Multi-modal Intersections

14 Feb 2023

WAKA KOTAHI
NZ TRANSPORT AGENCY

Te Kāwanatanga o Aotearoa
New Zealand Government

Introductions - Presenters

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abley

MRCagney
BETTER TRANSPORT • BETTER PLACES • BETTER CHOICES

VIASTRADA
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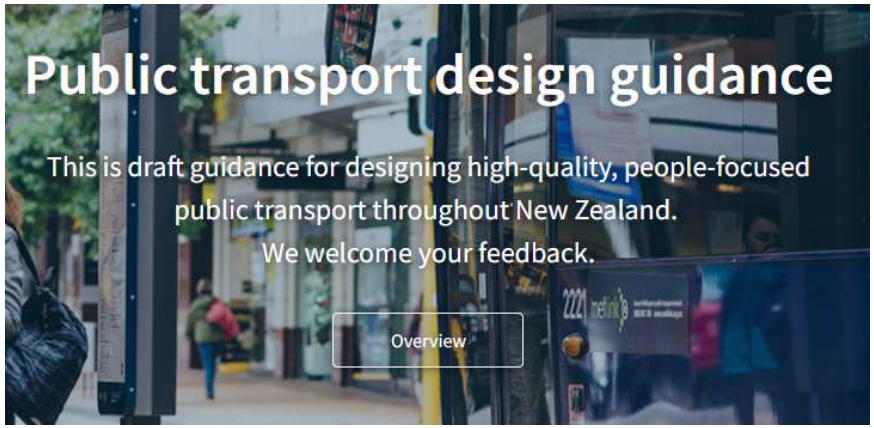
House-keeping

How will this webinar operate?

- You will see a Presentation on screen
  - Various presenters will speak to it
  - Your own microphones/cameras are **off**
- At any time you can type in a question in the Q&A panel about what you see/hear
  - We may address them after each session or at the end
- If you have any technical problems, please type in the chat panel and we will address

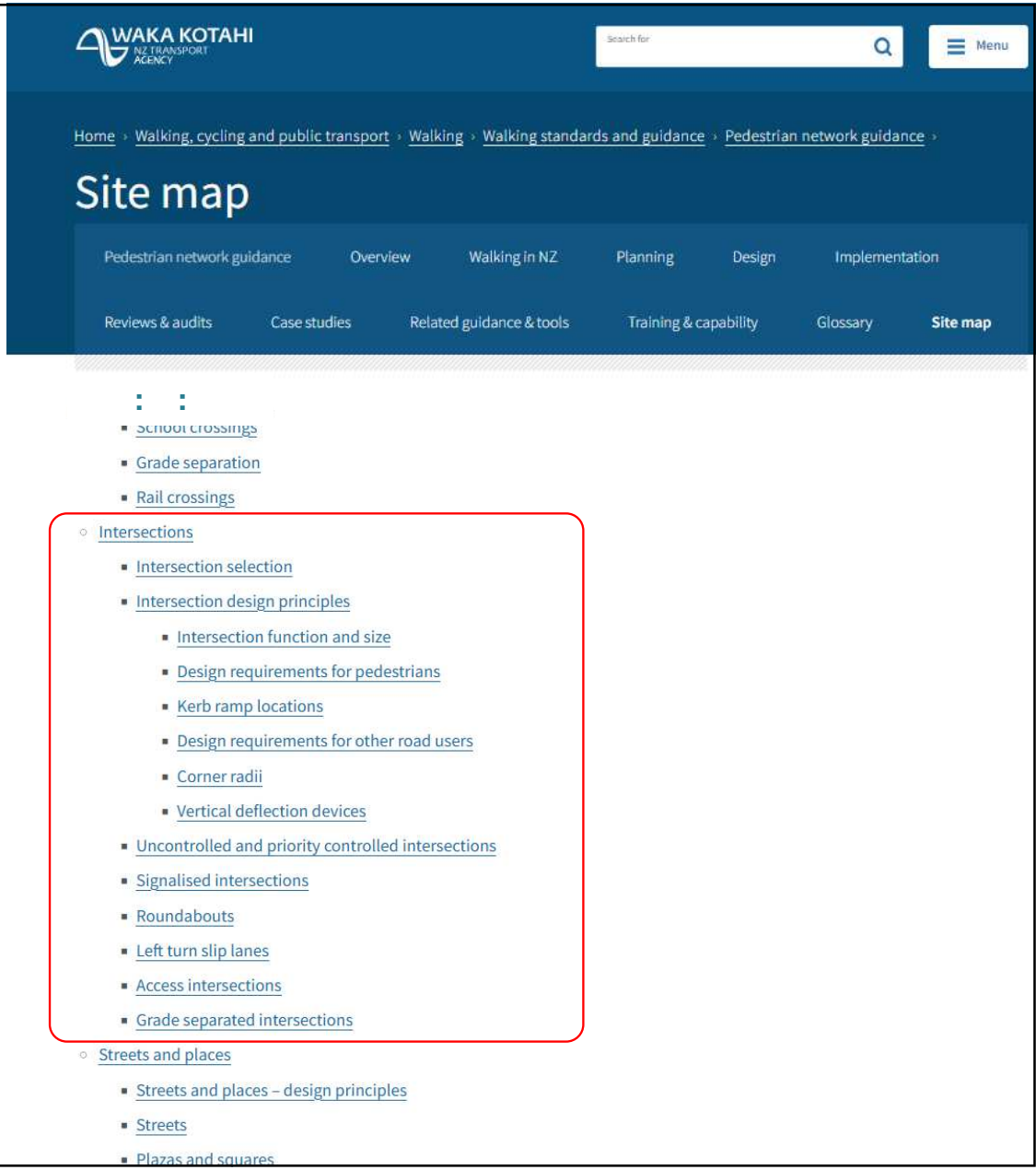
Waka Kotahi Multi-modal guidance

PNG, CNG, PTDG, AUSPDG…



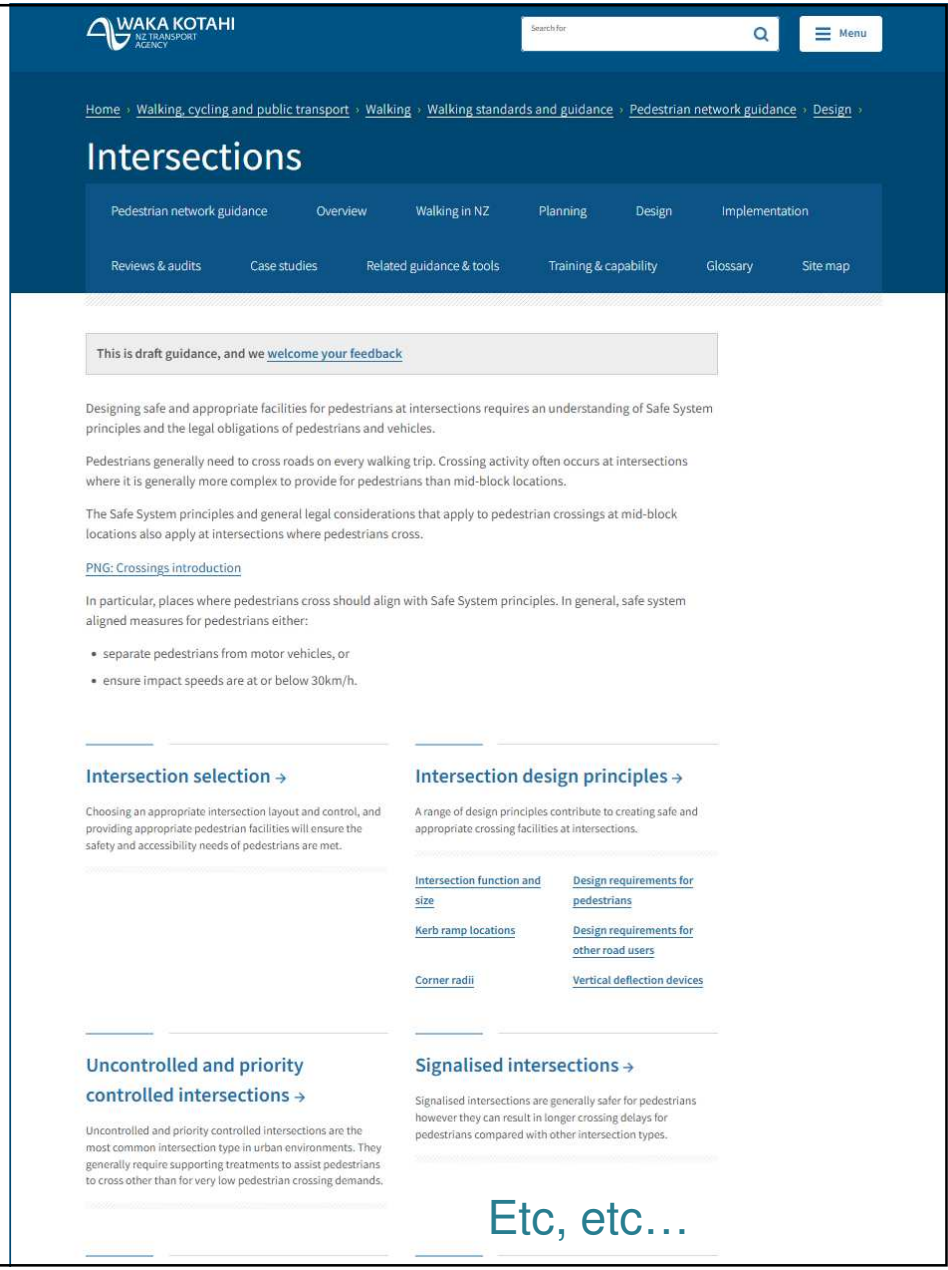
Common questions: Finding the guidance

- Bookmark the PNG, CNG etc.
  - https://nzta.govt.nz/png
  - https://nzta.govt.nz/cng
  - https://nzta.govt.nz/ptdg
  - https://nzta.govt.nz/urban-street-guide/
- You can use the Site Maps like a table of contents



