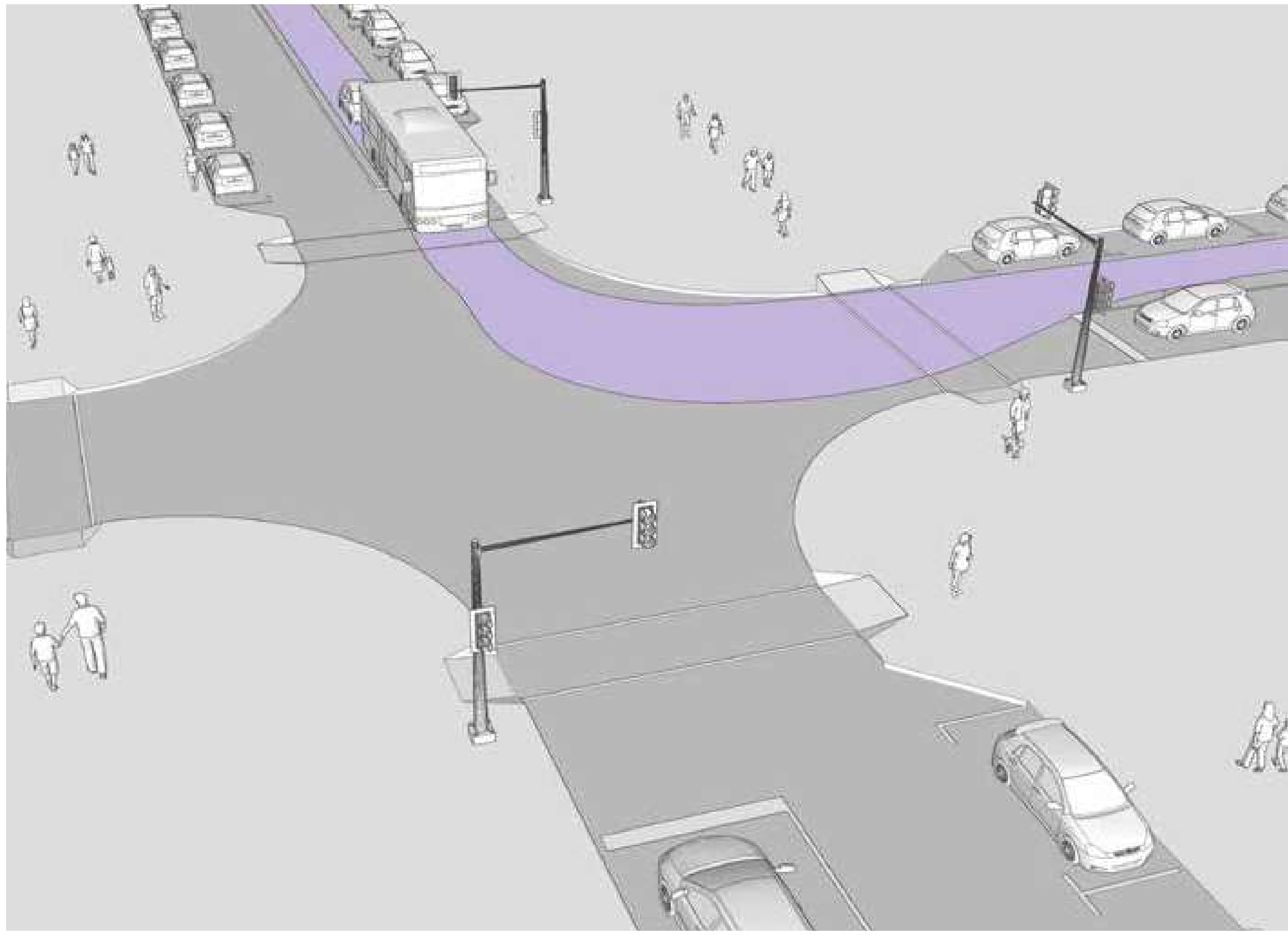
It is a useful reminder that public transport passengers are also pedestrians that have to navigate city streets before and after their trips.

Designers should still weigh up the peak frequency and opposing vehicle volumes to understand if significant delays will result from tighter turns being used. Other strategies such as bus pockets and bus advance lights can be used to allow buses to make tight turns on these frequent routes.

At intersections where multiple public transport routes converge or with a high number of large trucks (>10%, or slightly lower if traffic volumes are very high), a bus/large rigid truck will be more appropriate for use as the design vehicle.

It may be appropriate to accommodate an articulated bus or semi-trailer control vehicle on an arterial road, however such a large vehicle should not be used as a design vehicle unless exceptional circumstances exist.

Regardless, broader goals for the street must remain the primary design consideration.



Design hour

A street's uses, demands, and activities can change dramatically over the day. For example, Karangahape Road undergoes a remarkable shift from peak hour to lunchtime, and during the day to the late night hours. Street designers should consider how streets operate across all hours of the day, for all users. While understanding the demands of peak hours is valuable, streets should be designed for the needs of users and functions of the rest of the day.

Designing streets for two 30-minute peaks of each weekday leads to very wide streets with excess capacity for the rest of the day. This has a very high spatial footprint, and reduces the amenity of the street. This encourages high vehicle speeds during the remaining 23 hours of the day, and makes pedestrian crossings difficult and/or dangerous. It may fail to provide a safe and attractive environment during the rest of the day.

Vehicle capacity metrics should be established that seek to provide comfortable capacity during the typical hours of the day. Designing for peak hour vehicle capacity requires the construction and maintenance of costly infrastructure. By proactively setting vehicle capacity targets, traffic growth can be contained, while shifting to highly space-efficient modes. This enables a greater portion of space to be given to land use activity.

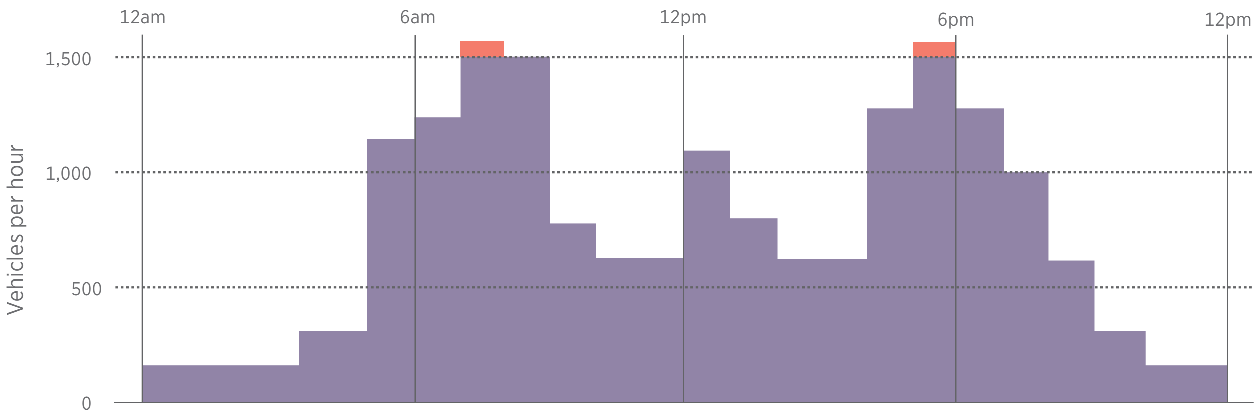
Additionally, it is recommended that the design hour accounts for the various peaks throughout the week for all users. All users of the street should be accounted for across the day and the week. This includes peak hour commuters, weekend markets, special events, evening strollers, shoppers and city servicing.

A day in the life of Karangahape Road

MORNING PEAK
Signals should maximise people movement.

MID-DAY
Pedestrian volumes reach their peak during lunch hour.

EVENING
Traffic volumes decrease, while pedestrian volumes tend to increase.



Highest daily hourly vehicle volume

Measuring the street

Transport vehicle capacity should be evaluated as person-trips. This provides a more comprehensive picture of the transport efficiency of the street. Additionally, more encompassing quantitative evaluation metrics can be used to measure the city's and community's goals.

MOBILITY AND ACCESS

This set of metrics includes the traditional traffic engineering metrics applied to other modes. Metrics under mobility and access include public transport to private vehicle time ratio and width of pedestrian spaces. Other metrics include person delay, walking kilometres/day, time needed for people to cross the street and number of pedestrian crossings per kilometre.

PUBLIC SPACE QUALITY AND SOCIAL INTERACTIONS

Critical metrics around the quality of urban spaces and human interactions include the number of women and children using a facility. In addition, active storefronts, number of neighbours known and the ratio of people staying versus passing through a place are other non-critical metrics.

PUBLIC HEALTH AND SAFETY

Important health and safety metrics include fatality rates for all street users, severity rates for all traffic injuries and coverage of street lighting. Others include coverage of pedestrian-scale lighting, extent of internally-lit windows at street level, and traffic noise.

ENVIRONMENT

Particulate matter is identified as the most critical environmental metric, while shade cover, connectivity of green spaces and amount of greenery are other environmental metrics.

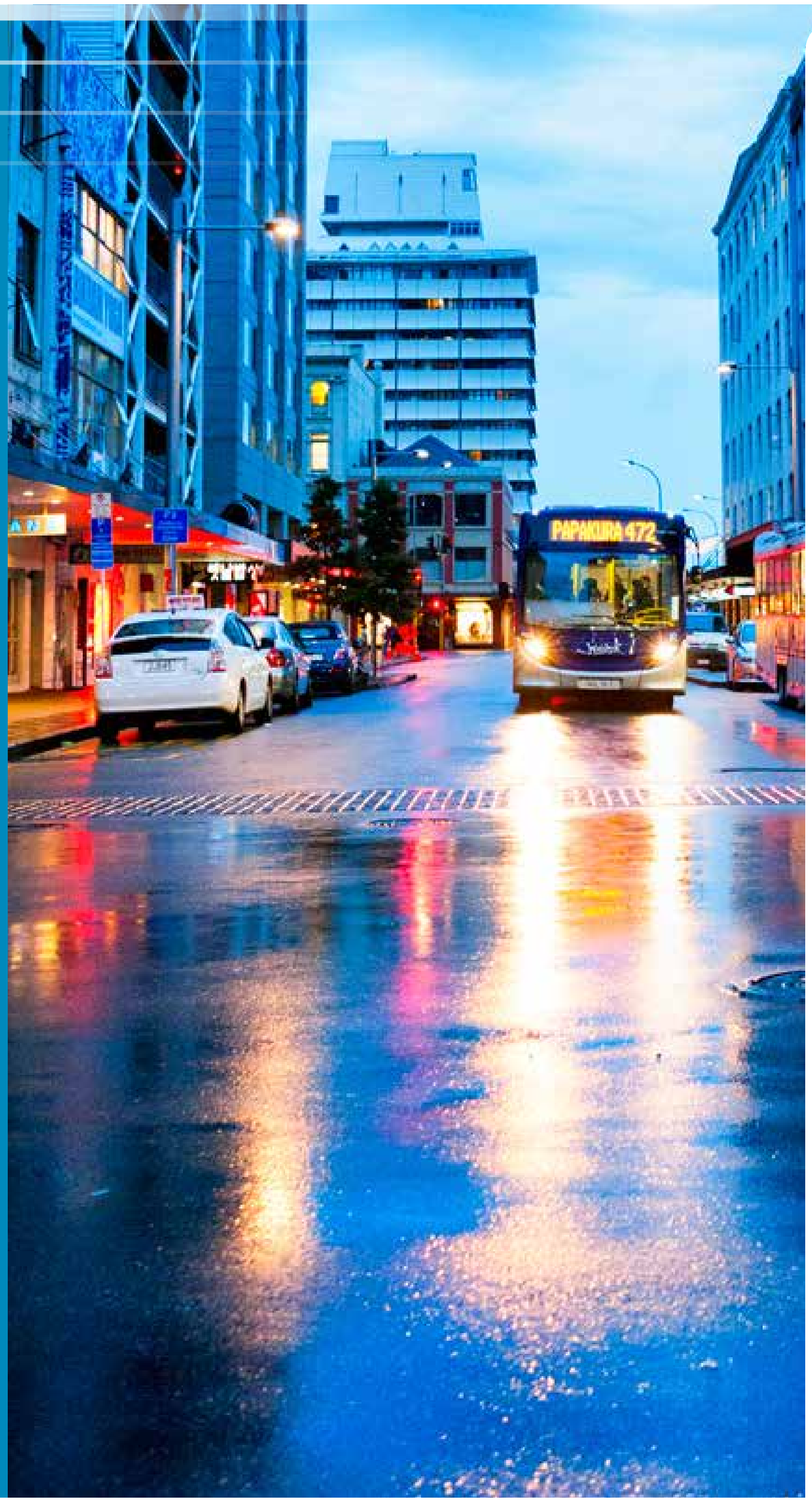
ECONOMY

Retail sales along the street are considered the most important economic metric, while commercial vacancy rates, foot traffic, property values and retail customer mode share are other indicators of an economically successful street.

CHAPTER

5 Street types

IN THIS CHAPTER



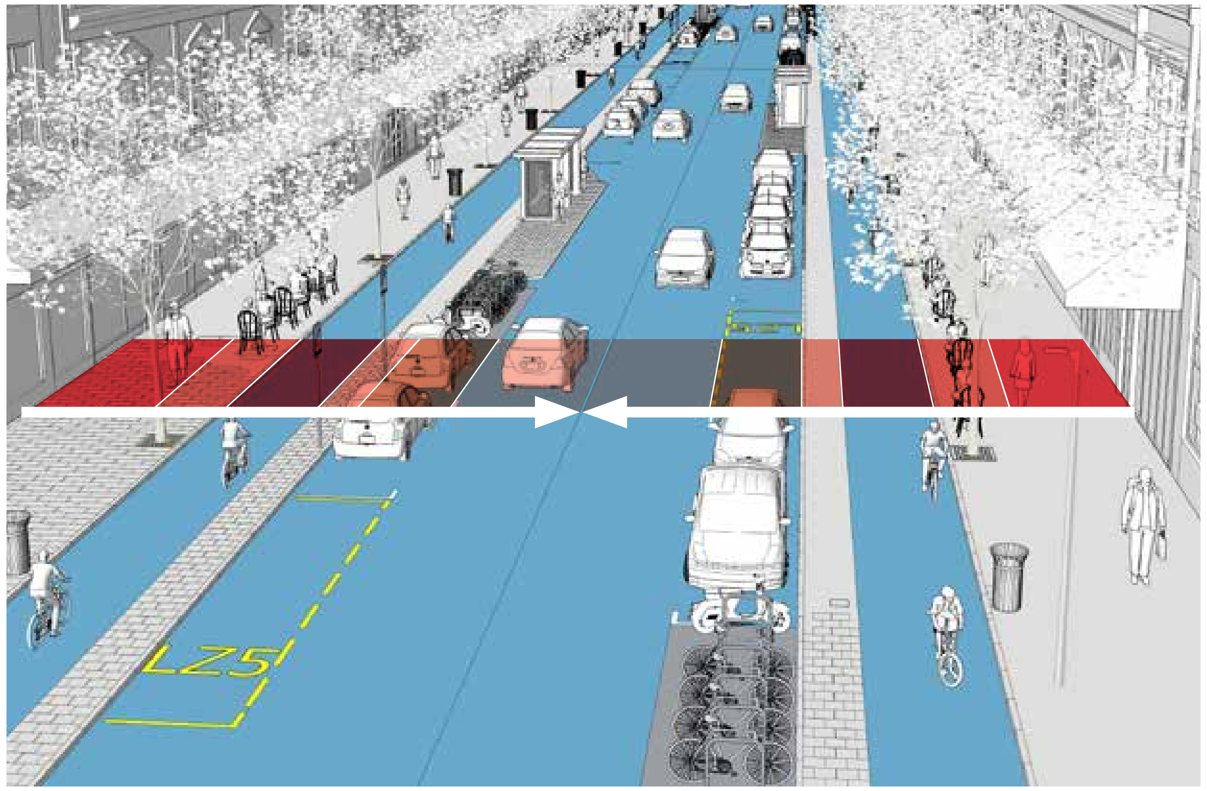
To guide both future development and road design projects, Auckland Transport has developed a new set of Street Types that classify Auckland's streets based on the adjacent land uses (place) and transport function (movement).

The new street types support the wider objectives of Auckland Council and Auckland Transport and provide guidance for the desired future conditions of Auckland's roads and streets. Street types are determined through the Roads and Street Framework. This chapter shows how the strategic direction of the street types outlined in the Roads and Street Framework can be translated into design solutions that meet the aim of the street. The illustrations are not prescriptive or to be used as templates, but are used to guide design thinking and discuss particular aspects.

Many streets will vary from commonplace functions. Some special cases are described in the sub-types included in this chapter, with discussion of design issues.

Where street space is limited by existing development or other fixed features, the design will have to respond to these constraints. However, the design considerations included in this chapter must be used to address all the requirements of the street type. If design objectives cannot be met, the Roads and Streets Framework may need to be used to alter the network objectives.

Design of streets by street type



PUTTING THE ELEMENTS TOGETHER

The following pages in this chapter show the design considerations for assembling the elements into street designs.

We recommend starting with the outer edges of the street, by considering adjoining land use (existing buildings, development opportunities, topographical constraints). How these land uses connect with the street, and how the street design zones can be laid out for the various use modes, can be worked through from the outer edge to the centre of the street.

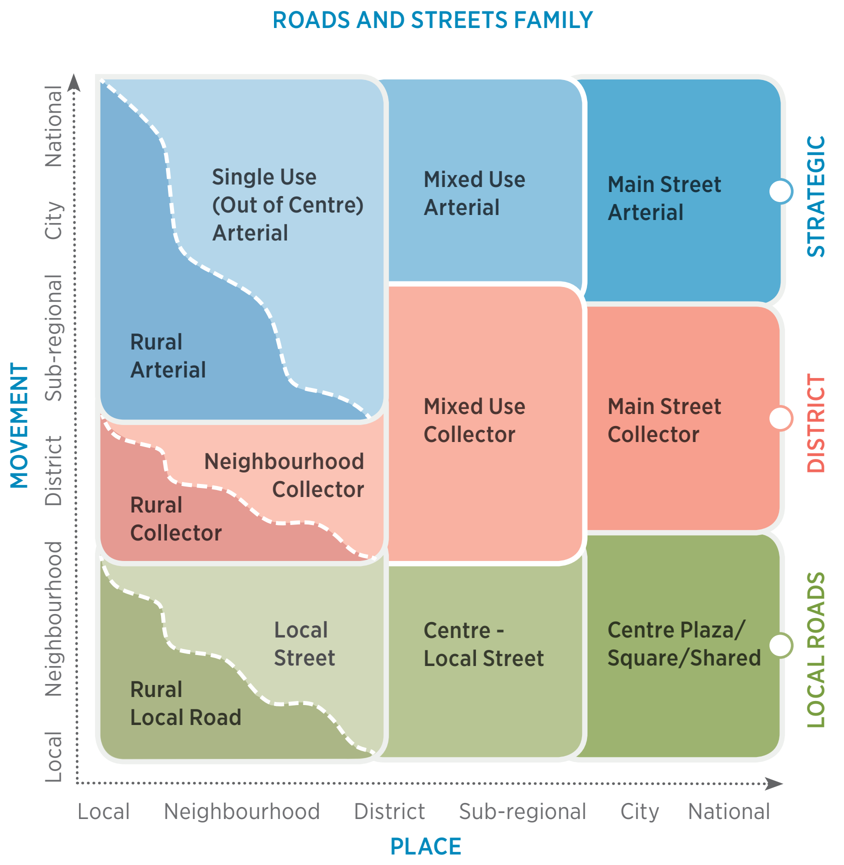
Characteristics of the particular street type should be used to identify safe desired speed and to set an appropriate speed limit. The general appearance should allow the type of street to be easily recognised so that people can behave consistently. This Design Guide can then be used to select appropriate elements and arrange them to build suitable whole-street designs for all the required functions.

Different options can be compared to find the best fit of elements for the functions. If constraints mean that a satisfactory design cannot be found to meet all planned network requirements, it will be necessary to use the Roads and Streets Framework to change the functions to be provided in any one street, while meeting the needs of all users in other streets across the wider local network.

Intersections have a significant effect on the streets that they join together. Design of the street should be carried out in conjunction with design of intersections, to ensure that the elements in them all work together. Intersections and crossings should be designed with survivable speeds. See Chapter 6: Intersections.

Note: The Roads and Streets Framework is under review by Auckland Transport and this Guide will be amended in due course.

Street types and classification



There are nine street types in the Roads and Streets Framework. The street family establishes the roles and priorities of the street types. The function priorities change, depending on the type of road or street. This simple categorisation aims to make it practical to apply and help developers, community groups and other stakeholders by providing a framework to assist with balancing competing demands. Ideally, major public realm and streetscape schemes can succeed in delivering improvements for many different users at the same time. In some cases, this will not be possible, but it is important to work through the balances that can be accepted.

MOVING PEOPLE

While street performance is conventionally measured based on vehicle throughput and speed, these fail to account for the range of functions of the street, including social, cultural, and economic activity. When balancing movement and place requirements of streets, it is critical to understand the movement quantum and dynamics. Measuring the number of people moving through a street provides a more complete picture of the how people get around a city and the efficiency and productivity of the transport network. As street space becomes scarce and more is expected of streets as places, shifting to spatially efficient transport modes can unlock street space. Public transport has the highest people-moving capacity in a constrained corridor, followed by walking and cycling. A dedicated bus lane can carry up to 8,000 passengers an hour.

NETWORK CAPACITY PARAMETERS FOR DESIGN

The Roads and Streets Framework should be used to determine what network functions are required for each mode in a street. Modelling or counts of existing use should be used to determine the capacities appropriate for each mode. Network operating plans provide a means of balancing capacities across all modes in the network, understanding throughput and delays in the context of end-to-end journeys made.

Quality of Service tools should be used along with these to ensure each street contributes to a balanced and consistent network.

These capacities can be used to determine the size of elements required in design of the street.

Design features for street types

This summary shows the general characteristics distinguishing each principal street type. Features will vary according to specific network requirements, however the distinct character of each street should be expressed so that the type is easily recognised by users.

This chapter shows several sub-types that discuss how particular variations in network requirements can be included in street designs.

Main Street Arterial

Main street arterials are characterised by a high traffic volumes, as well as a high density of on-street destinations. They support a high concentration of commercial, retail, cultural and residential activity. They also act as civic spaces for people. Pedestrian activity is very high on these streets. As such, the footpath must accommodate large volumes of footfall and crossings must be frequent. Cycle access is important, as these streets are destinations. Parking should be priced if present at all. Due to the spatial constraints of the street and the high focus on through movement, public transport is prioritised.

SUGGESTED DESIGN FEATURES

- Equal emphasis on public realm and through movement
- Strong public transport and pedestrian focus with frequent crossings
- Active street use throughout the day
- Limited or prohibited general traffic
- Lower speed zone (<30 km/h).

Main Street Collector

Similar to main street arterials, main street collectors are significant destinations in their own right. However, movement plays a less important role on main street collectors. These streets have a variety of land uses, including commercial, residential, and retail activity. The public realm should reflect these uses through large clear paths for pedestrians. Frequent public transport will be present. Depending on general traffic volumes, they may be able to mix with traffic. In areas that experience high levels of traffic, bus priority strategies can be used.

SUGGESTED DESIGN FEATURES

- Travel lanes as compact as possible
- Continuous street frontage
- Strong pedestrian focus with large clear paths and frequent crossings
- Separated cycleways
- Lower speed zone (<30 km/h).

Centre Plaza/Square/Shared Space

Centre plaza/square/shared spaces are where walking and cycling are prioritised. Speeds are typically between 10 and 15 km/h if vehicles are present at all. In these areas, commercial activity is particularly important. There are often many desire lines on these streets and thus crossing opportunities must be ample. These streets play a key role in civic function with events and fairs. Public transport is accessed at the edges.

SUGGESTED DESIGN FEATURES

- Very low speed (<15 km/h)
- Restricted vehicle access
- At grade streets
- Street furniture
- Temporal delivery regimes
- Strong pedestrian focus.

Mixed Use Arterial

The mixed-use arterial is characterised by high traffic volumes, with some limited destination types such as offices, shops and residences. There is low to medium density of uses. Large volumes of mixed traffic are present, including frequent transport provision. Thus public transport should get priority. Safety of vulnerable users moving along and across the road is to be ensured.

SUGGESTED DESIGN FEATURES

- Higher speed environment (30-40 km/h in centres and with access limited , 50 km/h in other urban areas without accesses)
- Separated cycle facilities
- Bus priority
- Pedestrian crossings near bus stops.

Note: The Roads and Streets Framework is under review by Auckland Transport and this Guide will be amended in due course.

Mixed Use Collector

Mixed use collectors serve residential, commercial and civic uses, with a mix of traffic and buses providing access. Pedestrian and cycling amenity should increase as the mixed use connector approaches centres and bus stops. There will be bus priority on frequent transport network routes.

SUGGESTED DESIGN FEATURES

- Medium speed environment (<40 km/h)
- Separated cycleways
- Ample pedestrian facilities around bus stops and centres
- On-street parking around centres.

Centre – Local Street

Centre – local streets are higher density local streets that support a variety of land uses, including offices and residential towers. They tend not to be locations for destinations. Pedestrians play an important role on this street and the road reserve sees a mix of all types of traffic.

SUGGESTED DESIGN FEATURES

- Slow speeds
- Private-public space interaction
- Ample public amenities (parks, footpaths, etc.)
- Parking is on street.

Single Use Arterial

Single use arterials are defined by low-density urban land uses, lower pedestrian activity and high levels of through movement. Of all the street types, this has the highest movement and lowest place values, thus intersections are less frequent. Pedestrian crossings should be placed near public transport stations and stops.

SUGGESTED DESIGN FEATURES

- Highest speed environment (50, 60-80 km/h in peri-urban areas with no accesses)
- Good parallel routes for local traffic and cycling
- No parking
- Keep high amounts of visibility
- Lower intersection density.

Neighbourhood Collector

Though not experiencing as much traffic as single use arterials, traffic volumes along neighbourhood collectors are still very high. They have a low intensity land-use context and have a mix of all traffic types. Pedestrians and cyclists have separated routes that are well lit and have ample space for moderate volumes.

SUGGESTED DESIGN FEATURES

- Medium speed environment (<40 km/h).
- On-street parking near centres
- Separated cycle facilities and pedestrian routes to bus stops and centres.

Local Street

Local streets have low traffic volumes, as well as travel speeds of 10 to 30 km/h. They are largely residential streets with occasional commercial and industrial uses. These streets have friction (trees, green infrastructure, parking, etc.) on either side of the street to slow speeds and allow for mixed-traffic cycling. Local streets are some of the most important street types, as this is where people live and play.

SUGGESTED DESIGN PRINCIPLES

- Low speeds (10 to <30 km/h)
- Distinctly marked entry treatments
- Fine-grained street design
- Controlled parking
- Short blocks.

Travel lane guidance

Travel lane width has a significant influence on traffic speeds and roadway space allocation. Narrower lanes help to reduce speeds, which in turn increases safety, and reduces the severity of crashes. On single or multi-lane streets, reducing lane width shortens crossing distances, and opens up space for cycling facilities and wider footpaths. Narrow carriageways also reduce the amount of storm water management (as there are reduced impervious surfaces), and are less expensive to build and maintain.

Lane width should be considered within the overall assemblage of the street.

In a street design context, carriageway width can often be a more instructive concept than lane width. This recognises that on slow, lower traffic streets opposing vehicles can, and routinely do, negotiate for space and passing opportunities.

It is recommended that the standard lane width for low-speed city streets with some bus traffic is 3.0 m.

For multi-lane roadways with bus lanes or high frequency of freight movements, a wider lane of 3.2 is appropriate. Wider lanes for buses and larger design vehicles should be located on the outside lane.

Inside lanes should continue to be designed at the minimum possible width. For freight routes, where multiple lanes may be occupied by trucks, lane widths of 3.5 m may be needed, where the speed of trucks and the numbers that may encounter each other require additional width for safety.

Parking lane widths between 2.1 - 2.7 m are generally recommended.

On two-way streets with lower volumes of traffic, it is recommended that centrelines are removed. This has a positive influence on traffic speeds and provides better sharing across the roadway for multiple users.

Vehicle widths, buffers, and adjacent uses

In assembling a street cross section that improves road safety and lowers traffic speeds, it is useful to consider vehicle widths and operating buffers. When determining lane width, first consider the design vehicle, the most common vehicle type, and the check vehicle, the infrequent but largest vehicle. In most cases, the design vehicle will use one lane, while the check vehicle may intermittently use multiple lanes. See also Chapter 4 on Design Controls for more on this subject.

Vehicles have both a clearly defined space (the size of the vehicle) as well as an operating space or buffer space that the vehicle needs to operate comfortably at moderate speeds. Understanding the physical spatial requirements of vehicles is critical to allocating street space in constrained spaces, which is the crux of street design. Predictable, low-speed environments enable the use of overlapping buffer zones. For instance, the following considerations may be helpful when allocating street space in constrained environments:

- Wider vehicles can be accommodated in narrower lanes on an infrequent basis
- Vehicles may on occasion use part of an adjacent lane
- Vulnerable users such as cyclists of all ages and abilities should always be given sufficient space to operate safely at a comfortable distance from fast-moving vehicles
- While buses in constrained spaces are sometimes subject to mirror strikes, wider mixed traffic lanes can increase the number and severity of total crashes.

Continuous vs flexible geometries

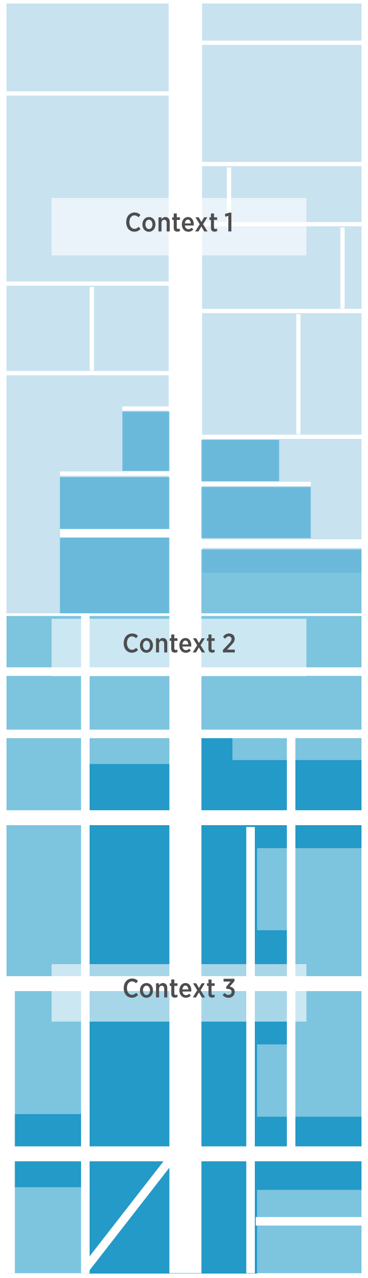
Designing streets should not be limited to one or even several sections of a street, but must include plans along the entire length. As the context, land uses, and user requirements change, the composition and spatial properties must be reflected in the design. As pedestrian volumes increase, more space is required in the footpath. If café seating/outdoor dining is expected, space needs to be allocated between the kerb and the building edge.

