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National Cycle Network Design Guidance
Stage 1 Report – Best Practice Review

NZ Transport Agency

NZ TRANSPORT AGENCY
WAKA KOTAHI

National Cycle Network Design Guidance

Stage 1 Report – Best Practice Review

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Executive Summary

Introduction

The Cycling Safety Panel identified the need for further guidance in cycle facility design; an action that is supported by the industry. In response to this, the NZ Transport Agency ('the Agency') initiated the National Cycle Network Design Guidance Project, which includes guidance for both planning cycle networks and designing facilities. The project aim is to develop a 'framework' that identifies and consolidates the appropriate guidance into a resource that is 'fit for purpose' for the sector. The 'framework' will be an online tool that is aligned with the One Network Road Classification (ONRC) approach.

The project is being overseen by the Agency Cycle Steering Group and undertaken in two stages. **Stage 1,** the subject of this report, involved a national and international best practice review and identified a list of planning and design guidance gaps and how they might be filled, including 'quick wins'. **Stage 2** will consider the outcomes of the national and international best practice review to develop the framework and will address some of the planning and design guidance gaps.

This project has relationships with other projects, law changes, initiatives, funding, research and also the Cyclist and Road Code as updates may be required to reflect design/law changes. The legal issues review is being carried out by the Agency Cycle Team, the ONRC by the Road Efficiency Group, and the Traffic Control Devices Manual by the Agency. There are also initiatives being led by others such as the Auckland Transport shared path signage project. There are a range of Agency research projects being undertaken by others that have potential links to this project, an example is the Urban Traffic Signals project. The funding aspects of cycle projects are also linked to this project, namely the Business Case approach where planning and design are key to the scope of the project.

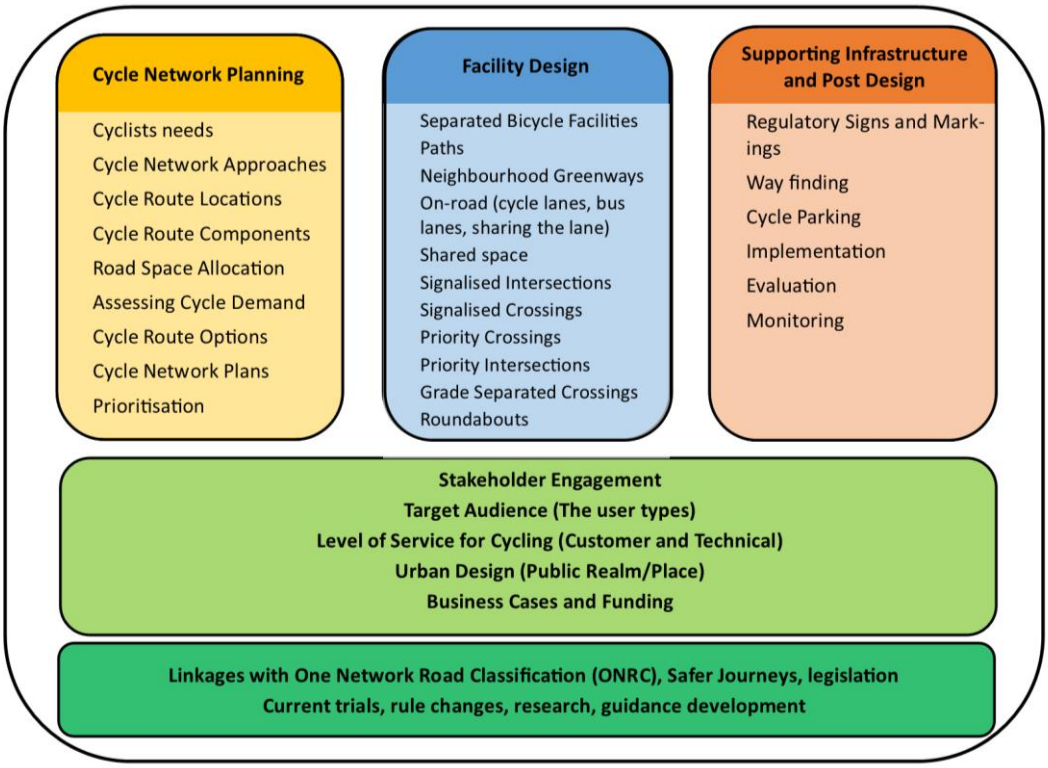
Consultation

The engagement process for the first stage of the project was targeted at technical stakeholders only. Consultation with a wider range of stakeholders is likely to occur in the next stage of the project. The technical stakeholders were made up of Agency staff plus three external groups; the Active Modes Infrastructure Group (AMIG) (a working group of the Road Controlling Authorities (RCA) Forum), the wider RCA membership, and the IPENZ Transportation Group.

An online survey asked for the technical stakeholders' views on the current issues encountered while planning and designing cycle networks, how an updated framework could assist and lessons learned from implementing cycle facilities. A total of 160 responses were received across the full spectrum of policy makers, planners and engineers from the public and private sector. The key findings were:

- The majority of respondents stated that the content of the updated framework would capture the subjects that would be of value to their organisation and offered suggestions on how to improve it or sought clarification on content.
- 'Insufficient or inadequate guidance on how to assess demand for the network' and 'Insufficient or inadequate wider transport policy to support development of a cycle network' were the two most commonly raised planning issues.
- 'Road space allocation' and 'Insufficient or inadequate guidance on intersections' were the most commonly raised design issues.
- Respondents suggested that whatever form the framework takes it needs to be simple to use, flexible, not be too restrictive, not exclude engineering judgement and not inhibit innovation.

To guide the best practice review and to be able to communicate the intent of the framework to technical stakeholders, the diagram below was developed to represent the potential content of the framework.



Best Practice Review

A best practice review of the current national, local and international design guidance, post implementation studies and relevant research was undertaken. This included the topics of network planning, midblock facility design, and intersection and crossing design. Although there are gaps in the guidance there are also positives in terms of what guidance exists or what guidance is being developed. Specifically the New Zealand Cycle Network and Route Planning Guide (CNRPG), which was developed ten years ago, still offers comprehensive guidance to the sector, although some additions to the guide are recommended in this project.

Prior to the new suite of Austroads guides being developed, the *NZ Supplement to the Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles* (referred to as 'the Supplement') had been developed to reflect the specific New Zealand traffic regulations and context. However, none of this content was incorporated into the new Austroads guides and therefore it is still recommended by leading experts and industry training providers as a relevant source of New Zealand guidance. The supplement is available on the Agency website. Most of the supplement guidance is still relevant today, although it requires some minor changes and a new 'home' within the structure that provides and recommends guidance to the industry.

It was found that road controlling authorities such as Christchurch City Council and Auckland Transport have developed guidance where there was none for facilities such as protected cycle lanes and neighbourhood greenways. Also the RCA Forum is facilitating research and trials of devices such as 'sharrows'.

Cycle Network Planning

The process of planning a cycle network involves several key steps, although it is often necessary to iterate between these and these steps should be seen in context of the broader, multi-modal transport system. The term 'cyclist' covers a multitude of people of different ages and abilities who choose to cycle for different reasons and have different needs and different criteria affecting their evaluation of level of service. Thus it is important to define the intended cyclist target audience(s) who a network link is intended to cater for, and the approach that will be taken in providing for these people within the existing framework of the transport network and land use environment. Data acquisition is key, both for enabling meaningful predictions of future demand on facilities and evaluating the appropriateness of existing facilities. It is also important for planners to understand the applications and limitations of the various facility types available within the designers' 'toolbox', to ensure feasible route alignments are proposed for evaluation. Understanding techniques for reallocating the scare resource that is road space is also a key component of this toolbox.

The existing national guidance for network was reviewed and gaps in the guidance identified. These are listed in the Guidance Gaps section below along with a suggested 'priority', to help inform the order in which the gaps could be filled.

Design of midblock facilities

There are a range of ways that cycling can be catered for between intersections, some are on the road and some are off the road. Often this involves building specific infrastructure and other times it involves ensuring the road can be shared safely. It is important that designers make well-informed choices regarding the facility type that best caters for the intended user group in a specific transport environment.

The existing national guidance for cycle lanes, shared traffic lanes, bus/cycle lanes, neighbourhood greenways, shared space, sealed shoulders, protected cycle lanes, cycle paths and shared paths was reviewed and gaps in the guidance identified. These are listed in the Guidance Gaps section below along with a suggested 'priority', to help inform the order in which the gaps could be filled.

Design of intersections and crossings

Cyclists are often required to interact with motorised traffic and pedestrians at intersections and crossings creating a higher risk situation than when travelling along a midblock facility. The form of the interaction is dependent on the intersection type, midblock facility type and how the facility is continued through the intersection or crossing. Intersection design is strongly linked to midblock facility type and the target users of the facility. Any interaction with vehicles can be perceived as unsafe for the least confident and youngest cyclists in the population. Intersections and driveways in urban areas are by far the highest risk areas for cyclists. Over the 2003 – 2012 period only 26% of serious and fatal crashes in urban areas did not occur at an intersection, therefore guidance on how to design these safely is key to a successful cycle network.

The national guidance for signalised intersections, priority intersections, roundabouts and crossings was reviewed and gaps in the guidance identified. These are listed in the Guidance Gaps section below along with a suggested 'priority', to help inform the order in which the gaps could be filled.

Guidance Gaps

From the review a list of guidance gaps was compiled. The way in which they could be addressed was also identified as requiring one of the following; research, legislative change, approved trials, full guidance to be developed or an action that can be developed quickly (quick wins). The actions are summarised below.

Planning Gaps

- Consistent terminology is required
- Cyclists' needs (target audience definition; design requirements for different audiences)
- Assessing demand (at a network level, as well as for target groups)
- Cycle route components (add protected bicycle facilities)
- Cycle route components (align CNRPG with ONRC)
- Level of Service for cycling (definition for routes and individual facilities)
- Level of Service for cycling (include in ONRC once above action is complete)
- Network planning approaches (approach based on target audience)
- Cycle route options (broaden to allow for different target audiences)
- Co-ordination with NZ Cycle Trail routes is required
- Road space allocation (toolkit for space allocation; aspects such as parking management planning guidance)
- Cycle network maps (mapping techniques have advances, examples could be provide)
- Prioritisation (guidance on methods that can be taken)
- Monitoring (need to provide more guidance and review policy to encourage/require monitoring)

Midblock Facility Gaps

- Cycle lanes minimum widths and where not appropriate (guidance required)
- No stopping markings in kerbside cycle lanes (additional guidance required)
- Bus/cycle lane design (additional guidance required)
- Bus stop treatments on high frequency routes (guidance required)
- Shared traffic lane design (additional guidance required)
- Shared and cycle path widths, signs and markings (additional guidance required)
- Shared path widths, signs and markings (guidance required)
- Sealed shoulders basis for establishing width for cyclists and minimum widths
- Shared space design for cycling (guidance required)
- Protected cycle facilities (full design guidance required)
- Neighbourhood greenways (full design guidance required)

Intersection and Crossing Gaps

- Give way rules: Legal basis in common law/roadway concept is problematic
- Disconnect between time and space components of traffic signal designs
- Vehicle mixing lanes at traffic signals (layout guidance missing; requires trials)
- Legal meaning of cycle aspects at traffic signals
- Austroads and MOTSAM inconsistent dimensions for traffic signals
- Lack of guidance on use of hook turns and advanced stop boxes/lines
- Potentially useful to incorporate cycle use into Barnes Dance operation
- All red time extension at wide intersections (NZ trial not in Austroads)
- Roundabouts (not clear when it is not appropriate to use them in relation to cycle routes)
- Lack of guidance on path networks around roundabouts and across approaches for cyclists
- Guidance for C-Roundabouts needs incorporating in TCD rule and manual
- Austroads not clear that cycle lanes in roundabouts not applicable in NZ
- Signalised roundabouts (further application in NZ needs exploring)
- Radial designs (application in NZ needs exploring)
- Lack of guidance on cycle detection methods

Next Steps

The outcomes of Stage 1 of the project have been presented to, and endorsed by, the Active Modes Infrastructure Group and the Cycle Steering Group. The next stage of the project is to develop the on-line 'framework' and fill some of the planning and design gaps, starting with the quick wins. As part of that work further consultation with the Technical Stakeholders will be undertaken. There is also scope to engage with other stakeholders associated with 'transport' and also advocacy groups.

The way in which many of the gaps can be filled is by updating the CNRPG and providing input to two chapters of the Traffic Control Devices (TCD) Manual that are currently being prepared, these are Part 4: Intersections and Part 5: Between Intersections. The cycle design guidance can be incorporated into the TCD Manual design guidance in such a way that all design for cycling is considered in an integrated manner. There will also be an 'Interim Note' developed to address certain gaps that do not fit within the CNRPG or TCD Manual.

It is recognised that the ONRC is a work in progress; one of the useful outcomes of this project is the identification of opportunities to better include consideration of cyclists in the ONRC. It should consider LOS for cyclists as per the CNRPG, and include measures other than just safety, as well as improving the safety LOS measures by specifying what constitutes 'separation'.

Contents

1. Introduction

1.1 Project Overview

The New Zealand Cycling Safety Panel (Leggat et al 2014) identified the need for further guidance in cycle facility design; an action that is supported by the industry. In response to this, the NZ Transport Agency ('the Agency') initiated the National Cycle Design Guidance Project, which includes guidance for both planning cycle networks and designing facilities.