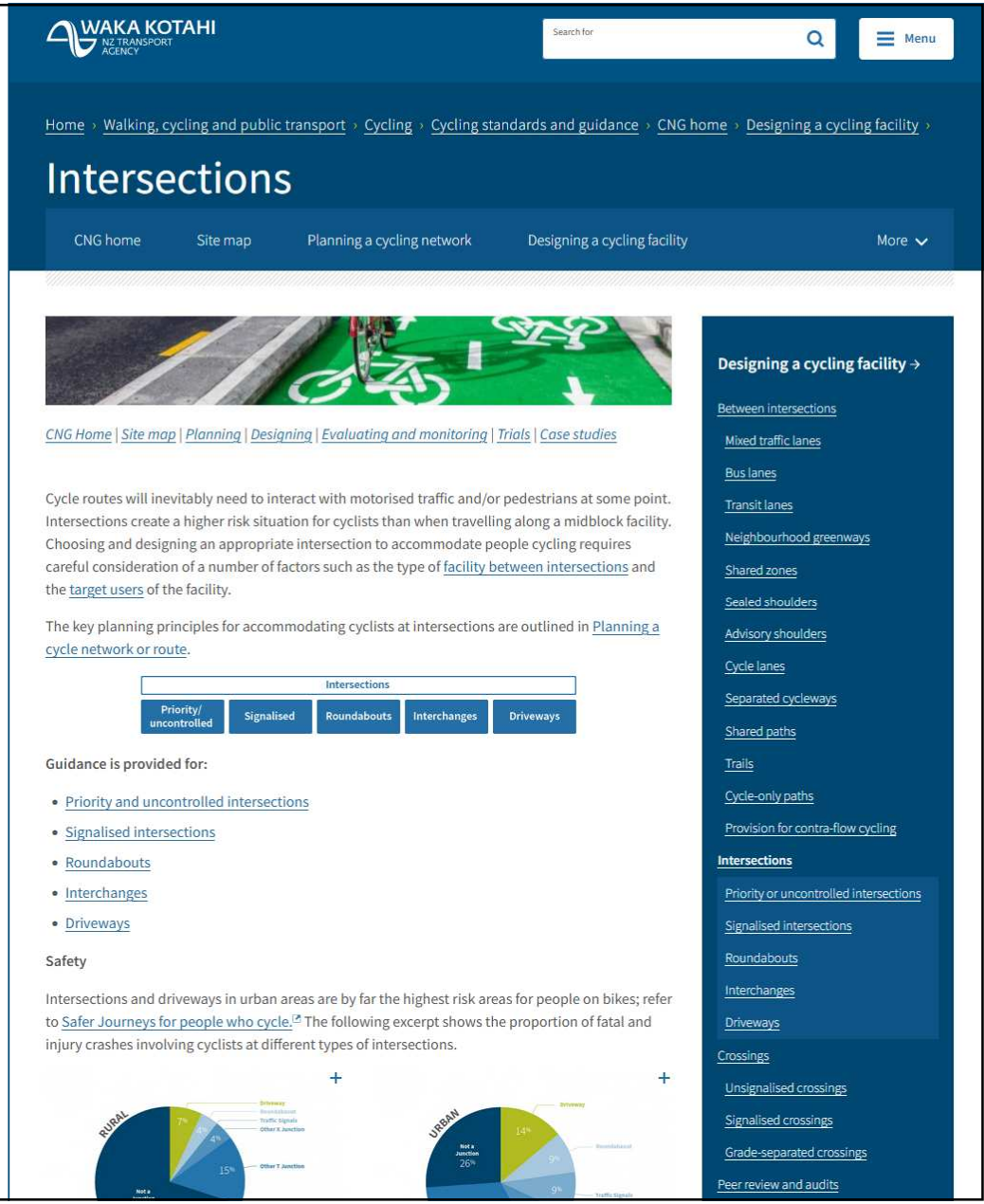
New PNG Guidance: Intersections

- PNG > Design > Intersections
  - https://www.nzta.govt.nz/walking-cycling-and-public-transport/walking/walking-standards-and-guidelines/pedestrian-network-guidance/design/intersections/
- New material incorporating latest Safe System and ONF thinking



Other Guidance

- CNG > Design guidance > Intersections
  - https://www.nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-standards-and-guidance/cycling-network-guidance/designing-a-cycle-facility/intersections-and-crossings/
- PTDG > Design guidance > Bus stop > Bus stop location planning > Bus stops near intersections



Session Outline

- Introduction
- General intersection principles
- Design principles for different users
- Intersection selection and Choice of control
- Intersection type details
  - No/Priority controlled, Signalised, Roundabouts, Grade separation
  - Other details (slip lanes, access intersections, restricting movements)
- Wrap up
- Q&A (15mins)

Also some Poll questions along the way…

General intersection principles

Road to Zero – Safe System Principles

ROAD TO ZERO
TE ARA KI TE ORA

Our vision...

is an Aotearoa where no one is killed or seriously injured on our roads

Ref: Home > Safety > Road to Zero

We promote good choices but plan for mistakes

We are human and are not able to perform perfectly 100% of the time. In any situation where a person may fail, the transport system should not.

We design for human vulnerability

Our bodies have a limited ability to withstand crash forces without being seriously injured or killed.

Accept we are human

We have a shared responsibility for improving road safety

Everyone involved in the transport system shares responsibility with road users for designing and operating a system that does not result in death or serious injury.

We strengthen all parts of the road transport system

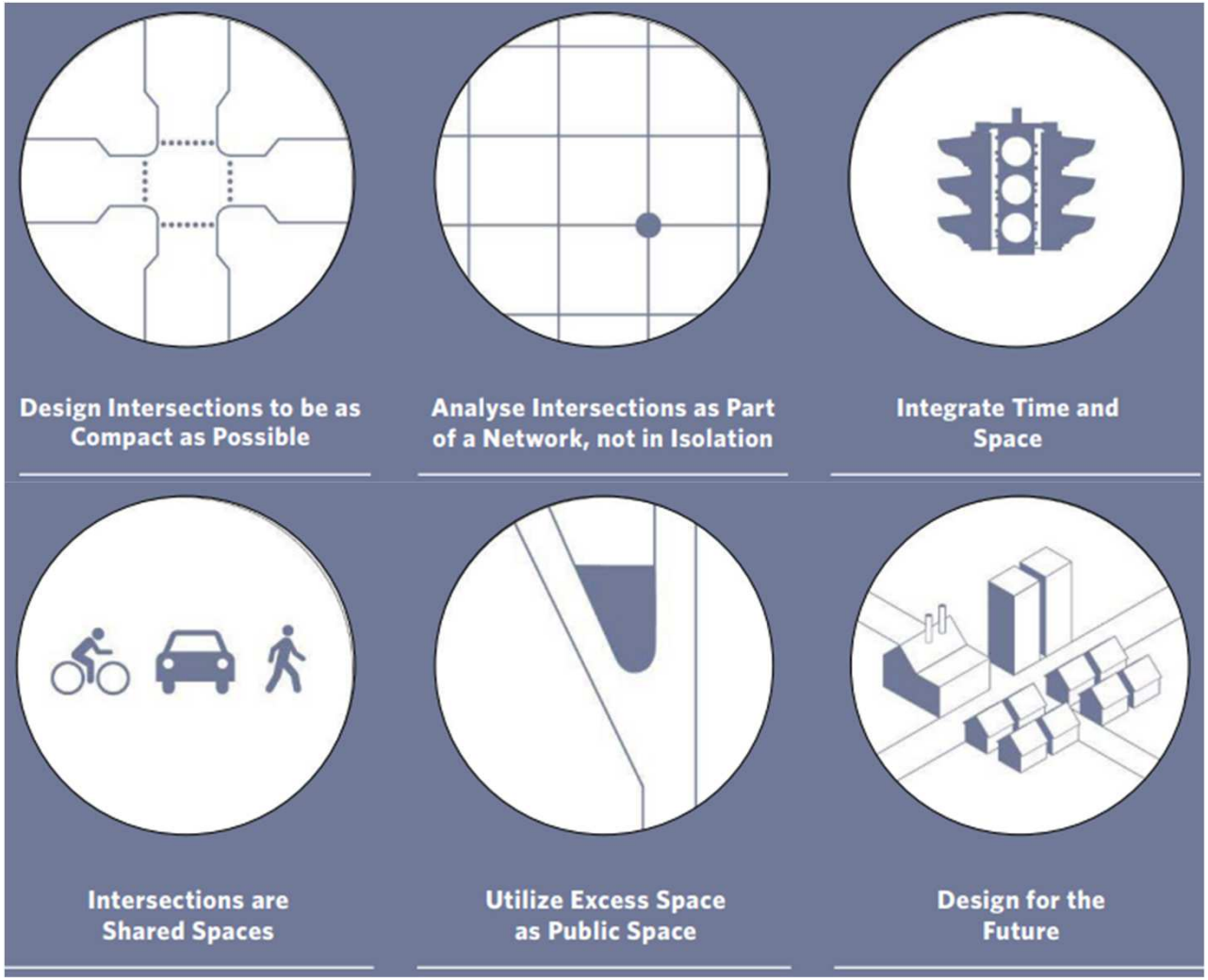
If we strengthen all parts of the system, then when something goes wrong and one part fails, the other parts will still protect people.