One way to allocate space is to denote whether the geometry is flexible or continuous. Travel lanes, cycleways and pedestrian clear paths need to be continuous and connected in order to function effectively. Flexible geometry is the space that is adaptable that can be configured with a range of elements that meet the need of the particular location.

In some cases, continuous geometry can be also be adapted to best reflect the needs of the street. For example, after peak hours, bus lanes can be reconfigured for kerbside loading, drop-off/pick-up space, and/or paid parking.

Streets can change across the city

Longer streets that pass through multiple areas of a city can change along their length, A single street may change street types as the surrounding land uses or as movement functions change. For example, a street may transition from a Neighbourhood Collector to a Main Street Collector as it passes through the commercial centre of a community. Different mode networks merge and diverge, so an arterial may split into collector and local types as it reaches its strategic destination. Because of the nature of Auckland's street network, there are many streets that have different functions at different points along the street. Dominion Road is a good example of a street that has different requirements along its length Understanding how streets change through the city in response to context is fundamental to the practice of street design.



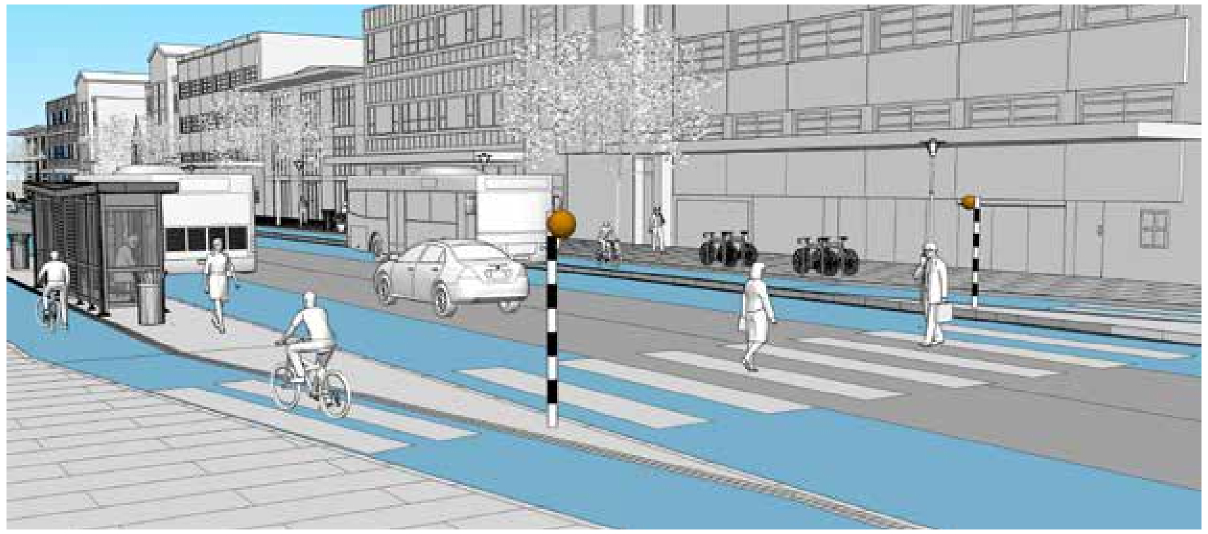
CONTEXT 1: MIXED USE ARTERIAL

CONTEXT 2: MAIN STREET ARTERIAL

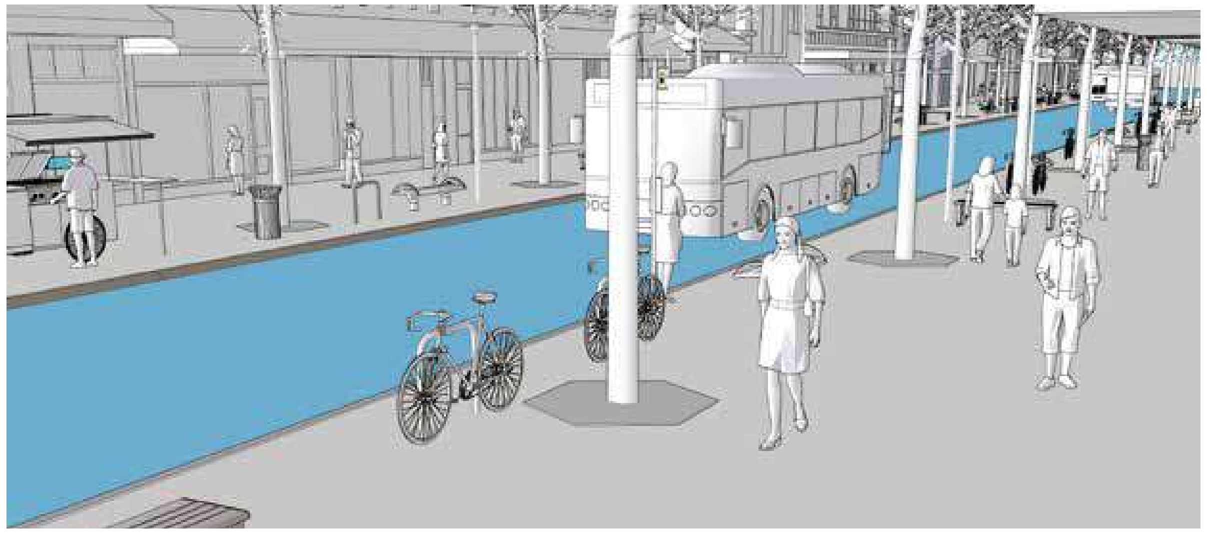
CONTEXT 3: MAIN STREET COLLECTOR

Example of how types may change along a street

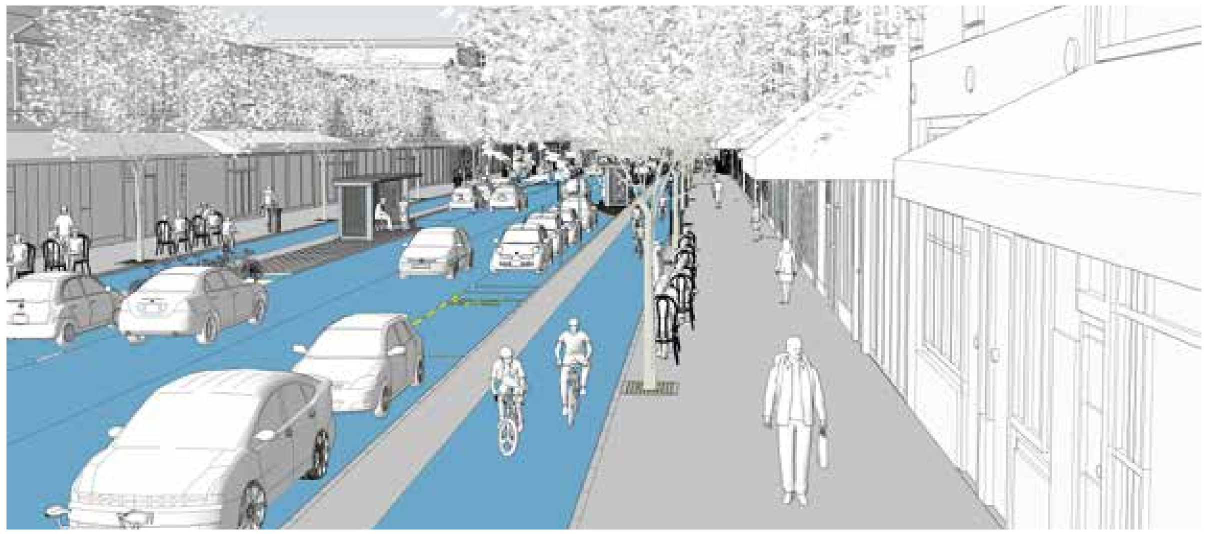
CONTEXT 1: MIXED USE ARTERIAL



CONTEXT 2: MAIN STREET ARTERIAL



CONTEXT 3: MAIN STREET COLLECTOR

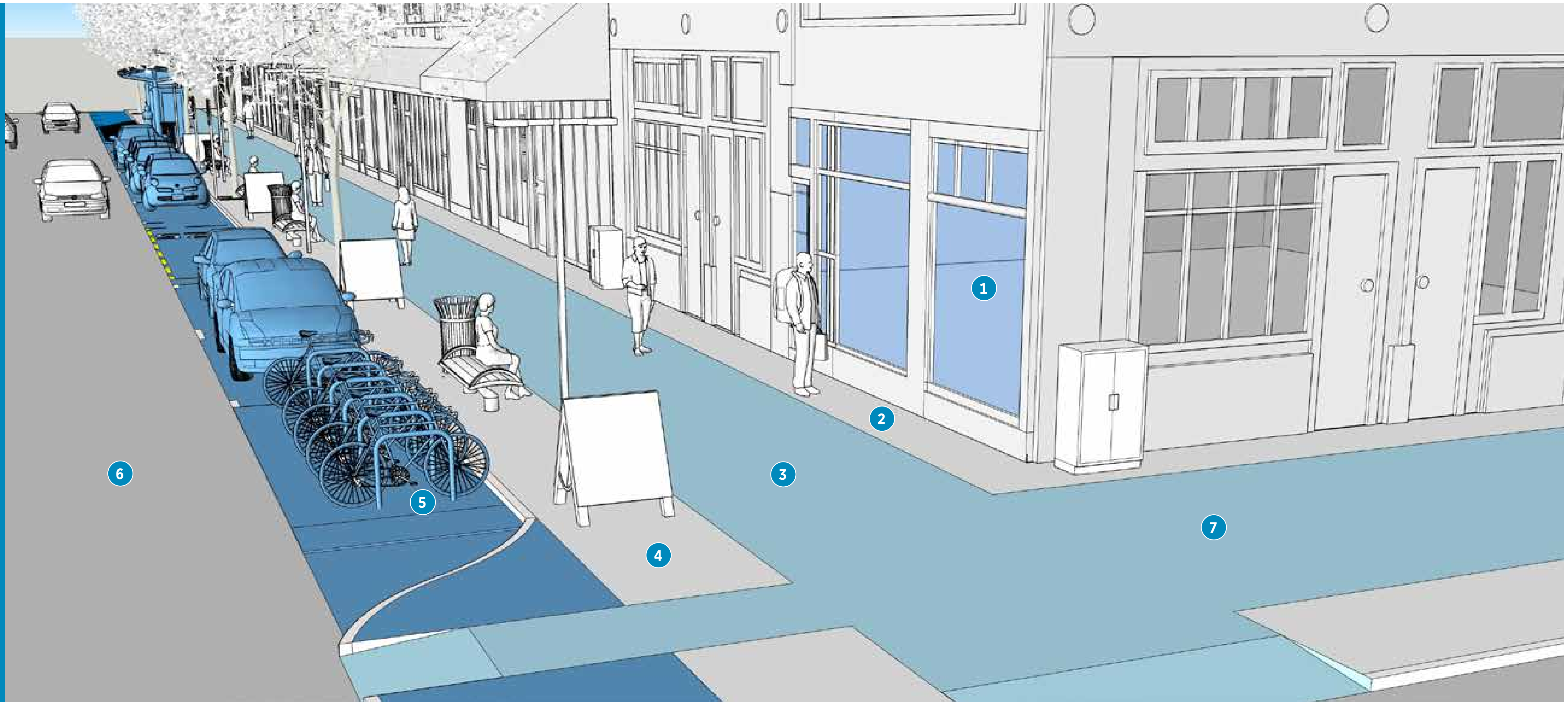


Street design zones – urban area

Different zones can be identified across the road reserve in high-density urban areas. From the building to the travelled way, they include:

- **Adjacent lands**
- **Frontage zone**
- **Pedestrian clear path**
- **Street furniture zone**
- **Ancillary zone**
- **Carriageway**

The following zones are considered when setting out a street cross section.



1 ADJACENT LANDS

The adjacent lands often contain active land uses, including places to eat and drink and ground-floor retail. The adjacent lands host the types of active land use that draws people to the street, and also serves as the point of origin for many pedestrians using the footpath.

2 FRONTAGE ZONE

The frontage zone is the space adjacent to the building edge where ground-floor uses spill out onto the footpath. It can be an extension of the active land uses found along a street. The frontage zone is where the features found along the edge of a street interact with the street use.

3 PEDESTRIAN THROUGH ROUTE

The pedestrian through route (also referred to as pedestrian through zone) provides a movement zone for pedestrians that is clear of any obstacles, facilitating through access for people walking along a street, regardless of age and abilities. Frequent safe crossings provide continuity for people on foot.

4 STREET FURNITURE ZONE

The street furniture zone is the designated area for a variety of features. It provides space for signs, light and signal poles, street trees, public transport stops, rubbish bins, and any additional underground infrastructure.

5 ANCILLARY ZONE

The ancillary zone sits between the street furniture zone and the carriageway, and offers opportunities to provide temporary pedestrian uses such as kerb build-outs, patios and parklets. Other uses include cycle and car parking, loading zones, taxi stands, pick-up/drop-off zones and public transport stops.

6 CARRIAGEWAY

The carriageway provides space for travelling through the street for vehicles, public transport and for the delivery of goods. In off-peak hours, this space may be partially used for parking and loading. On occasions, access to vehicles might be restricted to provide space for events and festivals.

Street design zones – suburban area

Different zones can be identified across the road reserve in a low-density residential setting. From the building to the travelled way, they are:

- **Adjacent lands**
- **Building setback**
- **Frontage zone**
- **Pedestrian clear path**
- **Street furniture zone**
- **Ancillary zone**
- **Carriageway.**

The following zones are considered when setting out a street cross section.

6 ANCILLARY ZONE

The ancillary zone is located between the berm and the carriageway. It offers opportunities to provide kerb build-outs to accommodate street trees, other soft landscaping, public transport stops and rubbish bin collection areas. Kerb build-outs can be used as one component of traffic calming measures to narrow the effective width of the carriageway. Between kerb build-outs, raised, paved bays can be used to accommodate bicycle and parallel car parking.

1 ADJACENT LANDS

The adjacent lands contain predominantly detached, single household dwellings. The residences serve as the point of origin for pedestrians and cyclists (who may be travelling to a public transport stop) as well as people travelling by private car. Small-scale local retail, schools and community facilities such as playgrounds serve as local destinations within easy distance on foot or on a bicycle.

2 BUILDING SETBACK

Building setbacks form the front yards of residential properties. The distance that buildings are set back and the design of front yards strongly influence the spatial character of the street and determine the interface between public and private space. Minimum building setbacks are set out in the Auckland Unitary Plan.

3 FRONTAGE ZONE

The frontage zone is the space between the property boundary and the footpath. It is used for soft landscaping such as lawns or low planting and can accommodate underground utilities. In spatially constrained existing street corridors, the frontage zone can be omitted.

4 PEDESTRIAN THROUGH ROUTE

The pedestrian through route provides a path for pedestrian movement that is clear of obstacles, facilitating through access for people walking along a street, regardless of age and abilities. It must be wide enough to allow two wheelchair users or people pushing prams to pass one another. Safe crossing locations provide continuity of the through route for all users.

5 BERM

The berm (or street furniture zone) is the designated area for soft landscaping such as lawns or low planting and water sensitive design infrastructure. It can be used to provide space for signs, light poles, street trees, public transport stops, rubbish bins and underground infrastructure. In spatially constrained existing street corridors, the berm can be omitted if soft landscaping is included in the ancillary zone.

7 CARRIAGEWAY

The carriageway provides space for travelling along the street for motor vehicles and people on bicycles. A carriageway kept to the minimum width that allows vehicles frequently using the street to pass one another and without a centreline encourages low speeds.

Street sub-type examples

A selection of street sub-types are provided to illustrate how the design principles, geometry and elements can be combined to create unique, context-appropriate designs that support mobility options and local business activity. Each street sub-type illustrated in this chapter reflects a design response that is intended for the Auckland context. Even so, these are not intended as templates, but examples to show how a design may be developed.

In some cases, the street sub-types can be used for retrofit designs, while others may be more practicable for greenfield development. The street sub-types sit inside the Roads and Streets Framework classification. In some cases, these street sub-types span multiple street types. For every street sub-type, a gridded notation reflects where the sub-type fits into the Roads and Streets Framework classification system. The classification system is also repeated in the diagram opposite.

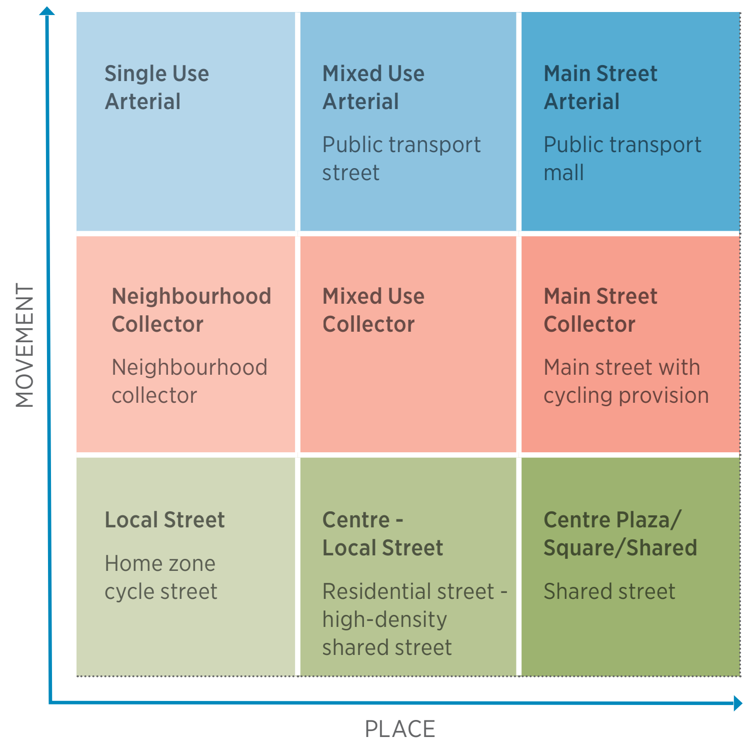
The street sub-types are various urban and transport design concepts applied to street design. They vary in their focal area (for example, designing a street primarily for buses or for cycling), and will be appropriate in different kinds of urban environments. All street sub-types present a unique composition that highlights the key design responses.

The street sub-types are based on actual streets built (and used successfully) in cities around the world. Many of the precedents for the street sub-types in this guide can be found in cities in Canada, the USA, continental Europe and New Zealand.

For each street sub-type, general guidance relevant for all street types will be discussed. This includes guidance on travel lane width and vehicle widths and buffers. Also, the many functionally distinct 'design zones' that can be distinguished on footpaths will be introduced.

It follows that certain design elements might be replaced with other elements quite flexibly in certain areas across the street cross section. For instance, a street tree zone might be replaced with a bus stop at certain locations; by the same token, on-street kerbside parking might be used instead for on-street cycle lanes or cycle parking. This concept of flexible geometry can be seen in the following pages.

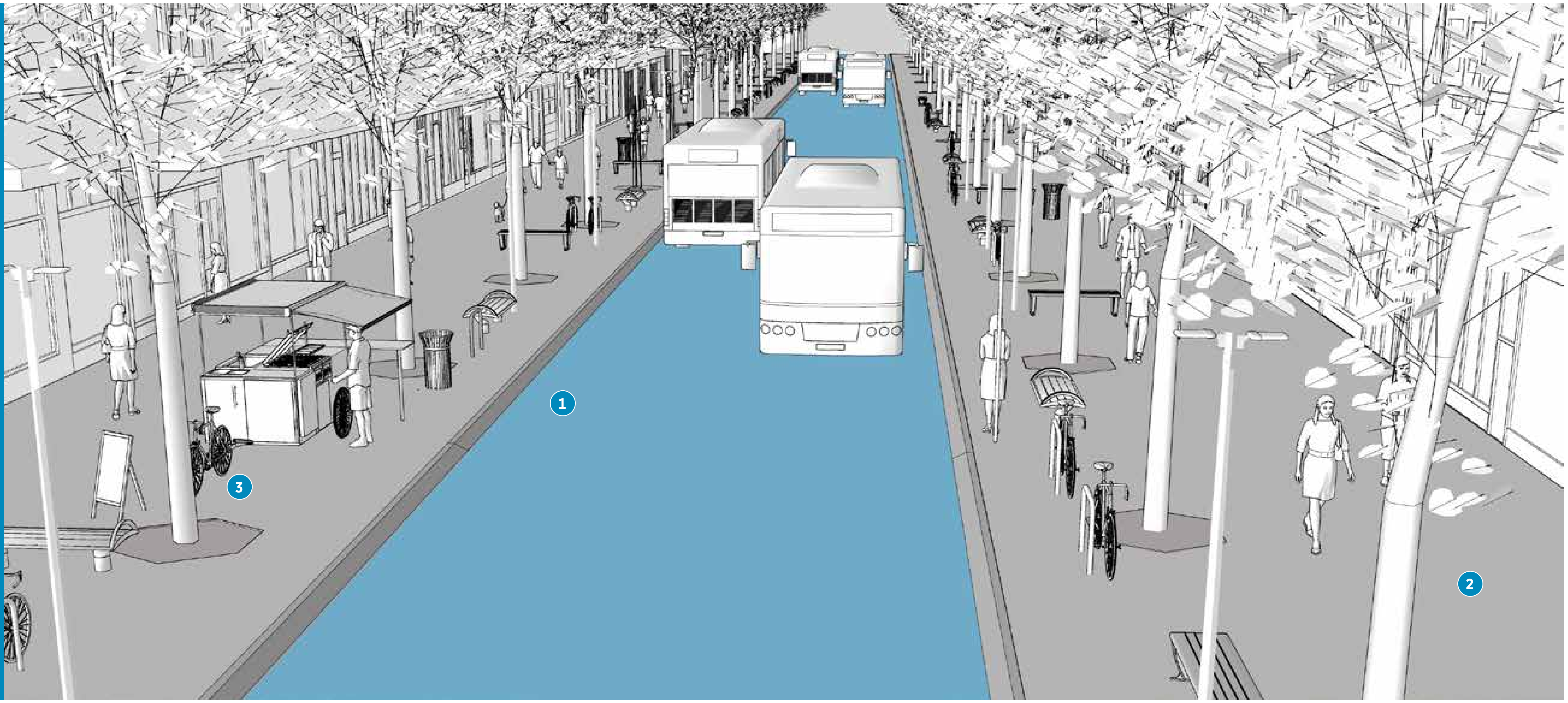
SUB-TYPE EXAMPLES



Public transport mall

Public transport malls are designed to accommodate high-frequency, high-quality public transport services through areas with very high pedestrian movements.

By creating a kerb-less or low-kerb environment, pedestrians are allowed to cross informally at many locations, while formalised signalised crossing can be provided where required. Public transport malls limit general traffic and manage service and delivery vehicles. An existing public road will require a legal process to declare it a Pedestrian Mall with buses and any other classes of vehicle exempted.



1 PUBLIC TRANSPORT ALIGNMENT & PRIORITY

Public transport vehicles move slowly through these streets at about 20-30 km/h. The high frequency of public transport services keep the central alignment clear from lingering pedestrians. Public transport priority is provided through intersections on the lead-in to the shared space. Safe crossings are important, especially near stops, and movement of buses must not compromise safety.

2 PUBLIC REALM

Street furniture is integrated into the overall street design, providing cues for how users share the space. Design elements provide guidance for the visually impaired. Planting and furniture can channel users into various paths.

Frequency of vehicles is critical to pedestrian safety when crossing. Median refuge space can prevent people being trapped between two buses. Crossing opportunities should be limited within 20 m of formal crossings.

3 TIME OF DAY FLEXIBILITY

Ensuring the street is actively used across the day and night is critical to providing social safety and a successful business environment. Time controls for use of space should be coordinated with local businesses. Shared streets are well configured for special events. Alternative public transport routes should be considered for events that require street closure.

TRAFFIC AND DELIVERY

General traffic is prohibited or limited. Allowing traffic after peak hours, in particular at night, may improve the feeling of safety for pedestrians. This traffic is limited by prohibiting or mandating certain turning movements. Enforcement of vehicle restrictions and for prevention of cross traffic backing up across intersections may be required. Delivery can be provided at off-peak times. Space allocated for delivery vehicles can be used for pedestrians during busy periods of the day.

CYCLING

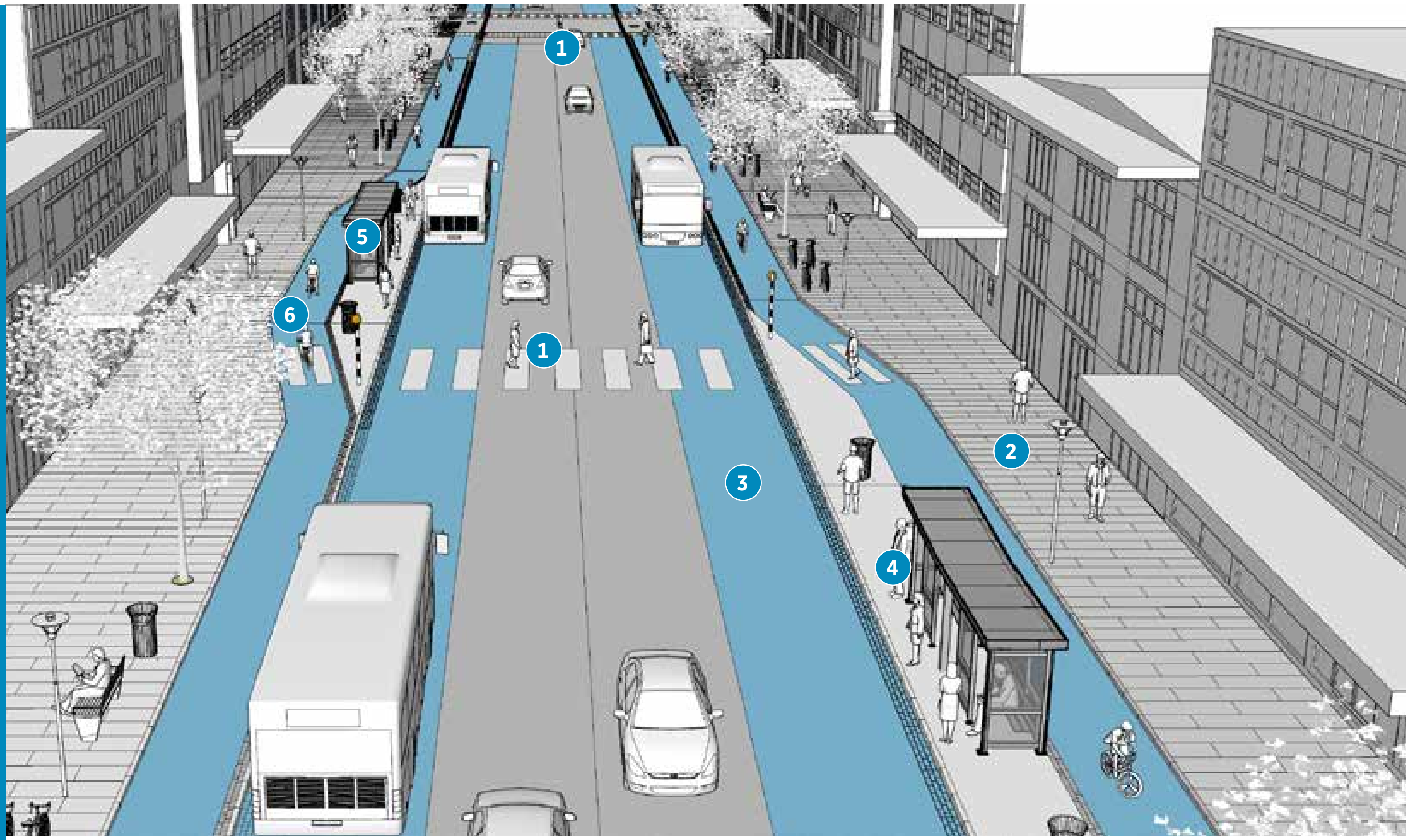
Cycle paths can be located between the transitway and the pedestrian space. Cycle paths can help to buffer pedestrians from the public transport vehicles moving through. At stations, the cycle path and footpath rise to create a level boarding platform. The cycle path should be designed to minimise conflict between pedestrians and cyclists. On streets with spatial constraints and/or comparatively low volumes of buses, it might be possible to ride comfortably in the street, provided that private vehicles are banned from using the street. Providing cycle parking is also recommended, as these streets are a major destination and attract people who cycle in addition to people using public transport.

Public transport street

Typically located in urban and town centres, public transport streets have high volumes of both pedestrians and public transport vehicles due to a concentration of destinations and the convergence of public transport routes.

Public transport streets have dedicated lanes for public transport services. This separation from general traffic is necessary in order to remove delays from general vehicle congestion and provide reliable service. Public transport streets integrate dedicated on-street facilities with stops, stations, pedestrian and cycle infrastructure and general traffic.

Public transport streets can be great public spaces. Reliable public transport provision is critical to intensively used centres, and can foster a substantial improvement of economic and social life. Furthermore, by prioritising public transport throughput on these streets, a higher overall capacity is supported city-wide.



1 PEDESTRIAN/PASSENGER ACCESS

VZ Public transport streets need to be designed so that people of all ages and abilities can safely reach stops and board comfortably. Because of the intensity of pedestrians, the design speed of public transport streets should not exceed 40 km/h. However, in main street environments, speeds should slow to 30 km/h. Designing for universal access will benefit all passengers, regardless of physical or sensory ability. Considering social safety and traffic safety is critical for passengers, and influences the decision to use the service. Safe, direct, and low-delay pedestrian crossings are a critical component of every stop design.