The project aim is to develop a 'framework' that identifies and consolidates the appropriate guidance into a resource that is 'fit for purpose' for the sector. The 'framework' will be an online tool that is aligned with the One Network Road Classification (ONRC) approach.

It is important to note that framework is not intended only for 'cycle-specific' planning and design but can (and should) be used within the process of planning and designing for general transport projects. Conversely, using the framework for cycle-specific projects will still require consideration of the wider transport planning and design context.

The project is being overseen by the Agency Cycle Steering Group. Abley Transportation Consultants Ltd and ViaStrada Ltd are assisting the Agency with the development of the framework, the process of which has been staged as described below. This report details the findings for Stage 1 only.

- **Stage 1** involved identifying the framework elements to inform a national and international best practice review and gap analysis. Engagement with technical stakeholders also informed the gap analysis. The output is a list of the gaps and how they might be filled, including any 'quick wins'.
- **Stage 2** will consider the outcomes of the national and international best practice review and gap analysis to develop a National Cycle (Network and Facility) Design Guidance Framework. Continuing engagement with the technical stakeholders will inform the refinement of the framework and its eventual form. It is anticipated that at least one workshop will be held to 'test' the framework. The key output of this stage will be the recommended framework.

It is important that the framework and selected best practice guidance retains sufficient flexibility that it allows 'value for money' outcomes for all road controlling authorities by recognising the differences between urban areas and the smaller districts.

1.2 Stage 1 - This report

The purpose of Stage 1 was to identify the gaps in the currently available design guidance in New Zealand and to work towards nationally consistent design principles and guidance for cycle network planning and infrastructure design. This involved engaging with technical stakeholders as outlined in Section 3. A survey of the stakeholders enabled the project team to identify the issues that are encountered in the transportation sector and any information that might inform the development of the framework.

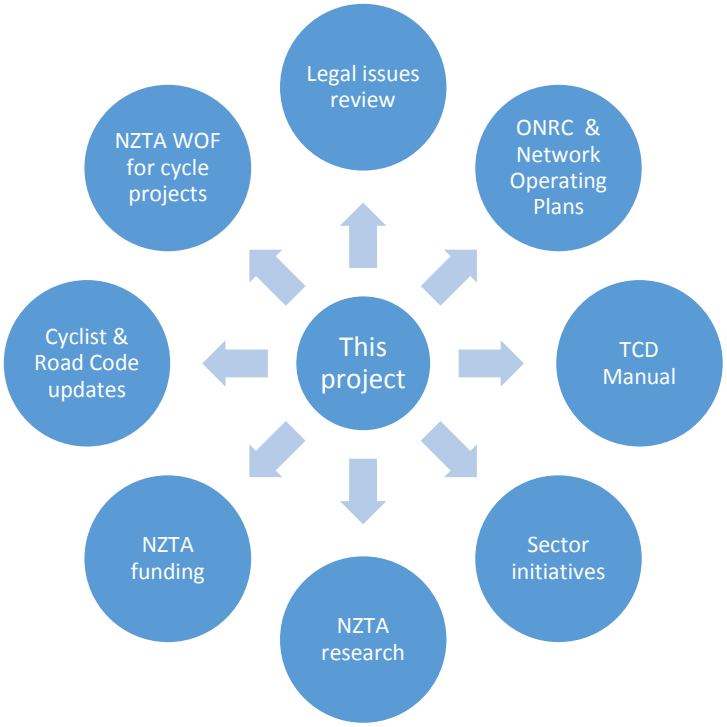
A best practice review of the current national, local and international design guidance, post implementation studies and relevant research was then undertaken. This included the topics of network planning, midblock design, and intersection and crossing design, as outlined in Sections 4, 5 and 6 respectively.

From the review a list of guidance gaps was compiled, each gap was prioritised as low, medium or high to inform the order in which they should be addressed as outlined in Section 7. The way in which they could be addressed was also identified as requiring one of the following; research, legislative change, approved trials, full guidance to be developed or an action that can be developed quickly (quick win).

1.3 Relationship with other projects

This project has relationships with other projects, law changes, initiatives, funding, research and also the Cyclist and Road Codes as updates may be required to reflect design/law changes. **Figure 1.1** shows the key relationships identified and being considered throughout the project.

Figure 1.1
Relationships between the Design Guide Project and others



The legal issues review is being carried out by the Agency Cycle Team and the Ministry of Transport, the ONRC by the Road Efficiency Group, Network Operating Plans by RCAs, and the Traffic Control Devices Manual (Part 4: Intersections and Part 5: Between Intersections) by the Agency. There are also initiatives being led by others such as the Auckland Transport shared path signage project.

There are also a range of Agency research projects being undertaken by others that have potential links to this project. Examples include the Urban Traffic Signals project. The Transport Agency has a research project underway, which is the first step in developing a consistent framework for assessing the costs and benefits of inner city parking. It is likely that further research will be needed to develop best practice guidelines for RCAs to refer to when considering parking in both a safety and efficiency context.

The Agency also recently developed a Warrant of Fitness (WOF) for cycle projects process. This was to provide guidance to RCAs in readiness for undertaking cycle projects and was rolled out in 2014.

The funding aspects of cycle projects are also linked to this project, namely through consideration of the Business Case Approach (BCA) where planning and design are key to the scope of the project. Specifically, the BCA requires the identification of:

- transport problems and their consequences;
- investment benefits (e.g. improved safety, mode choice, people/freight throughputs) and their significance.

These aspects are usually captured at the 'Strategic Case' level. Costing and testing strategic options against the investment benefits to then choose a preferred option is usually captured at a 'Programme' or 'Indicative Business Case' level. Developing, costing and testing of specific options occurs in the 'Detailed Business Case' level. All of these principles need to be embedded throughout the planning and design phase and this can be emphasised in the framework.

As well as their linkages to other engineering-based projects or processes, the Cycle Network Design framework and guidance developed need to consider the relationships with other planning and design aspects, for example, urban design, which can help enhance the attractiveness and user-friendliness of environments for cycling and transport in general.

2. Proposed Framework Content

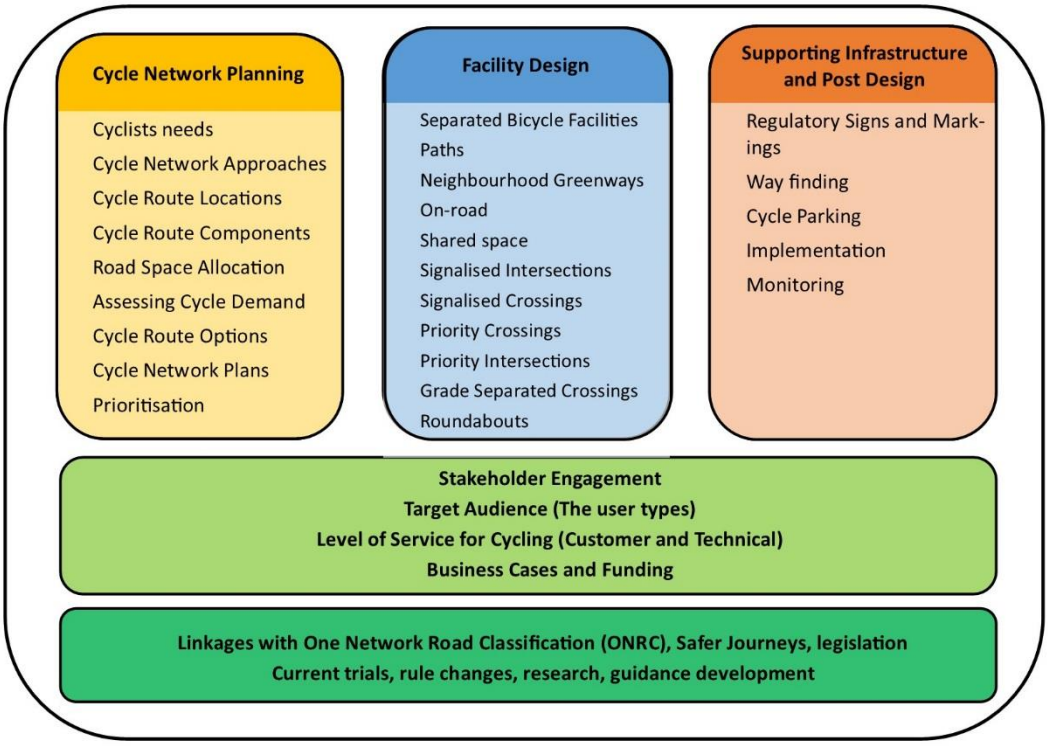
To guide the best practice review and to be able to communicate the intent of the framework to the technical stakeholders a graphical representation of the proposed framework was prepared as shown in **Figure 2.1.** The diagram represented the potential content of the framework rather than how the final framework might look. All topics listed will be referred to in the framework, but only some of the content will be reviewed for potential gaps as per the scope of the work documented in this report.

The **Cycle Network Planning** and **Facility Design** boxes were the focus of the Stage 1 best practice review. The section headings of the New Zealand Cycle Network and Route Planning Guide (LTSA 2004) were used to establish the Cycle Network Planning topics.

It is noted that aspects of the supporting infrastructure such as signs and markings and monitoring were also included in the review but that way finding, cycle parking and implementation (e.g. construction standards and quality control) were not. The topics of Level of Service and Target Users are included in the Stage 1 review however these were shown across all three boxes to acknowledge they apply to them all. Stakeholder engagement, business cases and funding also apply to all three boxes however these were not included in the review as they are processes that support the design process, or occur in parallel.

The topics in the lower box within the diagram, also spread across all three design boxes, represent links between planning and design with ONRC, Safer Journeys, Legislation, Current Trials, Rule Changes, Research and Guidance Development. Again these aspects were included to ensure that it was clear that the framework would be comprehensive in its coverage.

Figure 2.1
Diagram representing the framework content



3. Technical Stakeholder Consultation

3.1 Introduction

The engagement process for the first stage of the project was targeted at technical stakeholders only. Including a wider range of stakeholders is anticipated to occur in the next stage of the project. The technical stakeholders were made up of three key groups as described below. Each of these groups is comprised of people involved in both the planning and delivery of cycle infrastructure, and between them cover both urban and rural contexts. There is overlap between these groups, with some individuals being members of more than one of these:

- The **Active Modes Infrastructure Group (AMIG)** is a working group of the Road Controlling Authorities (RCA) Forum. This group is made up of representatives of Councils from around NZ (generally from larger urban authorities), NZTA, and one representative of the university sector. This group was involved in the development of the brief for this project.
- The **Road Controlling Authorities Forum** was also included so that councils not represented on the AMIG were consulted. It was considered that councils with a rural environment and smaller urban centres will have an interest in this project particularly as they are working towards connecting their towns and also developing networks within their towns.
- The **IPENZ Transportation Group** is a Technical Interest Group of the Institution of Professional Engineers New Zealand (IPENZ) with a membership of approximately 1,000. This group represents the industry that is involved in the planning, design and implementation of cycle networks and facilities, and therefore will have a high level of interest in this project.

3.2 The Survey

To help us inform the development of Cycle Network Design Guidance an online survey was sent out to Technical Stakeholders plus the Agency Highway Mangers and Agency walking and cycling staff. The stakeholders were asked for their views on the current issues encountered while planning and designing cycle networks, how an updated framework could assist and what lessons are out there to learn from.

A total of 160 responses were received across the full spectrum of policy makers, planners and engineers from the public and private sector. The survey findings prove to be another positive step towards delivering the step change needed to provide for cyclists in New Zealand as part of our transport system.

The key findings are listed below, more detailed results are in Appendix A.

- The majority of respondents stated that the content of the updated framework would capture the subjects that would be of value to their organisation and offered suggestions on how to improve it or sought clarification on content.
- ‘Insufficient or inadequate guidance on how to assess demand for the network’ and ‘Insufficient or inadequate wider transport policy to support development of a cycle network’ were the two most commonly raised planning issues.
- ‘Road space allocation’ and ‘Insufficient or inadequate guidance on intersections’ were the most commonly raised design issues.
- Respondents suggested that whatever form the framework takes it needs to be simple to use, flexible, not be too restrictive, not exclude engineering judgement and not inhibit innovation.

4. Best Practice Review: Cycle Network Planning

4.1 Introduction

As mentioned in Section 2 the structure of the Cycle Network and Route Planning Guide (CNRPG) informed the outline of topics to be reviewed. In addition to this a section on road space allocation was included in the review as this was identified through the technical stakeholder survey as a major issue in both the planning and design stages. The CNRPG gives a brief overview of the various elements of consultation, recognising that the approach to be taken depends on the specific context of each project however it was not included in the review.

This section covers the following topics:

- Cyclists' needs
- Level of Service for cyclists
- Possible cycle network approaches
- Assessing cycle demand
- Possible cycle route components
- Identifying and evaluating cycle route options
- Road space allocation
- Prioritisation and implementation
- Monitoring

The best practice review of each topic above includes a description of the topic, the national, local and international guidance available, any relevant feedback from the technical stakeholder survey, any relevant studies or research, a discussion and the gaps that have been identified.

4.2 Guidance Sources

In addition to the CNRPG, the national guidance used in the review includes the relevant sections of the Austroads Guide to Road Design, Guide to Road Safety and Guide to Traffic Management series, which (unless otherwise indicated in this document) are included in the summary document *Cycling Aspects of Austroads Guides* (Austroads 2014b). In addition, whilst the former Austroads Guide to Traffic Engineering part 14: Bicycles has been superseded by the new Austroads series mentioned above, it is still considered that the NZ Supplement to Austroads Part 14 (Transit 2008) is relevant in the New Zealand context. Very little local guidance of relevance to the planning stages has been identified, as local authorities tend to follow national guidance.