Manage the system

Make it safe for all users

- Minimise complexity and conflicts
- Ensure all users are visible and predictable
- Safe, survivable speeds where users' paths cross
- Safety more important than efficiency

General intersection principles



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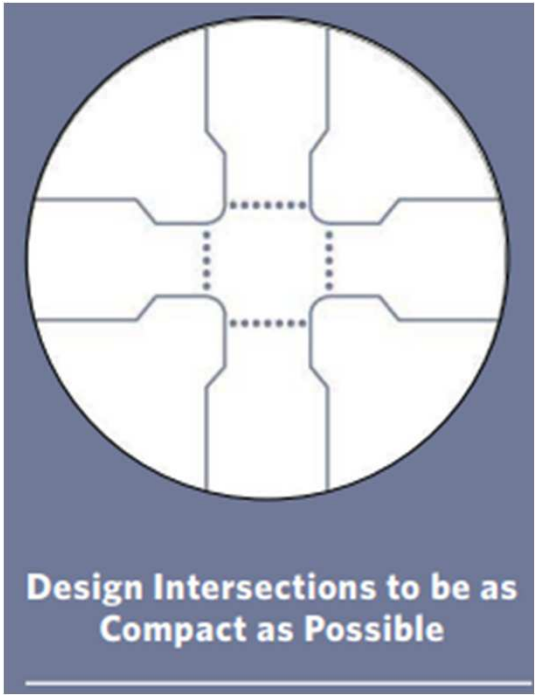
Ref: Aotearoa Urban street planning and design guide

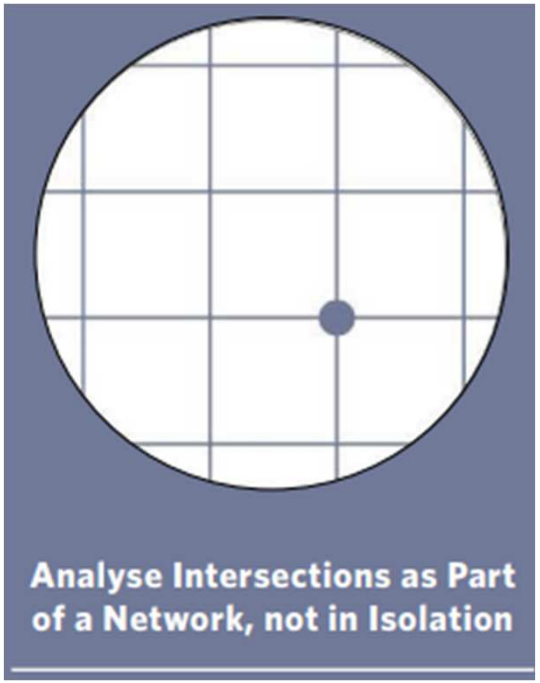
Design compact intersections



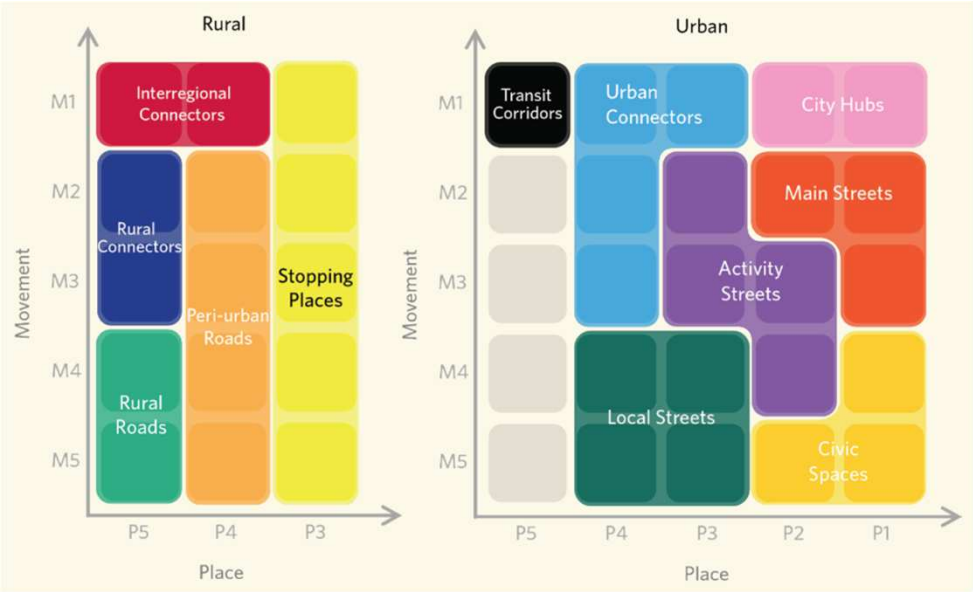
- Reduces exposure especially for pedestrians and people cycling
- Slows vehicle speeds
- Can increase visibility for users

Worcester/Stanmore intersection, Christchurch

Consider the network

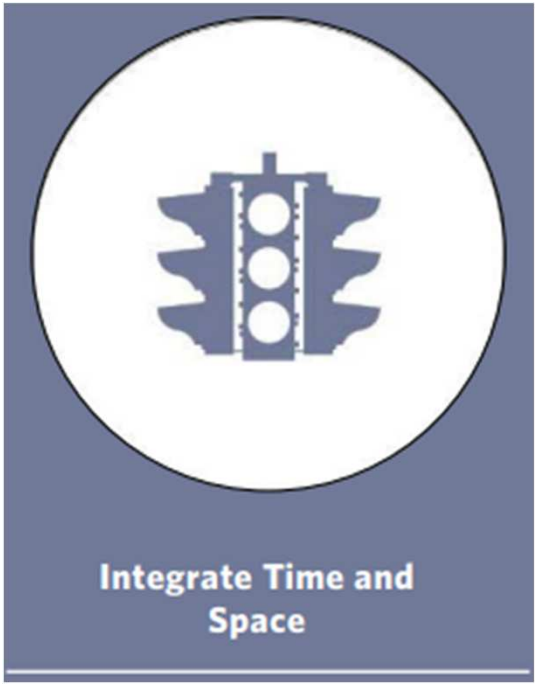


- ONF and modal classifications guide which users should be provided for and how they should be prioritised
- Consider intersection in context of the network
- Trade-offs can often be made when considering a whole of network view



Ref: [Home > Planning and investment > Planning > One Network Framework]

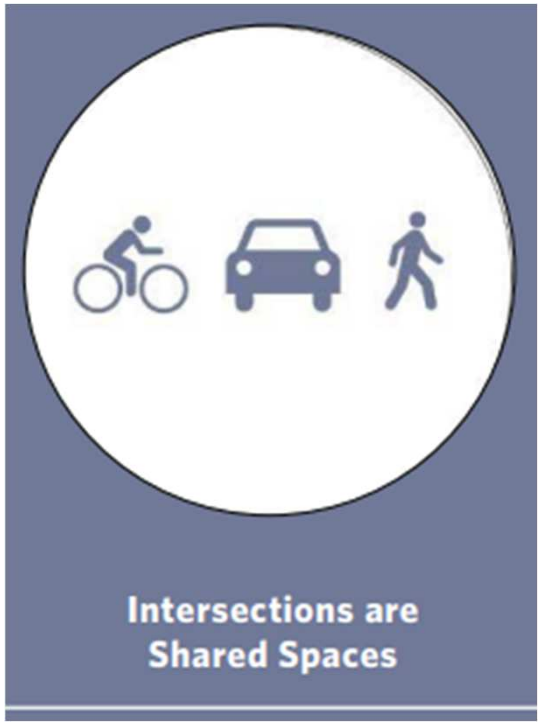
Separate or slow



- Slow speed environments allow safer interactions
- Provide separation between modes in space and/or time
- Separate in space
  - Ideally each mode has its own space on approach to intersection
- Separate in time
  - Signalisation allows same space to be used at different times
  - Regulates time for different users
  - Still need survivable speeds

If you can't safely separate road users, then at least slow them all down!