2 DESIGN FOR CONTEXT

While public transport streets are designed to provide excellent public transport service, they are likely located along streets/corridors that have a high place function. Street trees, street furniture, and cycle paths can provide a buffer between moving buses and footpath space, opening up opportunities for business activity and public spaces. Street crossing opportunities should be formalised and be closely spaced, less than 100 m apart. Signal timing should minimise pedestrian crossing delay.

3 DEDICATED LANES

VZ Dedicated public transport lanes are fundamental to the design of public transport streets. The dedicated lanes most commonly use the outermost lanes
. It is recommended that the dedicated lane be separated/ buffered from the pedestrian clear paths on the footpath by street furniture, street trees, a dedicated, protected cycle lane, or other elements. This creates a more comfortable walking environment and enables more streetside activity. Dedicated loading bays, bus lane cameras, signal timing strategies, turning movement bans, and raised kerbs can help to ensure that dedicated lanes remain uncongested.

4 BUS STOP PLACEMENT AND SIZE

Using in-line stops in conjunction with bus lanes has a range of spatial and accessibility benefits. In-line boarding stops require significantly less kerb space and do not require footpath space, freeing up room for alternative uses. The stop size and configuration depends on the overall frequency of the routes, the composition of routes and the destinations near the stop. The overall stop footprint should be as small as possible, while providing an adequate level of service. Keeping the stop size small frees up space for other street users, including passengers walking to access the stop.

INTERSECTION CONTROL

A signal phasing strategy that favours public transport vehicles is key to maintain competitive operating speeds of public transport vehicles. On moderately frequent routes, signal priority can be enhanced by fitting public transport vehicles with transponders that allow approaching buses to change the signal in their favour, ensuring that there is minimal waiting time at intersections.

5 BUS STOP DESIGN

Bus stops should be an integrated component of the streetscape and include shelter, places to sit, rubbish bins, cycle parking and shade trees. Social safety and security can be improved through proximity to all-hours activities, human-scale lighting, transparent and non-enclosed shelters. See Chapter 3 for further guidance.

LEFT-TURN TREATMENT

Where left-turn volumes are high, a dedicated left-turn lane might be provided. As the dedicated public transport lane will need to be crossed, it needs to be clearly communicated to motorists that public transport vehicles have priority in the mixing zone. Where lower volumes of leftturns are prevalent, it can either be permissible to temporarily drop the lane in the approach to the intersection to allow for a combined left-turn and public transport lane.

PARKING AND FREIGHT DELIVERY

Short-term parking and freight delivery should be allocated at dedicated kerbside space or bays and in conjunction with time-of-day restrictions, or removed entirely to adjacent streets.

6 CYCLING PROVISION

VZ Due to their location in the network, proximity to centres and concentration of destinations, providing cycle facilities on public transport streets is necessary. Because of the size, mass, and frequency of buses, cycle facilities must be separated from traffic using a full raised kerb or a series of separator islands. Signal timing should remove conflicts between cyclists travelling straight ahead and left-turning vehicles. The path of cyclists should be provided behind bus boarding islands, removing conflicts with buses. The boarding platform can extend to the intersection to create a pedestrian refuge island that shortens pedestrian crossings and tightens the kerb radii. Materials, level changes, barriers and zebra crossings can reduce conflicts between people on foot and on bikes.

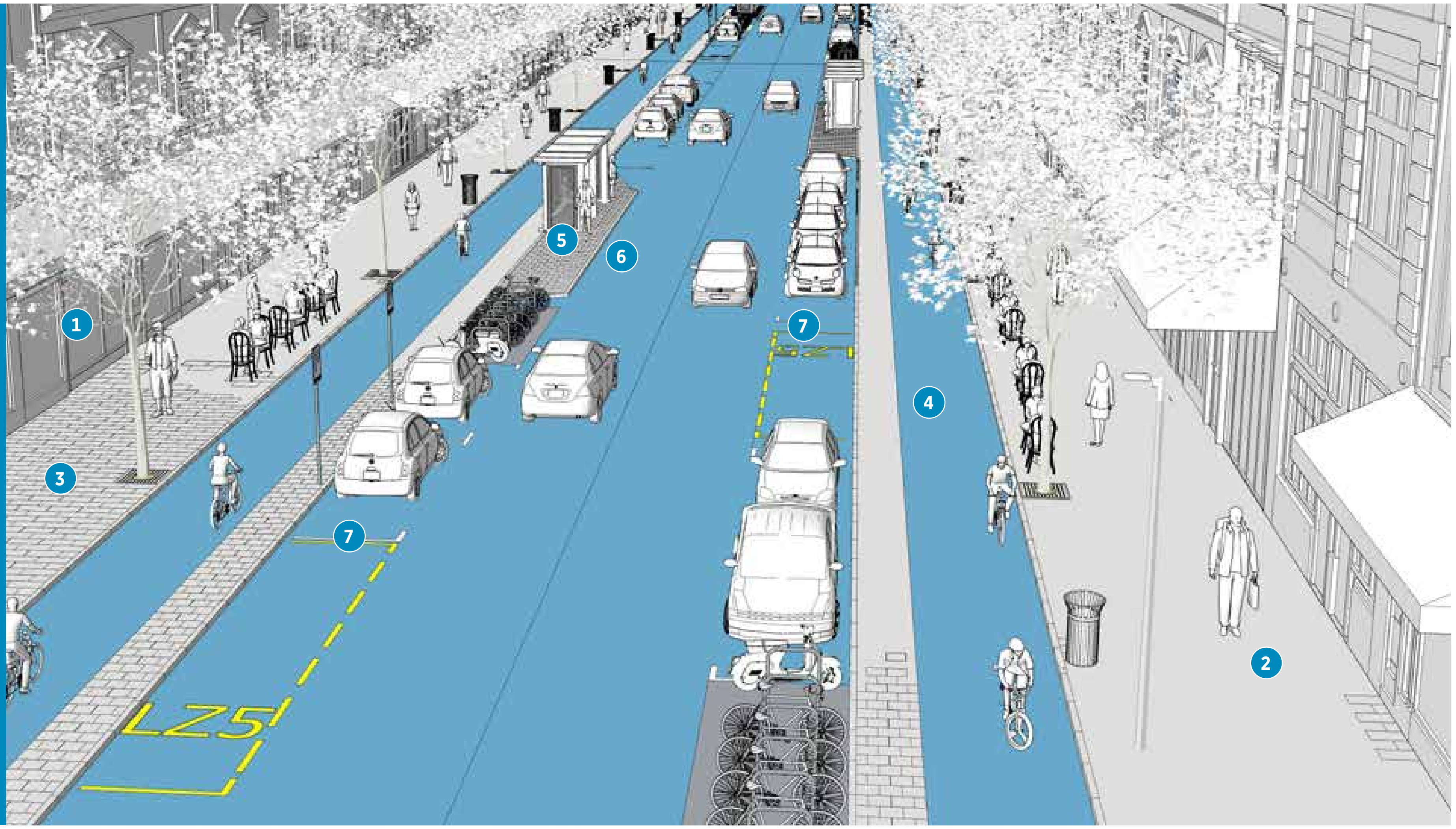
Main street with cycling provision

Main streets are vibrant public places and major centres of activity in Auckland's town centres. They are destinations, well-known locations and places to meet and enjoy public life. Main streets are also important movement corridors that tend to be found along long, continuous corridors connecting regional destinations.

Because main streets are located on logical routes and have a concentration of destinations, cycle facilities should be considered.

Main streets may be no wider than one lane in each direction, which presents challenges for cycleway provision. This street type will also see moderate, slow-moving vehicle traffic (30 km/h), and have a high expectation of kerbside parking.

This street type and its associated function as an urban living space and retail destination creates demand for all transport modes. In turn, its function as a destination is also supported by its walking, cycling, public transport and vehicular access.



1 SCALE AND SETBACKS

Street designs should minimise overall road reserve width by using narrow lanes, narrow geometry and applying strategies to share space between various users and multiple purposes. Buildings should have zero setback from the road reserve. Successful main streets have shops that are both side to side and close together (across the street) with closely-spaced pedestrian crossing opportunities (both formal and informal). This both increases the number of destinations available to visitors and increases the local catchment areas.

2 PEDESTRIANS

Main streets should facilitate easy and safe pedestrian movement. Traffic speed should be minimised (30 km/h at most) to increase the safety and minimise the negative impacts on kerbside activity. Controlled crossing should be closely spaced – no greater than 100 m apart in centres. Signal cycles should be short. Because of the concentration of people, a pedestrian clear path of a minimum of 2 m should be provided.

3 PUBLIC REALM DESIGN

In addition to pedestrian clear paths, there is a high requirement of kerbside space for exchange and public use. Space should be provided for gathering, dining, sitting, and browsing of shops. Awnings should be provided for shade and shelter. Trees and green infrastructure can increase user comfort and improve water quality. Green infrastructure should be based on pedestrian volume and the intensity of use of the footpath. The cycle path, street furniture and street trees can help to buffer pedestrians from moving traffic.

4 CYCLEWAY PROVISION

Where traffic volumes exceed 5,000 vehicles a day, or prevailing speed is higher than 30 km/h, cycleway designs should be separated from traffic.

5 BUS STOP LOCATION, SIZE AND DESIGN

Bus stops should be strategically located close to the centre of action. Bus stops should be as compact as possible to minimise displacing other uses and activities. Bus stops should be integrated into the wider streetscape

6 PUBLIC TRANSPORT

While most main streets will have important or even frequent public transport services, their spatial allocation through the most constrained sections may be secondary. Along relatively uncongested main streets, buses will mix with general traffic. General traffic will wait behind a bus picking up or setting down people at a stop. In main streets with regular congestion during peak hours, strategies can be used to improve the reliability of buses. For example, short, lead-in bus lanes and signal advance lights can be used to give buses a head start before reaching the most constrained sections.

7 KERBSIDE MANAGEMENT AND METERED PARKING

The space adjacent to the footpath will have a great variety of uses, which should prioritise pedestrians and cyclists. After kerb build-outs, bicycle parking and street trees have been accounted for, the kerbside space that remains could be used for metered parking and loading zones. Installing priced parking ensures a consistent, small amount of parking is available. This is beneficial, as it helps to reduce the number of vehicles driving around the block in search of a place to park.

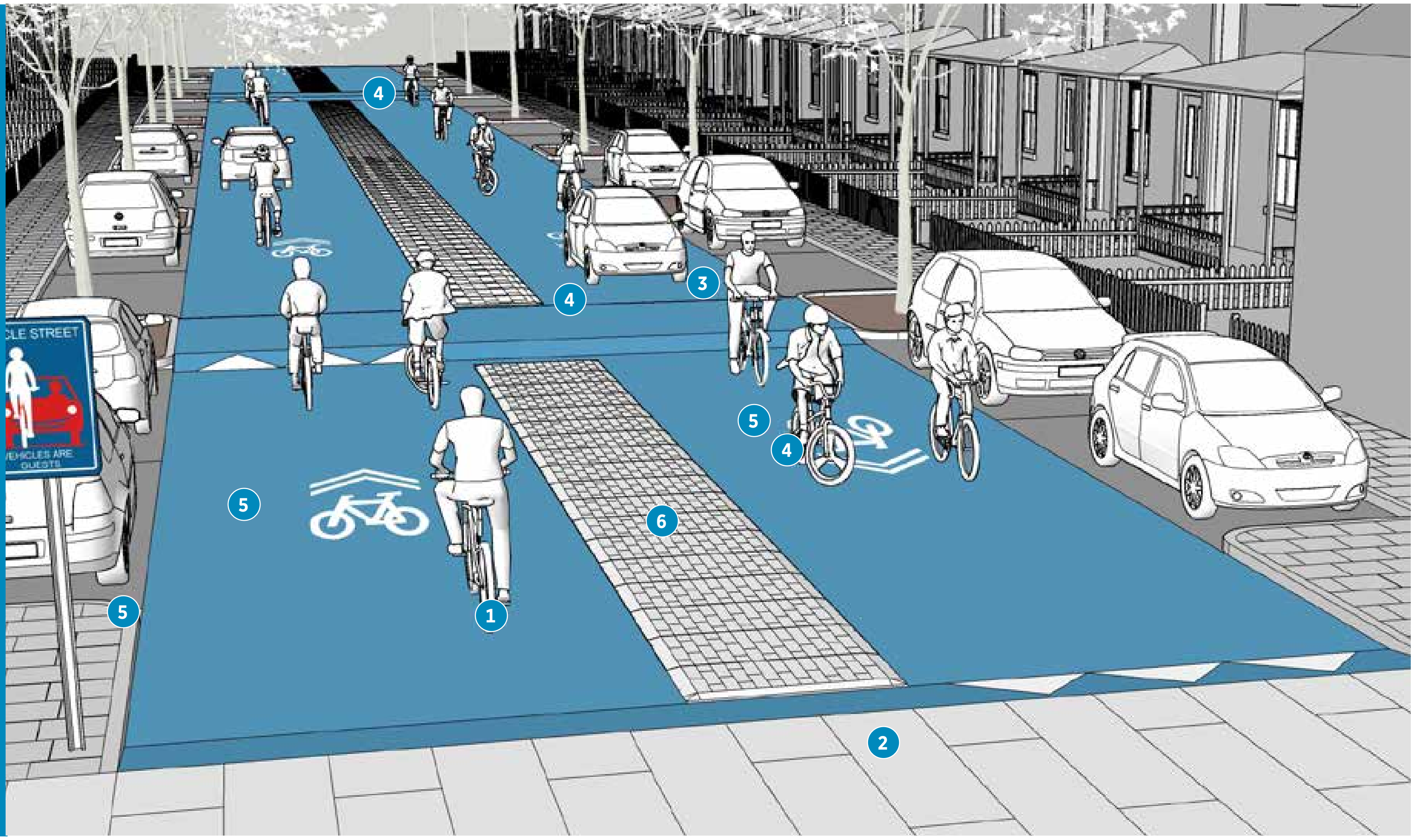
While it is necessary to provide loading access to businesses, the number of loading zones can be limited to one or a few each block, in addition to limiting loading access to off-hours. Loading zones can double as pickup/dropoff zones for people using taxis.

Cycle street

Cycle streets are streets with low traffic volumes and slow speeds that are integral to a local cycling network. They tend to be quiet streets in residential areas, but can also be mixed-use streets in city centres.

Because the number of cyclists using the street exceeds the number of vehicles, the design of the street reflects the street's primary function as a Cycle street. The width of the lanes varies, with wider lanes in newer areas and more narrow lanes in older neighbourhoods, but typically are at least 2 m in each direction. Vehicles are still permitted on the street, though the design encourages cars to act as careful guests in a cycling prioritised environment. The prevailing speed limit is (up to) 30 km/h.

Cycle streets provide a fast and comfortable cycling facility on already well-used cycling routes. They connect various neighbourhoods and city districts to one another, as well as providing easy and fast access to major destinations such as universities. Cycle streets are not recommended for streets used by over 2,500 vehicles per day. Additionally, vehicles are encouraged not to to overtake cyclists on Cycle streets.



1 COLOURED ASPHALT CYCLE PATHS

The carriageway consists of coloured asphalt, a smooth surface for cycling, sometimes combined with a narrow dividing strip of paving in the middle of the carriageway. (Footpaths and parking bays are paved.) Coloured asphalt gives cycle streets the look and feel of a cyclepath, which intuitively slows vehicles down. Trials with cycle streets in Europe have shown that while vehicle speeds go down on cycle streets, cycling speeds tend to go up, as cyclists are able to take advantage of the smooth riding surface.

2 DEFINED ENTRYWAYS

Entries to Cycle streets resemble the entries to Home Zones. There is a raised table at every entry point. This not only allows pedestrians walking on the footpath along the cycle street to cross side streets at-grade, it also provides vertical deflection, which slows vehicles and adds a clear threshold that indicates a changing street context. Entry to all or part of the street may be restricted for vehicles to reduce their numbers mixing with people on bikes.

3 30 KM/H SPEED LIMIT

On Cycle streets, cyclists are invited to ride in the centre of the lane and vehicles are expected to adapt to cyclists, especially when it comes to their speeds. In practice, cyclists dictate the pace at which vehicles travel on cycle streets, as vehicles are guests on this street type and are expected to behave as such.

4 REPEATED SPEED HUMPS

One of the techniques to ensure that vehicle speeds do not exceed 30 km/h is to place speed humps approximately every 80 m. Together with raised tables at side streets and the psychological effect of the coloured asphalt, speed bumps ensure that vehicle speeds remain low.

5 SIGNAGE

In addition to all the visual cues embedded in the cycle street, signage at the entry points onto it must make it clear that the street ahead is a cycle street, and that vehicles are allowed to enter, but only as guests in an otherwise cycle-centric environment. Sharrows should be used to show the place in the street given to people on bikes. Signs showing cycle priority could be an innovation to be developed with NZTA.

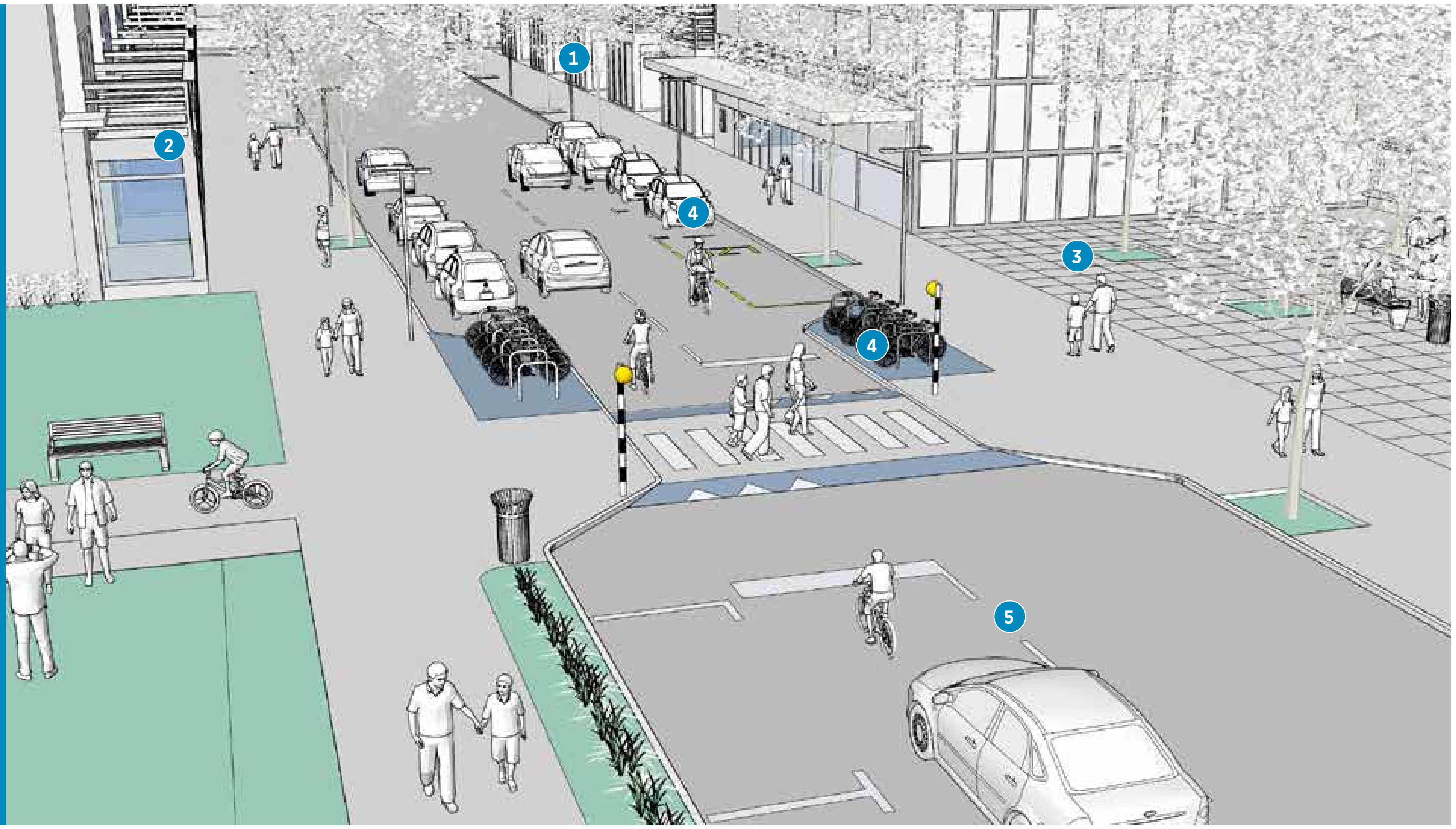
6 PAVED MEDIAN

Three types of cycle streets are currently built in the Netherlands and in Belgium. There are cycle streets without any median, with a coloured asphalt surface from kerb to kerb. Then there are others with a narrow or a wide paved median. These work slightly differently. A narrow median provides a small buffer between cyclists (and, occasionally, vehicles) going in opposing directions. They also spatially define the cycle lanes. On cycle streets with a wide paved median, the median is about as wide as either of the cycle lanes flanking it. Vehicles use the paved median, which at 2 m is just wide enough to hold a passenger vehicle. Only one vehicle at a time fits in the paved median. When vehicles approach one another from opposite directions, they must wait until they can safely pass one another. By partially moving into the cycle lanes when passing, vehicles make use of the cycle lanes when they need to. As such, the cycle lanes function just like advisory cycle lanes at times. Vehicles are accommodated in this design, though not prioritised; the emphasis remains very much with cyclists.

Residential street – high density

Higher density residential streets are neighbourhood streets that serve as urban living rooms. They have a higher requirement for public realm amenity, kerbside management and pedestrian accommodation.

Public realm amenity can come in the form of added street seating, public art, street trees, plantings, as well as public plazas (ideally in combination with civic buildings such as libraries) and parks. Because vehicle ownership tends to be lower in denser urban areas, the need for on-street parking becomes less pressing. Kerbside space might be used for bike bays (marked cycle parking areas in re-purposed parking spaces), vehicle hire or car share stations, as well as limited on-street parking. Pedestrian accommodation should cater to the increased volumes of pedestrians that are expected in denser areas, which means that footpaths are wide enough to accommodate small groups coming from opposing directions and passing one another.



1 SHORT BLOCK LENGTHS

VZ

Blocks should be short (60-70 m) with kerb extensions and mid-block crossings where appropriate. Short blocks enhance connectivity. Trip lengths are shorter in urban areas with a high degree of connectivity, making cycling and walking more attractive modes of transport.

Short blocks also help to keep vehicle speeds low. With low vehicle speeds, people on bikes can share the street comfortably. Generally, sharing the road is acceptable where vehicle speeds do not exceed 30 km/h. Not all blocks need to provide vehicle intersections. Accessibility for people on foot or bike enhances economic activity. Vehicle intersections can restrict accessibility, delay people and impair safety.

2 ENHANCE THE PRIVATE-PUBLIC SPACE INTERACTION

Steps, stoops and small garden spaces provide a transition from the public realm to the private realm. Private living rooms, small decks, and garden spaces should be located facing the street, regularly, providing passive surveillance.

3 QUALITY PUBLIC REALM

Public spaces are not just dedicated plazas and parks, but also include footpaths and other valuable spaces between buildings. The planning and design of public spaces must be coordinated in order to provide a comfortable, integrated and safe living environment. Wide footpaths connect larger public spaces and parks, and can be attractive places themselves. Providing a planted berm with continuous and closely-spaced street trees is key here. Street tree shape and size helps to define and enclose the street. The planted berm should be turf, or robust low-level plantings. A second planted berm is recommended in the frontage zone between the footpath and private property boundary. Rows of street trees can provide pedestrian and streetside amenity, help absorb stormwater runoff, provide cleaner air, and provide shade. Seating and play equipment can also be incorporated in the streetscape. Interruptions to the footpath should be minimised. Driveways are ideally narrow with a steep ramp to encourage slow movement. The footpath level direction should not be interrupted by the driveway.

4 PARKING

On-street parking is restricted, as kerbside space is divided between cycle parking, car sharing/vehicle hire locations, kerb build-outs and pedestrian crossings, and vehicle parking. Where possible, parking is provided underground, off back lanes or on side streets. Parking underground or behind a building is preferably consolidated at central access points, where transport choices should be provided for people to continue their journey by cycle, public transport, or on foot.

Where kerbside parking exists, it is managed through pricing or residential parking schemes. Short-term parking should be allocated kerbside at strategic locations for deliveries and loading. This space can double as drop-off and pick-up space.

5 REDUCE CARRIAGEWAY MARKINGS

VZ

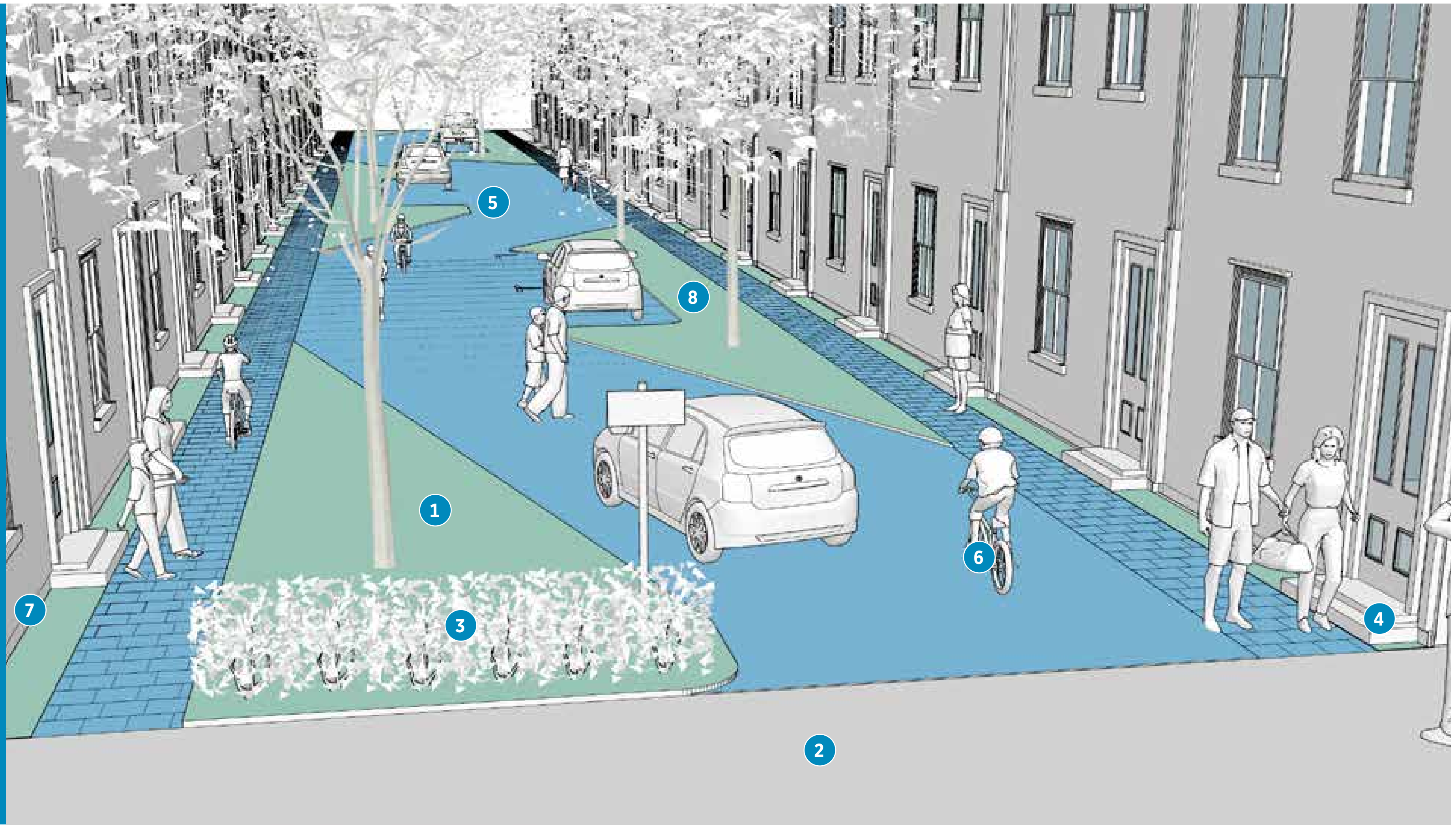
Markings on the carriageway are best minimised. Centre lines are not necessary, as these invite vehicle drivers to speed by providing a seemingly risk-free, controlled environment. In general, where markings are removed, vehicle drivers become more attentive and rely more on their observations to inform travel speeds.

Travel speeds are, in turn, kept low (20-30 km/h) by a narrowed roadway geometry and give-way or roundabout intersections. The provision of street trees and various kerbside uses, including cycle bays, car share stations and on-street parking also visually narrow the street.

Home zone

A Home Zone is a quiet, local street in a residential area that is characterised by paving that looks unlike conventional asphalt, street trees and planters, street seating, play areas separated from the carriageway, and an absence of signs and road markings.

Vehicles travel at walking speed, and are treated as guests in an environment that invites people to walk and cycle to and from their homes. Children and neighbours use the street as an extension of their living rooms. Home Zones combine high-quality public space with the needs of an efficient, integrated transport system. To be successful as liveable streets, it is imperative that traffic is slowed down to a maximum of 15 km/h, using horizontal and vertical deflection, and physical barriers, including landscaping and street furniture. The focus of the design is to create an attractive place for daily life, with attention to how the space will be used for all activities. A Home Zone must be made a "Shared zone" by traffic resolution.



1 SPEED REDUCTION

Speed reduction is a critical condition to the introduction of home zones. Limits of 10 km/h are appropriate for home zones, though in practice, drivers will slow in the presence of people. Speed reductions can be achieved with ramps at the entry of the home zones. Horizontal deflection, by planters or chicanes, is also a key way of ensuring that vehicle speeds are kept low and drivers' forward view is shortened to no more than 30 m. Shorter streets are better to keep speeds low. A maximum length of 100 m is suggested.

2 DISTINCTLY MARKED ENTRANCES

Entries into Home Zones need to be clearly defined. In addition to a speed table or speed ramp, a sign is conventionally placed at the entrance to a home zone. Signage is only located at the entrance of a home zone; after the first sign, road users must take their cues from the design of the environment to determine appropriate travel speeds. Signs at the entrance depict the various users of the home zone: people and a car next to a house. A 10 km/h speed limit sign may be added if authorised and restrictions on parking be signed in exceptional cases.