The **national guidance** includes:

- Guide to Traffic Management Part 6 (Austroads 2013)
- Cycling Aspects of Austroads Guides (Austroads 2014b)
- Austroads Guide to Traffic Engineering Part 14: Bicycles (Transit 2008)
- Cycle Network and Route Planning Guide (LTSA 2004)
- NZ Transport Agency-owned industry training course on Planning and Designing for Cycling.
- New Zealand Cycle Trail (NZCT) Design Guide, 4th edition (Lloyd et al 2015)
- New Zealand Standard Land Development and Subdivision Infrastructure. NZS 4404:2010 (Standards New Zealand 2010)
- Non-motorised User (NMU) Review Procedures (Land Transport NZ 2006)

The **local guidance** includes:

- Christchurch City Council Design Principles Best Practice Guide Revision A (Christchurch City Council 2014)

The **international guidance** includes:

- Design manual for bicycle traffic (CROW 2007) from the Netherlands, a country with an important history of being leaders in providing for cyclists
- Urban bikeway design guide (NACTO 2014) from the United States of America (accepted as the USA cycle design guidance as AASHTO is not up-to-date in terms of cycling provision).
- Highway Capacity Manual (TRB 2010) also from the United States of America
- Cycle Infrastructure Design Note (Department for Transport et al 2008) from the United Kingdom (with mention to other relevant notes where necessary)
- National Cycle Manual (National Transport Authority 2011) from Ireland
- Walking and Cycling Master Plan: Network Design (Department of Transport 2011) from Abu Dhabi.

4.3 Cyclists' needs

The term 'cyclist' covers a multitude of people of different ages and abilities who choose to cycle for different reasons and thus have different needs with respect to how the transport environment provides for their cycling trips. Note that in New Zealand, we use the term 'cycle' rather than 'bicycle' to include tricycles and courier cargo bikes. There is also a shift towards referring not to 'cyclists' but to 'people who cycle' to avoid the negative stereotypes sometimes associated with cyclists, and this also reflects that when cycling becomes more accessible to a broader section of society, many of those who use this mode would not think of themselves as cyclists. In this document, the term cyclist is generally employed, for simplicity, with the understanding of the wide range of people and trip types that this represents.

Guidance

A summary of existing local, national and international guidance regarding how to categorise the different types of cyclists and their various needs is shown in **Table 4.1**.

Note that NACTO has been consulted but it was found to not include any distinction of different types of cyclist or the needs of cyclists in general.

Table 4.1 Guidance table for categorising different Cyclist Types

	National	Local	International
Definition of types of cyclist	**CNRPG (Section 3)** The five types of cyclist are defined as: • Neighbourhood • Commuting • Sports • Recreation • Touring **Austroads GTM4** The rider characteristics of seven types of cyclist are: • Primary school children • Secondary school children • Recreational • Commuter • Utility • Touring • Sporting	**CCC MCR Design Guide** "Major Cycleways should aim to cater for the 'Interested but Concerned' group including both adults and children (10 years and over)." Where 'interested but concerned' refers to the terminology used by Geller, R (2009) (see description in *relevant studies and research*).	**CROW Manual** Outlines statistics on mode share of cyclists who travel for different purposes but does not discuss characteristics of user types. **Department for Transport (UK) Cycle Infrastructure Design Note** Outlines five different categories of cyclist: • Fast commuter • Utility cyclist • Inexperienced and / or leisure cyclist • Child • Users of specialised equipment (including trailers, trailer-cycles, tandems and tricycles and hand-cranked machines).
Cyclists' needs	**CNRPG (Section 3)** Gives a matrix of the five cyclist types' respective network / route requirements in terms of: • Safety • Comfort • Directness • Coherence • Attractiveness • Complementary facilities Note that the first 5 aspects listed above are identified as 'general route requirements' and complementary facilities are additional requirements.	**CCC MCR Design Guide** Defines five main objectives for providing for the 'interested but concerned' target audience: • Safety • Directness • Coherence and connectivity • Attractiveness and social safety • Comfort	**CROW Manual** Outlines five main requirements for bicycle-friendly infrastructure: • Cohesion • Directness • Attractiveness • Safety • Comfort.

	National	Local	International
	Austroads GTM4 Details the riding environment required by each of the seven types of cyclist. It also outlines six guiding principles for cyclists in general (i.e. not related to the seven types of cyclist): • Coherence • Directness • Safety • Attractiveness • Comfort End of trip facilities		**Department for Transport (UK) Cycle Infrastructure Design Note** Outlines the 'five core principles' of designing for cyclists: • Convenience • Accessibility • Safety • Comfort • Attractiveness **The Irish National Cycle Manual** Outlines the five needs of cyclists: • Road safety • Coherence • Directness • Attractiveness • Comfort **The Abu Dhabi Walking and Cycling Master Plan** Includes four principles for cycling: • Directness • Attractiveness • Safety • Connectivity

Relevant studies and research

Four categories of transportation cyclists (Geller 2009)

Roger Geller first presented his 'four categories of transportation cyclists' in 2005 based on a study from Portland, Oregon. His work was subsequently widely discussed by his American peers, and subject to academic research and led to an updated version (Geller 2009) which has now been taken into consideration by practitioners throughout the United States and beyond.

The Geller method is based on an entire population (e.g. the inhabitants of a particular city) being broken down into four types of transportation cyclists as shown in **Figure 4.1**, with the bar graph representing the proportions of a population that fall into the various categories (Geller 2009). Whilst Geller's original chart has defined boundaries between the four categories, **Figure 4.1** uses gradual transitions between the colours of the different categories to reflect the fact that groups are not necessarily fixed. Proportions might vary according to local culture and other demographic factors, and it is not possible to clearly assign every person into one of the categories. Geller's initial estimates of the category proportions have largely been confirmed through this process (Geller 2009).

Figure 4.1 *Geller's four types of transportation cyclists*

Geller's four groups shown in the figure can be explained as follows:

- **Strong & Fearless:** people who will travel by bike no matter what the road and traffic conditions are.
- **Enthused & Confident:** people who require some space on the carriageway, either informally (e.g. wide kerbside lanes) or formally (e.g. painted cycle lanes) to choose to cycle.
- **Interested but Concerned:** people who generally require physical separation from motorised traffic before they are prepared to travel by bike; some people in this group may be prepared to mix with motorised traffic where both volumes and speeds are low.
- **No Way No How:** people would not choose to use a bicycle regardless of the facilities provided and traffic environment.

Geller stresses that it is important to identify the target audience that a particular cycle route is supposed to cater for. Different routes may have different target audiences, for example Enthused & Confident cyclists may accept a facility that would not be sufficient for Interested but Concerned cyclists. It is important that the target audience be defined for each route, as the level and style of provision should meet the needs of its target audience over its entire length. Conversely, where a facility caters for novice cyclists over most of its length, but requires them to mix with traffic at even one intersection along the way, this could well be off-putting enough that the journey might not be undertaken by cycle along this corridor by novices.

Assessment of the type of cycling infrastructure required to attract new cyclists (Koorey et al 2011)

Koorey et al (2011) investigated what type of infrastructure would most likely result in people who do not yet ride a bike for transport to take up cycling. Through working with focus groups they determined that safety was by far the most important factor, and the required infrastructure had to achieve separation from motor vehicles. These findings align well with Geller's method in that the largest proportion of the population are prepared to cycle if offered separation from motor traffic – i.e. 'Interested but Concerned' cyclists

Cycling demand analysis (Pettit and Dodge 2014)

Pettit and Dodge (2014) surveyed people from Wellington to determine their attitudes to cycling and the factors that influence their willingness to cycle. They developed six classes of cyclist, represented in **Figure 4.2** according to their relative proportions:

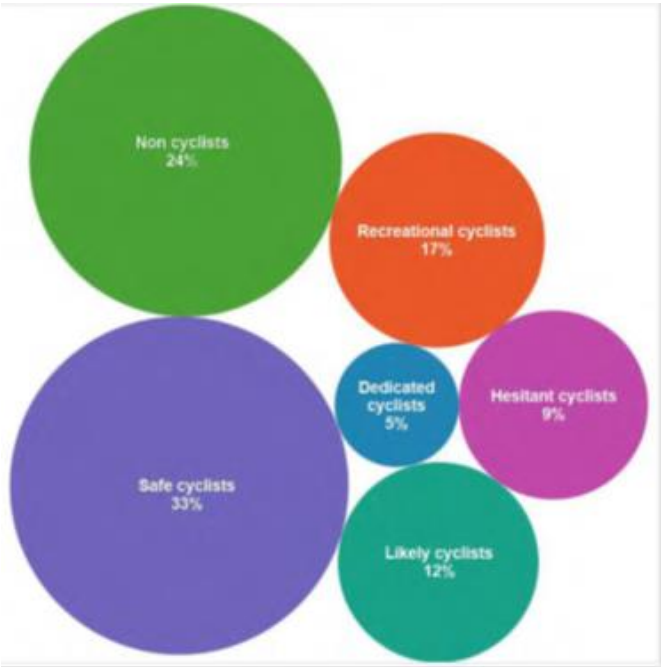


Figure 4.2 *Six classes of cyclist according to (Pettit and Dodge 2014)*

According to Pettit and Dodge's method, slope and infrastructure are key concerns relating to the propensity to cycle for different groups. Barrier-separated infrastructure was identified as the best way to get more people cycling more often. The authors considered this research to be a validation of international research that shows the most important issue to non-cyclists, when making the decision to cycle or not, is safety. The resulting model was identified as being appropriate for Wellington City, no comments were made regarding its transferability to other locations.

National network planning reviews

Dunedin City Cycle Network (Wilke et al 2014b)

The Geller (2009) classification (discussed above) was applied in the New Zealand context in developing the Dunedin City Cycle Network (Wilke et al 2014b). It was found from this exercise that it took longer to undertake the initial planning stages but, once the target audience had been established, the stakeholders indicated that it was more satisfactory compared with a network that had previously been developed by a more traditional process.

Discussion

Many available design guidelines identify the different requirements for cyclists; these are essentially based on the original CROW categories of safety, coherence (or "cohesion"), accessibility, comfort and attractiveness; the CNRPG and Austroads add complementary (or "end of trip") facilities. Some guidelines identify that people who cycle have different abilities and needs, and some classify different types of cyclist, but only the CNRPG goes so far as to identify for each of the types of cyclist, their specific requirements.

The Department for Transport (2008) makes an interesting point that not only is there a large range of types of cyclists, the cycles that people ride also differ from one another. Anecdotal evidence suggests that cargo bikes in particular are becoming more popular overseas; providing for such cycles places different requirements on the infrastructure. Austroads (Guide to Traffic Management, Section 4.6.2) defines seven categories of cyclists according to rider characteristics and appropriate riding environment. However, experience shows that this system is too complicated and not used by practitioners. Furthermore, these categories do not feed into the bulk of the subsequent advice relating to planning and designing for cycling. For example, whilst Austroads specifies six guiding principles for bicycle plans which are essentially the same as the CNRPG's six main requirements (safety, comfort, directness, coherence, attractiveness and end of trip facilities) Austroads does not specify a particular relationship for each of the seven categories of cyclist. Austroads does make some distinction in user type when considering design of off-road facilities by specifying different width requirements if paths are used for commuter or recreational cycling.

It is useful to highlight that the requirement of directness is significantly different to the other four general route requirements; safety, comfort, coherence and adhesion can all be applied to a particular facility (and complementary facilities are obviously specific facilities) whereas directness can only be applied over a route, and with respect to a specified origin-destination combination. This will have implications in evaluating route level of service (LOS), as discussed in the following chapter; the process of determining LOS for a particular facility type in a specific location will be different than when comparing LOS of two route options. Also, hilliness was identified as an important factor for some cyclists (Pettit and Dodge 2014) under the CNRPG general route requirements, hilliness is best captured within the "comfort" requirement, which aims for gentle slopes.

Agency funding focuses on utilitarian cycling[1], which relates to cycling as a transportation purpose, including but not limited to commuting. As NZ seeks to promote cycling as a means of transport, the concept of someone who cycles for transport (and the type people targeted to begin to cycle for transport) has now broadened significantly in comparison with the CNRPG definition of commuter cyclists. This guidance has an even greater coverage as it is intended to also be of use to local authorities who wish to include routes in their networks that target recreational users; although these may not attract Agency funding, they should still be designed according to guidelines that are appropriate and consistent with those used in the rest of the cycling network.

The CNRPG's definition of 'sports cyclist' highlights an important factor in that some cyclists use road bikes not just for sport but for commuting as well. Road bikes, which have narrow tyres, require smoother road surfaces to achieve a satisfactory level of service for their users; this should be accounted for in the LOS measures used.

Recent research illustrates that there is scope to further define the 'target audience' (i.e. the type of cyclist a facility or network is intended to cater for) to better reflect people's willingness to cycle under various circumstances. There are many different ways of 'cutting the cake' in trying to define different cyclist categories. As shown by Pettit and Dodge, and Geller the full potential of cycling uptake is only likely to be

[1] Note that, for travel by motor vehicle, no distinction in terms of trip purpose is made when determining funding allocation for roads.

reached if cyclist type is considered in conjunction with facility design. Current NZ design guidance does not identify appropriate facility types with respect to cyclist types or characteristics.