Users share the space



- Ensure intersection can be accessed, understood and used by all people (keep it simple)
- Visible and predictable user actions
- Safe system speeds for all users
- Design for the behaviour you want

Utilise excess space as public space

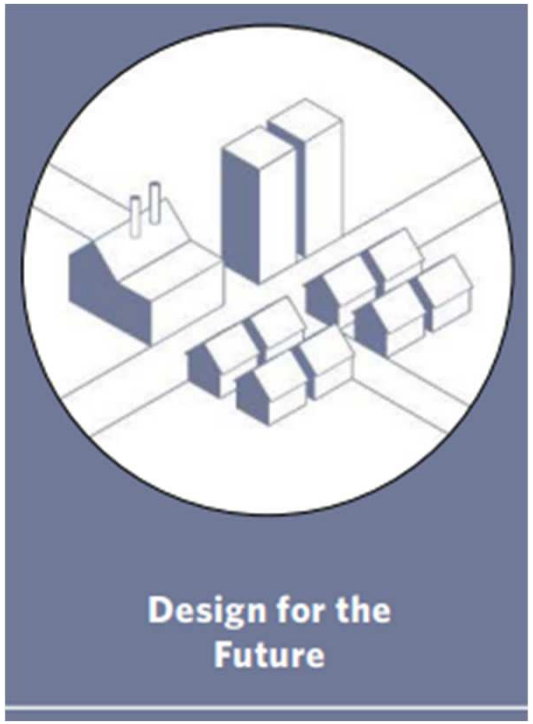
- Create public space with areas that are gained from making intersection more compact

Before

After

Brougham Street, New Plymouth

Design for the future



- Account for existing and future land uses and user demand
- Consider future context to shape objectives for the intersection

Reduce conflicts

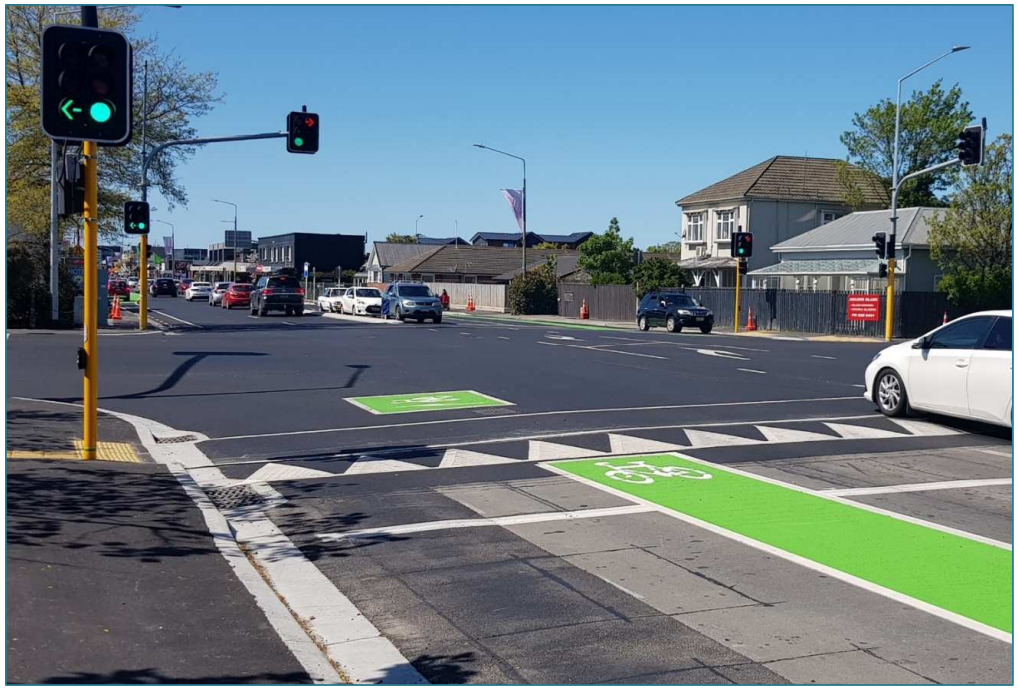
Simplify intersection layouts

- Restrict side-road access for vehicles
  - Especially local streets
- Maintain walking/cycling access

Radley / Sheldon intersection, Christchurch

Reduce speeds

Reduce likelihood and severity of crashes



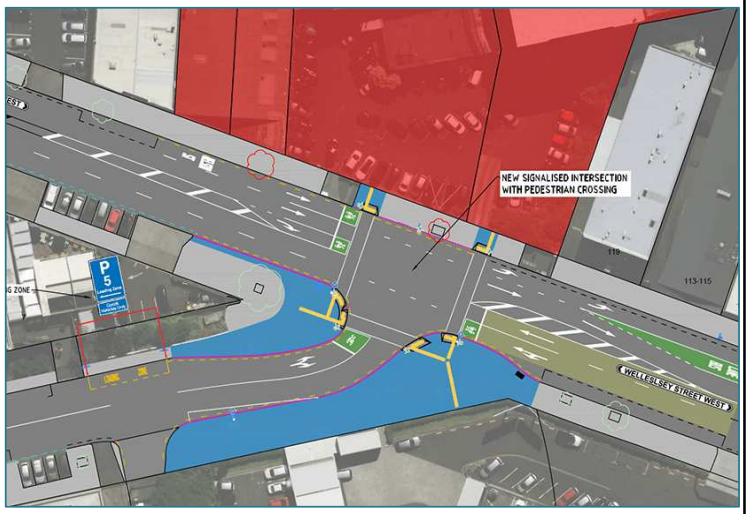
Lincoln / Whiteleigh / Barrington raised intersection, Christchurch

Reduce intersection size, change control

Historic intersections may not be fit for purpose

Before

Interim



Permanent upgrade

Ref: Streets for People case study Sale Street

Time for a Poll…

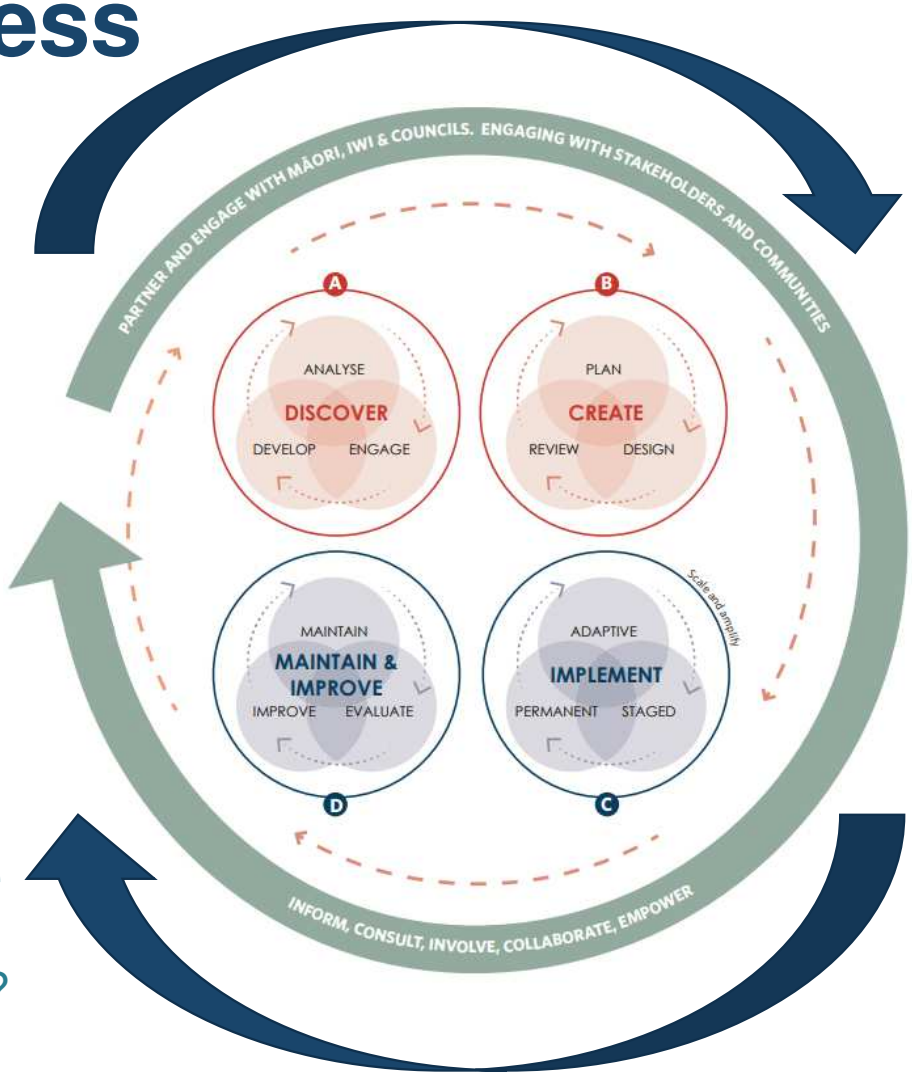
General process

Phase A - Discover

- Confirm the brief, what are the objectives?
- Form the appropriate team
- Gather all the background material
- Understand the users, context and any constraints
- Engage

Phase D – Maintain & improve

- Post construction audits
- Evaluate through assessing whether the objectives have been met
- Is it working how we hoped?