3 FINE-GRAINED STREET DESIGN

Home Zones are places that are removed from the overly regulated world of traffic. In the use and combination of planting, street furniture, and surfaces, the street designer has freedom to use creativity. Lighting should cater to the pedestrian, rather than the car. Lamp posts can be positioned to define spaces and gateways. Different surfaces and textures allow for variation, interest and individuality within Home Zones. Steps, building edge variation, and planting can provide a transition between the public and private realms.

4 HUMAN INTERACTION

Home Zones are successful only when they manage to extend the social realm into the traffic zone. When signs and road markings are removed, these spaces become safer, as the use of eye contact is encouraged. Encouraging eye contact is the guiding principle for taming traffic and successfully integrating the use of the private vehicle into an environment designed for people.

5 EMERGENCY VEHICLES

Ensure that a clear path of 3.5m is maintained at all times in the carriageway to allow for emergency vehicles.

6 CYCLING

Promoting walking and cycling especially are critical in the creation of a successful home zone. The presence of cyclists helps to determine appropriate travel speeds.

7 URBAN CONTEXT

Houses directly abut the street, and preferably consist of terrace (row) housing or town houses. Conventionally used setbacks as well as standalone buildings are less appropriate for home zones, because they strongly detract from the sense of spatial enclosure that home zones require in order to achieve low vehicle speeds. Small front yards should not be fenced. Side yards may be fenced for child safety. Furthermore, houses must be oriented towards the streets, with continuous doors and windows overlooking the street. Buildings oriented to the side or to the rear side of the lot are unfit for home zones. Neighbourhoods with a certain degree of density are best suited to host home zones.

8 PARKING

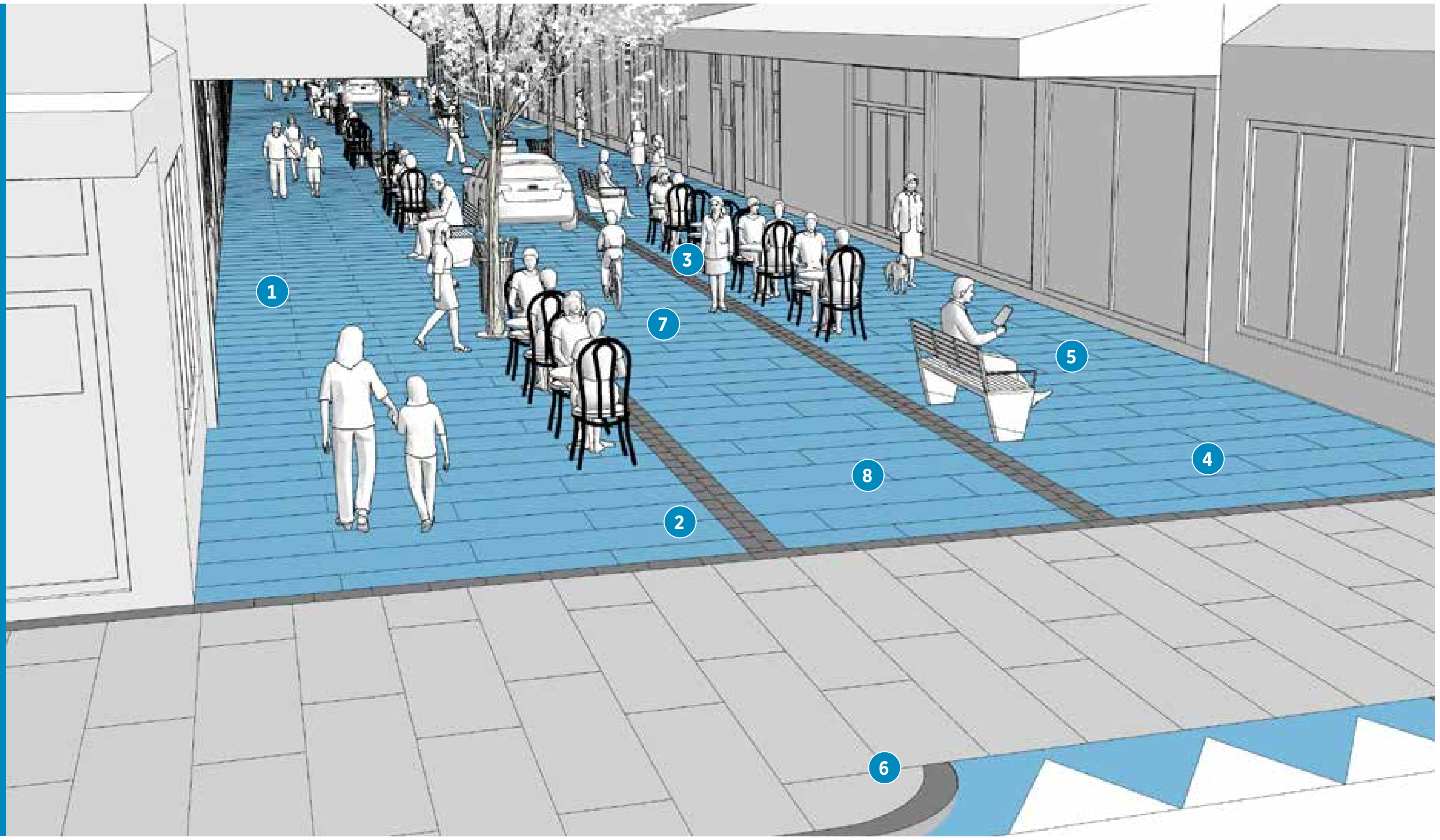
Controlled parking spaces are integral to a Home Zone's success. It is essential that parking provision is clearly defined in the design of streets, as opposed to drivers simply being able to park wherever kerbs exist. The addition of a discreet and simple parking plaque, or the letter P marked inside parking spaces using a different colour of paving, both provide a solution. It is recommended that the parking provision is alternately situated on opposite sides of the street, as this supports horizontal deflection for motorised traffic.

Shared street

Shared streets enable an efficient and equitable use of the street space by reducing the dominance of motor vehicles, primarily through lower speeds and encouraging drivers to behave more accommodatingly towards pedestrians.

Conventionally, traffic has been separated from civic spaces and strictly regulated using signage, vertical and horizontal separators, and traffic signals. Shared streets depart from established practice by paring back regulation, signage and visual clutter in low-speed environments. People on shared streets instead rely on eye contact and other cues to safely negotiate for space and safe passage for all, as speeds are slow enough to allow pedestrians to mix with traffic.

Shared streets are usually found where pedestrians are prioritised and where vehicles are treated as guests in an urban environment where sustainable transport has a high mode share. In the absence of spearated space and predictability, people in vehicles are forced to rely on informal social protocols and cultural signals. As a result, speeds drop and people in vehicles become a part of their social context. Shared streets must be made "shared zones" by traffic resolution.



1 LAND USE AND LEVELS OF PEDESTRIAN TRAFFIC

For successful shared streets there needs to be an appropriate level of activities on the street edge. Street activity is generated by people visiting shops, cafés, public spaces and other destinations. While shared streets attract pedestrians, they should also be located where there are naturally high pedestrian flows. One rule of thumb is that successful shared streets should have a pedestrian to car ratio of 4:1.

2 AT-GRADE STREETS

A primary identifier of shared streets is the feature that they always are at-grade, from building to building. The absence of a kerb and a footpath sends a signal to people in vehicles that the entire street is used by pedestrians, which it typically is. Having the entire street at-grade makes for a smoother and more dignified walking experience. Simultaneously, it sends a signal to drivers that pedestrians and other road users are at an equal footing, warning people in vehicles to be careful.

3 STREET FURNITURE

Items such as benches, trees, rubbish bins, urban canopies, cycle parking, bollards and water fountains all support a walking-friendly environment and are essential ingredients for a shared street. Any of these elements can also be strategically placed to define edges. Trees and other forms of urban canopy are important in providing shade. Street lighting should be human scaled, and where possible, overhead lighting is recommended, hanging from cables spanned between buildings.

4 ALTERNATIVE PEDESTRIAN PATH

Even though shared streets are pedestrian-centric streets by definition, having an alternative, clear pedestrian path is recommended. Given the vehicular access that is provided, shared spaces can experience brief periods of congestion. The pedestrian clear path, separated by the street furniture zone, ensures that pedestrian access is maintained to the ground floor uses that face the street. A width of at least 1.5 m is recommended.

5 TEMPORAL DELIVERY REGIME

While shared streets generally are deregulated spaces, it can be useful to regulate access for delivery vehicles. Usually, a brief, three or four-hour window in the morning hours is opened up for delivery vehicles to access shared streets. The supply needs of retailers and restaurants can be balanced with the needs of other street users. In addition to regulating delivery access, consider restricting access to private vehicles altogether, while maintaining access for taxis and commercial vehicles.

6 DEFINED ENTRYWAY

There is a ramp at every entry to a shared street. This provides vertical deflection which slows vehicles and adds a clear threshold that indicates a changing street context. Other features to define the transition include small corner radii and visual narrowing.

7 CYCLE ACCESS

Because vehicle volumes are low and speeds are slow (10 km/h), shared streets can be attractive and safe routes for cycling. If Shared Streets are uni-directional, allowing (or expecting) cyclists to travel in both directions should be considered.

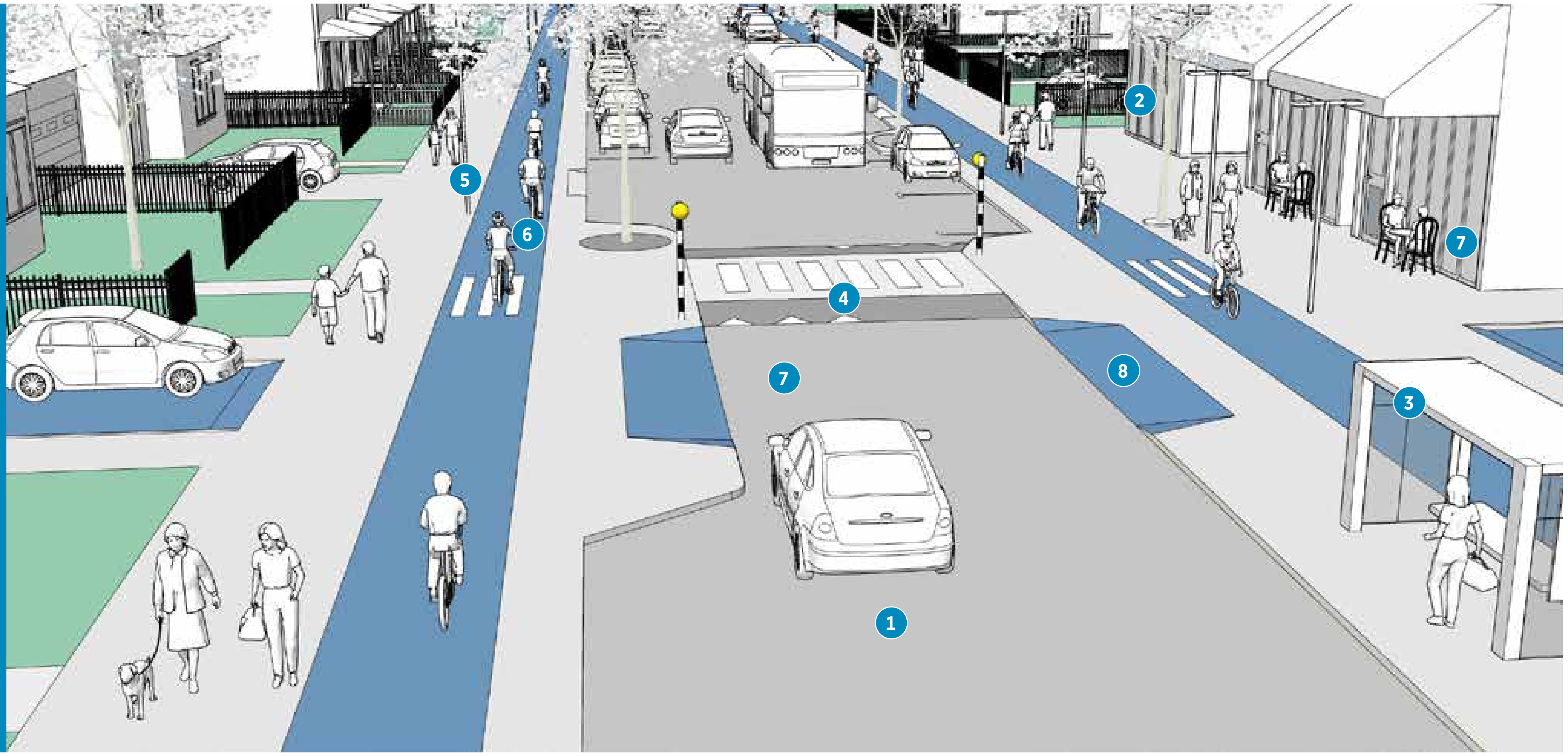
8 PAVING

Shared streets extend quality footpath materials to the entire street to intuitively reinforce the primacy of pedestrians in these spaces. The street surface on shared streets is more detailed than conventional street materials, reflecting that the human scale of the street. Multiple options can be used for pavement, as long as the choice communicates a distinctive environment for all users of the street. The carriageway is either defined by using a different type of paving or by a continuous line of paving that stands out from surrounding paving. It is recommended that the central carriageway is kept very narrow to keep vehicle speeds low. Material selection can also create an uneven surface that helps slow drivers down. Demarcation strips are required for separating the pedestrian accessible path and carriageway.

Neighbourhood collector

Neighbourhood collectors are long, contiguous streets that have higher levels of vehicle traffic. These streets connect quiet, local residential streets with streets that connect neighbourhoods to one another, such as Richmond Road in Grey Lynn.

Where connector roads intersect, various shops might be clustered together, forming a small neighbourhood retail centre. Outside of these neighbourhood centres, neighbourhood collectors are lined with apartments buildings, townhouses and single-family homes. Neighbourhood collectors typically run through the heart of residential neighbourhoods. Because of their function as a local centre, higher densities are acceptable and preferred along residential connectors.



1 APPROPRIATE SPEED LIMITS

VZ Neighbourhood collectors are places where people live, work and sometimes shop. Their name also conveys their function as a critical link in the road network, connecting local residential streets with the wider road and street network. This movement function should be balanced with the place function. Speeds above 40 km/h are not acceptable for residential collectors, as this conflicts with the desired and safe speeds that are appropriate for residential areas.

2 MIXED USE

Though neighbourhood collector roads traverse residential neighbourhoods, they are suitable to host a broader range of land uses rather than just residential. Their easy accessibility from adjacent local residential streets makes collector roads logical places for small-scale neighbourhood retail and institutional uses such as schools, libraries and houses of worship. Mixed uses ensure that collectors will be used by people throughout the day, providing social safety.

3 PUBLIC TRANSPORT PROVISION

As integral components of Auckland's street and road network, neighbourhood collector roads will typically service one or several bus routes. These bus services connect residential areas and local neighbourhood centres with the wider city, and connect local residents with jobs and destinations. It is advised that bus services are concentrated on neighbourhood collector roads, as bus traffic is less suitable for the local residential streets that intersect with connectors.

4 CROSSING POINTS

VZ As neighbourhood collectors evolve, there is a requirement to introduce better pedestrian crossing points. This enables safe access to public transport, supports a diversity of land use activities (as people can safely access both sides of the street) and can help to reinforce a context of slower, safer streets. Crossings should be located in places that serve extensive catchments in both directions and ideally be placed at existing or retrofitted cross roads.

5 STREET TREES

Street trees should be promoted along neighbourhood collectors. They help keep vehicle speeds down to appropriate levels by visually narrowing the street. Additionally, they contribute to the inviting character of the emerging neighbourhood centres along neighbourhood collector roads.

6 DRIVEWAY DESIGN

Where driveways intersect with collector roads, pedestrian safety and low speeds must be prioritised. Kerb radii should ideally be kept tight. Footpaths should continue at-grade, with driveways onto off-road parking lots being designed as speed bumps.

7 LIMIT SETBACKS

The de facto speeds on neighbourhood collectors are lower when these streets are visually narrowed. This can be achieved by maintaining street edges buildings close to the footpath. Creating a strong street edge and allowing ground floor uses to interact with the street contributes to the character of neighbourhood collectors as the heart of residential neighbourhoods. The type of residential buildings found along this street differ from local streets, as there are fewer single-family homes, with more building types such as townhouses and apartment buildings instead.

8 EFFICIENT STREET DESIGN

Neighbourhood collector roads currently often feature (angled) parking on either side, wide lanes, and a flush median. This type of over-designed geometry is unfitting of urban areas, and offers a great potential to be redesigned in a way that contributes to the functioning of neighbourhood collector roads as important local destinations. When lane widths are reduced, flush medians are removed, and angled parking is converted to parallel parking, space is unlocked for extended footpaths, cycleways, and (planted) buffers, without significantly reducing vehicle capacity.

CHAPTER

6 Intersections

IN THIS CHAPTER

Because different users come together and cross paths at intersections, this is where most vehicle crashes occur.

Intersection design must ensure that intersections can be seamlessly and intuitively navigated, safely and easily, and are predictable to all users passing through. Safe intersections allow all users to make eye contact with one another, and are places where pedestrians, cyclists and drivers are aware of each other. They encourage people to approach with care and at safe speeds, so that any errors are survivable. Mid-block crossings are included as intersections because more of the injuries to people on foot occur in the middle of the block.

Equally important to intersections being places where one passes through, is that intersections are public places where people meet and linger and conduct business. To tap into a city's economic and civic potential, and revive under-utilised intersections with street life, excellence in intersection design is required.

In urban contexts, intersections become the most complex and challenging part of street design. As pinch points in the roadway network, they are often overbuilt and tend to prioritise vehicle traffic and throughput, making them difficult to negotiate for pedestrians and cyclists. In order to guarantee safety for all users, a number of principles should be considered when designing intersections, not only to make them convenient to navigate, but to make them work well as public places.

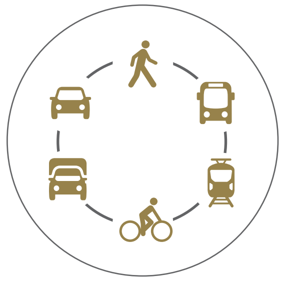
Intersection principles

MAKE INTERSECTIONS SAFE FOR ALL USERS

Intersections are safer when users can see each other, are aware of each other, and are able to anticipate and respond to each other's actions and movements. The goal of the intersection should be to not strictly reduce the number of conflicts, but to ensure a space where street users are visible and predictable in their actions. Where users' paths cross, they should do so at safe, survivable speeds and with separation in time and space if needed. Safe System Assessment Framework must be used in design.

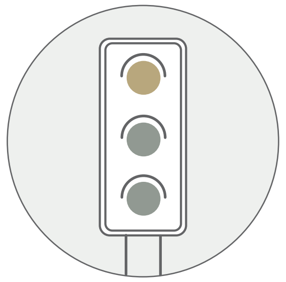
DESIGN FOR CONTEXT

The design of intersections should take the existing and projected land uses of the surrounding area into account. Land use is a key determinant of pedestrian, cyclist, public transport and vehicle volumes and denser, mixed-use areas will generate more trips than lower density single-use areas. Pedestrian generators located in the area should inform the decisions that are made in intersection design, and are as important as matters such as vehicle throughput.



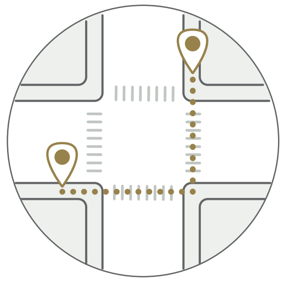
PART OF A MULTI-MODAL NETWORK

Intersections cannot be designed in isolation. It is possible to achieve a balance of a network's role in providing traffic capacity, and an intersection's role in providing a safe and comfortable crossing for people on foot and on bikes. In order to support a multi-modal network, intersection design should look to balance and prioritise spatially efficient modes with vehicular traffic.



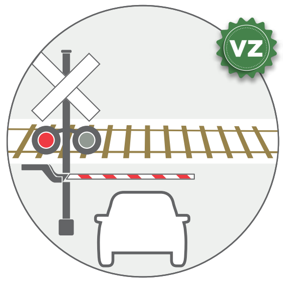
INTEGRATE TIME AND SPACE

Through signalisation, the use of an intersection might be altered instantly and temporarily. This allows for the same space to be opened up to some users, while access is restricted to others, alleviating the need to widen the intersection to address delays and congestion concerns. Signalisation allows regulation of the time taken to enter and cross the intersection, and the capacity of each movement for all users. But it is still necessary to ensure survivable approach speeds in case of mistakes.



AS COMPACT AS POSSIBLE

Compact intersections reduce pedestrian exposure, slow traffic where crashes are mostly likely to occur, and increase visibility for all users. Complicated and over-sized intersections deter cyclists and pedestrians, because of the distance and time that is needed to cross, as well as the number of potential conflicts. Oversized intersections take up valuable land, and compromise land economics and street life.



PROTECT CROSSINGS OF RAPID TRANSIT NETWORK

All users are vulnerable where they cross rapid transit network routes, which may be heavy rail, light rail or busway. Rapid transit network vehicles are heavy, fast and quiet, and cannot stop quickly. All other users should be grade separated or controlled with signals. Heavy rail crossings are governed by Kiwirail statutory control. New rail crossings must be negotiated with Kiwirail. Where existing crossings are affected by a scheme design, they should be upgraded as necessary to current safe standards.

Speed, observation and decision

The geometry of an intersection affects the speed at which users will choose to pass through it. A safe system requires that any mistake by a user should not result in death or serious injury, so where user paths conflict at an intersection, it is vital that each point of conflict should be approached at a speed suitable for a safe encounter. Mistakes can include misjudgment, distraction or inattention,. They may result in failing to give way to other users, including not complying with red signals.

Lower speeds require a shorter distance of observation for decisions. This makes judgment easier and safer. A clearly visible curved path will encourage choice of a suitable slow speed, as at a roundabout, or other speed reduction elements may be used on the approach.

Points of conflict should be designed to occur where vehicle speeds are lowest.

Observation of other users is critical to safe encounters, and to efficiency of the intersection.

The geometry can aid this by presenting a user with only a limited range of observation to to be able to decide to proceed safely. Turning to look in several directions, and looking for an opportunity to go, while also needing to look for people on foot or bike, pose a complex task that may lead to mistakes. Separating out these decisions in time into a sequence can reduce the risk of a mistake. Roundabouts are well suited to allowing this kind of decision sequencing.

Intersection geometry

The geometry of an intersection can be enhanced by considering a number of design treatments. The most important techniques are discussed below.

KERB RADII

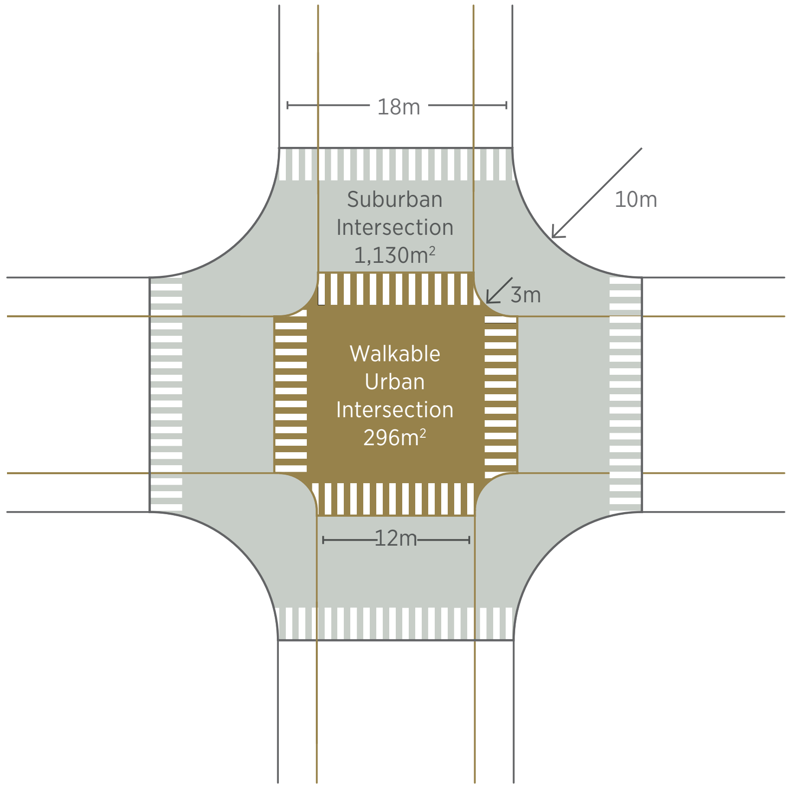
The geometry of a kerb radius (or corner radius) significantly affects the overall operation and safety of an intersection. The shape and dimensions of kerb radii vary based on street type and transport context.

Kerb radii should be designed to maximise pedestrian space and shorten pedestrian crossing distance. The smallest possible kerb radius should be used, while providing for the appropriate design vehicle. (See Design Vehicle, Chapter 4.)

Minimising kerb radii has multiple benefits for both pedestrians and cyclists. It reduces the crossing distance (thereby decreasing exposure to conflicts), enhances the visibility of the pedestrian, slows turning vehicles down significantly, and brings pedestrian crossings closer to the intersection. Because traffic on the intersection is slowed by minimised kerb radii, it becomes easier for people on the intersection to see one another and adequately respond to each other's movements and actions. Minimised kerb radii also benefit cyclists, as speeds of turning vehicles are reduced, thus reducing the risk of a turning motorist turning left across the path of a cyclist going straight across the intersection.

An appropriate kerb radius should be designed for every corner of an intersection, based on the range of vehicles that are expected to use the intersection. It is difficult to design for each and every type of vehicle that is expected to use the intersection, and the occasional difficult turning movement is acceptable. For instance, kerb radii at local neighbourhood streets should not be designed for the occasional moving truck. Appropriate Design and Check vehicles must be chosen. (See also Design Vehicle, Chapter 4.)

COMPATIVE SIZE OF INTERSECTIONS



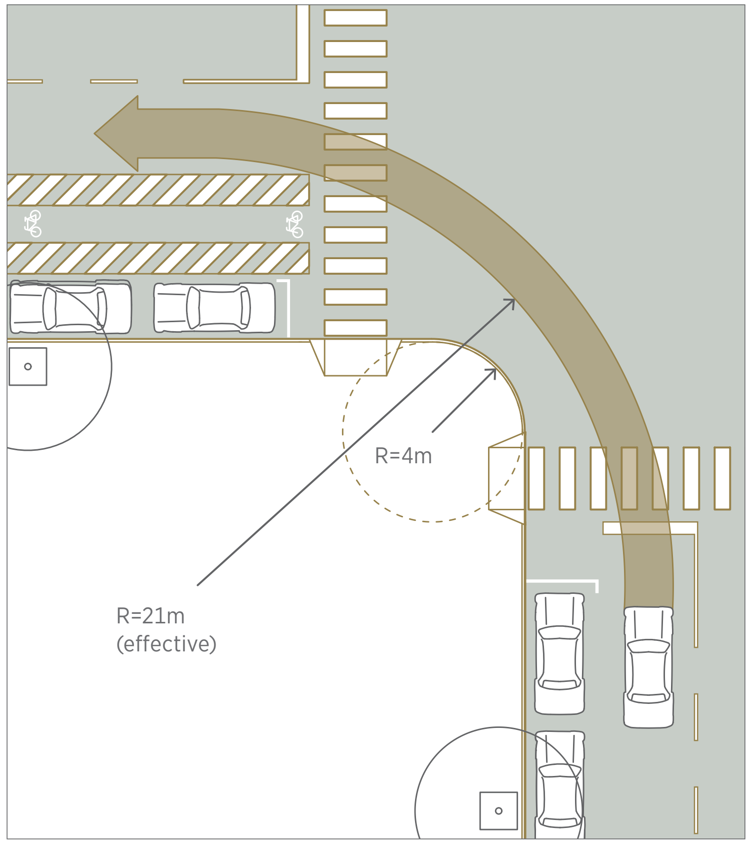
EFFECTIVE TURNING RADIUS

When designing intersections, it is critical to consider the elements that create the effective turning radius. The effective radius is the curve that vehicles follow when turning. The effective radius is influenced by kerb extensions, parking, cycle lanes, medians and receiving lanes.

Many drivers will turn into the centre-most lane to minimise centrifugal force. In order to create the desired conditions of a street type, e.g. slow turning speeds, the effective turning radius must be considered when establishing the actual kerb radius.

The effective turning radius is also a key tool for designing for streets with regular large-vehicle movements. The receiving and the kerbside elements (parking, cycle lanes) defines the effective turning radius that needs to be balanced with the desire to keep the actual kerb radius and intersection as small as possible. Where the effective turning radius for cars exceeds the preferred maximum radius, over-run paved areas can be used for large vehicles turning to manage speed and user conflicts.

Rare large-vehicle movements on neighbourhood and narrow streets can be accommodated by using the entire carriageway, including adjacent and oncoming lanes.



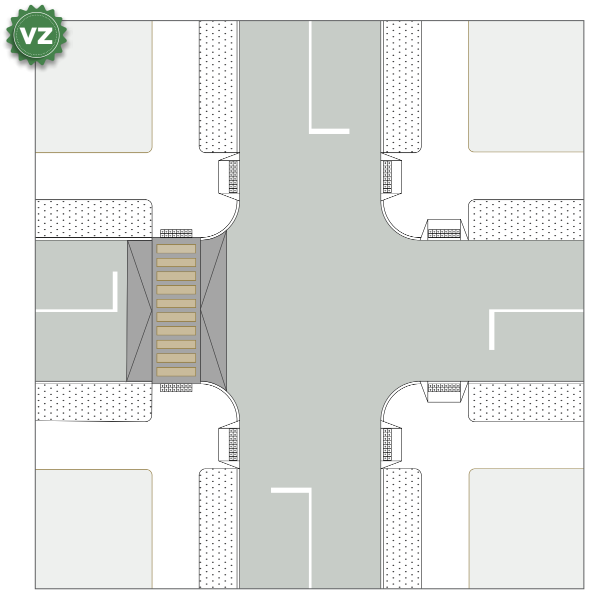
LANE MATCHING

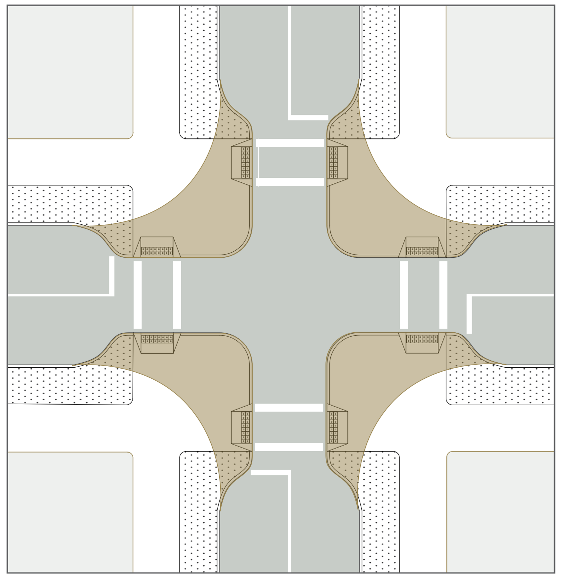
Lane matching ensures that lanes are allocated in a manner intuitive for users and that supports the priorities of the street type. The number of entering lanes entering an intersection should align with the number of receiving lanes.