Geller's method is useful in that it is simple and 'fit for purpose' when aiming to distinguish between those who currently cycle on traditionally designed networks and those who may be encouraged to cycle with further changes made. Pettit and Dodge highlighted that safety (the fundamental criterion used by Geller in his spectrum of commuter cyclists) is not the most important factor in everyone's decision when choosing whether or not to cycle. This principle is inherent in Geller's work, as it follows to reason that those cyclists who are less concerned about separation from motor traffic (the strong and fearless and enthused and confident groups) will base their route choice on other criteria. The six guiding principles listed in the CNRPG could be usefully applied to the different cyclist types on Geller's spectrum.

Note that no direct mention of Geller's classification was made by Pettit and Dodge, but it would be useful to consider whether the two systems contradict or support each other, and which would be more applicable for this design guide's purposes. The Geller classification focuses on transportation cyclists whereas Pettit and Dodge's classification includes a class for recreational cyclists. The definitions of safe cyclists, hesitant cyclists and likely cyclists would best correspond to Geller's 'interested but concerned' group, but as some people in each of these groups do currently cycle for transportation purposes (and given Wellington City's current state of provision for cycling) there is in fact some overlap into the 'enthused and confident' group.

The development processes for the two models were different: while Geller focussed on people's perceptions of safety and a pre-defined classification system, Pettit and Dodge used the survey process to identify the various factors that were most important to individuals and used a modelling process to identify how many groups there are and the characteristics of people in these groups.

Essentially, the two classifications both show that there is a huge potential for increasing cycling volumes by targeting a greater audience through provision of infrastructure that separates cyclists from motor vehicles on routes with high traffic speeds and volumes.

The CNRPG includes identification of cyclists' needs in the section on 'principles of cycle network planning' but recent research and best practice application (Wilke et al 2014b) shows that the definition of the intended cycle network users on a route-by-route level should be the initial step in the planning process.

Gap Identification

Gaps identified in the guidance related to cyclists' needs are identified in **Table 4.2**.

***Table 4.2** Gap table for Cyclist' Needs*

Gap	Type	Comments
G1. Further refine definition of cyclist types for determining 'target audience' and relative importance of the design requirements relating to different types of cyclists.	Minimal guidance exists	The CNRPG makes a start in terms of defining types of existing cyclist, but is somewhat limited in how it focuses on trip types rather than cyclist types. Geller's method is useful as it focuses on cycling for transport and is presented as a spectrum which includes people who do not currently cycle and who may choose to cycle more under different conditions. This could be more easily applied in transport network planning and related to cyclists' requirements, LOS and demand estimation. CNRPG goes the farthest in that it links the types of cyclists to the main requirements, however this will require further distinction if the types of commuter cyclists are to be defined differently and also consideration of actual facility types that are suitable for various types of cyclist.

4.4 Level of Service for cyclists

The concept of Level of Service (LOS) is often applied in general traffic engineering planning and design. Current LOS ratings tend to evaluate transportation system performance based primarily on motor vehicle traffic speed and delay; however there are different characteristics other than speed and delay that are important to people who cycle. Given that the CNRPG defining the general route requirements for cycling (safety, comfort, directness, coherence and attractiveness) early in the planning process, it would be logical that these are all captured in the proposed guidance and used to measure LOS for cyclists to ensure the route components and alignments cater adequately for the target audience.

Guidance

A summary of existing national and international guidance relating to level (or quality) of service for cyclists is shown in **Table 4.3**. Note that no local guidance of relevance was identified.

Table 4.3
Guidance table for Level of Service for Cyclists

	National	International
Level of Service (LoS) a.k.a. "Quality of Service (QoS)	**CNRPG** Presents several international methods (these are explained further under the international guidance): • Bicycle Compatibility Index ("BCI" - FHWA, 1998) • Cycle review LOS (Institution of Highways and Transportation, et al., 1998). • Bicycling Levels of Quality (Walkable Communities, no date) **ONRC** Defines 'customer levels of service outcomes', but for 'active users' (i.e. pedestrians as well as cyclists) these are generally limited to 'safety' outcomes in terms of whether users are provided separate facilities from motor traffic, although 'separation' is not defined. For road categories between arterial and national, the ONRC does not as yet include cyclists in the other LOS measures (travel time reliability, resilience, optimal speeds, and accessibility).	**Bicycle Compatibility Index ("BCI" - FHWA, 1998)** Overall LOS obtained from sum of individual scores for variables relating to geometry and roadside characteristics, traffic operations and parking. **Cycle review LOS Assessment (IHT et al, 1998)** Overall LOS obtained from sum of individual scores for variables relating to geometry and roadside characteristics, traffic operations and parking. **Walkable Communities: "Bicycling - Levels of Quality".** Gives pictorial examples of locations with QoS from A to F for various facility types: • Wide curb (i.e. "kerbside") lanes • Bike lanes • Paved shoulders • Multi-use trails (i.e. "paths") • Crossings **VicRoads Cycle Notes 21 (VicRoads 2013)** Uses a threshold acceptable LOS to determine width and appropriateness of shared and segregated paths for cyclists and pedestrians, based on user volumes.

	National	International
		Technical Note 133 (Queensland Government, Department of Transport and Main Roads 2014a) Uses a similar approach to VicRoads (2013) to relate path width with an acceptable delay threshold (i.e. a set LOS value), **The Highway Capacity Manual (TRB, 2010)** Uses the Bicycle Level of Service (BLOS) model based on research detailed in NCHRP (2008). The variables represent motor traffic and bicycle facility characteristics. Different models are used for midblock road segments and intersections, although not all intersections are included. The full process consists of 8-steps, but this can be reduced for more simple evaluations of midblock facilities. The BLOS model is used in conjunction with models for motor vehicle drivers, bus passengers and pedestrians to achieve a multi-modal LOS analysis for urban streets, however the individual modal LoSs are not combined into a single model to represent overall LOS for a given road segment. **The Abu Dhabi Walking and Cycling Master Plan** States that LOS and QOS are different as they rely on different metrics. It presents a method of measuring LOS for pedestrians and identifies the need to develop a method of gauging multi-modal QLOS for corridors. **Ireland's National Cycle Manual** Specifies the QoS from A+ to D for five criteria: • Pavement condition index • Number of adjacent cyclists • Number of conflicts per 100m of route • Journey time delay (% of total travel time) • Heavy goods vehicles influence (% of total traffic volume)

Available post implementation studies

Wellington (McPhedran and Nicholls 2014)

McPhedran and Nicholls (2014) examined eight international methods of gauging LOS for cycling and concluded that the "Danish method" (Jensen 2007) and (Jensen 2012 - discussed below) and the American Highway Capacity Manual (TRB 2010 - see guidance table) were the most applicable to the Wellington cycling context. They applied these models, and several variations based on them, to 19 selected routes from Wellington and determined that the Danish method was the most appropriate. However, it was also identified that this method does not account for surface condition or access / intersection conflicts and that the intersection model was not appropriate for NZ conditions due to significant differences in road rules.

Relevant studies and research

Cycle for Science: NZ LOS tool (Bezuidenhout et al 2005)

Bezuidenhout developed LOS models for midblock sections of road (including painted cycle lanes) in Christchurch as rated by a range of cyclists, based on the criteria of delay, safety, surface condition and attractiveness (although it is not clear from the paper how the overall perception score, i.e. LOS, was aggregated from these individual criteria). It was found that lesser-experienced cyclists gave higher LOS ratings than more experienced cyclists, or those with a technical traffic engineering background.

Danish method (Jensen 2007) and (Jensen 2008)

The "Danish method" developed for midblock segments (Jensen 2007) and later intersections (Jensen 2012) determines LOS for cyclists based on various traffic and roadway variables. Whilst the variables used may not be explicitly linked to the 5 general route requirements, the authors of this report consider that each variable used by Jensen is an inherent factor in determining people's perceptions of one or more of the 5 requirements. It is not clear whether this method has been officially adopted as guidance in Denmark, but it has been included in guidance or as motivating research by practitioners from countries such as the United Kingdom, the United States, Australia and New Zealand.

Low-stress bicycling and network connectivity (Mekuria et al 2012)

This research for the Mineta Transportation Institute presents a scheme for classifying road segments by one of four levels of "traffic stress" caused to cyclists based on motor traffic characteristics (volumes and speeds) and the interaction between cyclists and motor traffic. The values assigned to determining the traffic stress levels were derived so that the levels correlate with different types of cyclists (in a classification based on Geller's) and thus can be used as a planning tool to determine which facilities will be appropriate for a particular target audience.

CLOSAT (Hollander 2014)

VicRoads[2] and Bicycle Network[3] jointly developed the "Cyclist Level of Service Assessment Tool" (CLOSAT) for assessment of on-road and off-road bicycle facilities in Melbourne (Hollander 2014). The tool developers make a very clear case for the importance of considering LOS to cyclists and why LOS is measured differently for cyclists than for motorists. The tool assesses intersections separately from midblock sections. It gauges LOS based on a variety of factors including facility type, separation from traffic, geometry, speed of adjacent motor traffic and volume of adjacent motor traffic. The tool developers state that the tool essentially measures a facility's attractiveness to cyclists, although this definition of

[2] the road controlling authority for the Australian state of Victoria] and Bicycle Network
[3] a Melbourne-based non-governmental organisation aiming to make cycling easy for everyone

"attractiveness" is quite different to that of the CNRPG route requirement definition (which is concerned with the wider environmental surroundings) and is more aligned with the requirements of safety and comfort.

The authors acknowledged the importance of identifying the types of cyclists and their various needs and developed a schematic of Geller's (Geller 2009) classification as applied to the Melbourne network. Their analysis was that Geller's classification shows that LOS will increase as level of separation from motor traffic increases. However, it seems from the paper that CLOSAT has not been developed with any particular target audience in mind.

LOS Metrics for Network Operations Planning (Austroads 2015)

Austroads undertook a project to develop a LOS framework for network operations from the perspective of all road users, including motorists, transit users, freight, pedestrians and cyclists (Austroads 2015). The framework is based on a series of "LOS needs" (mobility, safety, access, information and amenity) which are each subdivided into "LOS measures" specific to each road user type. Ratings (from A to F) are assigned according to various defined "service measure values". The LOS needs and measures for cycling used are shown in **Table 4.4**.

Table 4.4 Excerpt of LOS measures and needs of cyclists (Austroads 2015)

	LOS Measures				
	Mobility	**Safety**	**Access**	**Information**	**Amenity**
LOS Needs	• Travel speed • Congestion (of cycling Infrastructure • Grades	• Risk of cycle-to-cycle / pedestrian crash • Risk of crash caused by surface unevenness or slippage • Risk of crash with stationary hazards • Risk of cycle-to-motor vehicle crash at mid-blocks • Risk of cycle-to-motor vehicle crash at intersections and/or driveways	• Access to and ability to park close to destination • Suitability	• Traveller information available, including signposting	• Aesthetics • Security • Pavement ride quality

It was identified that the framework would be useful in highlighting trade-offs between users, as a quick reference guide as to what issues should be considered during project development and as a tool to identify aspects to be modified to achieve a higher LOS to the project or specific user groups. The need to develop guidance on applying weightings to the various 'LOS needs' to obtain the overall LOS for a route was also identified.

Discussion

LOS is based on different criteria for cyclists than for motorists. The CNRPG discusses LOS near the end of the planning process as a means of evaluating route options, however as LOS is a key concept that is strongly linked to cyclists' needs, it would be beneficial to include it from the start of the planning process. The CNRPG essentially defines how LOS for cyclists should be gauged by defining the five general route requirements, which is a guiding principle to be understood before even commencing the planning process. Note that these requirements include not only 'transport' focused aspects (e.g. directness) but also measures that relate to the quality of a surrounding environment and the cycling experience – collaboration with urban design specialists is therefore critical in achieving a high LOS for cycling. Consideration of LOS can add great value when determining the facility types most appropriate to the chosen group of cyclists to be provided for.

A number of different guidelines / research documents present different methods of how to assign LOS grades, ranging from qualitative comparisons (e.g. the Walkable Communities QOS pictorial guide) to quantitative methods using different variables to explain the cycling environment (e.g. the Danish method, the Highway Capacity Manual and the Irish National Cycle Manual). While the Austroads research report on LOS metrics does not give quantified values, it presents a useful framework of variables for assessing cyclist LoS. Such sources may be a useful starting point to develop a similar tool for NZ, but further research would be required to determine the appropriate criteria and their weightings to be applied to the NZ context. McPhedran and Nicholls (2014) concluded that the Danish method was the most applicable to Wellington's cycling environment, but also identified several limitations, especially with respect to intersections and accessways along routes.

The Highway Capacity Manual and CLOSAT illustrate the importance of evaluating the LOS of each individual intersection and midblock section over a route and thus determining the critical areas that need to be addressed to ensure a target minimum LOS over the route.

Among the research reports and guidelines that do offer LOS classification systems, very few have been validated by surveying real people. Bezuidenhout et al, Jensen and Hollander did include some validation. Geller's classification is based on people's stated preferences, but does not extend to a validated LOS assessment of how these people would rate particular facilities.