Phase B - Create

- Develop and test options
- Develop a design and refine/test
- Involve users where appropriate
- Engage

Phase C - Implement

- Testing the design through transitional means could be feasible
- Staging the work to help with community acceptance, etc

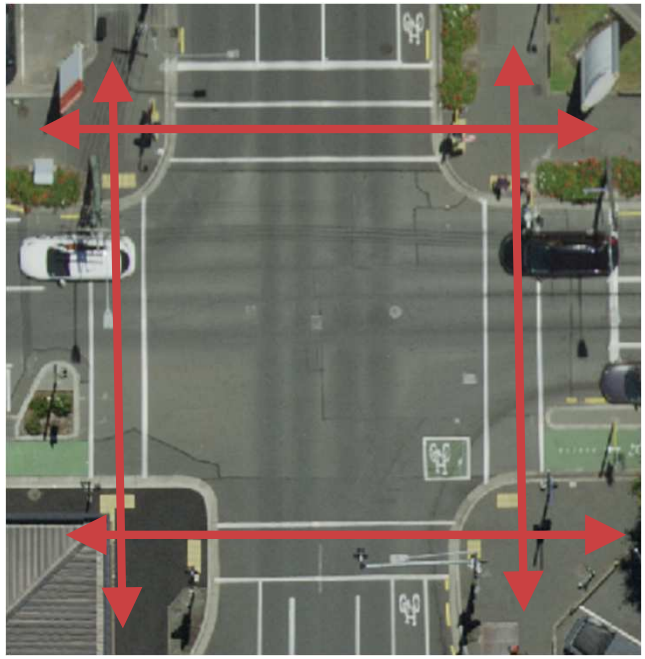
Ref: Aotearoa Urban Street Planning and Design Guide

Design principles for different users

Providing for walking

Factors to consider

- Provide a crossing across each leg of the intersection
- Make crossings direct – locate crossings on or as close to desire lines as possible
- Make crossings short – compact intersections with small corner radii provide the shortest crossing distances



Ref: PNG > Design > Intersections > Intersection design principles

Providing for walking

Factors to consider

- **S**afe, **O**bvious, **S**tep-free
  - Transition from footpath to crossing – usually kerb ramps
  - Space to wait
  - Visibility

Good example

Poor example of kerb ramp

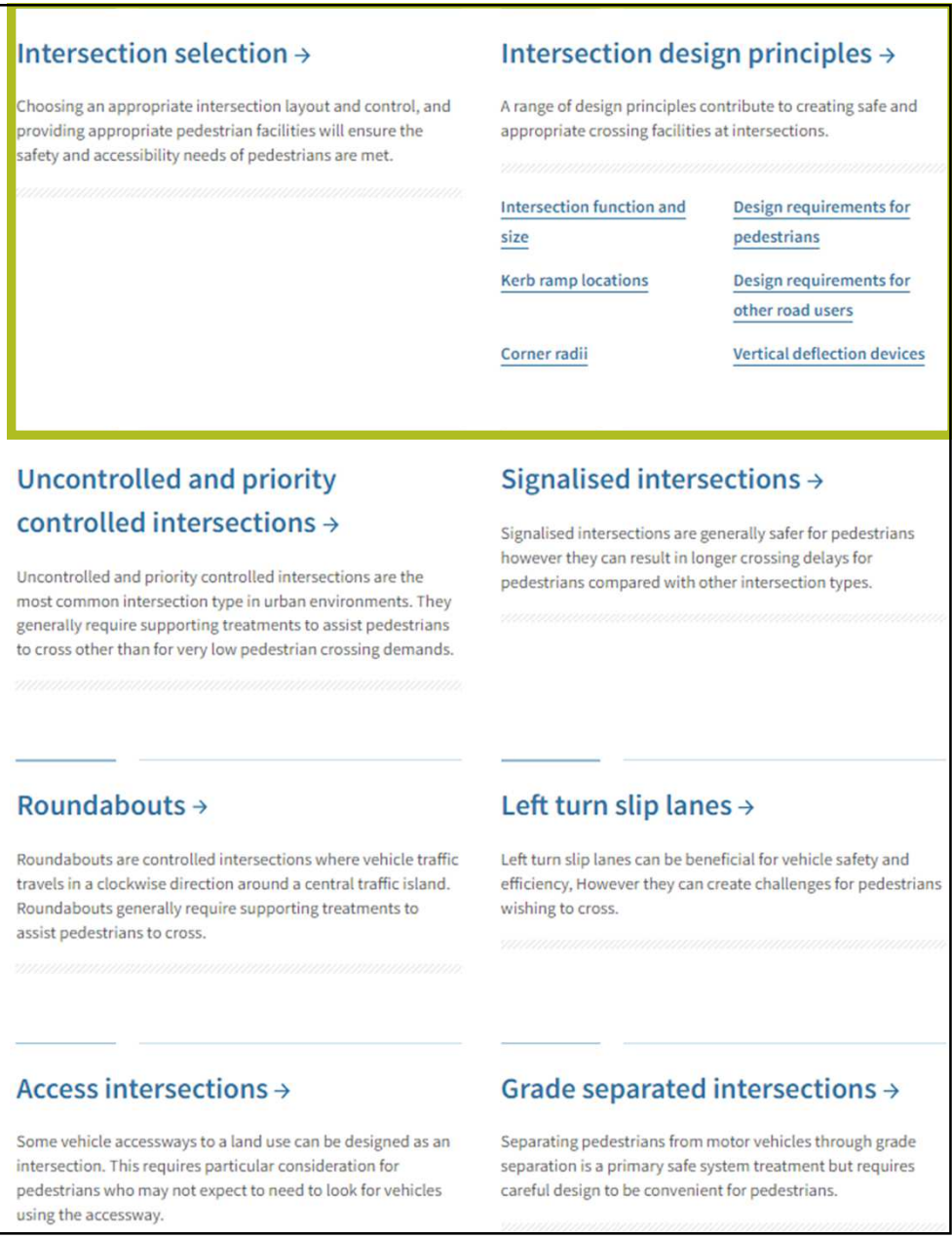
If the kerb ramp is too steep, or there is too much of a lip between the traffic lane and the channel, I can't use it and have to go find another one. It can mean a much longer walking trip for me.

Wendy

Providing for walking

Further guidance

Ref: PNG > Intersections



Intersection selection →

Choosing an appropriate intersection layout and control, and providing appropriate pedestrian facilities will ensure the safety and accessibility needs of pedestrians are met.

Intersection design principles →

A range of design principles contribute to creating safe and appropriate crossing facilities at intersections.

- Intersection function and size
- Design requirements for pedestrians
- Kerb ramp locations
- Design requirements for other road users
- Corner radii
- Vertical deflection devices

Uncontrolled and priority controlled intersections →

Uncontrolled and priority controlled intersections are the most common intersection type in urban environments. They generally require supporting treatments to assist pedestrians to cross other than for very low pedestrian crossing demands.

Signalised intersections →

Signalised intersections are generally safer for pedestrians however they can result in longer crossing delays for pedestrians compared with other intersection types.

Roundabouts →

Roundabouts are controlled intersections where vehicle traffic travels in a clockwise direction around a central traffic island. Roundabouts generally require supporting treatments to assist pedestrians to cross.

Left turn slip lanes →

Left turn slip lanes can be beneficial for vehicle safety and efficiency, However they can create challenges for pedestrians wishing to cross.

Access intersections →

Some vehicle accessways to a land use can be designed as an intersection. This requires particular consideration for pedestrians who may not expect to need to look for vehicles using the accessway.

Grade separated intersections →

Separating pedestrians from motor vehicles through grade separation is a primary safe system treatment but requires careful design to be convenient for pedestrians.