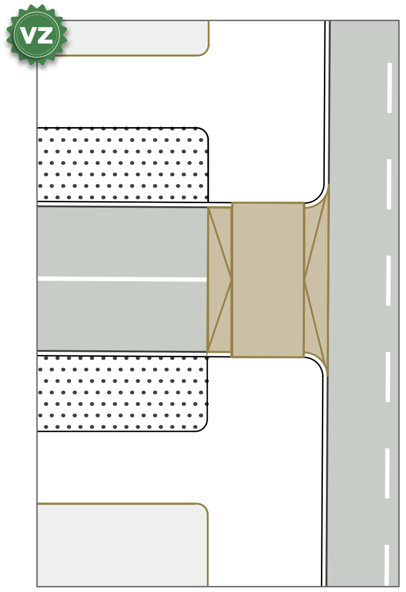
The introduction of additional, short vehicle lanes (e.g. stacking lanes) at intersection approaches introduces turbulence (unconfined, unpredictable vehicle movements), rewards aggressive drivers and compromises the objectives of designing a compact, multi-modal intersection.

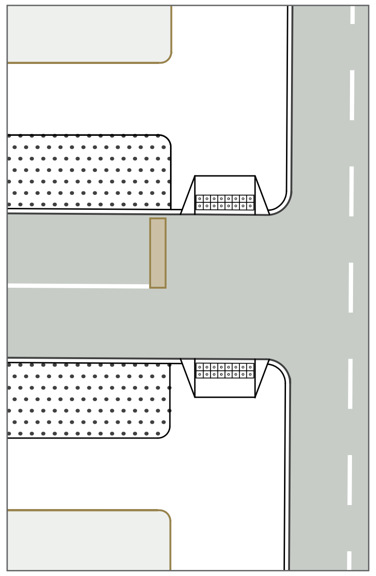
Exclusive right turn lanes generally should be introduced to the right of the centre-most through-moving vehicle lane. Through-moving lanes that become right-turning lanes introduce unnecessary complexity and traffic turbulence and force people driving to make abrupt, unpredictable lane changes. The right turn lane should be as short as possible to accommodate the typical queue.

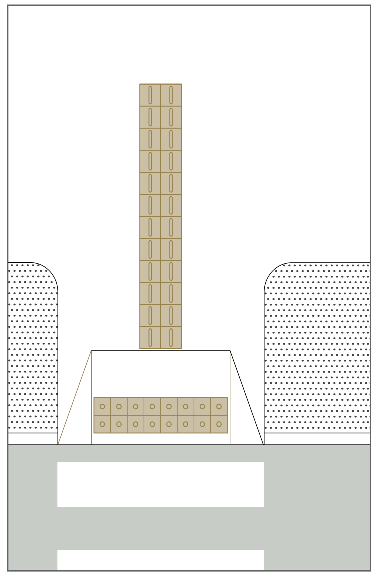
Intersection elements











PEDESTRIAN CROSSING

Pedestrian crossings (zebras) are a common crossing facility in Auckland. The pedestrian crossing consists of striped roadway markings running from kerb to kerb. Drivers are required to give way to pedestrians on both sides of all zebra crossings, unless the crossing is divided by a raised traffic island.

Pedestrian crossings are not recommended on streets with traffic speed over 50 km/h or where there are more than two lanes in any direction, as the pedestrian may not be able to determine the appropriate time to cross due to the higher speed and/or traffic volume of the road; use signals instead. Raised tables should be used to ensure survivable speed at the crossing.

Consider pedestrian crossings at intersections or across side roads to increase accessibility and safety.

KERB EXTENSIONS

Kerb extensions physically and visually narrow down the carriageway, increase general driver awareness, and are useful in reducing vehicle speeds. They are a commonly used tool to enhance pedestrian crossings, as they shorten the crossing distance and make pedestrians waiting to cross more visible, and allow pedestrians to see oncoming traffic. When applied at both ends of a street, they act as effective traffic calming devices. Kerb extensions are generally most appropriate for streets with on-street parking.

RAISED TABLE

A raised table or raised crossing extends the footpath across the intersections and creates a ramp to slow down crossing vehicles. This design solution makes it easier for pedestrians to cross and slows vehicle movements. Raised tables are appropriate in town centre contexts with high pedestrian volumes and at local or collector street intersections. They can be used at a speed zone threshold. Raised tables can also be marked with a zebra crossing or used with signal-controlled crossings.

RECESSED STOP LINE

As road rules are reviewed to give pedestrians priority at side roads, there is an opportunity to provide a simple, low-cost solution for pedestrian crossings, across most T-intersections. In combination with kerb extensions and smaller corner geometry to slow left turning vehicles, the stop line can be recessed before the pedestrian crossing point, creating a de facto pedestrian crossing at every intersection. This can be further supplemented by materials or colour to enhance the pedestrian crossing zone. This design has the added benefit of accommodating rare large vehicle movements, while maintaining a short pedestrian crossing. Visibility from the stop line must be considered, and how vehicles may move forward from it and possibly stop again before entering the main road.

KERB RAMPS

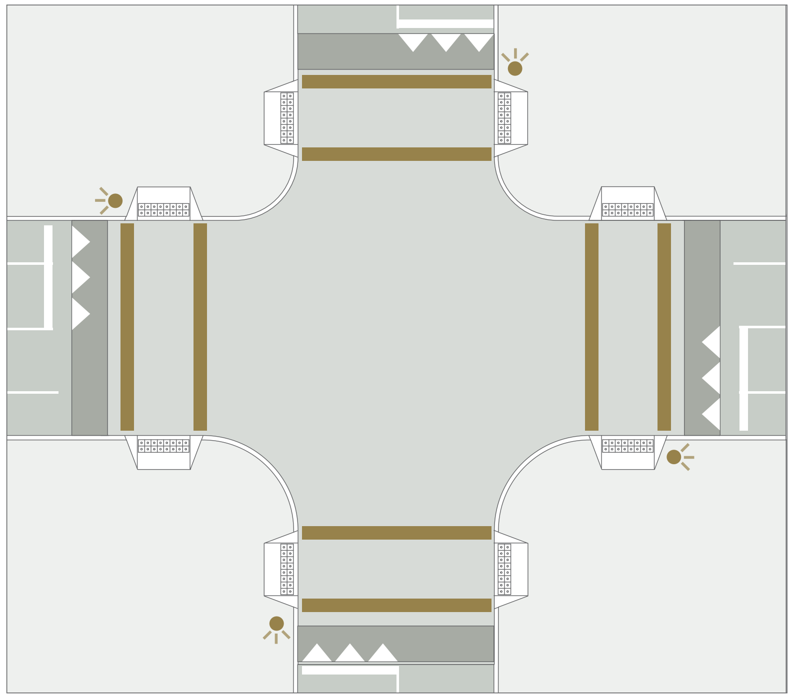
Kerb ramps are gently sloping ramps that mediate the transition from the footpath to the carriageway at pedestrian crossings. They are especially critical for people in wheelchairs and people pushing prams or shopping carts. They ought to be placed at a 90-degree angle to the direction of the crossing.

VISION IMPAIRED GUIDANCE

Placed along footpaths, at kerb ramps and platform edges at public transport stations, tactile paving strips guide the visually impaired along pedestrian connections and other urban environments. They have a different texture from the surrounding paving, and have highly visible colouring as well.

Signalisation

An intersection's look and feel often mirrors that of the intersecting streets. When two busy urban arterials meet, the intersection will experience high volumes of traffic, and will often need signalisation to guide traffic through and avoid collisions. As a general rule, the more traffic an intersection sees, the more regulation is warranted to guide users of various modes through the intersection in a safe way.



CROSSWALK

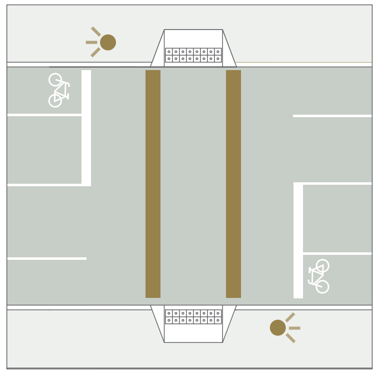
Pedestrian crossings should be designed to offer as much comfort and protection as possible. Current practice utilises designs with narrow striping. Most designs use the bare minimum width of 100 mm, making the pedestrian crossing the narrowest line marking on the street.

International best practice uses a more prominent road marking for pedestrian crossings that take the form of a zebra, ladder, or continental crossing. These are more visible to motorists. Crosswalk designs should evolve with the adoption of new road user rules in New Zealand and become more in line with international best practice. An interim solution may be to make the typical crosswalk stripe much wider, going to the maximum allowed.

Mark the crosswalk to be at least as wide as the footpath it extends to. The crossing path should be aligned as closely to the pedestrian desire line as possible.

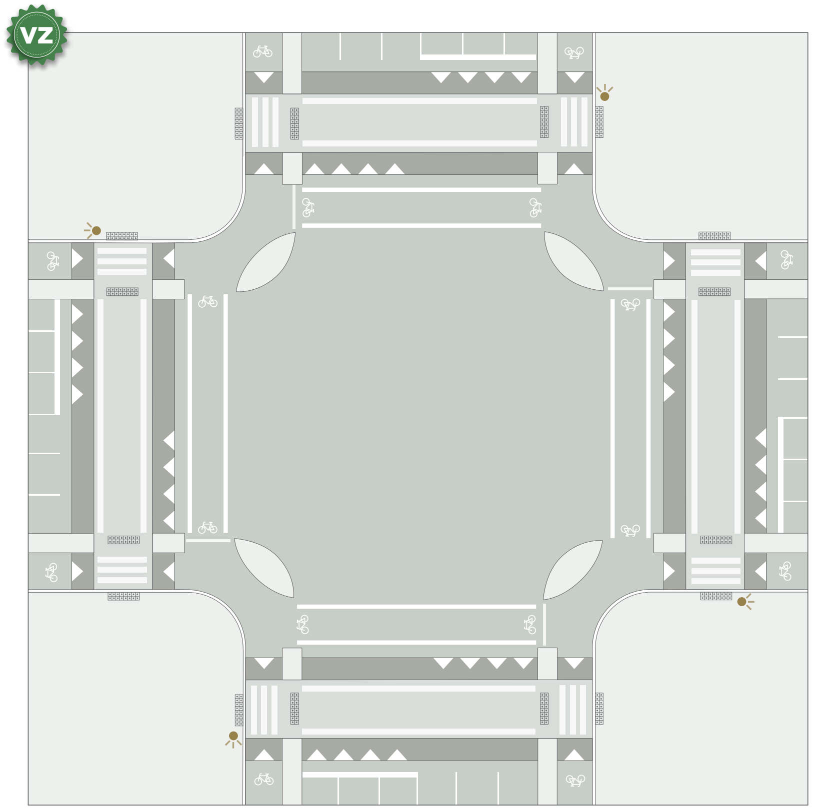
Crosswalks with kerb ramps should preferably be located at every leg of the intersection to provide safe and direct crossing opportunities.

An advance vehicle stop line should be placed at least 2.4 m in advance of the crosswalk. If the street has a cycleway or high levels of bike traffic, the stop bar should be recessed even further (7.0 m before the crosswalk).



MID-BLOCK CROSSINGS

Mid-block pedestrian signals are installations that stop traffic, so pedestrians can cross safely and unimpeded. The signals are activated by pedestrians.Mid-block signals are important features on busy urban arterials. They improve safety, accessibility and permeability of the walking network in town centres.

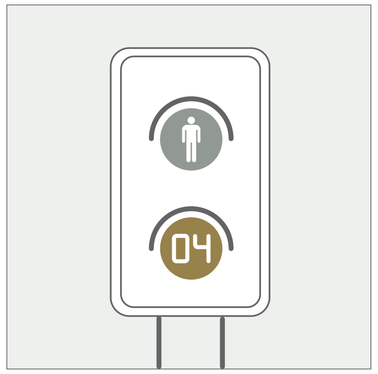


RAISED INTERSECTION ENTRIES

Operation of traffic signals does not entirely prevent mistakes that lead to conflicts within the controlled intersection. It may be possible to reduce vehicle operating speed on all approaches to a signalised intersection, but often this is not feasible. It is then necessary to ensure that vehicles enter the intersection at a speed that is survivable in the event of a collision. One method is to provide a raised intersection table, or provide raised crossings on the approach arms. These should be designed to achieve a safe speed through to the last conflict point on the vehicle's path, which may be a crosswalk on the exit side. Where there are pedestrian or cycle crossings, the safe speed is 30 km/h or less. For conflicts with other vehicles, the angle of incidence determines the acceptable collision speed. The choice of raised platform intersection, raised crossing tables or approach-only (Swedish) ramps depends on local factors, including drainage. Additional measures on approaches may be needed to ensure that vehicles do not approach a raised intersection entry at an unsafe speed for the ramp height and gradient.

The design should aim to encourage a steady speed through the intersection on a green light phase, not high acceleration or deceleration, for both safety and efficiency. Any design should be evaluated with the Safe System Assessment Framework.

Alternative treatments may be closing intersection arms, grade separation, roundabout or fully managed low-speed approaches.



COUNTDOWN PEDESTRIAN DISPLAYS

Countdown pedestrian displays inform pedestrians of the amount of time in seconds that is available to safely cross. Pedestrian countdown timers should be used in town centres, metropolitan centres and the city centre, and in other places with high pedestrian volumes. Currently, countdown timers are only used in mid-block locations and at intersections with Barnes dance signal phasing.

Signal timing

DESIGN GOALS TO IMPROVE PEDESTRIAN SAFETY AND COMFORT

- Reduce vehicle speeds
- Minimise crossing distance
- Minimise wait for WALK indication
- Minimise conflicts with turning vehicles
- Provide sufficient signal time to cross the street.

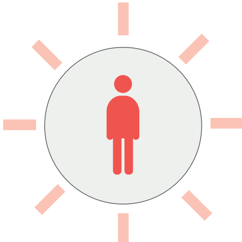
Signal timing for pedestrians is provided through the use of pedestrian signal heads. Pedestrian signal heads should be provided at all signalised intersections.

In the absence of pedestrian signals, or when the pedestrian signals have not been activated, pedestrians' movements are managed by the primary signal heads. While the New Zealand road rules do not provide explicit pedestrian right-of-way at unsignalised intersections, the road rules imply that pedestrians can cross the street concurrently with a green light at signalised intersections.

"(2) While a green signal in the form of a disc is the only signal displayed, pedestrians... facing the signal may enter the roadway unless a special signal for pedestrians indicates a flashing or steady red standing human figure symbol."

PEDESTRIAN SIGNAL HEADS DISPLAY THE THREE INTERVALS OF THE PEDESTRIAN PHASE:

Green figure symbol:
YOU MAY CROSS THE ROAD



Flashing red figure:
DON'T START,
BUT YOU MAY FINISH CROSSING

Steady red figure:
DON'T CROSS

LEAD-PEDESTRIAN INTERVAL

Where concurrent pedestrian phases are allowed, left turns should be held by a red arrow aspect rather than relying on "Give way to pedestrians crossing" signs. This reduces pedestrian-vehicle conflicts that otherwise might arise when vehicles start to infringe on the crosswalk when pedestrians are crossing.

The total time for the flashing red interval plus the buffer interval is called the pedestrian clearance time, or the time it takes for a pedestrian to clear the intersection if they leave at the onset of the **DON'T CROSS** indication.

The pedestrian clearance time is calculated using the pedestrian walking speed and the distance a pedestrian has to cross the street. It is recommended that the walking speed of 1 metre per second is used in determining the signal timing to account for an aging population. Pedestrian signals should allocate enough time for pedestrians of all abilities to safely cross the roadway.

Exclusive vs concurrent

EXCLUSIVE

VZ Exclusive pedestrian phasing is when pedestrians are able to cross when there are no conflicting movements. Exclusive phasing is generally considered safer, since it theoretically removes conflicts. However, evidence presents a mixed story of the overall safety record of exclusive phasing schemes. This is largely related to the occurrence of pedestrian non-compliance (i.e. crossing against the don't enter indicator).

Exclusive signals make signal cycles complex and long for all intersection users. The green pedestrian walk indication is typically short, usually requiring a pedestrian to be waiting at the corner and have activated the pedestrian call button in order to cross. It is common for pedestrians to be required to wait for as much as 90 seconds to cross the street. The long wait time is potentially unsafe, as it leads to people crossing against the signals, or mid-block before the intersection. Long wait times are a significant barrier to walking, in particular when the destination is the diagonal corner.

Best practice guidance suggests that pedestrian wait times in urban centres should be no longer 30 seconds. However, because of road user rules in New Zealand and prevailing engineering practice in Auckland, it is difficult to provide comprehensive signal phasing and timing guidance. In addition to the design goals outlined above, the following general strategies should be considered to improve walking conditions.

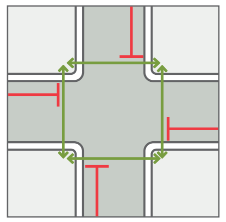
- Provide crossings on all intersection legs wherever possible.
- Vehicular movements should be analysed at every intersection in order to utilise non-conflicting phases to implement walk intervals.

For example:

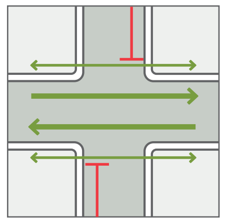
1. Where a one-way street approaches an intersection, pedestrians can always cross that leg while it is stopped.
2. Introduce concurrent pedestrian phases within signal cycles that also include an all-pedestrian phase
3. Introduce concurrent pedestrian phases at intersections that have slip lanes and an all-pedestrian phase
4. Use double-phase Barnes Dance (two pedestrian phases each cycle) where long cycles cause excessive delays for pedestrians.

CONCURRENT

A concurrent pedestrian phase is when pedestrians are able to cross while parallel and non-conflicting vehicular traffic is also moving. Concurrent phasing is often accompanied by signage, such as turning vehicles give way to pedestrians.



Exclusive



Concurrent

Signal coordination and other strategies

The practice of synchronising a series of signals that are situated in close proximity to each other, often referred to as creating a ”green wave” for road users, is called coordinated signal timing or signal coordination. Traffic signals are planned to allow vehicles, traveling steadily at the desired speed, to progress with little delay along a corridor by obtaining a sequence of green lights at signalised intersections. Traffic moves through signals with ease and delays are minimised, while mid-block speeding is discouraged simultaneously.

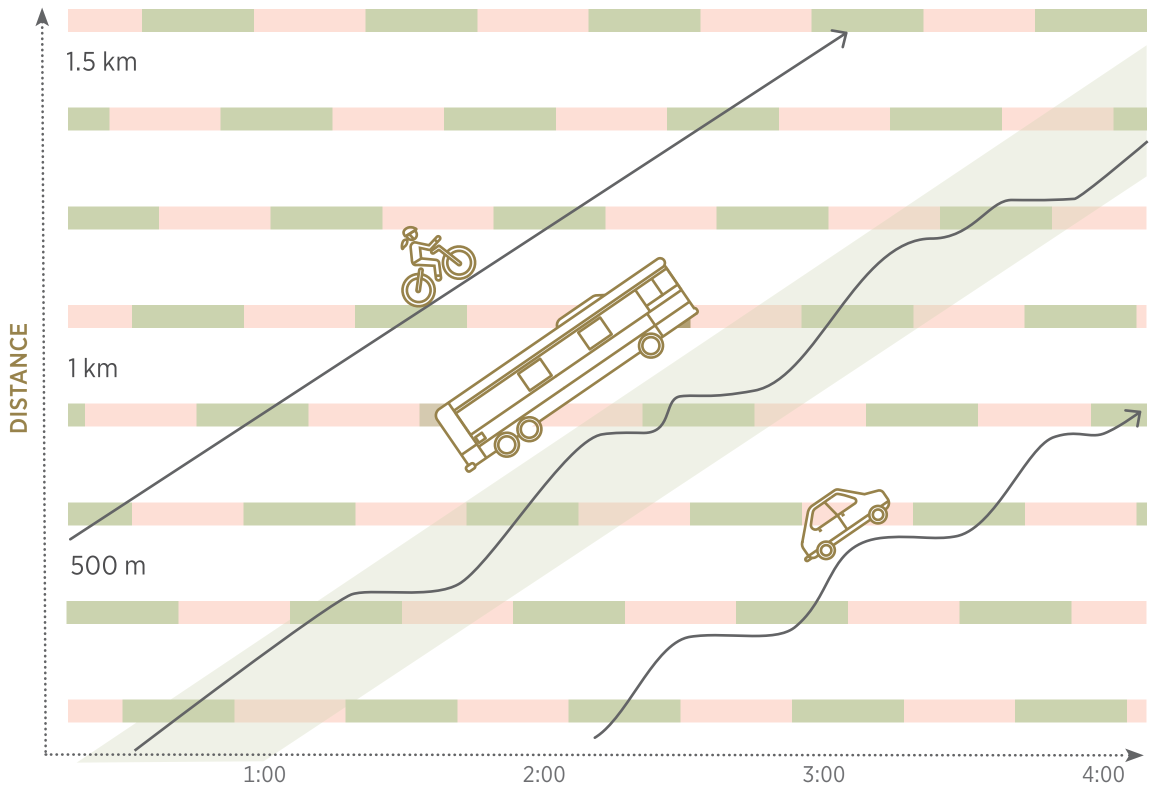
When used, signal coordination must be optimised to take into account the needs of all road users. Delays for pedestrians, cyclists and public transport vehicles need to be minimised. Furthermore, cycle speeds should be considered when planning signal coordination along bicycle routes. Ideally, signal coordination would allow both cyclists and motorised traffic to travel through a series of intersections without stopping.

Signal coordination can also be used as a tool to provide safe transitions between high-speed roads (and motorways) and urban streets. This is done by stopping all vehicles before they enter an urban area with red lights and platooning vehicles slowly as a group. A similar strategy can be utilised where the signals are held in a default red phase unless triggered by vehicles. This should be considered in very busy urban areas, in particular during late hours of the night, where vehicle speeds need to respond to the presence of vulnerable road users.

Slow signal progressions have multiple benefits, providing a green wave for cyclists and buses, while slowing speeds for private vehicles.

Placement of bus stops needs to be considered along with phasing.

LOW-SPEED SIGNAL PROGRESSION SPEEDS



Low speed signal progressions create amenable environments for both bicycle green waves and bus or LRT priority streets.

ACTUATED VS AUTOMATED SIGNALS

Pedestrian phases can be programmed to be automated at each cycle, or to be actuated by using push buttons. Generally, automated pedestrian phases are preferred, particularly in areas where higher volumes of pedestrians create a need for a pedestrian phase during every cycle. Vehicles are detected automatically at signalised intersections; pedestrians should be provided with the same service.

Push buttons are most fitting for intersections with infrequent pedestrian use and intersections designed to operate only with vehicle detection.

Where signal cycles require pedestrian actuation, it is critical to consider how people on bikes will be affected when the pedestrian phase is not activated. Independent cycling detectors may be necessary to remove conflicts with left turning vehicles, for example.

Mobile phone technology to call the pedestrian phase for low-vision people is already in existence. Mobile phone Bluetooth technology can allow people to trigger the pedestrian phase without having to detour off a straight walking route to find the button. This allows a vision-impaired person to stay on the intended travel path up to the kerb crossing, and across the intersection without having to reassess the direction of travel after finding the button, so that crossing the intersection at the right place in the right direction is more likely. This is very useful where people cross concurrently with traffic, as it is easy to get a bit turned around and step towards the flow of traffic.

Pedestrian provision

Pedestrian crossings, both formal and informal, are a key component of urban streets. Busier streets with high volumes or speeds over 30 km/h require multiple design treatments to provide safe and effective crossing facilities. Streets designed for lower vehicle speeds require less intervention and can support more opportunities for informal crossing.

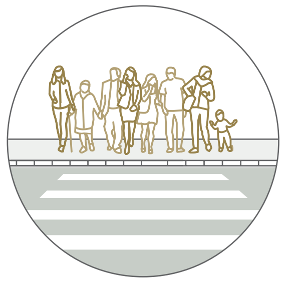
Determining which type of crossing to use for a particular intersection or mid-block crossing depends on a variety of factors. These include traffic speed, average daily traffic (ADT), anticipated pedestrian volumes, and street geometry. Crossing locations should enable the desired land use activity of the street type and support wider transport access (e.g. bus stops) and pedestrian and cycling networks. Frequent signalised or zebra crossings are vital to a safe and busy centre.

Vehicle speeds are slowed well in advance of the pedestrian crossings.

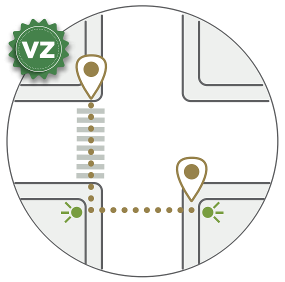
Crossing the street is made simple and convenient for pedestrians in a clearly visible location.

Vehicle drivers are made aware of the presence of a crossing.

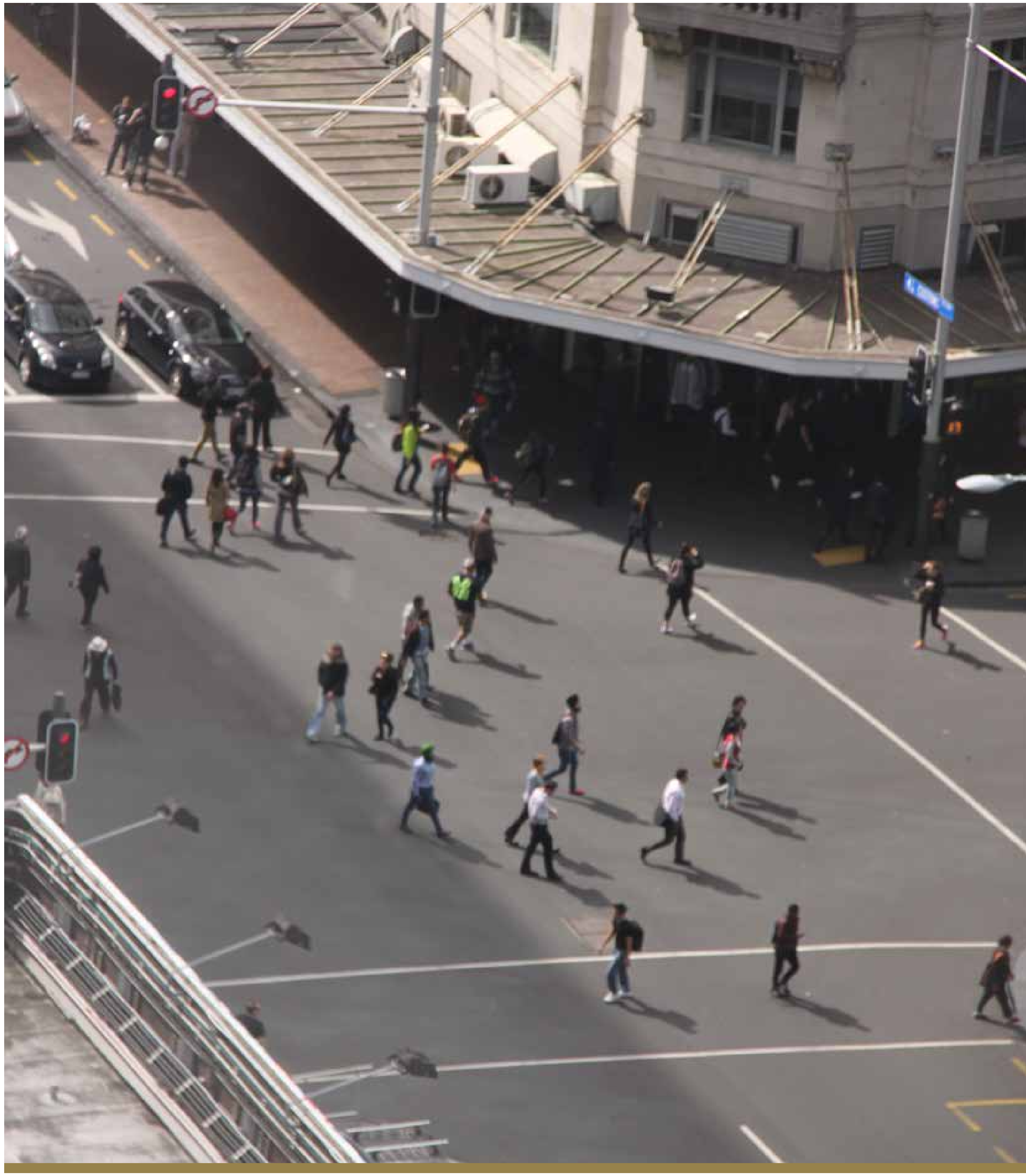
Vehicle drivers give way to legally crossing pedestrians and cyclists. It is legal to cross informally anywhere, as long as it is not within 20m of a crossing.



Concentrating pedestrian movements requires good attention to desire lines. Crossings can be wider than the minimum or become a shared zone if concentration is not natural.



There are two types of formal Controlled crossing: Zebra, requiring vehicles to give way, and signals, requiring vehicles to stop. These should be used whenever safety of people crossing the street requires formal control.