It stands to reason that LOS weightings given to different variables will differ depending on the type of cyclist. The CNRPG illustrates this point by showing a matrix of cyclist types compared with network / route requirements. Pettit and Dodge (2014), for example, have shown that different cyclists place different emphasis on different factors – under the Geller classification, enthused and confident cyclists value directness more highly than interested but concerned cyclists, whereas the latter group may place a greater importance on physical separation. The LOS of a facility is therefore subjective according to each individual user; regardless of the weightings of individual variables. It would seem logical that a facility that enthused and confident cyclists rate as LOS B may be considered LOS D or E by interested but concerned cyclists. However, from Bezuidenhout et al (2005) the reverse appears to be true - less-experienced cyclists were identified as "more forgiving" in their LOS assessment. This would suggest that people's perceptions are the greatest barrier to cycling; someone who hasn't cycled may be afraid of doing so (hence the "interested but concerned" label) but, once these people are convinced to try, their LOS rating is higher than someone who has more experience of cycling (and the associated hazards). Hollander reflected this by basing CLOSAT on the attractiveness of facilities, i.e. their ability to encourage more people to cycle.

Of the available tools or guidelines identified, only the Mineta Transportation Institute's method (Mekuria et al 2012) relates the LOS measure (in this case, level of traffic stress) with cyclist target audience – that is, each level of traffic stress represents the acceptable level of service for a certain user type. However, the MTI method does not give a spectrum for each individual user group; for example, there is no distinction between an adequate facility and a great facility as judged by an interested but concerned cyclist. Given the cycling culture in Denmark, it is likely that the Danish method may inherently reflect the LOS for interested but concerned cyclists.

It is noted that Auckland Transport is currently exploring the principle of level of traffic stress to analyse the proposed Auckland cycle network.

None of the LOS tools identified gauge LOS based directly on the five general route requirements of safety, attractiveness, directness comfort and coherence. Most of the tools account for at least safety by using proxy measures such as degree of separation and motor traffic speeds and volumes. However few tools actually account for the other requirements as per the CNRPG definitions.

Many of the most recent LOS tools focus on facilities that provide solely for cyclists. However, the possible route components (see Chapter 4.7) also include facilities shared with pedestrians. The presence of pedestrians on a path introduces a number of different effects to cyclists' LOS, and the LOS to pedestrians themselves must also be considered. Austroads (2015) includes the risk of crashes with pedestrians in the safety LOS measures. VicRoads (2013)and Queensland Government, Department of Transport and Main Roads (2014a) include interaction with pedestrians to some extent by setting a threshold LOS to determine the appropriate facility types (i.e. shared or exclusive) and path widths when both cyclists and pedestrians should be catered for. This threshold LOS is based on user encounters and resulting delays in passing or overtaking manoeuvres. Given the prevalence of shared facilities within a cycle network, the presence of pedestrians should be considered in LOS measures used. Note that VicRoads (2013), in considering interaction with pedestrians and resulting path width does not incorporate many other factors relating to LOS, such as interaction with motor traffic, comfort, accessibility etc.

LOS assessment is used at different stages of the planning and design process. It is therefore necessary to be able to gauge LOS for individual facilities in specific locations (e.g. an individual midblock section) and over an entire route. As discussed in the previous section, the requirement of directness is only relevant when considering specific origin-destination combinations and comparing routes. Any method of combining LOS scores for individual route elements must also include consideration of directness to give an overall route LOS score.

It is recognised that the ONRC is a work in progress; one of the useful outcomes of this Stage 1 review is the identification of opportunities to better include consideration of cyclists in the ONRC. It should consider LOS for cyclists as per the CNRPG, and include measures other than just safety, as well as improving the safety LOS measures by specifying what constitutes 'separation'.

Gap Identification

Gaps identified in the level of service guidance are identified in **Table 4.5**.

Table 4.5 Gap table for Level of Service for Cyclists

Gap	Type	Comments
G2. Definition of LOS ratings for individual facilities and along routes based on NZ traffic environment and specific target audience, including factors related to presence of pedestrians on shared paths.	No (NZ) guidance exists	The Mineta Transportation Institute level of traffic stress analysis and CLOSAT tools go the furthest in terms of identifying the criteria and quantifying the LOS ratings, but these are not adapted to the NZ context and the level of traffic stress is only related to the safety requirement. CLOSAT also does not define the target audience to which it applies. CLOSAT does aim to combine LOS of homogenous elements to give an overall route LOS, but it does not include directness as a consideration in route LOS. Few LOS measures account for the presence of pedestrians on shared paths; (VicRoads 2013) does inherently, and Austroads (2015) includes the risk or crashes with pedestrians.
G3. Inclusion of more LOS measures for cycling in ONRC	Minimal NZ guidance exists.	The ONRC customer LOS definitions are largely based on motor vehicle users; there is scope to improve the ONRC to better assess LOS for cyclists.

4.5 Possible Cycle Network Approaches

The CNRPG recognises that the objectives, opportunities and constraints to developing a cycle network differ for each town or city and therefore offers practitioners different possibilities for the approach that can be used for planning a cycle network. **Table 4.6** outlines the five different approaches offered by the CNRPG; internationally, this seems to be the most comprehensive and versatile guidance available for this aspect of cycle planning.

Guidance

A summary of existing local, national and international guidance is shown in **Table 4.6**. No appropriate local guidance was identified and, among the international guides, only CROW mentions this topic.

Table 4.6
Guidance Table for Possible Cycle Network Approaches

National	International
CNRPG Section 5 of the CNRPG outlines five approaches to determining the route coverage of a cycle network: • The *every street* approach maintains all streets and intersections should involve a high quality of provision for cyclists. • The *roads or paths* approach outlines the relative advantages and disadvantages of providing cycle facilities within the road corridor versus providing them separate from the road corridor. • The *dual networks* approach provides two networks each based on different types of cyclist. • The *hierarchy* approach assigns a hierarchy to various routes in a network based on trip length and user type. • The *needs* approach involves choosing the option that best provides for cyclists' needs in each situation. **NZCT Design Guide** Does not intend to develop networks, rather focuses on recreational / tourism routes in iconic locations. Uses one planning approach, based on: identifying key attractions; determining appropriate leg / route distances; linking to towns, cities and existing routes; determining provision. NZS 4404:2010 Place and link approach which considers the surrounding land use as well as the need for connectivity of a network. **Austroads** Guidance on cycle network development: • Emphasises the need for integrated and multi-modal network planning (Guide to Road Transport Planning, 2009) • Outlines requirements, functions and objectives for a bicycle network (Guide to Traffic Management Part 4) Does not detail different approaches that could be made in developing networks according to these guidelines.	**CROW Manual** Talks about the need to integrate cycle planning within the greater transport network planning process. Only one method for developing the "bicycle structure plan" (i.e. network plan) is given; this is based on understanding key origins and destinations of existing cyclists and seeking to achieve directness, reduce encounters with motorist vehicles and create a coherent network structure.

Relevant studies and research

NZ examples

Wilke (2014a) give two recent examples of developing cycle networks in NZ. Christchurch City and Dunedin City both decided to develop networks aimed at providing for the interested but concerned target audience, as per Geller's (2009) classification. It was identified that beginning the planning process by defining who a network link is supposed to cater for has the advantage of creating routes that are consistent in their level of service over their entire length. The authors acknowledged that this planning approach requires more planning effort upfront, but results in corridors being chosen that are more realistic to achieve.

Macbeth et al (2007) document the development of the Auckland cycle network for the Auckland Regional Transport Authority (ARTA), where GIS was used to compare the merits of different potential routes.

Discussion

Most guidelines give some guidance on the process to be undertaken in planning a cycle network; the importance of considering cycle networks in relation to other transport networks is a key factor. As detailed in the previous sections, most guidelines detail the key features of the finished cycle network. However, only the CNRPG outlines different possible planning approaches to achieving this network. Austroads effectively focuses on what the CNRPG calls a hierarchical approach. Subsequent to the work quoted by Macbeth et al (2007) above, a hierarchy approach was used in the Auckland region.

Although it is not explicitly stated, the CNRPG approaches are not necessarily mutually exclusive; two or more could be relevant to a particular network. However, some are unlikely to ever be appropriate. For example, in constrained urban environments with competing objectives for different transport modes it is not likely that it would ever be viable to adopt the every street approach, especially for an interested but concerned audience who requires greater separation from motor traffic. Similarly, it is unlikely that a cycle network could ever consist solely of off-road facilities and a cycle network constructed solely within the existing road network would likely miss out on opportunities to facilitate cycling trips by using off-road links.

By having several planning approach options, the CNRPG provides planners with options. These options are effectively a way of answering the underlying question of “who is to be catered for?” Only by addressing this question is it possible to determine the level of provision required (e.g. for the every street, hierarchy or needs approaches), to distinguish whether roads or paths are more appropriate, to identify the difference required for two networks within a dual network approach or to assign a hierarchy to route choices. It would be more beneficial to address the question of “who?” directly at the start of the planning process and thus selection of the relevant planning approach(es) would become more obvious to the planner.

The Dunedin cycle network development (Wilke et al 2014b) addressed the fundamental question of “who?” at the start of the planning process through use of the Geller (2009) classification. In this exercise, the target audience and potential network(s) were considered simultaneously, without having a pre-determined outcome in mind. As a result, two overlapping cycle networks were created; one for enthused and confident cyclists and the other, larger network, for interested but concerned cyclists. The two networks developed could be seen as best fitting under the CNRPG’s definition of the needs approach as the location and subsequent design of each route was assessed based on the requirements of the target audience. By catering for two target audiences, the overall Dunedin cycle network therefore incorporates elements of the dual network approach. Therefore it is recommended that any planning approaches provided in the NZ cycle design guidance be more closely related to the process of choosing a target audience; it may be necessary to include iteration between these two steps. The planning approaches should include determination of the trip requirements (origins and destinations) and consideration of the practicality of providing within the current transport network in a suitable way for the target audience.

The 'place and link' approach considers the surrounding land use as well as the need for connectivity of a network (e.g. NZS 4404:2010 which refers to the general transport network, but this principle can be usefully applied to cycle networks in particular).

Gap Identification

Gaps identified in the possible cycle network approaches guidance are identified in **Table 4.7**.

***Table 4.7** Gap Table for Possible Cycle Network Approaches*

Gap	Type	Comments
G4. Identification of appropriate planning approach(es) in conjunction with identification of target audience.	Minimal guidance exists	This stems from the need to properly identify the objectives of the route in terms of who it is to cater for and the requirements of these people.

4.6 Assessing Cycle Demand

"To know what to provide for cyclists, and where, it is important to have good information — such as how many people cycle or wish to cycle, where they wish to ride, for what purpose they ride, and how competent they are to handle a variety of conditions" (LTSA 2004). Whilst models for predicting general traffic demand are well-established, there is need to further develop models for assessing demand for cycling. This need is accentuated by the increasing desire to provide for a target audience that includes a greater proportion of the population as different factors affect these people's choice to cycle.

Guidance

A summary of existing local, national and international guidance is shown in **Table 4.8** . The standard international design manuals provide very little guidance on how to assess demand for cycling. CROW, the Department for Transport (UK) and NACTO do not offer any guidance. Austroads and the Irish National Cycle Manual offer some pointers for gathering data but no substantial guidance on how to transform this data into meaningful demand predictions. Useful advice in this area comes more from research reports and best practice examples, rather than official guidance manuals.

***Table 4.8** Guidance Table for Assessing Cycle Demand*

	National	International
Non-volume based methods of assessing demand	**CNRPG** • Identifying origin and destination locations (e.g. Census data, school surveys, visitor numbers, parked cycle counts) • Desire lines and barriers • Route data (e.g. road hierarchy, cycle crash data, existing cycle facilities, consultation with cyclists) • Questionnaires	**The Irish Cycle Manual** Identifies the main sources of information on trip demand as: 1. Census data 2. Origin surveys 3. Designation surveys 4. Transport models (but no information on developing these is given) 5. Trip generation rates.
Counting methods	**CNRPG** Gives a brief overview of advantages and disadvantages of manual and automatic counting techniques (does	

	National	International
	not go into detail about types of automatic counting devices). **Cycling Aspects of Austroads Guides** Suggests that "data on some of the movements made by cyclists can be collected using methods similar to those used for collecting other traffic data (see Appendix B and GTM 3 for more detail on designing surveys)" however it then goes on to discuss the limitations of cycle data compared with motor vehicle data.	
Methods of obtaining AADT estimates for specific facilities	**CNRPG** • Method of scaling short-term counts to estimate AADT for an existing facility (on- or off-road) • NZTA Research Report 340 (McDonald, et al., 2007): • On-road estimation tool; step function to represent introduction of new facility to existing road environment, based on existing cycle volumes and census mode share growth rate. • Off-road estimation tool – for a new facility, parallel to an existing road; based on cycle AADT on parallel road, census cycle mode share, motor vehicle volume on parallel road, ratio of NZ average trip length by cycles to motor vehicles (from NZ Travel Survey). **EEM SP11 procedure** • Method of estimating AADT based on census population and mode share data for new facility (significant limitations for certain locations). Includes a relative benefit factor for different types of cycle facilities compared with a base case of cycling in mixed traffic with road-side parking.	

Relevant studies and research

New Zealand (ViaStrada 2009)

An Agency trial of continuous cycle counting (ViaStrada, 2009) resulted in detailed information on the requirements, limitations, abilities and accuracies of two types of automatic inductive loop counting devices, with comparison with SCATs loops and pneumatic tubes. The scope of this trial did not include predictions of demand based on the cycle counts gained.