Providing for cycling

Factors to consider

- Safe cycle routes need safe intersections
- Maintain route continuity and consistency for target audience

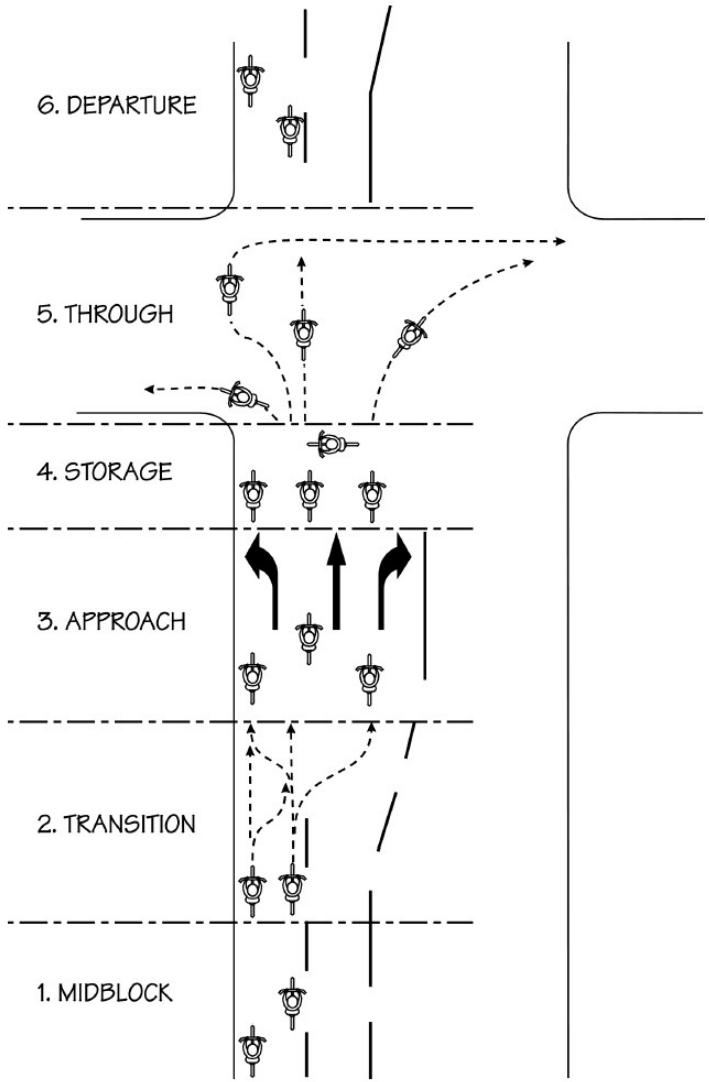
  (*Ref: CNG > Planning a cycle network > Principles > People who cycle*)

- Minimise exposure to conflicts
- Communicate desired behaviour (who has priority)

Six elements of continuity

A useful way to think of intersections for people cycling

- 6. Departure
- 5. Through
- 4. Storage
- 3. Approach
- 2. Transition
- 1. Mid-block



Providing for cycling

Further guidance

Ref: CNG > Designing a cycling facility > Intersections

Cycle routes will inevitably need to interact with motorised traffic and/or pedestrians at some point. Intersections create a higher risk situation for cyclists than when travelling along a midblock facility. Choosing and designing an appropriate intersection to accommodate people cycling requires careful consideration of a number of factors such as the type of facility between intersections and the target users of the facility.

The key planning principles for accommodating cyclists at intersections are outlined in Planning a cycle network or route.

Providing for public transport

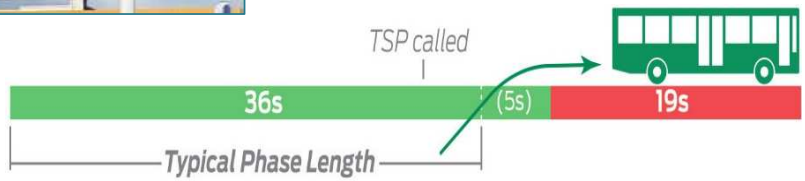
Factors to consider

- Most delay to bus transport occurs at intersections – prioritising and optimising bus travel can help
- Bus stops to connect people to services are often at or close to intersections
- Turning and manoeuvring of buses

Public transport priority and optimisation

There are lots of tools in the tool box

- Consider mid-block facility for context
- Intersection priority/optimisation tools
  - Passive signal priority (‘green waves’)
  - Active signal priority
  - Queue jumps
  - Movement prohibitions (buses exempt)
  - Traffic access restriction (bus gate)

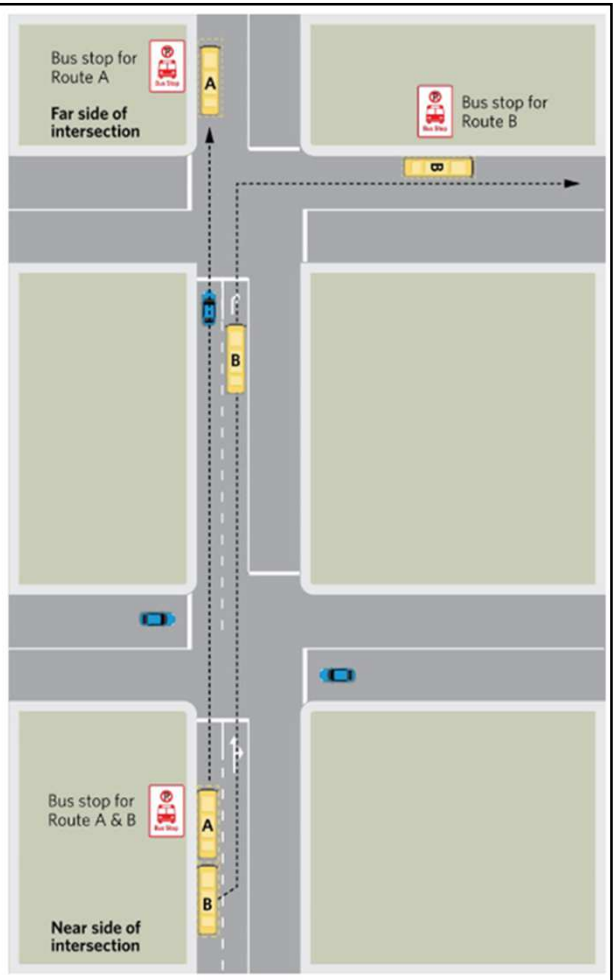


Green extension example

Bus stops near intersections

Factors to consider

- At intersections maximises walking catchments and often provides for a crossing facility close by
- Generally, best located ***after*** an intersection
- Walking accessibility to bus stops: easy, safe, direct, maximise catchment
- Safety and security: visibility, lighting, wayfinding
- Visibility: between driver and waiting passengers



Bus stop crossroad placement.

Ref: PTDG > Bus stop > Bus stop location planning > Bus stops near intersections

Design and check vehicles

Establish these at the *start* of the process

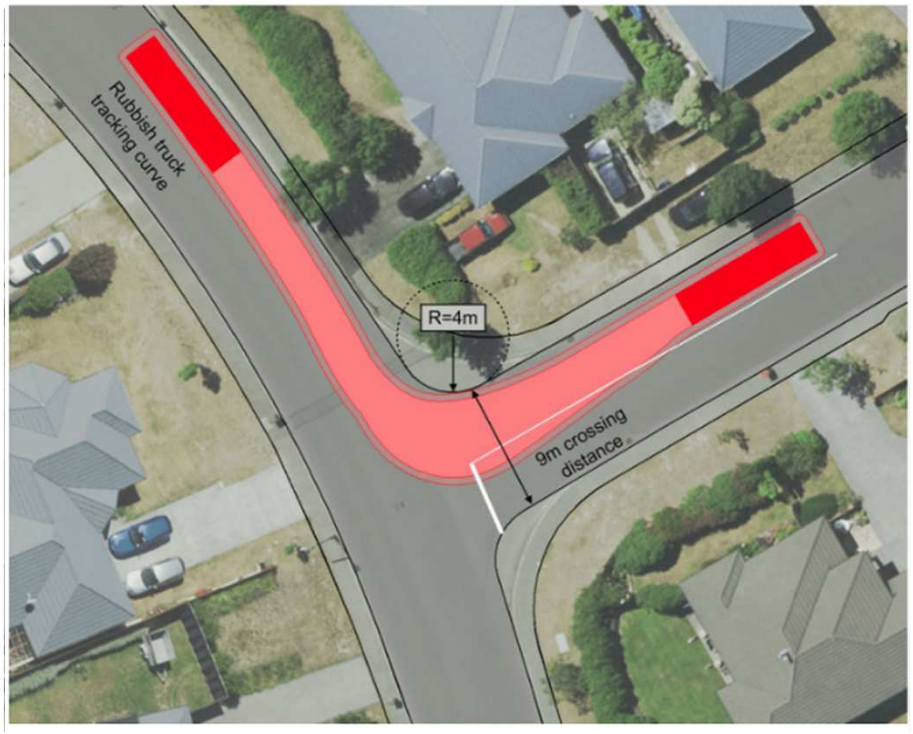
- The design vehicle is the largest vehicle that frequently uses the street
  - Expected to be able to remain within their assigned space/lane
- Check vehicles are larger vehicles that may be expected to use a street from time to time
  - May not always remain within a traffic lane, especially when turning

You don't need to design for this everywhere! Over dimension loads have routes they can travel on

Corner radii

Things to consider

- Minimise corner radii whilst still providing for design vehicles. OK for larger (check vehicles) to cross centreline
  - Reduces turning speeds
  - Improves LOS for pedestrians
  - Can provide more space for other things (landscaping, seating etc)



Retrofitting smaller corner radii at a residential intersection would result in a shorter crossing distance for pedestrians. Note the turning vehicle would cross into the opposing traffic lane.