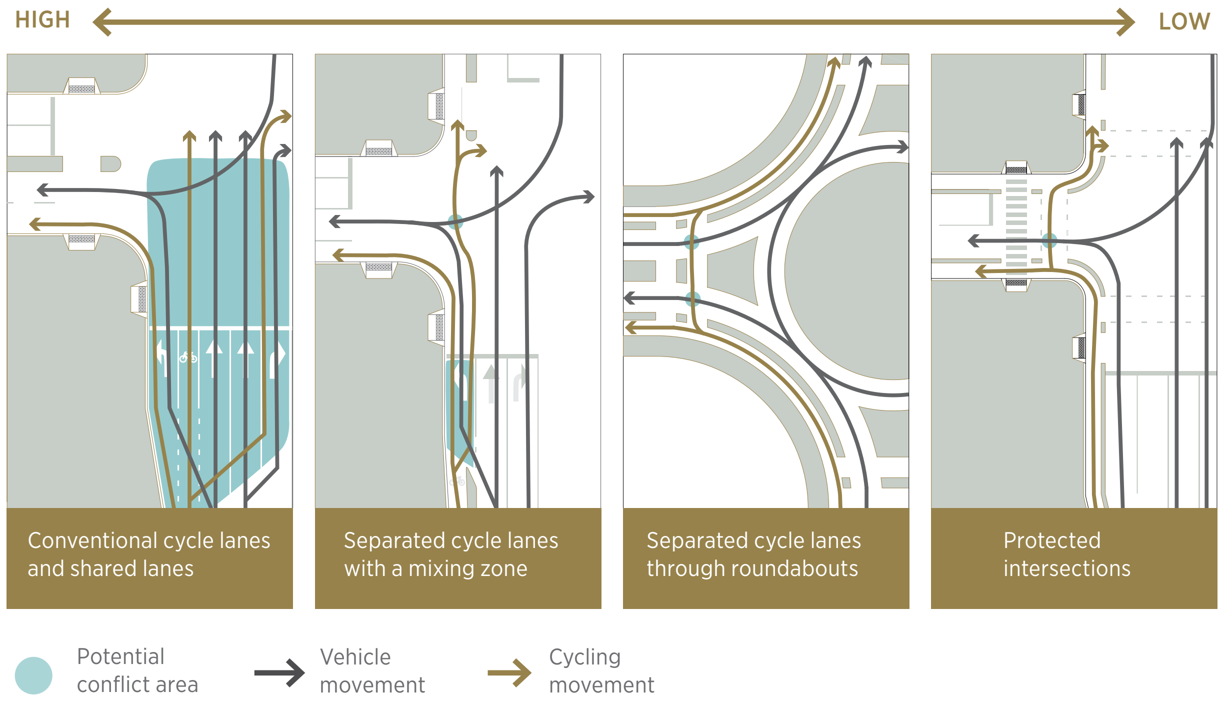
Cycle provision

Intersections can be highly stressful for cyclists, forming one of the main barriers to cycling for the wider population. By far the most collisions in urban areas involving cyclists occur at intersections. In New Zealand cities, up to 74% of collisions occur at driveways, roundabouts, traffic signals and intersections (Cycling Safety Panel, 2014). Getting the design of cycling facilities at intersections right, and creating a safe cycling environment, is therefore of critical importance to increasing cycling uptake

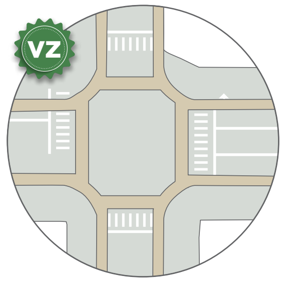
Observing how cyclists use the street can provide useful cues to intersection design. Also consider the wider network in intersection design. Sometimes, solutions for the wider network may be unlocked at nearby intersections. In general, greater separation between cyclists and other modes reduces the risk of crashes and increases the cyclists' level of comfort.

Because of the importance of intersections in supporting cycling, there may be justification to provide intersection improvements for cyclists in advance of, or even independent of, wider corridor improvements.

CYCLE EXPOSURE AT INTERSECTIONS



Principles of cycle provision at intersections



MINIMISE EXPOSURE TO CONFLICTS

Intersections with cycle facilities should be designed to minimise the area of potential conflict points between cyclists and other vulnerable users and vehicles. This can be achieved by separating cyclists and other vulnerable users from road users with higher speeds and higher mass, particularly at intersections with high traffic volumes. Intersection design should provide clearly marked places for cyclists to traverse the intersection. This both guides cyclists along the intersection and informs them where to ride, and at times, provides cyclists with enhanced visibility.

COMMUNICATE RIGHT-OF-WAY PRIORITY

Communicating the desired right-of-way removes ambiguity and confusion that can lead to crashes even with clear sight lines. Designs should reinforce normal rules of the road where turning traffic from the main street has to give way because turning traffic gives way to through traffic. Markings (traffic control devices), warning signs, and physical features (e.g. raised crossings) should reinforce the desired user behaviour. These signs may need special authorization.

REDUCE SPEEDS AT CONFLICT POINTS

Lower speeds allow drivers to be more observant and aware of their immediate environment, and reduce the severity of crashes when they do occur. Tightening an intersection's geometry through the use of kerb build-outs, sharp kerb radii, narrow lanes, and by limiting the number of lanes all contribute to lower speeds. Roundabouts reduce speeds and give time to observe each conflict in turn. Raised table crossings and raised intersections slow vehicles at pedestrian crosswalks.

RAISE AWARENESS

Visual cues such as sharrows, a (dashed) painted lane across the intersection, green surfacing, and additional signage can aid in managing drivers' awareness of where to expect cyclists.

MAXIMISE SAFETY & COMFORT

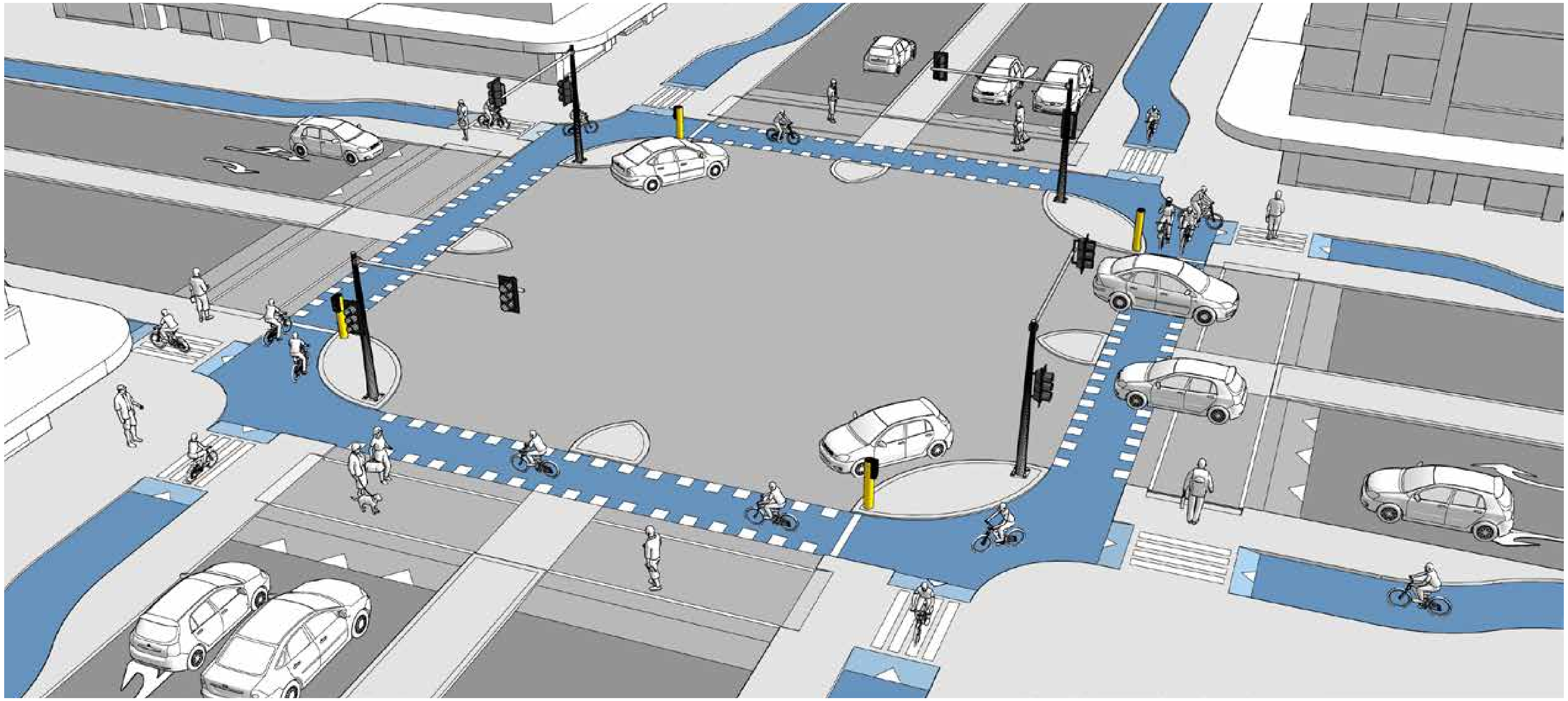
Design measures include not only the array of safety-enhancing features, but also measures to increase cyclist comfort, such as hand rails and automated cyclist detection at intersections. When cycling facilities are both safe and offer a degree of comfort, cycling becomes an attractive mode of transport.

PROVIDE ADEQUATE SIGHT DISTANCE

Providing an appropriate sight distance is fundamental in making intersections safe. At a minimum, oncoming road users must be able to see others who are approaching the intersection and who are already at the intersection.

Signalised intersections – protected

Both protected and unprotected cycleways at intersections must consider signal operations and phasing in order to avoid conflicts between turning vehicles and cyclists. It is highly recommended that separate bicycle signal heads are installed at intersections with cycle facilities, especially at intersections with higher traffic volumes.



Pedestrian crossings are situated behind the cycle crossing. Pedestrians crossing the intersection first cross the cycle paths, where cyclists must give way to them. Pedestrian safety islands are provided between the cycle paths and the pedestrian crossing, which is preferably demarcated using a zebra crossing.

To ensure that cycle crossings at protected intersections work properly and remain safe, crossing cyclists must have the right of way. This can be attained by signalising the intersection and allocating a dedicated signal phase to crossing cyclists. Alternatively, on intersections with low traffic volumes, a policy of yielding to crossing cyclists can be chosen, however this only works where speeds are low (30 km/h) so that eye contact becomes possible. Traffic volumes must be low enough that an occupied queue area does not cause backed-up traffic.

The protected intersection provides opportunities to safely cross the intersection in any direction, facilitating left and right turns as well as through movements.

Where pedestrian volumes are high, pedestrian-cyclist conflicts should be considered.

Protected intersections maintain the physical separation through the intersection, thereby eliminating the merging and weaving movements inherent in conventional cycle lane and shared lane design.

The protected intersection design with corner safety islands emerged in the Netherlands and other northern European countries as an approach to define traffic movements at the intersection of two separated bike lanes. The central design element is the corner safety island. They are used to tighten the turning radius for cars to decrease their speeds and slowly negotiate the turning movement. Additionally, they are required in order to design the cycle track slightly set back from from the intersection. Situating cycle tracks behind the corner safety island enables left-turning cyclists to turn without having to mix with traffic. The space behind the corner safety island allows cyclists to wait to cross the intersection.

The corner safety island also provides a queue space for a single vehicle to wait while yielding to crossing cycle traffic immediately after having made a turn. Vehicles will have significantly slowed down before they begin to cross the cycle path. This facilitates vehicles coming to a standstill when they need to yield. It also places crossing pedestrians and cyclists firmly within the driver's view.

A forward stop line is situated on the cyclepath right before the crossing, between the corner safety island and the pedestrian safety island (see diagram). The space at this line serves as a waiting area for cyclists waiting to cross. This allows left-turning cyclists to proceed freely, unimpeded by cyclists waiting to cross the intersection.

Signalised intersections – unprotected

Unprotected intersections are intersections where cyclists are more exposed to traffic due to a lack of corner safety islands. Cyclists mix with vehicle traffic on the intersection and with pedestrian traffic where they cross the crosswalk.

While it is highly recommended to apply a design treatment that includes corner safety islands as described in the previous section, this may not always be feasible at signalised intersections, given financial and/or spatial constraints. A number of alternative cycleway design treatments for intersections are provided below. These include recessed stop lines for vehicles, intersection crossing markings, no parking on intersection approaches, bicycle signal phasing, and two-stage turn queue boxes.

At signalised intersections, it is recommended that the stop line for vehicles is further recessed by 3-5 m to increase cyclists' visibility. Pushing back the stop line for vehicles and allowing cyclists to queue in the lane ahead of vehicles, provides cyclists with a head start and lets them clear the intersection more rapidly. This treatment might be supplemented by the addition of a bicycle box, to provide more queue space for cyclists where volumes warrant it. Even though bicycle boxes use coloured surfaces to encourage compliance by motorists, bicycle boxes have the disadvantage that there is no physical barrier to prevent vehicles from occupying this space when cycling volumes are low. For this reason, think carefully before implementing bicycle boxes.

From the stop line, the cyclist crosses the pedestrian crossing and is subsequently guided through the intersection by intersection crossing markings that indicate the intended path for cyclists. These can be short dashed lines that ideally are supplemented by coloured pavement markings and shared-use markings or bicycle stencils. Their purpose is to define a safe and direct path through intersections, and to define the boundaries between the path of through cyclists and through and turning vehicles in adjoining lanes.

It is recommended to remove a number of parking spots ahead of the intersection where on-street parking exists between the cycleway and the travel lanes. This enhances cyclists' visibility leading up to the intersection.

While a bicycle exclusive signal phase may be used to segregate conflicting movements between cyclists and motorists, it might also be practical to investigate the use of a protected, yet concurrent signal phase. This phase might be adapted to allow cyclists a green light a few seconds before vehicles, allowing them to largely clear the intersection before vehicles get the light. Also see below under Signal Design for Cycling for more information.

Two-stage turn queue boxes may be included in the intersection design to allow cyclists to make a safe and comfortable right turn at multi-lane signalised intersections. They might be necessary where conventional cycleway design prevents cyclists from merging into traffic to turn (which is generally best to avoid). By providing two-stage turns, this issue is addressed. Two-stage turn queue boxes are most appropriate for multi-lane roads at signalised intersections, as well as at roads with high traffic speeds and volumes, and where a high number of cyclists turn right.

Noted disadvantages of the two-stage turn queue box include an increase in delay, as cyclists use two signal cycles to complete the turn (one for the through street and one for the cross street). Queue boxes must be located clear of moving vehicles and cyclists and ideally physically protected by a kerb or other barrier.

Unsignalised intersections

Avoiding conflicts at unsignalised intersections depends on the geometric design of junctions to encourage safe interactions between people using different modes. The behaviour of street users can be guided by visual and tactile cues, including changes in level and road marking.

RAISED

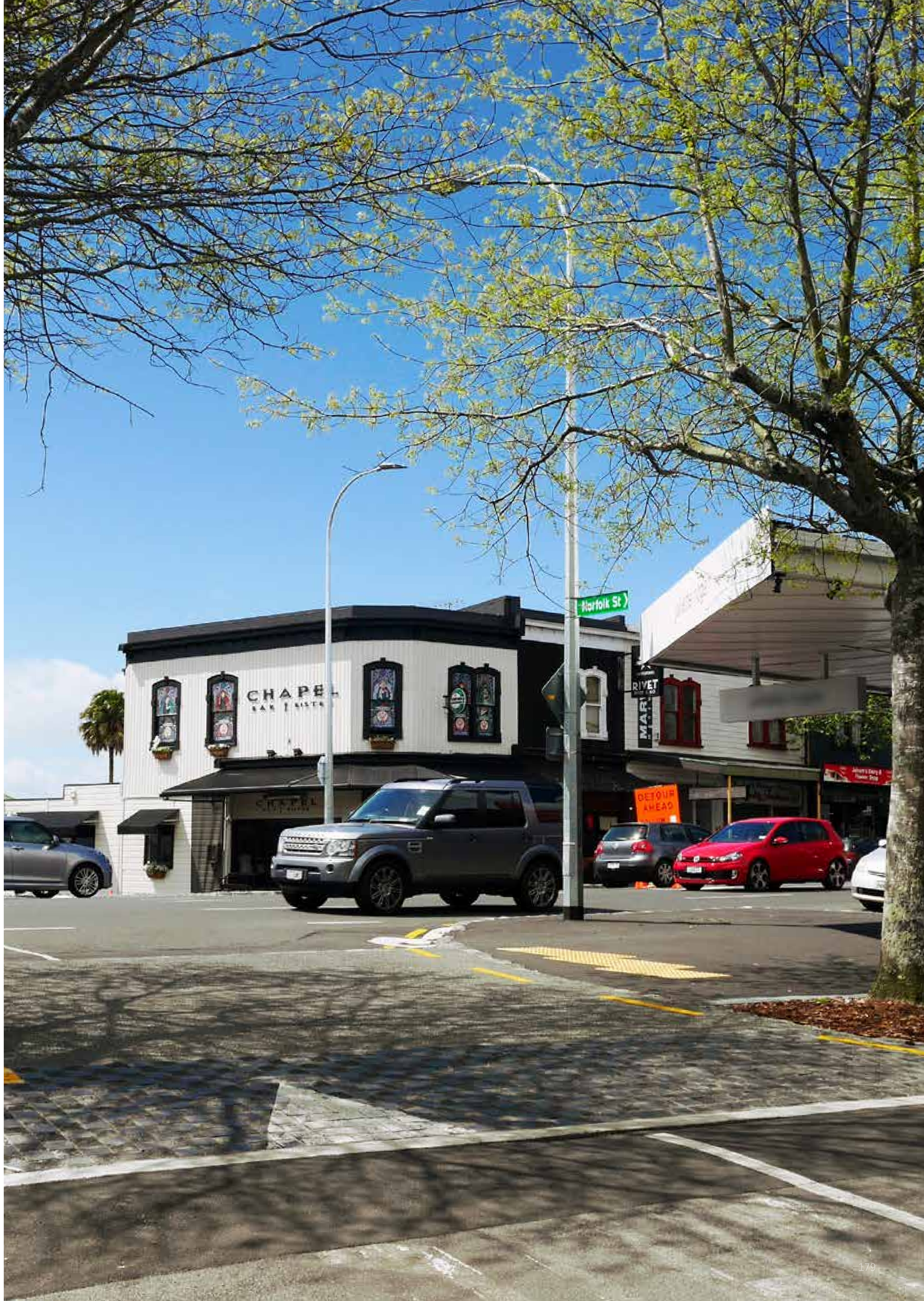
VZ Raised cycleways are a preferred solution wherever cycleways cross minor side streets at T and crossroad intersections, as well as at driveways and entry lanes. They can be used on approaches to roundabouts. They can be stand-alone raised cycleways, or form part of a raised table that accommodates both a pedestrian and a cycle crossing across the side street, and acts as a speed bump for traffic turning into the side street. At the same time, raised tables function as a clearly defined entry point to a street type that is different than the intersecting street, thus acting as a spatial threshold that informs motorists that different speeds and behaviour is expected on the side street. While New Zealand road rules are not explicit about yielding requirements for vehicles turning into side streets, the design treatment of raised tables can be such that good yielding practice is implied. Where it is necessary, the raised table can be slightly set back from the intersection, to allow vehicles to wait before crossing the raised table just outside the intersection, ahead of the raised table. While this causes modest deflection from cyclist desire lines, it is required to provide a vehicle queue area where vehicles can wait while yielding to crossing cyclists, outside the heavy flow of traffic along some major and medium streets. It also improves visibility to observe cyclists. For compact intersections and mini-roundabouts, the whole intersection can be raised, provided vehicles cannot gain too much speed once they have entered the intersection before reaching a cycleway crossing their exit lane.

STREET-LEVEL FACILITIES

For conventional, unprotected, on-street bike lanes, the treatment of protected and unprotected intersections is similar to some extent. Street level facilities might feature recessed stop lines for vehicles, combined with signage informing motorists to stop. Intersection crossing markings are used to guide cyclists on safe and direct paths through intersections, defining the boundary between the path of the through cyclist and through and/or turning vehicle traffic. Short dashed lines are recommended as a continuation of the bike lane across the intersection; preferably these are filled in with (green-) coloured pavement and shared-use markings.

Where there is on-street parking, this should be suspended on the approaches to the intersection, in order to improve visibility. This is especially critical where the cycleway is buffered by a parking lane.

As street-level facilities provide a minimal level of protection (a horizontal buffer) at best, it is highly recommended that other types of cycling facilities that offer a greater degree of separation are considered.



Signal design for people on bikes

Signal design plays an integral role in making intersections safe and usable for cyclists. Signals are used to separate users by time, and help to make intersections conflict-free places for all modes. There are many opportunities to improve signal design in order to make it work better for cyclists. These include phasing strategies, advance green lights, and minimising delays across corridors.

REMOVE THE COMBINATION LEFT TURN ARROW- GREEN DISC PHASE

A combination left turn arrow - green disc (straight through) phase remains a legacy of superseded road rules where left turning vehicles had to give way to oncoming right turning vehicles. This communicates to motorists an "all clear" turning movement. This practice should be reviewed in light of the desire to have turning vehicles take care and look for other road users, in particular where people on bikes may be expected to pass to the left of turning vehicles.

THE GREEN WAVE

Applying advanced (leading) green lights for cyclists and pedestrians at most intersections along the key cycling routes is important, both in terms of ensuring cyclist's safety, and in visibly promoting cycling as an efficient and fast mode of transport. The signals should be synchronised at average cyclist speeds, about 20 km/h, assuring a consecutive string of green lights for cyclists - a "green wave". This speed is also preferable for public transport operations and pedestrians. (See Chapter 3: Street Users.)

CYCLING BYPASS

In some locations, it may be possible to design a short cyclepath to bypass or avoid a signalised intersection, providing cyclists with a direct route that removes conflicts with traffic. Opportunities to provide a bypass may be found at T-intersections and where cyclists turn left from a cyclepath.

ALL-WAY PHASE

Cyclists can be observed using the pedestrian all-way phase (Barnes Dance) as it creates a low stress crossing opportunity in particular for right turn and U-turn movements. This practice should be formalised with a caveat that there will be a point when the volume of cyclists requires separating them from pedestrians. The overall signal cycle times and the delay to cyclists should be considered.

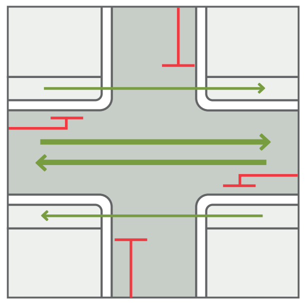
PROTECTED, YET CONCURRENT SIGNAL PHASE FOR BICYCLES

The conflict between left-turning vehicles and people on bikes is a critical design consideration at intersections. In the New Zealand context, an all-pedestrian phase, also known as a Barnes Dance, or an exclusive bicycle phase is often considered to resolve this conflict. Using an all-pedestrian phase adds delays, as overall turning cycles increase substantially both for vehicles as well as pedestrians. This is because an additional signal phase is introduced. As vehicle phases have longer red times, queues grow longer and, in turn, need more time to clear. These long cycles also increase waiting times for pedestrians. Therefore, all-pedestrian phases or exclusive bicycle phases may limit an intersection's capacity. Dangerous situations might also arise from pedestrian non-compliance, with pedestrians refusing to wait for their phase and crossing with parallel traffic, or mid-block, avoiding the intersection, leading to unanticipated conflicts. It is for these reasons that an all-pedestrian/all-bicycle phase is virtually non-existent in the Netherlands.

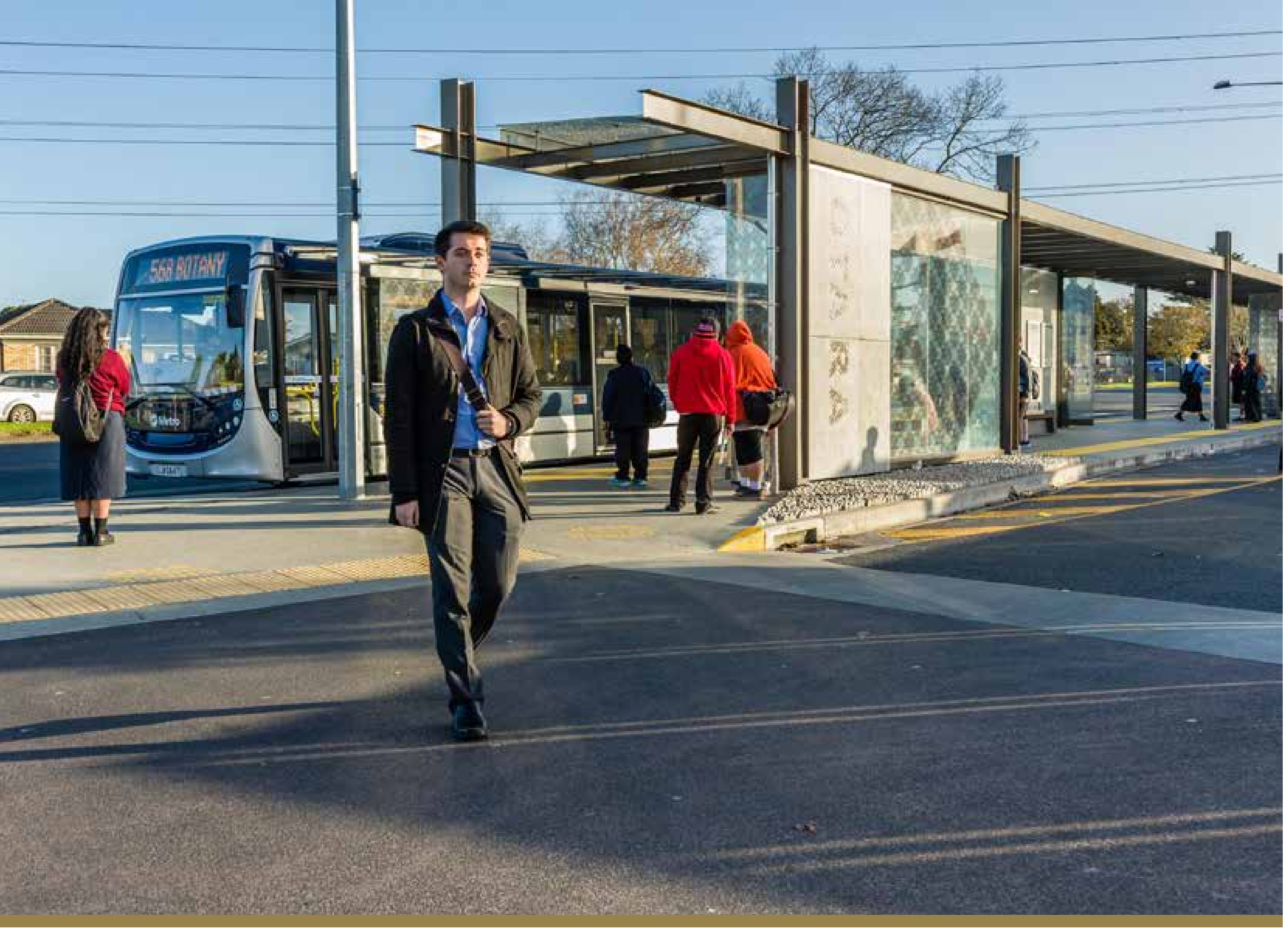
It is recommended to use protected, yet concurrent phases instead. Protected phasing ensures conflicting pedestrian-bicyle movements are not allowed to run concurrently. Left-turning vehicle traffic is allocated its own phase, usually in its own lane, directed by turn arrows. The cyclists' (and pedestrians') crossing phase runs concurrently with parallel through traffic, and conflicts caused by left-turning vehicles is eliminated. The crossing phase might begin later or earlier, to allow additional time for the conflicting left turn phase. There is also an option to run an additional lagging phase to allow more people on bikes through an intersection.

A protected, yet concurren phasing uses both time and space efficiently. Protected, yet concurrent phasing requires fewer lanes to serve traffic. This contributes to keeping an intersection's geometry tight. The protected, yet concurrent phases are what is normally used at signalised intersections with bicycle facilities in the Netherlands and are being increasingly used on cyclepaths in North America.

One alternative is to permit conflicting vehicle turning movements, using permitted phasing. This should be considered acceptable for pedestrian and bicycle crossings only on two conditions; the geometry (turning radius) must force the turning movement to be made at a low speed, and the volume of turning vehicles must be low. One rule of thumb uses 250 turning vehicles per hour as the maximum for allowing permitted phasing. Because of the added traffic stress for pedestrians and especially cyclists wherever conflicts with turning traffic exist, it is highly recommended that this conflict is removed to the greatest extent possible, and that the protected, yet concurrent configuration always be considered before any other treatments.



Protected, yet concurrent movement



Public transport provision

The main consideration when accommodating public transport vehicles at intersections is to enhance the reliability of the public transport service, and connecting pedestrians to public transport. Most public transport stops are near intersections, and they are also where most delays are incurred. For instance, in major cities globally, over 10% of overall bus trip time and as much as 50% of bus delay is accounted for by waiting at traffic signals. It is estimated that similar percentages apply in Auckland.

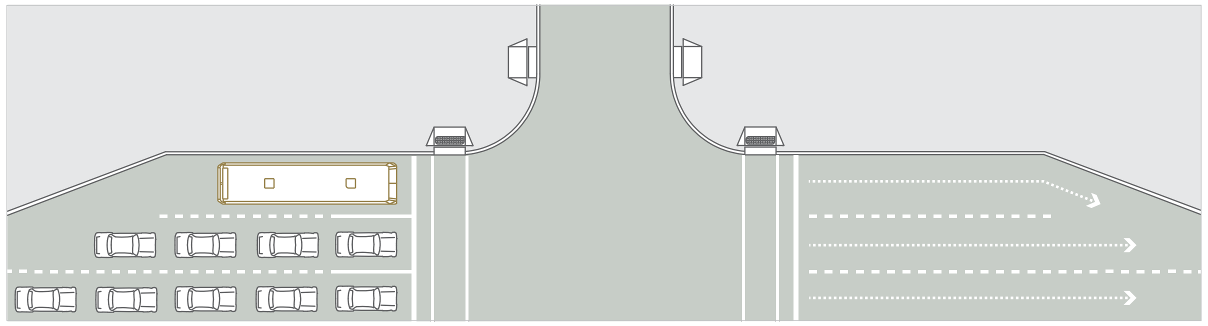
Careful attention should be given to the design of cycling facilities and footpaths around public transport stops, as well as how they are integrated with public transport stops. Where space is available, each mode should be provided with its own space. Where this is not possible, street and intersection designs should seek to maximise safety, provide good sight lines, and minimise conflicts. Wherever different users mix together, they must do so with time to see each other and follow predictable paths at safe, survivable speeds.