Wellington (Pettit and Dodge 2014)

Pettit and Dodge (2014) developed a model for Wellington City to assess willingness to cycle for people in different user type categories (see discussion in Section 4.3: Cyclists' needs). They considered that this method could be used for assessing demand on longer routes or the broad network in Wellington City.

Christchurch (Roberts 2014)

Roberts (2014) discusses how the Christchurch Strategic Cycle Model (CSCM) was developed for Christchurch City to inform its "Major Cycle Network" planning process. The CSCM was based on the city's existing traffic model, and takes account of changes in demographics, traffic congestion, fuel prices as well as people's perceptions of the utility of cycling and attractiveness of various network improvement packages. The CSM uses a factor of 30% to estimate the maximum proportion of car users who would actually choose cycling as a viable alternative if given suitable improvements. This value was considered by the model developers to be "realistic but still aspirational".

America (Kuzmyak et al 2014)

The US National Cooperative Highway Research Program's "Estimating Bicycling and Walking for Planning and Project Development: A Guidebook" (Kuzmyak et al 2014) developed certain choice-based tour generation models that account better for walking and cycling facilities. "Choice-based" models (as opposed to facility-based) are structured according to the traditional 4-step trip assignment modelling process. Assessing tours (rather than trips) recognises the importance of trip-chaining in people's mode choice. The report recognises the importance of various facility and environmental factors likely to attract a larger proportion of the population to cycle. The research developed certain models, however these are complex and generally applicable in a network planning context rather than in assessing the demand on individual facilities. Furthermore the variables identified and, more importantly, the coefficients assigned, relate specifically to American cities, and would not be directly transferable to modelling mode choice in NZ towns and cities.

Discussion

The NCHRP report (Kuzmyak et al 2014) highlights a growing awareness of the need to develop more sophisticated methods of estimating cycling demand and the importance of adequately including cycling as a mode choice in general transportation planning. People's willingness to cycle depends on a raft of variables relating to the nature of their trip(s), available facilities, road environment, natural environment, surrounding land use context and the people themselves. However, models developed to incorporate these variables can become complex and have high input requirements; thus they can become inaccessible to the planners and designers who need to use them.

A cycle network model has been developed for Christchurch (Roberts 2014). The CSCM involves a fundamental assumption regarding the number of people who will take up cycling (effectively, the interested but concerned audience) as there is a lack of empirical data in this area given that relevant facilities are uncommon and those that do exist have not been around long enough and do not provide sufficient coverage on a network level. Other network models that include various methods of predicting

future demand are also in use in other localities throughout New Zealand. Future guidance in this field should be aimed at developing a consistent method that can be applied throughout the country.

Whilst NCHRP recommends moving away from a facility-based approach, most NZ local authorities (except for the large cities) will not have the resources or motivation to develop large-scale cycle network models. And, as identified for the CSCM, there is a lack of empirical data available to develop models with a guaranteed accuracy. Therefore, it seems that there is still a place for facility-based demand estimation tools in the NZ context, even if these tools cannot provide a level of accuracy comparable to that of a modelling approach based on trip assignment.

NZ's current facility-based tools, namely those from the CNRPG, Research Report 340 and SP11, are limited. They are all based on historic data gained from existing cycle facilities and therefore, in general, represent a small part of the general population who are willing to cycle without physical separation from motor traffic. The CNRPG method is not applicable to new facilities. SP11 places a great emphasis on resident population adjacent to the proposed cycle facility, which is, for example, inapplicable to central business district environments with a low population but a high number of jobs. SP11 gives some consideration to how the type of facility affects demand through the use of a relative benefit factor, and two tools presented in Research Report 340 distinguish between off-road and on-road cycling, although this research is based on a very small number of samples. Overall, there is significant room for improvement in terms of incorporating the type of facility into demand estimation methods.

The CNRPG briefly mentions the concept of latent demand – potential new cycle trips that are currently suppressed but that would occur if cycling conditions were improved. The CNRPG does not make the link that the form of "improvement" required to release this suppressed demand depends on the type of cyclist to be catered for. Pettit and Dodge (2014) give an example of NZ research regarding people's willingness to cycle with respect to facility characteristics and route location. However, this research did not result in the development of a tool that could be used to predict demand for a specific facility.

Gap Identification

Gaps identified in the assessing cycle demand guidance are identified in **Table 4.9**.

Table 4.9 *Gap Table for Assessing Cycle Demand*

Gap	Type	Comments
G5. Models / methods to develop predict demand on facilities targeted at greater cycling population (e.g. interested but concerned cyclists).	No (NZ) guidance exists	Due to lack of empirical data (due to lack of existing facilities) relating to interested but concerned type cyclists

4.7 Possible Cycle Route Components

The midblock environment accounts for by far the greatest proportion of length of any given cycle route. The design aspects of these route components will be discussed in detail in Section 5. Planners and designers should have a general understanding of the potential applications (in terms of who they best cater for and where they can be applied) and limitations of these route components early on in the planning process to ensure the routes proposed are achievable and fit-for-purpose.

Guidance

A summary of existing local, national and international guidance is shown in **Table 4.10**.

Table 4.10 Guidance Table for Possible Cycle Route Components

	National	Local	International
Facility Type	**Austroads GTM Figure 4.7 (see Figure 4.3 below)** Defines the level of separation of cyclists and motor vehicles (mixed traffic, bicycle lanes / shoulders or separate paths) in terms of volume and speed of motor vehicles. It discusses various midblock facility types. **CNRPG** The CNRPG describes the advantages and disadvantages of nine types of midblock facility: • Kerbside cycle lanes • Cycle lanes next to parking • Contra-flow cycle lanes • Wide kerbside lanes • Sealed shoulders • Bus-bike lanes • Transit lanes • Mixed traffic • Paths **NZCT Design Guide** Focuses on "trails" but these can be: • On-road or off-road • Paved or sealed For a variety of different user grades (i.e. abilities / comfort levels).	**CCC MCR Design Guide** Defines four main link types for the Interested but Concerned target audience: • Paths (i.e. off carriageway, can be shared with or separated from pedestrians) • Separated cycle lane (i.e. on carriageway with physical separation) • Separated 2-way cycle path (i.e. adjacent to carriageway) • Neighbourhood greenways (i.e. quiet streets).	**Ireland's National Cycle Manual** Gives seven broad categories of link type: • Mixed / shared street • Standard cycle lanes • Cycling and bus lanes • Standard cycle tracks (i.e. separated bicycle facilities) • Contra-flow cycle lanes and tracks • Cycle trails • Cycle ways **CROW Manual** Gives guidance on similar midblock facility types. **NACTO Guide** Includes buffered and protected bike lanes / tracks and gives the most comprehensive guidance available on "bicycle boulevards" (i.e. quiet streets) **The Abu Dhabi Walking and Cycling Master Plan** Along with the elements mentioned above for the other guides, includes a number of different variations on streets shared by pedestrians, cyclists and motor vehicles, with the distinctions being in terms of who has right of way and the extent of vehicle access is permitted

	National	Local	International
Appropriateness of facility for certain types of cyclist	**CNRPG** The CNRPG builds on from Austroads and rates the suitability of various cycle facility options for three categories of cyclist; “child/novice”, “basic competence” and “experienced” in terms of three degrees of “benefit” – minimal, moderate and most benefit	**CCC MCR Design Guide** Defines the appropriate road category, posted speed limit and AADT for the four main link types (above).	

Relevant studies and research

On-road facilities (Bicycle Network 2015)

This report identifies a bias in the current Austroads guidance towards providing for adult commuter cyclists. It proposes an adjustment to Figure 4.7 from Austroads Guide to Traffic Management Part 4 to account for less confident adults, family groups and children. The proposed modification can be seen in **Figure 4.3**.

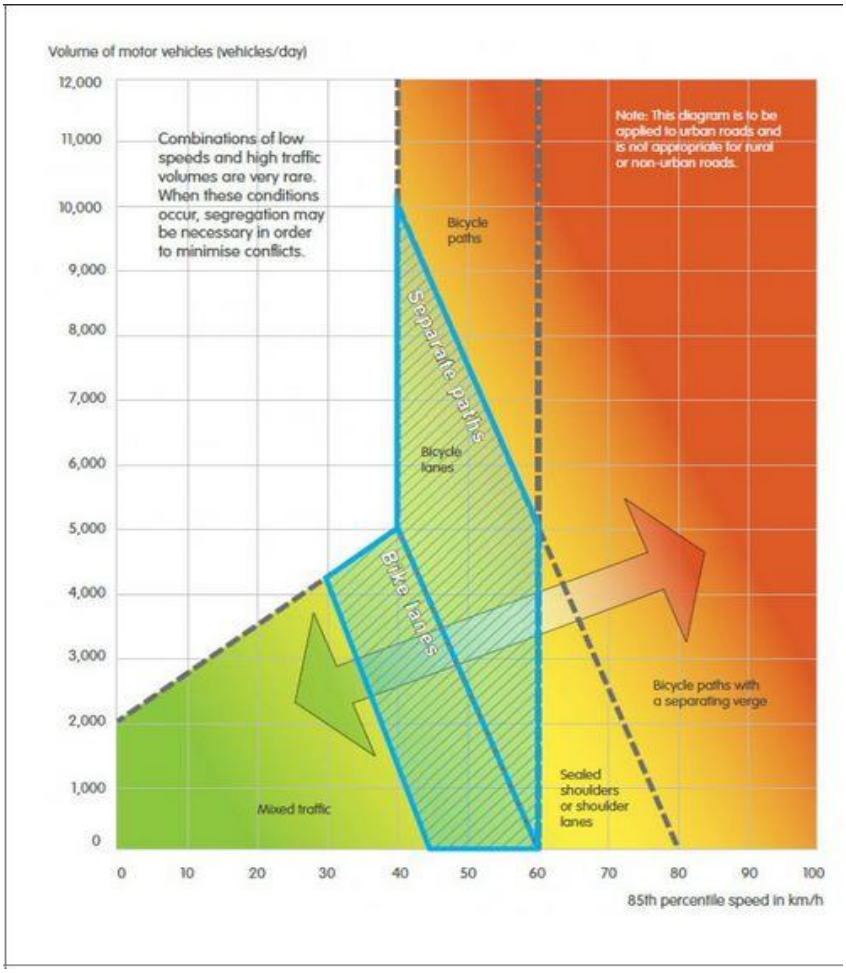


Figure 4.3
Separation of cyclists and motor vehicles by speed and volume (Austroads Guide to Traffic Management part 4, Figure 4.7)

Discussion

The various provisions available for catering for cyclists in the midblock environment are generally well-known. However there is little guidance on how to determine what facilities are appropriate for certain types of cyclist in certain traffic environments and how to choose from a range of appropriate facilities. The CNRPG is the best developed guide but further definition is required in this area. The concept of Level of Service, discussed in a previous section, is related to this.

International guidance recognises that quiet streets (otherwise called “bicycle boulevards” or “neighbourhood greenways”) is an important possible route component. The CNRPG identifies that it may be an option to not provide any formal cycle facility and expect cyclists to mix with motorised traffic when volumes are low and speeds are slow, however it does not quantify what constitutes “low” or “slow”. NACTO and the CCC MCR best practice design guide quantify thresholds for these criteria - this will be examined further in Section 5 under Neighbourhood Greenways.

Similarly, the CNRPG does not include separated bicycle facilities, which are becoming increasingly popular both nationally and internationally, as a facility option.

This section of the CNRPG is perhaps not necessary in the preliminary guidance sections on planning; the design sections will cover the various midblock elements in detail. It is important that planners and designers have an understanding of the types of facilities available construct at network from the beginning of the planning process. The subsequent design sections in the guidance documents should go into more detail, however. This literature review has been useful in identifying additional facility types that should be covered by the design guidance (SBFs and quiet streets) and the importance of considering LOS for the chosen cyclist target audience when selecting facility types.

As mentioned in Section 4.4, the ONRC (which is a work in progress) currently defines customer levels of service outcomes but for ‘active users’ the levels of service are only in terms of whether they are provided separate facilities from motor traffic. By specifying separation, the ONRC is effectively biased towards providing for the interested but concerned target audience; although this is increasingly recommended, it should not be obligatory and planners should be able to choose to provide for more confident cyclists along some routes or specific networks. Therefore, painted facilities may be acceptable on some roads of higher volumes and higher national importance. As well as ‘physical separation’, the ONRC specifies ‘separate space’ in some circumstances - this terminology should be aligned with that used in the National cycle guidance to better reflect the types of facilities it refers to (e.g. painted cycle lanes).

Nga Haerenga, the New Zealand Cycle Trail (NZCT), is a relatively new initiative (compared with the CNRPG) that brings significant national support for cycling infrastructure. The focus of the NZCT is on recreational cycling, with a strong emphasis on tourism in rural environments, and the construction of isolated routes rather than connected networks. NZCT’s vision is to create an expanded network of rides that link the great rides together enabling people to explore New Zealand by bike. In comparison, the Agency (and hence this national cycle network design guidance project) focuses on cycling for utilitarian transport purposes, generally in an urban environment and the development of strategic cycling networks.

Despite these different focuses, there may still be scope for integration of parts of certain NZCT routes within a particular RCA’s cycling network; this aligns with the NZCT’s planning principle of connecting with key attractions and local towns / cities and the practicalities of NZCT users needing to be able to access the routes. It is expected that the framework from this project will eventually be used to enhance the NZCT specifications for on-road facilities and some grades of off-road facilities. However, the NZCT also includes many unsealed trails (with either aggregate or natural surfaces) and the appropriateness of these as route components for an RCA’s cycle network may need to be investigated.