Ref: PNG > Design > Intersections > Intersection design principles > Corner radii

Providing for larger vehicles

Things to consider

- Adapt street geometry but consider safety and accessibility of other road users:
  - Paving treatments and mountable kerbs
  - Recessed stop lines
  - Compound corners
  - Restrict access (permanently or at certain times of the day)

Ref: RTS 18 - NZ on-road tracking curves for heavy vehicles 2007

Ref: PTDG > Bus dimensions for design

Providing for cars

Things to consider

- How many traffic lanes are really needed?
- On-street parking near intersections can be a hazard and reduce visibility
- Manage speeds (platforms, roundabouts)
- Intersection movements are important in terms of kerb radii and the impacts on speeds and pedestrians crossing the intersection

Small kerb radii makes pedestrian crossing shorter

Selecting the Type of Intersection

General Selection Principles

Choice of intersection control

- **Traffic volumes** and **road hierarchy** often influence choice of control:

Uncontrolled	LESS TRAFFIC
Priority Control	:
Roundabout	:
Signalised	:
Grade Separated	MORE TRAFFIC

- May however choose a different option to encourage better network behaviour

  e.g. to discourage "rat-running" of local streets

Choice of Intersection Control

Factors to consider

- Road hierarchy (ONF)
  - Incl. hierarchy of non-car mode routes →
- Construction/installation costs
  - Also ongoing maintenance/operation costs
- Road user costs (tangible & intangible)
  - Safety – previous crashes, conflicts
  - Efficiency – current delays, queues
- Other factors
  - Effect on adjacent land uses incl. access/parking
  - Available land for installing the intersection

Ref: PNG > Design > Intersections > Intersection Selection

Time for another Poll…

Intersection type Details

No/priority control intersections

Most common intersections in our network

- Typically no path priority for peds/cycles
  - Provide suitable wait features (tactiles, holdrails)
  - Consider refuge islands & kerb extensions

  Or provide a priority crossing?
- Speed on uncontrolled/priority approaches
  - Traffic calming (humps, platforms, channelisation)
- Tight corners to minimise speeds
  - Infrequent large vehicles can cross centrelines

Ref: PNG > Design > Intersections > Uncontrolled and priority controlled intersections

No/priority control intersections cont'd

Issues along busier routes

- Can be a challenge to keep clear of queues
  - No-stopping hatched markings →
- Sight lines difficult when crossing SV lanes
  - Clearly highlight bus/cycle through-lanes
  - Extend no-stopping area ahead of side-road
  - Set back parking from intersection
- Raised crossing to manage side-road speeds
  - Ensure road user priority is clear →

Riddiford St, Wellington

Karangahape Rd / Liverpool St, Auckland

Roundabouts

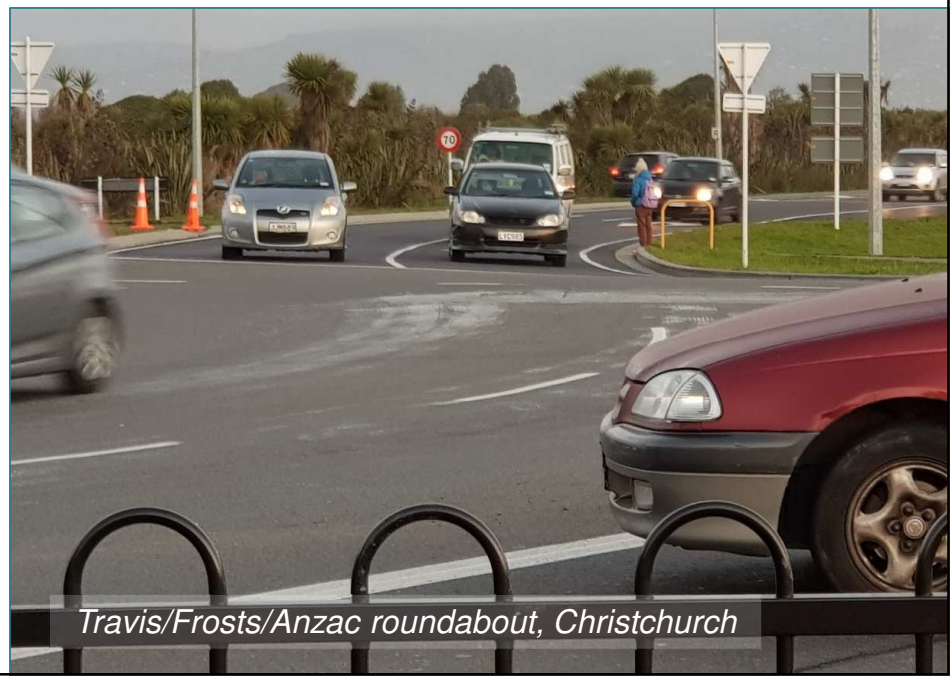
Managing conflicting movements

- Use geometric deflection to control speeds and simplify road user conflict points
  - Not all layouts do this well…
- Generally shouldn't have cycle lanes there
  - Switch to in-lane sharrow markings on approach
- Multi-lane roundabouts are very problematic for active modes
  - Difficult to cross multiple approach lanes
  - Often high-speed and limited priority

Consider changing to other layout/control?

Ref: PNG > Design > Intersections > Roundabouts

Wilsons/Centaurus/Albert roundabout, Christchurch



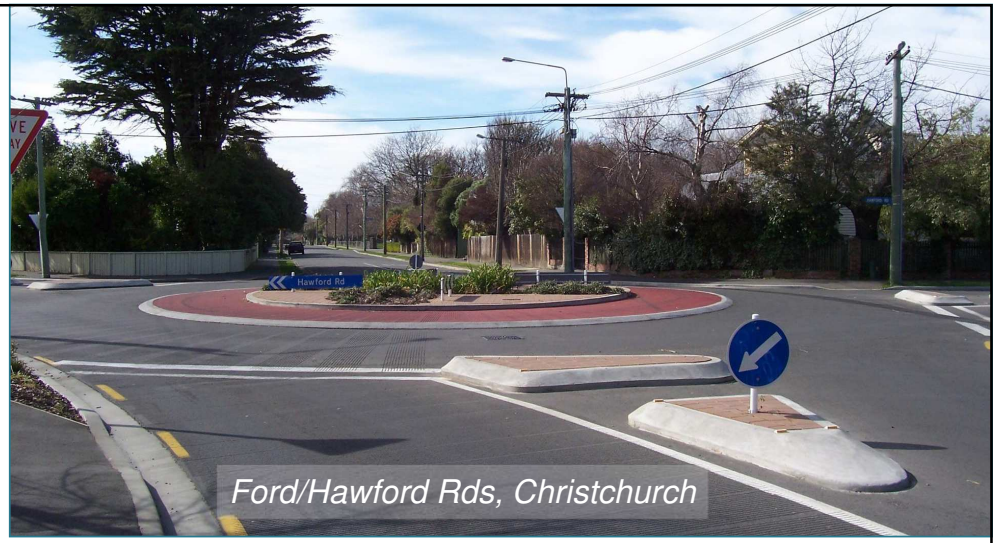
Travis/Frosts/Anzac roundabout, Christchurch

Roundabouts cont'd

Key Design Principles

- Adequate entry widths & circulation space
  - Or mountable aprons for large vehicles →
- Consider path crossing point locations
  - Balance directness with set-back distances
- Control motorist **speeds**
  - Deflection of traffic to left on entry
  - Deflection of *all* through/crossing movements
  - Raised roundabout or approach humps →
  - Raised aprons for large vehicles to traverse