SIGNAL PRIORITY

Widely used at prioritised busways in many cities, public transport signal priority allows public transport vehicles to extend a green phase or shorten a red phase, without interfering with the phase sequencing or overall signal timing. The time difference is made up for in the subsequent cycle, when the bus has passed. All other signal operations remain intact. Using an in-vehicle transponder, public transport vehicle drivers can trigger a signal change on their approach to an intersection, ensuring that they have a green light. This minimises waiting times at the intersection, or eliminates it altogether. This reduction of delays allows public transport to stay on schedule and it minimises bunching.

DEDICATED BUS LANE, SHORT APPROACH LANES, QUEUE JUMPS

Continuous bus lanes, short approach lanes and queue jump lanes provide a by-pass for public transport vehicles to reach the front of the intersections. These are used in conjunction with active signal priority (e.g. a white B-phase signal) to give buses a head start into a receiving public transport lane or a general traffic lane.



PUBLIC TRANSPORT ROUTES

Public transport routes include service routes as well as routes vehicles use to and from the depot. At intersections with very frequent bus turning movements (>12 buses/hour), streets should be designed for the 12.6m urban bus.

The intersection principles established above are especially relevant to public transport routes, as they are likely to have high levels of people on foot, as well as multiple, competing interests in the road reserve.

In order to maintain compact intersections along frequent bus routes (> 12 buses an hour), the techniques to accommodate large vehicle movements should be used.

The following public transport strategies should also be considered to maintain compact intersections:

- Minimise bus route turning movements
- Consolidate turning movements at one intersection (instead of at multiple adjacent intersections)
- Consider right turning patterns for bus routes (to minimise intersection geometry).

Other public transport design considerations:

- Consider the mutual benefits of public transport priority elements (bus lanes, queue jumps, signal advance, etc.) in intersection design
- Consideration should also be given to private transport operators in areas where large tourist buses and vans are likely to conduct business on a regular, basis.

PUBLIC TRANSPORT PRIORITISATION/ SIGNAL TIMING

Public transport prioritisation at intersections can contribute to a more reliable, more efficient public transport service. It also makes it less polluting, as it leads to less queuing, stopping and starting. Public transport prioritisation encompasses signal coordination, signal priority, dedicated public transport-only lanes, as well as queue jumps or bypass lanes.

Signal coordination and priority strategies are typically used in conjunction with dedicated public transport-only lanes and queue jumps. Where signal priority and queue jumps are provided, the impact on overall signal cycle lengths as well as the impacts to delay for other users should be considered.

Bus head starts and bypasses can be an effective strategy to allocate road space across constrained corridors.

Intersection guidance

This section presents guidance on a variety of intersection types.

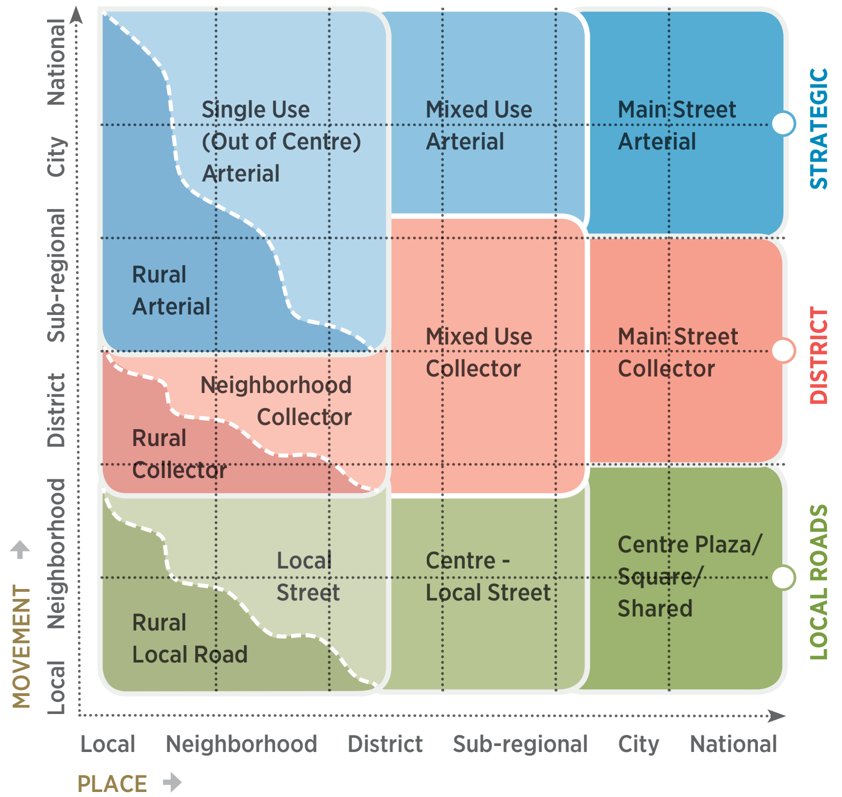
The intersection guidance shows the following intersection examples:

- Roundabout
- Arterial to Arterial
- Collector to Collector
- Collector to Local Street
- Local to Local Street
- Laneway/driveway
- Local network intersection.

The existing conditions, design objectives and recommended treatments for each of these intersection types is discussed.

Guidance focuses on the desired outcome (design objectives) and provides a roadmap on how to get there, by providing recommended design treatments for each intersection type. Beforehand, the existing conditions are to be analysed.

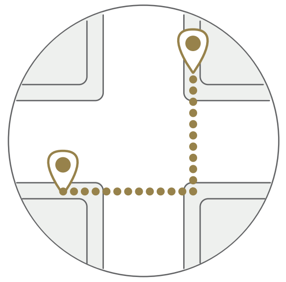
Roads and streets family



Not all combinations of major and minor roads at intersections are covered, but the design considerations will allow other combinations to be understood. Different land use contexts will require adaptation of the examples to be adapted to the context.

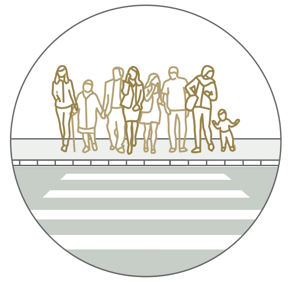
Intersection analysis

When considering a redesign of any type of intersection, one should collect and consider the following features of the intersection:



CONTEXT

Document gathering places, landmarks, transit stations, and other relevant activity.



PEDESTRIAN ACTIVITY

Note desire lines and where people linger. Where do informal crossings occur? Use land use plans, census data and employment data to assess demand, not just measure current use. Do older people, users of mobility aids and children use the intersection? If not, it may indicate suppressed accessibility.

SAFETY ANALYSIS

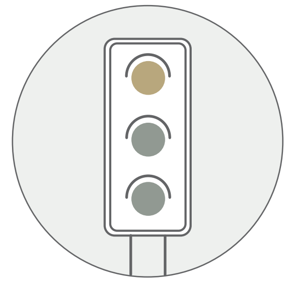
Analyse crash history and assess safety of existing user conflict points. What may need to be improved for safe system design?

PUBLIC TRANSPORT AND CYCLEWAY ACTIVITY

Calculate the volume of people that may move through the intersection.

VEHICLE VOLUMES

Map and understand the turning movements required of the intersection. Overlaying vehicle volumes gives perspective on the relative importance of that link in the network.



SIGNALISATION

Acquire signal plans (SCATS data) from the Auckland Transport Operations Centre.

Intersection design

After acquiring and analysing the above data, one can begin to make informed decisions on what should be prioritised in the intersection. The following guidance provides illustrated intersection examples that show the principles and address the outlined features above. Not all features will be present at all intersections, especially where existing streets are being altered over time. Network planning will guide what features and considerations are currently required.

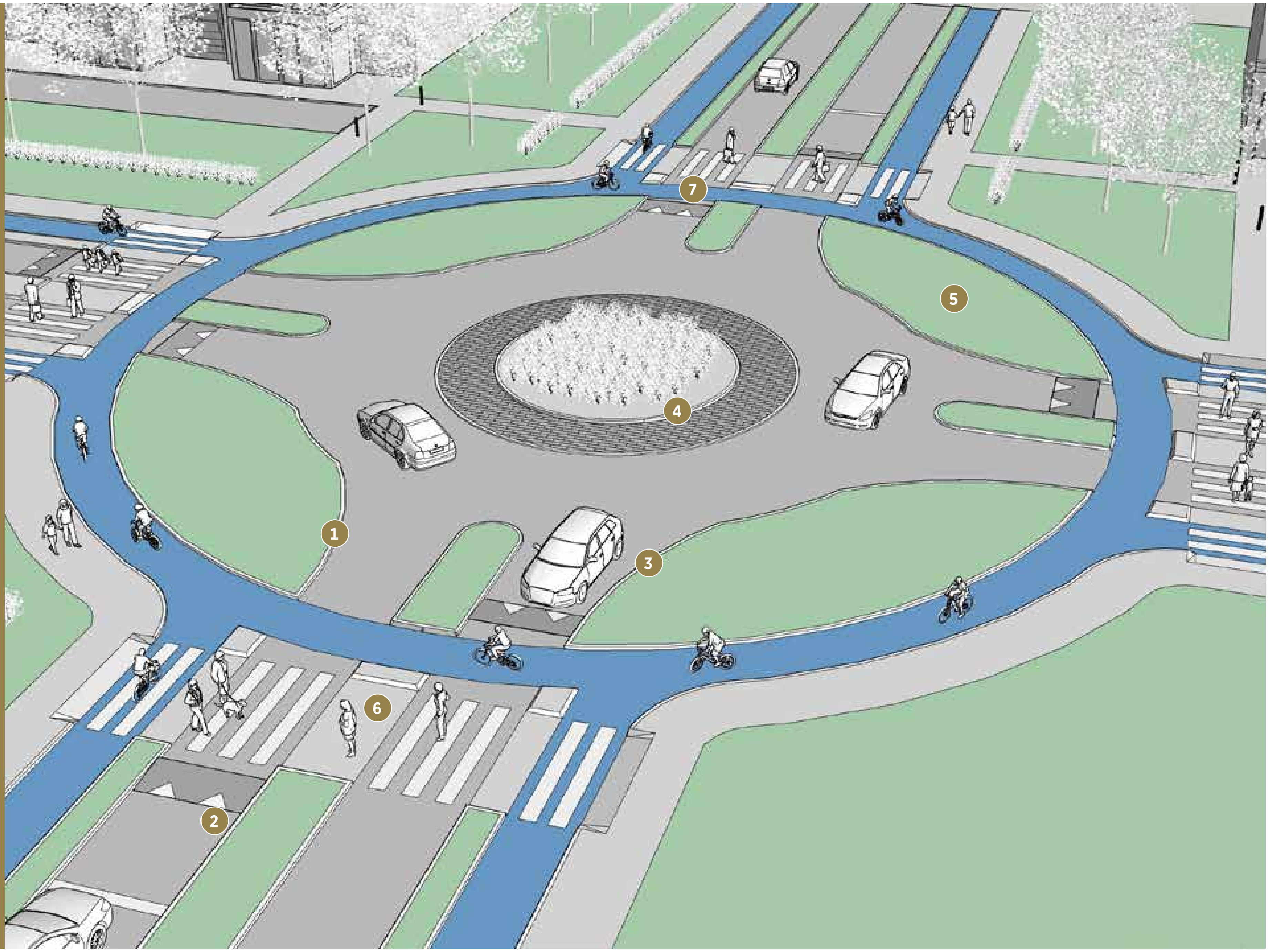
Roundabout

Roundabouts are the preferred safe intersection type. This is because they reduce the number of potential conflicts between road users, and lower speed and angle where conflicts may occur. The traffic flow is usually better at roundabouts, as approaching drivers only need to wait for a gap in traffic in order to enter the roundabout (as opposed to having to wait to get a green signal). Because of this, exhaust emissions and noise levels are lower at roundabouts.

Roundabouts take up more corner space but less approach lane space than conventional intersections. Internationally, roundabouts are widely used instead of intersections, because of their safety benefits. In the Netherlands replacing an intersection with a roundabout is estimated to reduce the number of severe casualties by around 46%. Where road users face a difficult task at intersections because of the more complex traffic situation (drivers have to make a decision about their route, steer their vehicle, and also allow for the unexpected manoeuvres of other road users), roundabouts offer a simplified and straightforward driving experience that is relatively stress-free.

Traffic flow on roundabouts depends on the amount of traffic on the approach roads. Where traffic on these roads is balanced, a good traffic flow on the roundabout is ensured. Note that multi-lane roundabouts require specialist design.

This example discusses features that may not be necessary at all roundabouts.



DESIGN OBJECTIVES

By their design, roundabouts slow down traffic. The design must also make drivers yield naturally to any crossing pedestrians and cyclists, who must have priority at crossings. This is supported by designing the roundabout in such a way that drivers have crossing cyclists and pedestrians squarely within their view when exiting or approaching the roundabout. At a typical roundabout, drivers will sit at a 90-degree angle with the crossings for cyclists and pedestrians before proceeding, which ensures eye contact between road users. An approach speed of 30 km/h is considered appropriate for a roundabout. To ensure this approach speed, the roundabout should meet certain design requirements, such as featuring consecutive bends that motor vehicles have to follow when approaching and driving on a roundabout, or ramped approaches.

RECOMMENDED TREATMENTS

1. Before entering the roundabout and after passing the pedestrian and cyclist crossings, drivers wait in a vehicle storage area for a gap in traffic. The space must balance the need for a smooth entrance onto the roundabout with the need for low speeds.
2. Any vehicles approaching and leaving the roundabout must be ready to yield to pedestrians and cyclists. Roundabouts are designed to reflect this priority.
3. After leaving the roundabout, but prior to the pedestrian and cyclist crossings, drivers yield to crossing pedestrians and cyclists in the motorist yield zone. This zone must provide enough room so that the vehicle does not impede the flow of the roundabout, while also ensuring that the vehicle approaches the crossings perpendicularly to maximise visibility of pedestrians and cyclists.
4. A truck apron (a mountable outer portion of the central island) only has a modest vertical deflection. This allows trucks, buses, and emergency vehicles to mount it if needed.
5. Similar to protected intersections, corner safety islands are used to separate cyclists from conflicting vehicle movements on the roundabout and provide a high degree of safety and comfort for cyclists.
6. Pedestrian crossing islands ensure that pedestrians only have to cross one direction of traffic at a time, eliminating the need to look in both directions simultaneously, thus reducing the stress of crossing.
7. Raised table crossings with zebra, paired crossing or signal crossing allow safe crossings without long delays.

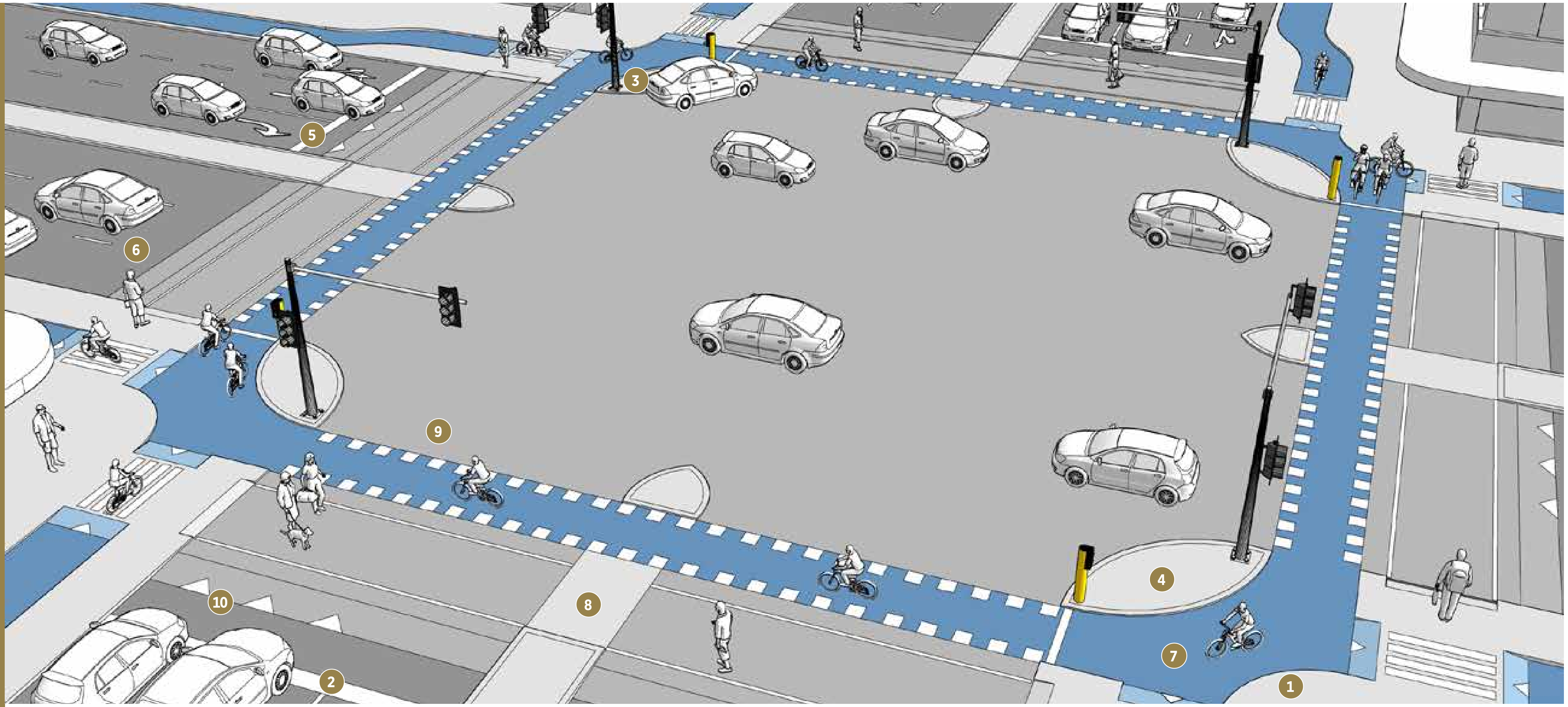
- For high traffic flows, multi-lane roundabouts may be required. Additional safety measures are needed for people on foot or bike, such as signal-controlled crossings.
- For high or unbalanced flows, entry metering or full signalised roundabouts may be safe and efficient, incorporating signal-controlled crossings.

Arterial to arterial

Arterial to arterial intersections exist wherever arterials intersect. These roads provide access to the motorway network and to main street arterials, and connect to the wider region. Their main purpose is servicing through movement. They are often the most intensively used by people in vehicles as places to pass through, though they are also destinations in their own right in some places, by virtue of the land uses adjacent to these roads.

As the backbone of the city's street network, it is important to create adequate facilities for pedestrians and cyclists. This is especially important given that large intersections can become barriers to walking and cycling.

There is also a unique opportunity to redesign these arterial streets, which presently are mostly traffic-dominated places, back into the urban fabric by supporting the adjacent land uses and minimising the number of lanes, transforming them into better places.



DESIGN OBJECTIVES

The primary function of arterial to arterial intersections is to support an exchange of traffic flows where two arterial streets intersect. Traffic flows include and should prioritise pedestrian, cycling and public transport vehicles.

These intersections tend to support retail activity, because of the great accessibility and visibility of the location.

Providing a safe environment for all street users at these intersections is achieved by the following conditions:

- Shortened pedestrian crossing distances
- Accommodated desire lines
- Footpath widths that are appropriate for retail centres
- Safe and attractive facilities for cyclists and public transport
- Slow down traffic movements between intersections (40 km/h for urban areas)
- Slow down turning vehicles (target turning speed 15 km/h)
- Slow down vehicles through intersections to survivable speeds <30 km/h
- Public space or green infrastructure.

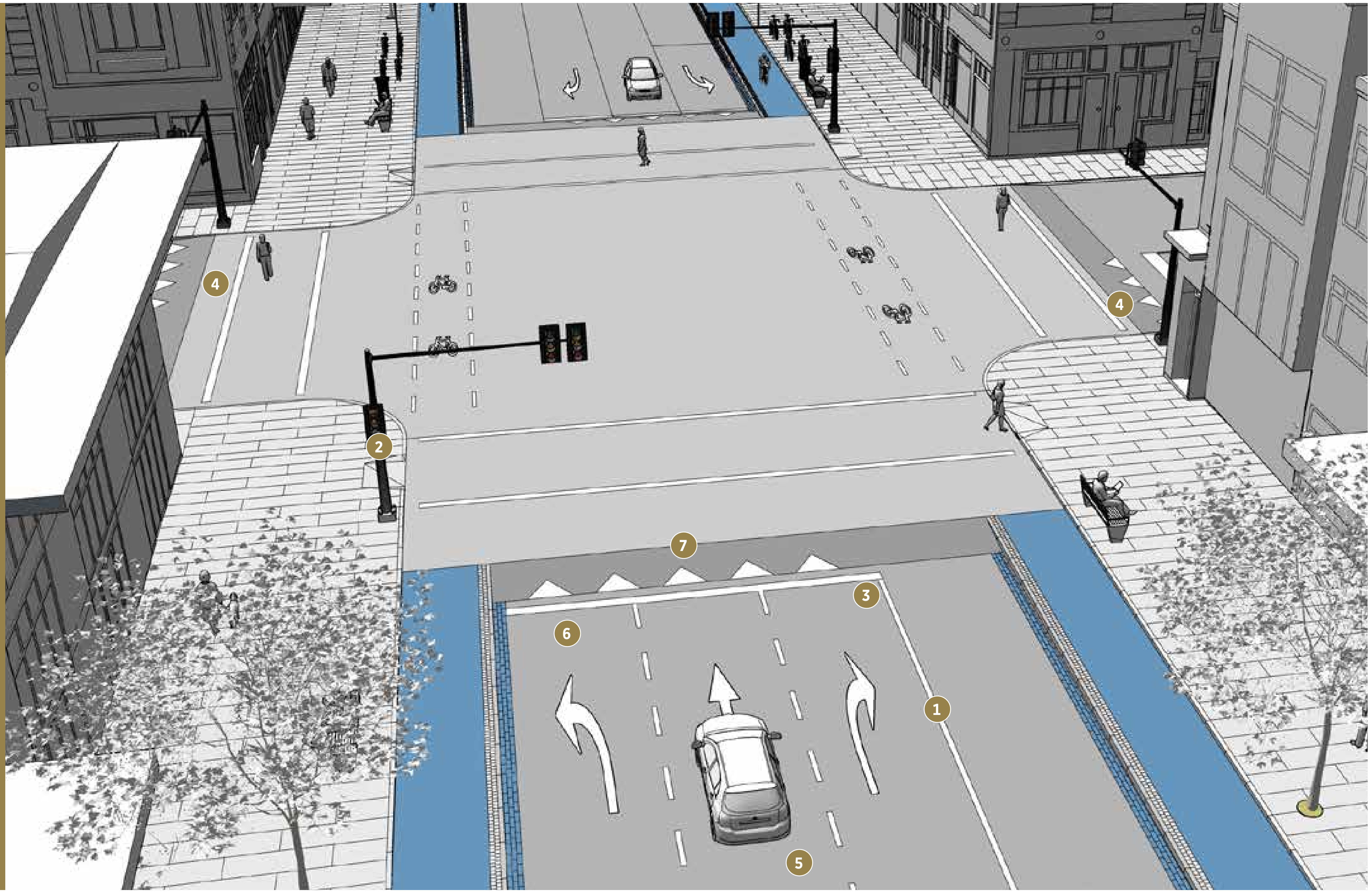
RECOMMENDED TREATMENTS

It is best to apply design treatments that naturally slow down vehicles and provide safe methods for pedestrians and cyclists to cross. This can be done in a number of ways:

1. Tightening the kerb radii will enforces lower speeds as vehicles are making a turn and provide more pedestrian space.
2. Placing the stop line at a slight distance from the intersection is recommended to improve pedestrian and cyclist visibility.
3. Remove slip lanes and add signalised turn lanes for vehicles turning across oncoming traffic.
4. Corner safety islands prevent cars from turning into the path of the cyclists and provide more visibility for pedestrians.
5. Reducing the number of single-purpose lanes (and having multi-purpose lanes instead) can support a narrower geometry.
6. Narrower lanes can save space and visually narrow the carriageway, slowing traffic down.
7. Bicycle lanes should lead up to the intersection from each direction
8. Pedestrian refuge to allow pedestrians to focus on one direction of traffic at a time as they cross the street and to reduce crossing times.
9. Direct and visible pedestrian and cyclist crossings that follow desire lines.
10. Ramps or raised tables on approaches slow down vehicles, allowing safe speeds if drivers fail to stop, and protecting people on crossings.

Collector to collector

'Collector to collector' intersections are common in Auckland and exist wherever the city's main streets, mixed-use and neighbourhood collectors intersect. Collector streets provide access to neighbourhoods and residential streets, and connect to the wider urban area. They are focal points of neighbourhood activity and retail. They are often the most intensively used by pedestrians, both as places to pass through and destinations. As the backbone of the city's walking network, it is important to create adequate facilities for pedestrians and to provide pedestrian amenity in collector to collector Intersections.



2 Tightening the kerb radii will enforce lower speeds as vehicles turn.

3 Placing the stop line at a slight distance from the pedestrian crossing is recommended to improve pedestrian visibility. Removing on-street parking along the roads leading up to the intersection is advised as well, as it frees up further space to keep crossing distances short.

4 Where capacity allows, reducing the number of single-movement lanes (and having multi-purpose lanes instead) can support a narrower geometry. In addition, understanding the number of through and turning vehicles in each lane is important, to optimise allocation of lanes and avoid sudden lane change.

5 Narrowing lanes is also highly recommended; many medium streets have excessively wide lanes and some of these are widened even further at intersections. Narrower lanes do not only save space, they also visually narrow the carriageway, slowing traffic down.

DESIGN OBJECTIVES

The primary function of collector to collector intersections is to support an exchange of traffic flows where two main streets intersect. Traffic flows include and should prioritise pedestrian, cycling and public transport traffic. In most cases, these intersections support a wide variety of retail stores.

Providing a safe environment for all streets users at collector to collector intersections is achieved by the following conditions:

- Shortened pedestrian crossing distances
- Accommodated desire lines
- Footpath widths that are appropriate for retails centres
- Safe facilities for cyclists and public transport
- Slow down traffic movements between intersections (target 30 km/h for local streets, 40 km/h for neighbourhood collectors)
- Slow down turning vehicles (design turning speed 15 km/h)
- Public space or green infrastructure.

RECOMMENDED TREATMENTS

It is best to apply design treatments that intuitively slow vehicles down, and make it safer, and quicker for pedestrians and cyclists to cross. This can be done in a number of ways:

1 By removing excessive markings on the carriageway, centre lines in particular, drivers become more observant of their surroundings, and will begin to slow down, as their desired position on the carriageway is less clear. Limit markings to the minimum required for safe intersection control.

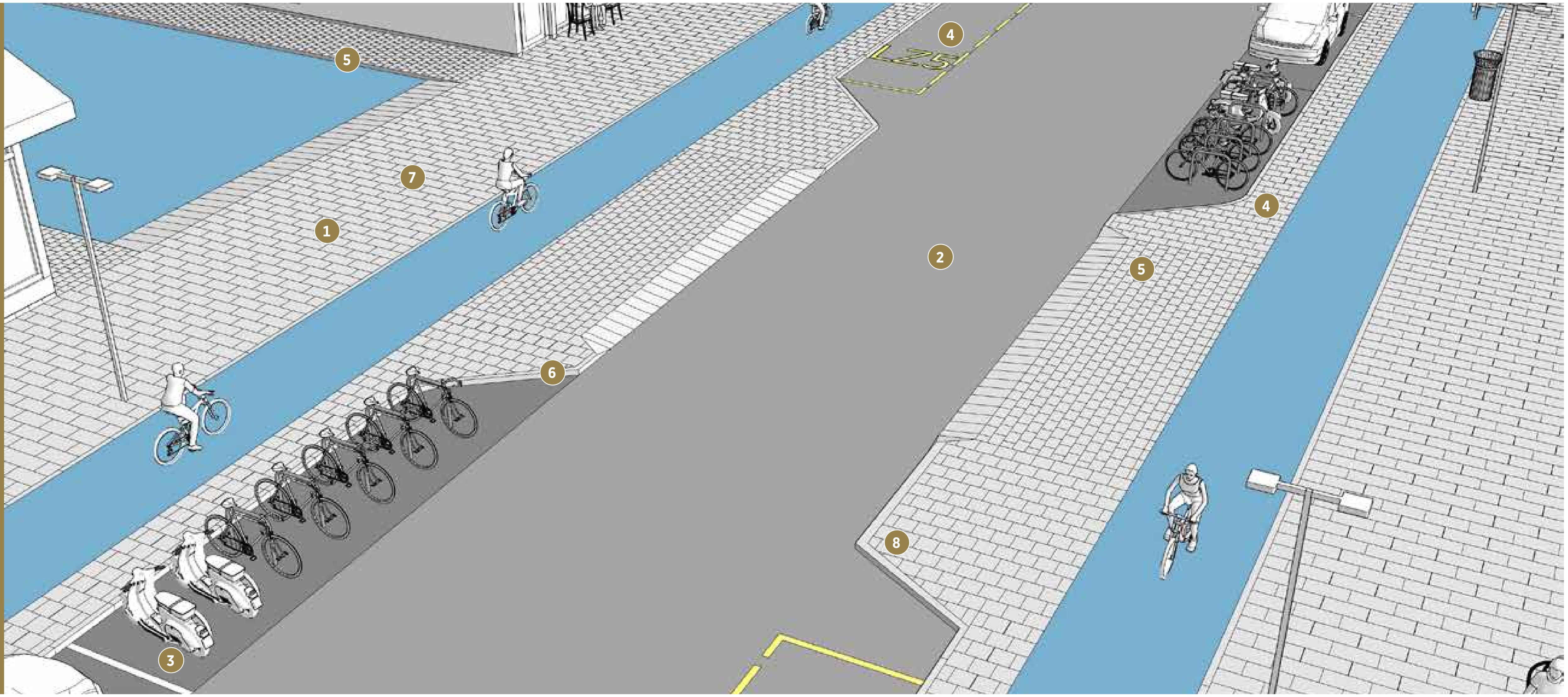
6 Provide protected, yet concurrent turn controls to allow cycle and pedestrian through movement priority.