Gap Identification

Gaps identified in the possible cycle route components guidance are identified in **Table 4.11**.

***Table 4.11** Gap Table for Possible Cycle Route Components*

Gap	Type	Comments
G6. Terminology of cycle facilities and other terms	Inconsistency	Update the CNRPG Glossary
G7. Consideration of separated (or "protected") bicycle facilities and appropriateness for different user types	Minimal NZ guidance exists	CNRPG needs to include separated bicycle facility as a route component type.
G8. Coordination with NZCT routes	Lack of Clarity	Consider the appropriateness of integrating unsealed NZCT routes with an RCA's cycle network.
G9. Consistency with ONRC specifications	Inconsistency	The current specifications in the ONRC specifications of when active road users (i.e. including cyclists) must be separated from general traffic do not necessarily align with current cycling guidance and do not give flexibility in the choice of target audience.

4.8 Identifying and evaluating cycle route options

When the pattern of demand for cycling trips has been established, it is necessary to identify possible routes that will cater for this demand. Some form of evaluation is required to determine the general network layout (which will consist of multiple routes or sections) and, for each individual route, the most appropriate alignment.

This section combines three chapters of the CNRPG. The three chapters are shown in **Table 4.12**

***Table 4.12** CNRPG Chapters*

Chapter	Section
• **Possible locations for cycle routes (Chapter 4)**	The principles of cycle network planning
• **Identify possible cycle routes and provision (Ch 8)** • **Evaluate cycle route options (Ch 9)**	The cycle network planning process

These three sections have been combined here as there is significant overlap between them.

Guidance

A summary of guidance from CNRPG is shown in **Table 4.13**. As the concept of Level of Service has already been discussed in Section 4.4 (on the principle that LOS should be employed not just at the evaluation stage but also earlier on in the planning process when considering various options) and the CNRPG covers the remainder of this topic comprehensively, it was not considered necessary to seek further international guidance for this section.

Table 4.13 *Guidance Table for Identifying and Evaluating Cycle Route Options*

	National		International
Possible cycle route locations	**CNRPG** Roads: • State highways • Urban arterial roads • Urban backstreets • Urban off-road paths • Rural arterial roads (includes state highways) • Rural secondary roads	**CNRPG** Paths: • Operating railways • Disused railways • Watercourses • Foreshores • Reserves and parks • Other locations • Public transport	
Identifying cycle route options	**CNRPG** – a brief overview of the process, • links to principles discussed in previous sections (identify demand, needs of cyclists, possible route locations, possible network approaches, cycle route components) • IHT five-point hierarchy of measures to help cyclists (reduce traffic volumes, reduce traffic speeds, adapt intersections, reallocate road space, provide on- and off-road cycle facilities) • Measures for finding space to accommodate cycle facilities on existing roads.		**The Abu Dhabi Walking and Cycling Master Plan** Gives comprehensive guidance on corridor design assessment, where different factors relating to the road space, traffic, adjacent land use, pedestrian and cycle demand and safety feed into the decision of facility type.
Evaluating cycle route options	**CNRPG** • Gives a brief overview of a “needs assessment” (see Section 4.2) • Mentions cycle audits, but recommends that these are not appropriate for distinguishing between or rating options • Discusses IHT et al (1998) guidelines for Cycle Audit and Cycle Review – can be applied to routes intended to form part of a cycle network • Presents several methods of LOS assessment (discussed in Section 4.3). • Directs user to follow current NZTA procedures on economic evaluation to assess viability and value for money. **Non-Motorised User (NMU) Review Procedures** (Land Transport NZ 2006) Sets out the procedures for undertaking reviews of roading projects with due regards to the travel needs of non-motorised users (NMUs) i.e. pedestrians, cyclists and equestrians.		

Relevant studies and research

The research relating to Level of Service for cyclists in Section 4.4 and summaries of (Wilke et al 2014b) and (Beetham 2014) in Section 4.9 are also relevant to this topic.

Discussion

It is important to note that cycle networks will not necessarily take the same structure and hierarchy as road networks. The CNRPG recognises that cycle routes do not have to be on or adjacent to roads. Various "non-road" cycle route options are discussed, specifically routes running alongside to operating railways, disused railways, watercourses or foreshores, through reserves or parks, and on public transport systems (e.g. bicycle transport on buses, trains, or ferries).

As discussed above, it is important that the routes chosen can accommodate the provisions appropriate to the types of cyclist to be catered for. The LOS measures discussed previously could be useful in evaluating and comparing the appropriateness of various routes to cater for the target audience.

The ability to provide for cyclists along a given route alignment depends on the limitations and opportunities of the natural and built environments. The demand of people to travel on certain facilities will depend on the type of facility and location; thus the steps of assessing demand and identifying routes can be an iterative process.

There are certain surrounding land use types that designers should be particularly aware of during the stage of identifying route alignment options as it may be necessary to begin consultation early, to determine the viability of these routes. In particular, for paths alongside rail corridors and especially those that may involve at-grade rail crossings, designers should be advised to begin consultation with KiwiRail as soon as possible.

As discussed in Chapter 4.7, cycle network planners should consider opportunities for including existing cycle tourism routes (such as Nga Haerenga – the New Zealand Cycle Trail) within the overall cycle network.

Gap Identification

Gaps identified in the identifying and evaluating cycle route options guidance are identified in **Table 4.14**.

Table 4.14 *Gap Identification Table for Identifying and Evaluating Cycle Route Options*

Gap	Type	Comments
G10. Appropriateness of different route locations for different cyclist types	No guidance exists	The CNRPG text could be updated to emphasise the importance of tailoring cycle routes to fit the desire lines of the intended cycling target audience and selecting the appropriate facility type to provide for this target audience taking in to consideration the existing environment (e.g. road type)

4.9 Road space allocation

Road space is limited and all potential uses of the road corridor must compete for a share of this asset. The reallocation of road space to provide for cyclists was the most commonly raised issue in the stakeholder survey; it is an issue for both the planning and design stages of cycle network development.

Guidance

A summary of existing local, national and international guidance is shown in **Table 4.15**. No particularly relevant local guidance has been identified. NACTO, CROW and the Department for Transport (UK) do not include any useful guidance on this issue. The Irish National Cycle Manual gives most comprehensive guidance in terms of aspects to consider in reallocating road space to accommodate cycling, however, the most detailed guidance on how to achieve some of these possibilities is that provided in the NZ Transport Agency-owned industry training course on Planning and Designing for Cycling.

Table 4.15
Guidance Table for Road Space Allocation

National	International
NZTA Planning and Designing for Cycling Course Presents several techniques for "finding space" to accommodate cycle facilities within a road corridor. These include: • Reducing the width of general traffic lanes • Reducing the number of general traffic lanes ("road diet") • "road diet" option, where a four-lane road is converted to two lanes plus a flush median; this may generate room for other modes • Modifying / removing flush medians • Removing parking • Possibility in some cases to provide parking on one side of the road, alternating between sides along the road. • Indenting parking bays **The Cycling Aspects of Austroads Guide (Austroads 2014b)** Identifies a number of techniques to obtain space for the provision of cyclist facilities: • rearrangement of space by: • adjustment of existing carriageway (narrowing adjacent traffic lanes) • upgrading service roads • sealing road shoulders • trading space through: • indented car parking • restricting car parking • road widening at the verge • road widening at the median • removing a traffic lane • closing a road • alternative space such as: • an alternative off-road route. **CNPRG** Gives a list of possible methods of rearranging space and trading space.	**The Irish National Cycle Manual** Gives a comprehensive procedure of items that should be considered when it is found that the road network cannot accommodate the facility necessary to achieve the required level of service for cycling. These items are presented for three levels: link level, route level and network level. This list, which is too long to reproduce here, is found under Section 7.6 "No Room for the Bicycle" of the Irish National Cycle Manual.

Relevant studies and research

Parking

The ability to provide for cyclists along a specific route often comes down to a decision between providing cycle facilities and providing parking space; this is a highly controversial issue that has been identified as a major barrier in the stakeholder survey. Strategies to manage parking demand or improve stakeholder awareness about the actual (not the perceived) situation can help mitigate this problem and thus achieve provision for cycling. There are several research projects and international parking management approaches outlined below which may assist in road space allocation.

Parking management strategies – international perspective

Parking management strategies that reflect the real value of the road space used for parking can improve the economic efficiency of road space allocation. One such application is the 'SF park pilot programme' implemented by the San Francisco Municipal Transportation Agency (SFMTA) in 2014. This implemented the used demand-responsive pricing to meet parking occupancy targets. It was found that this system reduced the amount of time people spend searching for a parking space and thus reduced congestion and circulation, improved traffic flow, speed and reliability and improved safety for all road users. Incidents of illegal parking, the number of parking tickets issued and the average hourly rate people pay for parking were all also reduced. Importantly, when such a tool has been implemented, it will be easier to reallocate some road space; when parking demand gets displaced from a main road to a side street, the pricing mechanisms will ensure that target parking occupancy rates will still be met, and everybody's parking demand will continue to be accommodated. Hence, the main reason for parking removal to not go ahead could potentially be reduced.

Shoup (1997) studied the effects of a Californian law change in 1992 which required employers to offer staff the option to choose a pay increase in lieu of a car park. It was found that the number of people who drove to work as the sole vehicle occupant decreased significantly, whereas those who commuted by carpool, public transport, walking or cycling increased. Thus the price and availability of car parks has a direct correlation with cycling mode share and by influencing a reduction in the demand for parking (through cost increase) an added benefit of increasing cyclist volumes can also be achieved. Conversely, VTPI (2014) presents walking and cycling improvements as a possible parking management strategy, as improving the quality of walking and cycling:

- expands the range of parking facilities that serve a destination;
- increases the rate of 'park once' trips (rather than trip-chaining several trips);
- encourages mode shift from driving to walking and cycling; and
- encourages public transport use.

Thus, whilst parking management is a necessary precursor to providing for cycling, good provision for walking and cycling can increase the effectiveness of parking management initiatives.

NZ research

The Agency currently has an active research project involving the first step in developing a consistent framework for assessing the costs and benefits of inner city parking. It is likely that further research will be needed to develop best practice guidelines for RCAs considering parking in both a safety and efficiency context. Removing kerbside parking will not always be the most appropriate solution to optimise safety and efficiency for all transport users. The ONRC accessibility category highlights that the provision of parking is sometimes desirable depending on the function of the corridor and the adjacent land use.

In some locations, stakeholder perceptions of the necessity of parking do not align with the reality of the situation. Fleming et al (2013) researched the retail spending of different transport users in relation to road

space allocation. They found that sustainable transport users contribute a higher economic spend proportional to mode use than other road users. Beetham (2014) explored the extent to which road space reallocation from on-street parking to an arterial cycleway may be warranted on Tory Street, a key street in central Wellington. The study found that the contribution of those who use on-street parking to adjacent retail vitality on Tory Street is minor, compared to the contribution of those who do not require parking and those who use off-street parking.

Traffic lane/flush median widths

Burden and Lagerway (1999) present the concept of "road diet" where the number and / or width of general traffic lanes can be reduced and the road space gained reallocated to other uses, for example cycle infrastructure. They used several case studies from the United States and Canada to show how such conversions could improve mobility, access and safety. Rosales (2006) presents detailed guidance on how to implement road diets in different contexts, as well as further case studies illustrating their success.

2+1 roadways

NZTA Research Report 549 (Kirby et al 2014) suggests that 2+1 roadways (without appropriately wide shoulders) are not particularly compatible with lower speed vehicles, including bicycles, as they allow other vehicles to travel faster and thus increase the speed differential. As an alternative to what is known as a "road diet", a conversion from four lanes to three can also generate room for other transport modes.

Amenity related space

In town centre environments wider footpaths maybe sought as part of a street upgrade to increase space for activities such as outdoor dining and landscaping. Ward et al (2012) found that completion between wider footpaths and cycle lanes was the fundamental issue for the design team in the redesign of the main street of Kaiapoi as retaining the on-street parking was agreed by the stakeholders to be critical. The type of traffic environment was the key factor in choosing the cycle lanes over the wider footpaths. In this particular project the use of a community reference group allowed a decision such as this to be robustly made and supported.

Discussion

Road space allocation was the most commonly identified issue in the stakeholder survey, with 83% of respondents identifying it as a key issue. Respondents specified a range of elements within the road corridor as causing difficulty. Comments made such as "conflict with other corridor users and neighbouring land use" indicate that some practitioners struggle to cater for the objectives of different users within and adjacent to a road corridor. Integration of cyclists in conjunction with bus users and pedestrians was identified as a source of difficulty. The objective of providing flush medians was also identified as a barrier to introducing cycle facilities. Problems with catering for parking demand and the public / political resistance to removal of parking were commonly stated in response to many questions throughout the survey.

Optimal road space allocation, that balances the priorities of various user groups, should be addressed at the high-level planning stage, i.e. in Network Operating Plans (NOPs). By continually developing NOPs, a more appropriate approach to road space allocation can be achieved, within the constraints of the ONRC which specifies more generic LOSs for various user groups.