30km/h max speeds ideal in urban areas

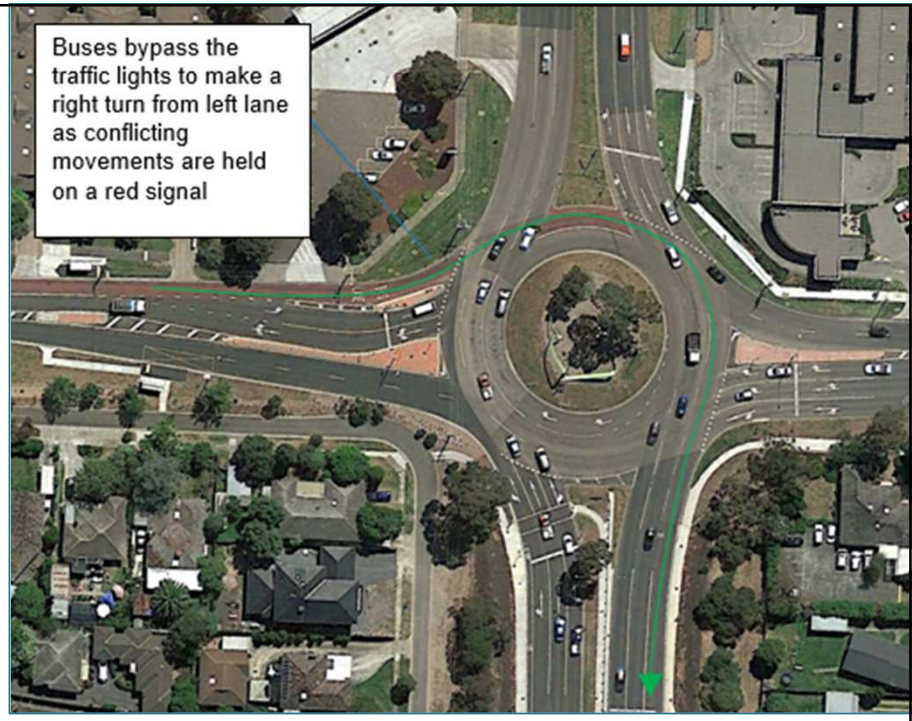


Ford/Hawford Rds, Christchurch

Wilsons/Centaurus/Albert roundabout, Christchurch

PT Priority at roundabouts

- Context is key – is delay due to the roundabout or downstream issues?
  - If queue is continuous through roundabout, priority likely needed before/during/after roundabout
- Easier to provide PT Priority with signals
  - Location of PT stops in relation to the roundabout may influence which priority measures are needed
- Priority options:
  - Public transport vehicle queue-jump with priority on approach
  - Signalising (metering) a major conflicting traffic movement(s)
  - Signalising approaches (replacing GIVE WAY arrangements)
  - Continuous public transport priority lane through the roundabout
  - Converting the roundabout to a signalised intersection
  - Grade separating the public transport movement



Williamsons/Porter roundabout, Melbourne

Signalised intersections

Separating different movements in time

- Generally more costly to install, operate and maintain than other intersection types
- In theory, provide separate opportunities for different movements and users
  - Still a danger of red-light running → crashes
  - Through vs turning conflicts still occur → crashes
  - Long delays can cause some users to go anyway
- Consider the use of a raised intersection or raised approach platforms to manage speed

Ref: PNG > Design > Intersections > Signalised intersections

Lincoln / Whiteleigh / Barrington intersection, Christchurch


Claudelands Rd / Grey St, Hamilton

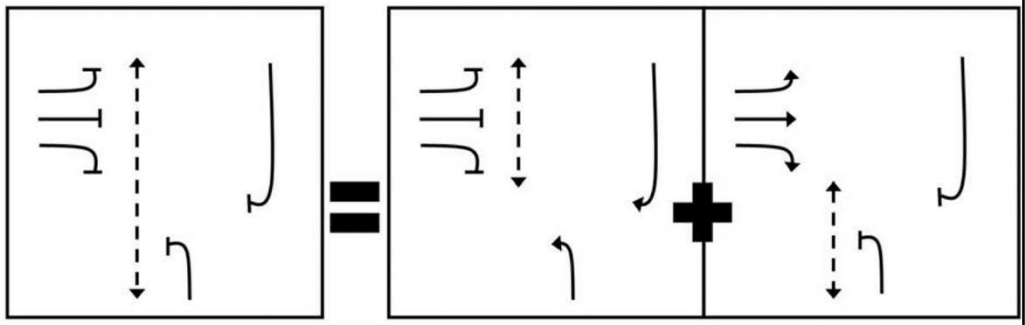
Signalised intersections cont'd

Priority road user phases

- Signals allow opportunities to let some road users go exclusively before others
  - Bus priority queue-jump signals
  - Pedestrian/cycle lead signals before turning traffic →
  - Pedestrian Barnes Dances
- Consider phasing to manage multiple movements concurrently

  e.g staged pedestrian crossings →
- Ensure good detection at or on approach
  - Tactile indicators to lead people to push-buttons

Manchester / Tuam intersection, Christchurch


Traditional, one-part crossing

Equivalent phases of staged crossing operation

Grade-separated intersections

Separating different movements in space

- Usually the most expensive option
  - Typically used with major arterial routes
- Provide maximum safe separation of movements and modes
  - Assuming that people use intended routes!
  - Good lighting and sightlines for personal security
- Check desire lines
  - Ensure that walk/cycle paths do not unduly increase travel distances and times
  - Steps and steep gradients can be difficult for some

Ref: PNG > Design > Intersections > Grade separated intersections

Other details

Left-turn slip lanes

A bad reputation?

- Poorly designed slip lanes can be unsafe for different road users
  - High speeds of turning traffic
  - Poor visibility with merging traffic
  - No safe priority for ped'ns/cycles
- Good slip lane design has
  - High-entry angle for better visibility/speed
  - Raised priority crossings for path users →

If not able to achieve these, then remove and have a normal left-turn lane

Ref: PNG > Design > Intersections > Left turn slip lanes

SH16 / St Lukes Rd / Great North Rd, Auckland

Other details

Access intersections

Converting busy driveways to intersections

- Should always be clear whether a side access acts as a **driveway** or a **side-road**
  - Different legal priorities for path users
- Paths across driveways should be continuous not interrupted
  - Path users have precedence by law
  - If driveways a different surface drivers may think they have priority
- Access intersections should use tactile indicators to locate wait points

Ref: [PNG > Design > Intersections > Access intersections]

Lichfield St, Christchurch

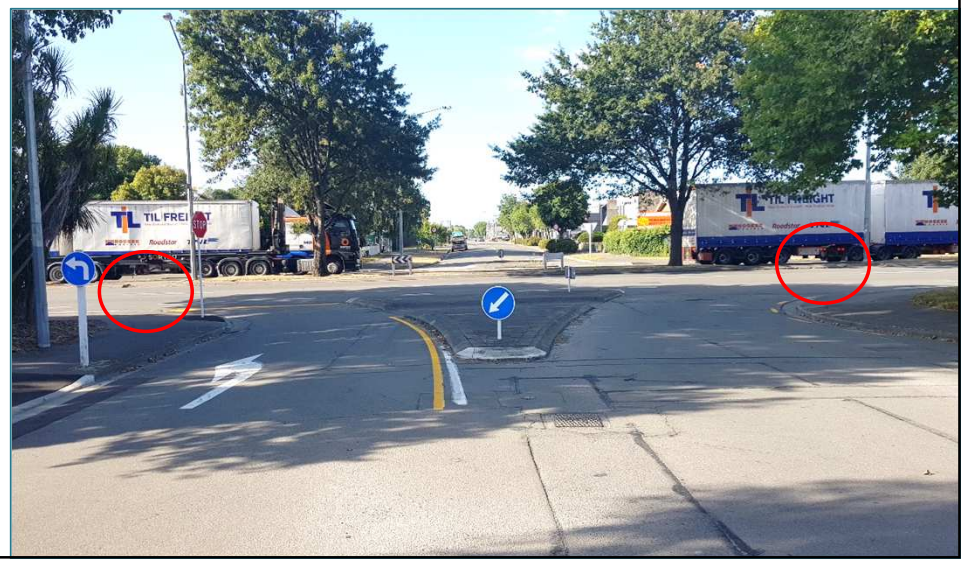
Champion Rd, Richmond

Other details

Restricting movements

Potentially the solution to many conflicts?

- Consider restriction of some movements
  - Simplify complex multi-leg intersections
  - Retain exit-only to simplify approach options →
  - Ban some right-turn movements
- Consider restrictions to some road users
  - Retain walk/cycle access only to a closed leg
  - Through-paths at left in/out intersections →
- Look at the wider network implications
  - Length of likely detours?
  - More preferable alternate routes?



Wrap-up

Wrap up

- Intersection design is not easy!
  - Especially when trying to consider multiple road user types
- Today we have looked at the principles to consider
  - For intersections overall
  - For each road user type
  - For each intersection type
- This is just a *brief* overview
  - The various Waka Kotahi guides provide more details and case studies
- Stay tuned for our next webinar in another month or so…
  - Also details of some in-person multi-modal workshops later in the year

Q & A

Please put your questions in the Q&A box (not Chat)

WAKA KOTAHI

Thank You!

nzta.govt.nz/PNG – Pedestrians

nzta.govt.nz/CNG – Cycling

nzta.govt.nz/PTDG – Public Transport

nzta.govt.nz/urban-street-guide – Street Guide