7 Ramps or raised tables on approaches slow down vehicles, allowing safe speeds if drivers fail to stop, and protecting people on crossings.

Collector to local street

Collector to local intersections are where traffic transitions from busier streets, often characterised by higher speeds, to the more quiet residential, commercial, industrial, or urban mixed-use streets; characterised by a limited amount of vehicle traffic.

There is a potential change between the continuing collector street and the local side street in terms of prevailing speeds, traffic volumes, land uses, public transport service and pedestrian amenity.



DESIGN OBJECTIVES

Turning speeds from the medium street to minor street should be slow. Tight kerb radii are advised to help achieve this.

These intersections should be designed to provide a safe and easy crossing for all users, including children, the elderly and people on bikes. This includes crossings across the local street, and across the collector street. Creating a compact and safe intersection for all modes may be difficult to achieve simultaneously. In these situations, the design should clearly reflect the appropriate user hierarchy for the street, and prioritise people walking and cycling. In light of this, it is important to slow speeds on local streets to no more than 30 km/h (with 40 km/h being the advised top speed for the collector street). The intersection must be designed for the design vehicle and not for the control vehicle. (See also Chapter 4 Design Controls.)

A key set of outcomes that any collector to local intersection must seek to achieve:

- Minimised crossing distances
- Safe (and where possible, level) pedestrian crossings
- Defined entryways onto the side street (raised crossings or speed bumps may achieve this)
- Enforced slower speeds.

RECOMMENDED TREATMENTS

1. Provide pedestrian priority through a combination of techniques, including a raised crossing in line with pedestrian desire lines. The raised platform reinforces pedestrian priority and encourages slow speeds for turning vehicles. Platform ramp slope is designed to achieve the desired turning speed.
2. Traffic lanes are reduced in size to reinforce slower traffic speed.
3. On-street parking may be reclaimed for other uses, or reduced and balanced with other kerbside functions.
4. Provide protected cycle lanes. The cycle lanes provide a buffer between the footpath (including outdoor seating areas) and the carriageway and may help accommodate occasional larger vehicle turns made by the control vehicle, as they enlarge the effective turning radius.
5. Provide a threshold to the different street type.
6. Introduce kerb extensions in order to reduce pedestrian crossing distance.
7. Remove the splitter island where it is present.
8. Keep kerb radii small to slow down turning vehicles.

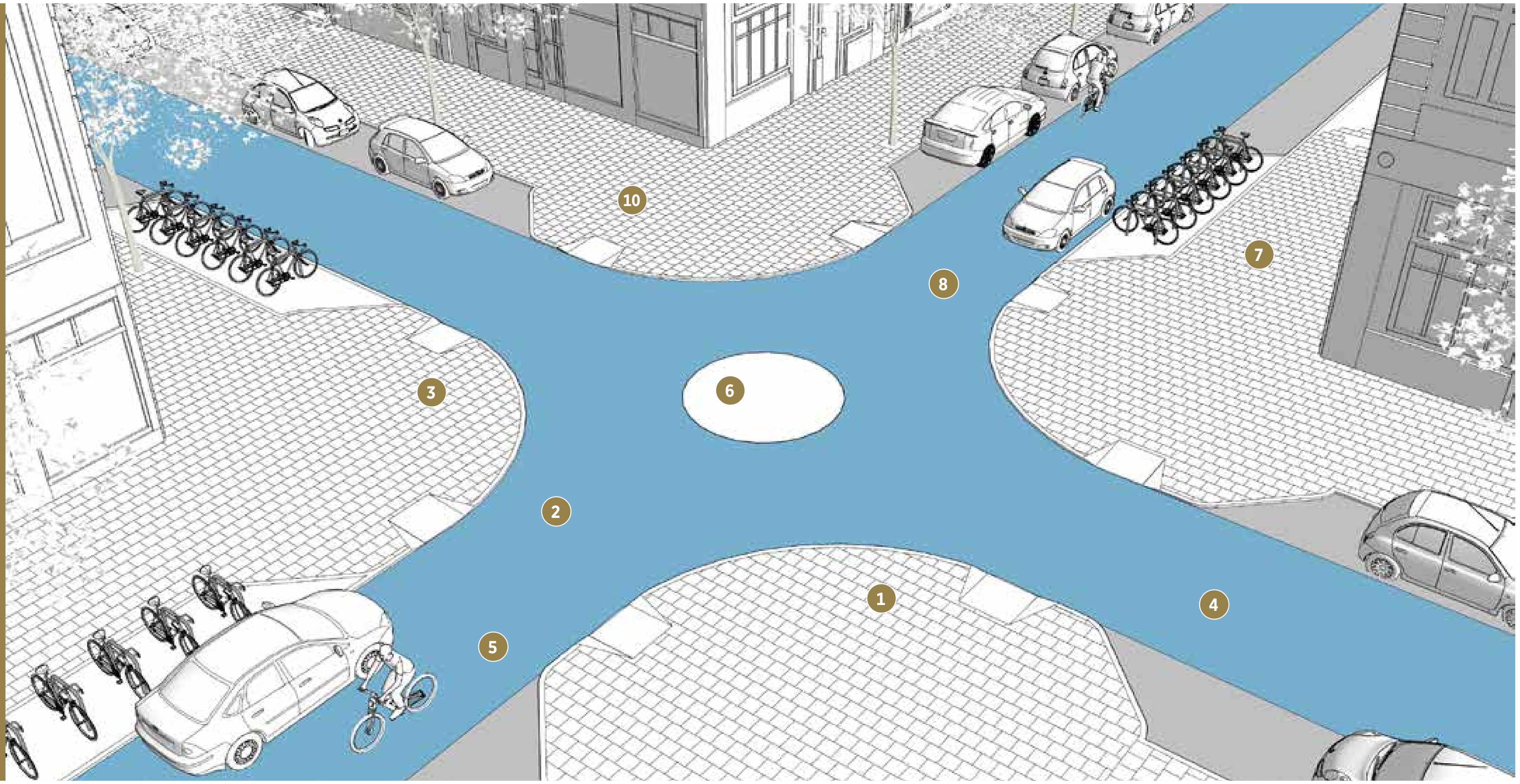
Local to local street

Local to local intersections make up the bulk of intersections in Auckland.

They are the quiet intersections between the local streets that make up the fabric of Auckland's neighbourhoods.

Whether they are situated in residential, commercial, industrial or mixed-use districts, local streets tend to be characterised by comparatively low volumes of vehicular traffic.

They are the places where people live, work and socialise.



DESIGN OBJECTIVES

The primary functions of local streets is to support daily activities such as walking to school and nearby destinations, encouraging social interaction among neighbours and creating a pleasant living environment. In some cases, these intersections support important local services such as dairies and shops.

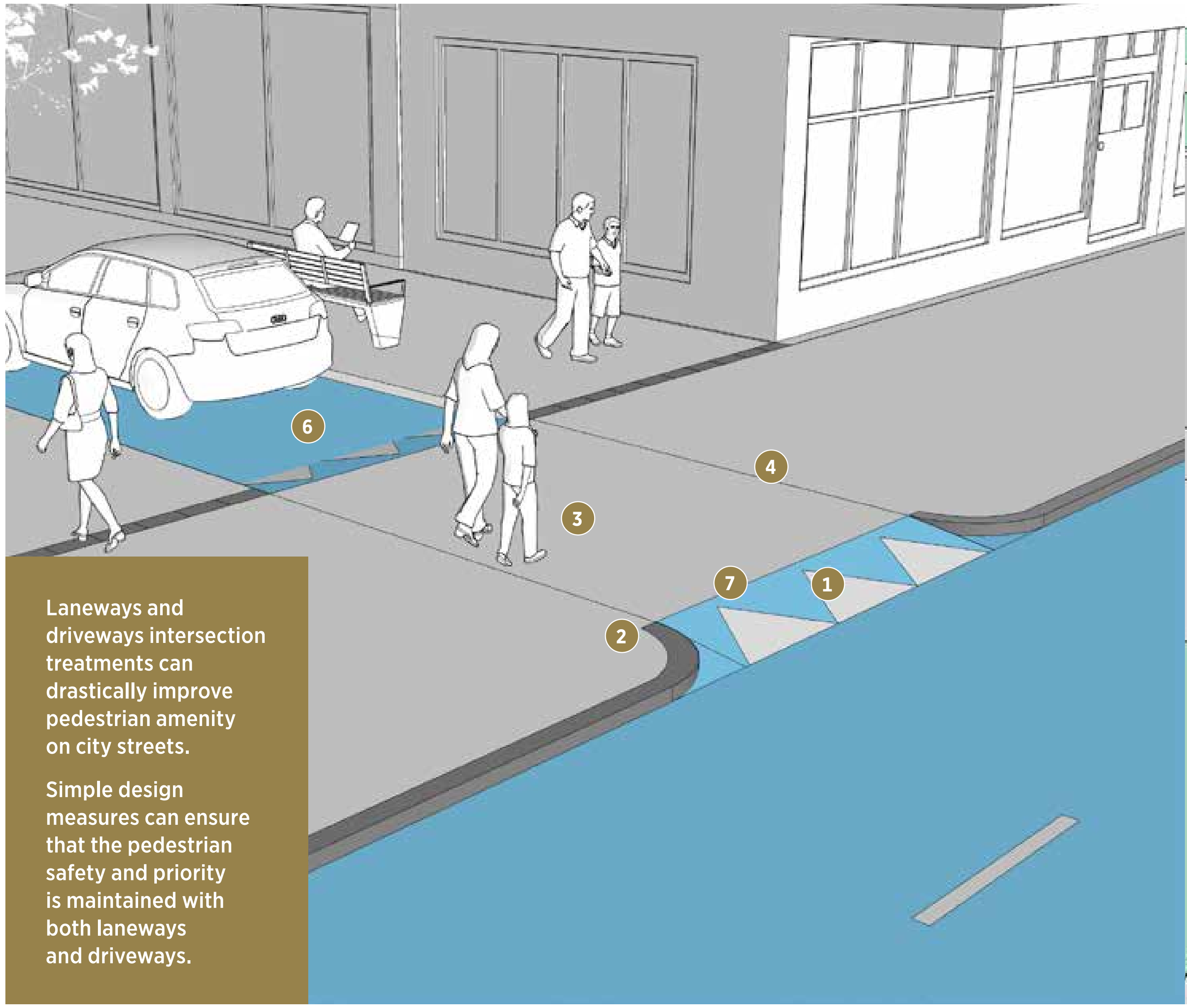
Creating a safer environment for all street users at local to local intersections is achieved by the following conditions:

- Slow down traffic movements along segments (with a maximum of 30 km/h for local streets).
- Slow down turning vehicles (with a maximum turning speed 15 km/h).
- Enable eye contact between users where mixing occurs.
- Shorten pedestrian crossing distances. This might be achieved by scaling down the kerb radius and by implementing kerb build-outs, and by narrowing travel lanes.
- Accommodate pedestrian desire lines. This is particularly critical at pedestrian crossings. Detours should be avoided and pedestrian crossings should be kept as close to the intersection as possible.
- Re-allocate roadway space to public space or green infrastructure. Currently, the roadways on local streets tend to provide far more space than is required for regular vehicle operations. Excess roadway space can be repurposed as public space, or as green infrastructure such as rain gardens, bioswales, street trees, or berm gardening.
- Consider strategies across the wider network (traffic calming, local paths). Interventions across a network of streets might work together to bring speeds down across neighbourhoods, and to make communities more liveable.
- Manage traffic volume and speed so that people on bikes can travel safely with other vehicles.

RECOMMENDED TREATMENTS

1. Square the intersection by removing oversized kerb radii.
2. Remove pedestrian splitter islands where these exist, and instead shorten crossing distances by narrowing the street's geometry.
3. Shorten pedestrian crossings with kerb build-outs.
4. Remove road markings except limit lines at crossroads. The removal of centre lines encourages drivers to reduce their speed.
5. Placing the limit line at a slight distance from the pedestrian crossing is recommended to improve pedestrian visibility. Removing on-street parking along the roads leading up to the intersection is advised as well, as it frees up further space to keep crossing distances short.
6. Introduce mini-roundabouts where appropriate (best introduced at regular intervals to help keep speeds low throughout the street network).
7. Add missing footpaths where deficiencies exist in the footpath network. Where it is possible, footpaths must be provided on both sides of the road.
8. Close redundant links.
9. At T-intersections, align the side street and ongoing street intersect at a 90-degree angle.
10. Provide pedestrian facilities along desire lines. These can be distinguished using a different form of pavement material for the pedestrian crossing.
11. Consider adding traffic calming elements that provide vertical deflection, in order to effectively slow traffic. These could be either raised tables that span the intersection, or individual speed bumps on each of the approaches to the intersection.

Laneway or driveway



Laneways and driveways intersection treatments can drastically improve pedestrian amenity on city streets.

Simple design measures can ensure that the pedestrian safety and priority is maintained with both laneways and driveways.

RECOMMENDED TREATMENTS

1. Install steep ramp profiles that slow down vehicles.

3. Ensure that the footpath treatment is level and uninterrupted across the intersection.

4. Footpath material should reinforce the continuity of the path and be distinct from the roadway material. This helps to enforce proper yielding behaviour by motorists.

2. Consistently apply very small corner radii of less than 2 m.

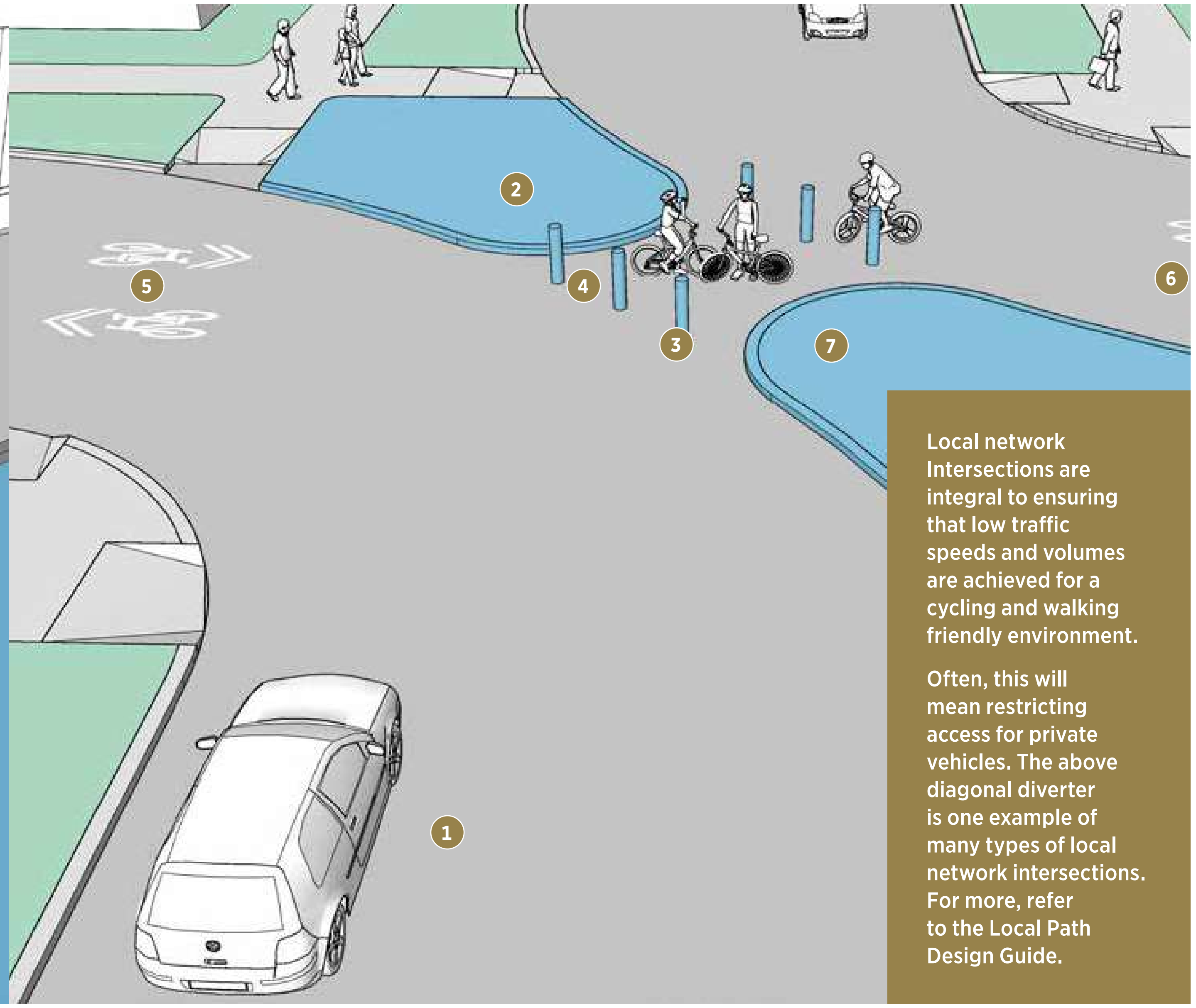
5. Add a stop line or speed hump at the exit of the laneway or driveway, before the footpath.

6. Overall laneway width is minimised by allowing vehicles to share adjacent lanes, or (preferably) by limiting vehicles to one direction.

7. Ensure that the driveway ramps are minimised and do not extend into the clear pedestrian travel zone.

- Overall design treatment should ensure that these intersections between main roads and laneways or driveways are clear entry points or transitions into a different type of environment.

Local network intersection



Local network Intersections are integral to ensuring that low traffic speeds and volumes are achieved for a cycling and walking friendly environment.

Often, this will mean restricting access for private vehicles. The above diagonal diverter is one example of many types of local network intersections. For more, refer to the Local Path Design Guide.

RECOMMENDED TREATMENTS

1. This treatment is recommended in areas with sufficient access options in the street network.

2. No parking should be allowed around the central diverter.

3. Use reflective pavement markings and signage to increase visibility at night.

4. Gaps between bollards should be around 1.5 m to provide for bicycles, but not motorised vehicles.

5. Sharrow markings may be used for wayfinding and warning purposes.

6. Consider alternate emergency response routes.

7. These intersections can provide an opportunity for landscaping; native and low-maintenance plants are recommended. Planting should not obstruct visibility and should be <1.0 m high in general.

Resources

IN THIS CHAPTER

Glossary of terms a-z

ACCESSIBILITY Ease of access/egress to any location by walking, cycling, public transport and private vehicles, or for commercial vehicles. In terms of those with disabilities (including the elderly), the aim is to provide those pedestrian citizens with greater accessibility to the outdoors throughout the year.

ACTIVE MODES See Active Transport

ACTIVE TRANSPORT Any mode of transport by which people use their own energy to power their motion, including walking, running, cycling, skateboarding, inline skating and use of a manual wheelchair.

ACTIVE STREETS Streets where building edges/frontages are oriented toward, and are directly accessible from, the street by foot to promote pedestrian activity.

ARTERIAL ROADS Roads intended to carry large volumes of traffic between areas (through traffic) with fewer access opportunities to adjacent developments.

BARRIER-FREE A design characteristic that maximises accessibility for persons with physical or cognitive difficulties.

CAPACITY (ROADWAY) Maximum hourly rate at which vehicles can reasonably be expected to pass a given point under prevailing roadway, traffic, and control conditions.

CARRIAGEWAY The (kerb-to-kerb) section of a street or road that is primarily used by motor vehicles, but may also be used by pedestrians and cyclists. It is legally defined as roadway.

COLLECTOR ROADS Roads that provide neighbourhood travel between local and arterial roads and direct access to adjacent lands. Buses generally operate on collector roads within neighbourhoods.

COMPLETE COMMUNITY A community that is fully developed and meets the needs of local residents through an entire lifetime. Complete communities include a full range of housing, commerce, recreational, institutional and public spaces. They provide a physical and social environment where residents and visitors can live, learn, work and play.

COMPLETE STREET A street that moves people, by foot, bike, bus and car; provides places where people can live, work, shop and play; supports the natural environment; facilitates movement of trucks and service vehicles, and supports our economy.

CONNECTIVITY Connectivity entails how easily and directly users can move through street networks.

CORNER RADII The measure of how broad or tight corners are at a junction, measured from the outside of a kerb or the outside of a cycle lane (where present).

CYCLE FRIENDLY A street environment designed to allow cyclists to move about in safety and comfort.

DENSITY The number of dwelling units, square metres of floor space, or people per acre or hectare of land.

DESIGN SPEED Design speed is the speed selected as a basis to establish appropriate geometric design elements for a particular section of road. Essentially, it is the maximum speed at which it is envisaged/intended that the majority of vehicles will travel under normal conditions.

DESIRE LINES Normally the shortest route from one place to another, but can also be the most convenient, easy to use or comfortable route between two places.

ENCLOSURE (SENSE OF) A condition created by providing a continuous line of buildings and/or street trees that has the effect of calming traffic and creating a greater perception of safety, especially for pedestrians and cyclists.

FOOTPATHS The area within the road reserve that is generally reserved for pedestrian use.

FORMAL OR FORMALISED CROSSINGS Crossings that require motorised traffic to stop to let pedestrians cross. These can include zebra crossings and signalised crossings.

FREQUENCY (TRANSIT) The number of transit units (buses or trains) on a given route or line, moving in the same direction, that pass a given point, within a specified interval of time, usually 1 hour.

FUNCTIONAL CLASSIFICATION Functional classification is the process by which streets and highways are grouped into classes according to the land use, service function, traffic volume and speed, flow characteristics, vehicle type, and connections.

GREEN INFRASTRUCTURE An interconnected network of natural green and engineered green elements applicable at multiple scales. Natural green elements include the conservation and integration of traditional green elements including trees, wetlands, riparian areas and parks. Engineered green elements include systems and technologies designed to mimic ecological functions, or to reduce impacts on ecological systems. Examples include green alleys, green buildings and green roadways.

GREENWAYS See local paths.

GREENFIELD DEVELOPMENT Urban development where there is no need to demolish or rebuild any existing structures. Typically, this development occurs on the periphery of the metropolitan area.

HIGH-OCCUPANCY VEHICLE (HOV) A vehicle occupied by multiple occupants, usually 2-3 or more occupants. Often HOVs are defined by a local regulation or sign, indicating how many occupants are required for the vehicle to be able to travel in a separate lane for HOVs. Buses are usually included by rules and resolutions.

HOME ZONE A type of shared street in a residential area which may also include items of street furniture that would normally be used within areas of open spaces.

HORIZONTAL DEFLECTIONS Changes that occur within the horizontal alignment of the carriageway, such as pinch points, that slow vehicles and require drivers to change direction.

HUMAN SCALE A person's perception of the size, scale, height, bulk and/or massing of buildings and other features of the built environment.

INTEGRATED STREET NETWORKS Highly connected street networks that support the integration of land use and transport.

IMPERVIOUS SURFACES Mainly artificial structures such as building roofs, roadway pavements, footpaths and car parks that cannot be easily penetrated by water, thereby resulting in runoff.

LEGIBILITY The ease in which a user can navigate a street or street network using a series of environmental cues, such as buildings and landmarks.

LEVEL OF SERVICE (LOS) An indicator of the quality of operating conditions for the transport system that may be applied to cycling or walking facilities (to reflect safety, connectivity, convenience and comfort), transit service (to reflect speed, reliability, frequency and passenger comfort) or roadways (to reflect the ratio of vehicle demand to roadway capacity, and resultant delay).

LINK The role of the street in serving as a facility for the movement of people through the corridor.

LOCAL PATHS A road or street designed to slow down traffic, limit traffic volumes, facilitate cycling and walking, and to reduce environmental impacts and discharges to the storm sewer system. Local paths provide amenity and are pleasant, slow-traffic roads and streets that are inviting routes for walking and cycling. Local paths utilize storm water management strategies with features such as street trees, landscaped swales and special paving materials that allow infiltration and limit runoff. Increased vegetation may also improve air quality.

LOCAL ROADS Roads that provide direct access to adjacent lands and serve neighbourhood travel.

MIXED USE A development, street or broader area that contains a range of different land uses.

MODE (OR MODAL) SPLIT The proportion of total person trips using each of the various modes of transportation. The proportion using any one mode is its modal share. Together, transit, cycling, and walking trips make up the non-auto modal share.

MODE SHARE The percentage of person-trips made by one travel mode, relative to the total number of person-trips made by all modes

MODE SHIFT The shift away from single-occupant vehicle use and dependency to an increased variety of transport mode usage for various types of trips.

NODES Major places of convergence and interchange between different forms of transport.

NEIGHBOURHOOD — A residential area with an appropriate mix of housing types with convenience-type commercial facilities and, where appropriate, schools or park facilities.

OPERATING SPEED — The prevailing speed of traffic on a transport facility. Typically quantified as the 85th percentile speed (i.e. the speed at or below which 85% of vehicles are traveling at or below).

PASSIVE SURVEILLANCE — Overlooking of streets and spaces from adjoining buildings.

PEDESTRIAN-FRIENDLY — See Walkable.

PERMEABILITY — The degree to which an area has a variety of pleasant, convenient and safe routes through it.

PLACE — The role of the street in serving as a destination for people to spend time.

PLACEMAKING — Placemaking is the process of creating spaces, such as squares, plazas, parks, and streets, that will attract people because they are pleasurable or interesting.

PUBLIC REALM — The region of a road reserve between buildings and the driving lanes used by pedestrians. It can include footpaths, street furniture, street trees, signs, street lights and patio space.

PUBLIC TRANSPORT — Public transport is a shared passenger transport service which is available for use by the general public, as distinct from modes such as taxicab, carpooling or hired buses, which are not shared by strangers without private arrangement.

ROAD RESERVE — Publicly owned land containing carriageway, paths, street furniture, landscaping and/or utilities.

ROAD DIET — A technique to reduce the number of lanes on a roadway cross-section. One of the most common applications of a road diet is to improve space for other users (e.g., pedestrians, cyclists) in the context of two-way streets with two lanes in each direction.

SAFE SYSTEM — Aims for a more forgiving road system that takes human fallibility and vulnerability into account. While alert and compliant road user behaviour is promoted, under a Safe System we design the whole transport system to protect people from death and serious injury. Vision Zero has a stronger ethical emphasis.

SECURITY — The real or perceived sense of personal security, including the condition of being protected from criminal activity such as assault, theft and vandalism.

SEGREGATION — Streets within which interactions between modes of transport are discouraged or prevented through the use of a series of barriers and other design measures.

SELF-EXPLAINING — When road design communicates through layout and ergonomics or instinctive design techniques.

SHARED USE PATH — A facility for active transport modes (including walking, wheel chair use, jogging, cycling, and in-line skating) which is generally constructed to a wider, asphalt standard, but may be concrete or granular.

SHARED STREETS — A street where pedestrians, cyclists and vehicles share the main carriageway and where pedestrians have priority of movement over other users.

SPEED LIMIT — The legally-defined maximum speed of vehicles on a transport facility. The speed limit is sometimes referred to as the posted speed, though not all speed limits are posted.

SPEED MANAGEMENT — Processes and techniques to preserve neighbourhood liveability by mitigating excessive traffic speeds in neighbourhoods where traffic volume or short cutting is not the concern.

STOPPING SIGHT DISTANCE — The distance ahead a driver needs to see in order to stop safely should an obstruction enter their path.

STREET — In this guide, any public road within an urban area. This is to remind users of the guide of the need to consider all street uses and activities, physical features and surrounding context, even when designing expressways and highways in the urban area.

STREET FURNITURE — Items placed within the street with the purpose of directing movement and/or enhancing its place value, including public art, lighting, bollards, guardrails, seating and cycle parking.

STREET TYPE — Street type defines a street, taking into consideration the land use context, the relationship of the buildings to the street and the number of travel lanes, users, volume, type and speed of traffic.

STREETSCAPE — All elements that make up the physical environment of a street and define its character. This includes paving, trees, lighting, building type, setback style, pedestrian, cycle and transit amenities, street furniture, etc.

SURVIVABLE SPEED — Based on research into survivability, means there is less than 10% chance of a fatal injury in an impact at this speed.

SUSTAINABLE MODES OF TRANSPORT — Transport that has a lower impact on the environment, including walking, cycling and public transport.

TRAFFIC CALMING — The elements of a streetscape that are designed to slow the speed of traffic.

TRANSIT-ORIENTED DEVELOPMENT (TOD) — A walkable, cycleable, mixed-use form of development typically focused within 600 m of a rail or busway station. Its intent is to create mobility options for a higher density of transit riders and the local community.

TRAVEL MODE — The selected method of travel, such as automobile use (driver or passenger), public transport (bus, light rail, trains), or active transport (including walking, wheel chair use, jogging, cycling and in-line skating).

TYPOLOGY — Defines the key geographic areas within the urban boundary that share common characteristics. Typologies establish the framework within which more detailed land use designations and policies can be established. Integral to each typology and the city as a whole are the Road and Street Palette and public transport services, which are integrated with land use or typologies.

UNIVERSAL DESIGN — The design of products and environments to be usable by all people (of all abilities) to the greatest extent possible, without the need for adaptation or specialized design.

URBAN FOREST — All the trees and associated vegetative under-story in the city, including trees and shrubs intentionally planted, naturally occurring, or accidentally seeded within the city limits.

UTILITIES
Facilities for gas, electricity, telephone, cable television, water, storm and sanitary sewer.

VERTICAL DEFLECTIONS
Changes that occur within the vertical alignment of the carriageway, such as speed bumps, that require drivers to slow down.

VISION ZERO
More directly states the zero-harm goal of a safe system and is ethically based – it is unacceptable that people should die or be seriously injured as a result of a road crash.

VULNERABLE USERS
Road users who are most at risk—pedestrians and cyclists, specifically children, the elderly, and people with mobility, visual and cognitive impairments.

WALKABILITY
The extent to which the built environment allows people to walk to get to everyday destinations for work, shopping, education, and recreation. Walkability can be affected by street connectivity, mix of land uses, destinations and pedestrian infrastructure.

WALKABLE
An environment designed to make travel on foot convenient, attractive and comfortable for various ages and abilities. Considerations include directness of the route, interest along the route, safety, amount of street activity, separation of pedestrians and traffic, street furniture, surface material, footpath width, prevailing wind direction, intersection treatment, kerb cuts, ramps and landscaping.

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