It appears from the stakeholder survey that planners and designers require a toolkit for ways of allocating space on existing roads; the level of detail provided by each "tool" should reflect the level of difficulty of implementing it. Sometimes the tool will be more focussed on ways of gaining stakeholder buy-in than actual design guidance; this could include best practice examples of existing facilities or supporting research.

Generally the most politically-charged issue when wanting to introduce cycling infrastructure is the potential removal of on-street parking. Planning for cycling must be integrated into the planning process for the wider transport network; this includes a strategic approach to parking management, for example through ORNC and NOPs. However, NOPs do not appear to be currently configured to consider parking provision, as 'parking' is not identified as a mode within the road reserve. Parking is an end-of-trip activity undertaken by all modes in different ways and with different requirements, especially in terms of physical space; it is therefore suitable to consider its effects on the road space allocation when making decisions to balance the needs and requirements of users of different modes.

Having a strategic approach to parking management in place will greatly facilitate subsequent planning and implementation of a cycle network in an urban environment. The 'SF park principles' could be part of parking management approaches for use in New Zealand cities and maybe even in towns. Parking management is an area where guidance for local authorities is needed, and where the Transport Agency could consider creating an environment with which it would be easier to implement the necessary changes.

Guidance should reflect that people do have genuine parking needs. In some cases, it may be appropriate for a cycling project to provide parking opportunities elsewhere, as a compensation for lost parking spaces.

Other items in the toolbox should include guidance on flush median provision. There are a number of safety and operational benefits that can be gained from flush medians, but these must be weighed up in comparison with the benefits to be gained by providing cycle facilities. The original intention of installing the flush median should also be stated – it may have been to reduce the widths of the general traffic lanes, which would also be achieved by introducing cycle lanes or SBFs. In some cases, for example, the road diets discussed in the Planning and Designing for Cycling Course (ViaStrada 2015), introducing cycle facilities may also result in the installation of flush medians.

The planning and designing for cycling industry training courses proposes "road diet" or 2+1 conversion as a potential solution for reallocating road space to make room for cycle lanes. Note that this is in a different context than the 2+1 roadways identified by NZTA Research Report 549 (Kirby et al 2014) as being incompatible with providing for cycling, which is focussed on rural passing lanes and in the situation where the road shoulders are not sufficiently wide to safely accommodate cyclists. The training courses focus on urban roadways, in the context where cyclists have exclusive facilities and are therefore not mixing with traffic; this can be a useful element in the designers' toolbox.

The toolbox should also make reference to facilities that cyclists share with pedestrians (see **Section 5.11**) or with buses (see **Section 5.6**) and when it may be appropriate to adopt such facilities as a way of including all users.

Gap Identification

Gaps identified in the cycle lane design guidance are identified in **Table 4.16**.

Table 4.16 Gap Identification Table for Road Space Allocation

Gap	Type	Comments
G11. Practitioner "toolkit" for methods of allocating space on roads (including consideration of aspects such as parking management) and gaining the necessary stakeholder support	Minimal guidance exists in NZ.	Should include guidance on road diets, flush medians, shared facilities, and parking management approaches. Note that parking management is a particularly politically-charged subject which needs to be considered at a wider level, outside of cycle design guidance with a view to supporting planning for cycling.
G12. Better inclusion of cyclists' needs and parking in Network Operating Plans	Minimal guidance exists in NZ.	Including cyclists in road space allocation decisions needs to occur at a higher level, before cycle planning. If cyclists are adequately included in Network Operating Plans, it should be sufficient for the CNRPG to reference these, rather than planners and designers having to negotiate changing the road space allocation to accommodate cycle facilities. Parking requirements should also be included in NOPs so that its effects on road space allocation and prioritisation of various modes is accurately reflected.

4.10 The cycle network plan

Once the routes that form the cycle network have been chosen, it is important to present this information as a network map and schedule of infrastructure projects required to develop the network. This is also critical for integrating the cycle network within the broader transport network and associated operations plans.

Guidance

A summary of existing national and international guidance is shown in **Table 4.17**. CROW, NACTO and the Irish National Cycle Manual do not include this subject. The CNRPG is relatively brief, and focuses on two distinct elements: mapping and costing.

Table 4.17
Guidance Table for Cycle Network Planning

	National	International
Cycle network map	**CNRPG** Very brief advice on what to include in map presentation with a sample map shown	**Department for Transport (UK) Cycle Infrastructure Design Note** Mentions the importance of providing maps in locations where cyclists can obtain or view them.
Project schedule	**CNRPG** Describes the information to be included in the schedule, but gives little guidance on how to estimate costs.	

Discussion

Presentation and scheduling of the resulting cycle network is a necessary step in transforming the plan into a reality. If the steps of the planning process have been adequately followed, the production of the network map and schedule should be easily achieved, hence why the CNRPG does not go into much detail on this subject. It would however, be useful to provide more examples and information to make scheduling useful; the web-based interface of the framework could facilitate this.

The CNRPG also discusses the importance of having a rough-order cost for implementing the cycle network in this section. This is important as it helps planners develop the staging of the network. An important element that should be conveyed to planners and designers regarding costing of cycle networks is that, in comparison to standard roading projects, the design and consultation fees for cycle projects can account for a greater proportion of the project expenditure. In fact, the design requirement is often not more involved but the physical works are less expensive, for example cycle lane projects (where line marking is the main work required). It could be useful to practitioners to have a source of guidance outlining 'per km' costs for standard cycle facilities and road modifications.

The topic of costing is somewhat broader than its application in the network mapping stage and it could be useful at other project stages (for example, it is useful to have a basic understanding of the relative costs of different facility options when the initial route planning is undertaken). It may be more appropriate for the costing guidance to be included as an individual section, with references made in the network mapping section.

Gap Identification

Gaps identified in the cycle network plan guidance are identified in **Error! Reference source not found.**.

Gap	Type	Comments
G13. Sample maps	Minimal Guidance Exists	Mapping techniques have advanced since the CNRPG was produced; it would be useful to describe modern techniques (e.g. GIS) and some updated examples.

4.11 Prioritisation and Implementation

It will generally not be possible to implement all of the various components on the cycle network schedule all at once; some form of prioritisation method is required.

Guidance

As identified in the previous sections, the CNRPG goes further in the planning process than the majority of other international guidance documents. A summary of national guidance relating to prioritisation and implementation as found in the CNRPG is shown in **Table 4.18**, no local guidance has been identified in this review.

Table 4.18 *Guidance Table for Prioritisation and Implementation*

	National
Methods of prioritisation	**CNRPG** States that "prioritisation of cycle route network implementation is more an art than a science". It presents several possible prioritisation approaches: • LOS / cycle review – prioritise sections that have the worst LOS • Usage numbers – prioritise routes with highest existing volumes or projected demand • Crash records – prioritise locations with highest potential crash cost savings • Blockage removal – prioritise locations that are currently barriers along routes • Easiest or cheapest first • Quality demonstration projects • Area consolidation
Implementation	**CNRPG** Discusses various aspects of implementation of the agreed cycle plan.

Discussion

The CLOSAT approach (Hollander 2014) discussed in Section 4.4: accords with the CNRPG LOS approach where sections with the lowest LOS are addressed first, to achieve a route with a suitable minimal LOS along its length.

The other approaches in the CNRPG can still be appropriate, and the principle of giving planners different options remains beneficial, however it may be beneficial to provide more guidance on when each of the prioritisation approaches may be suitable. In general, the most benefits can be achieved by providing fully connected routes that cater for end-to-end journeys, especially when aiming to attract the interested but concerned target audience.

Another possible approach that could be included in the CNRPG is alignment with other works programmes.

Gap Identification

Gaps identified in the prioritisation and implementation guidance are identified in **Table 4.19**.

Table 4.19 Gap Table for Prioritisation and Implementation

Gap	Type	Comments
G14. Increase guidance on prioritisation	Minimal Guidance Exists	Provide guidance on methods that can be taken to prioritisation, whilst giving designers flexibility and supporting guidance on when the methods may be suitable.

4.12 Monitoring

Monitoring is essential to evaluate whether a cycle project achieved its objectives and determine the relevance of the planning philosophies and design criteria employed. Counting cyclists is important at stages of cycle network development earlier than the stage of monitoring the final product and has therefore been discussed in **Section 4.6,** as an aspect of assessing demand for cycling. Thus this section gives a brief overview of the CNRPG guidance only, without repeating other guidance sources on monitoring.

Guidance

A summary of existing national (i.e. CNRPG) guidance on monitoring cyclists is shown in **Table 4.20**.

Table 4.20 Guidance Table for Monitoring

	National
Features to monitor	**CNRPG** Gives brief guidance on the following features to be monitored: • Physical works programmes • Cycle use and mode share • Cycle crashes • Satisfaction levels regarding cycle facilities • Cycle facilities' condition • Cycle network implementation • LOS improvements **Agency's Business Case Approach (NZ Transport Agency, 2013)** Whilst not specifically tailored to cycling projects, the various measures presented in the Agency's Business Case Approach can be applied in monitoring the effectiveness of cycling projects. These measures are related to the broad categories of network performance and capacity, safety, cost, health and environment.

Discussion

Even though the information presented in the CNRPG is extremely brief, when considered in conjunction with the planning and design guidance given in the preceding CNRPG chapters and future additions / modifications to be made as a result of this project, it provides an adequate structure for road controlling authorities to establish suitable monitoring programmes for cycle facilities. Monitoring of a specific facility is necessary to determine whether it satisfies the design objectives. On a larger scale, monitoring is also of great importance in terms of refining the planning and design criteria to ensure that subsequent projects are more effective. The Transport Agency recognises this through the emphasis made on measuring investment performance in the Business Case Approach (NZ Transport Agency, 2013).

However, experience shows that monitoring is often discarded as a project component during the planning stages or quickly abandoned after project completion. This is often due to constraints on finance and staff availability. NZTA should consider its role in encouraging, supporting and / or requiring monitoring programmes to be undertaken and the use of information gained from monitoring in continually updating and improving planning and design guidance. The NZ Cycling Safety Panel (Leggat et al 2014) identified "improved data collection, relevant Key Performance Indicators and performance monitoring" as necessary "enablers" for framework and funding.

Smartphone applications are being increasingly used worldwide to gather data on cyclist trips. From these data, some estimates of the total demand over a route or facility can be derived. However, it is important to remember that such applications generally only capture a certain sub-set of total cyclists. Data will only be gathered from cyclists who have a smartphone, the motivation to use the required application, and the dedication to do so consistently. Thus younger children, older adults (who are generally less technologically-inclined), people with lower incomes and people who are not enthusiastic about recording their trips are much less likely to be included in data collection. This represents a bias towards collecting data from *enthused and confident* cyclists as opposed to *interested but concerned* cyclists.

Gap Identification

Gaps identified in the cycle lane design guidance are identified in **Table 4.21**.

Table 4.21 *Gap Table for Monitoring*

Gap	Type	Comments
G15. Requirement to undertake monitoring	Inconsistency	Monitoring is a key component of the Business Case Approach, and is useful at a network level, but there is no real incentive offered or enforced requirement to TLAs to undertake this for cycling-related projects.

5. Best Practice Review: Midblock Facility Design

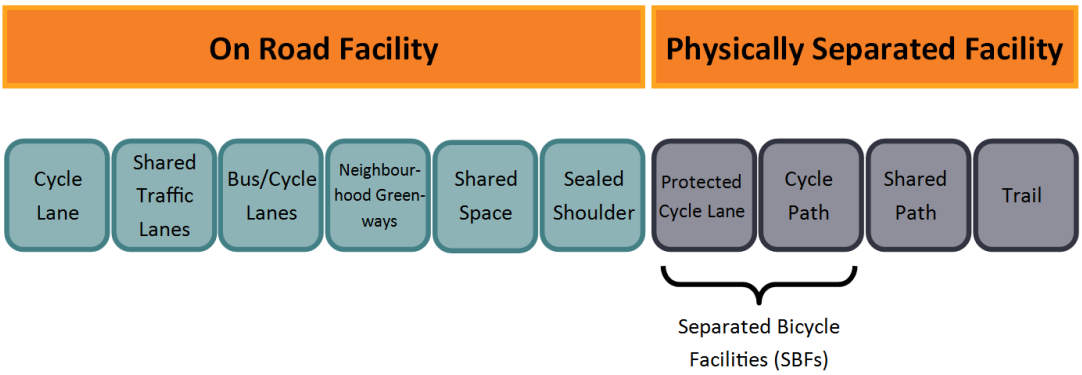
5.1 Introduction

There is a range of ways that cycling can be catered for between intersections; some on-road and others off-road. This can involve ensuring the road space can be shared safely, or it may require building specific infrastructure for cyclists, referred to as a 'facility'. It is important that designers make well-informed choices regarding the facility type to best cater for the intended user group in a specific transport environment. The initial process of selecting the facility type was discussed in **Section 4.7**. This section outlines the guidance that is required to then design the facility or incorporate cycling into an overall facility, such as the carriageway.

For each of the facility types shown in **Figure 5.1** this section provides a description, outlines the legal status and the current guidance on the national, local and (to a certain extent) international level is identified. Any relevant post-implementation reviews, studies, research are discussed and then the 'gaps' in the guidance are identified. Where feedback from the technical stakeholder survey is relevant, it is also referred to in the review. The identification of the gaps is a key output of this project.

It was identified in Section 4 that there is a lack of consistency in the terminology currently used to describe cycle facilities. **Figure 5.1** shows the cycle facility types and clarifies the facility terminology used for the purposes of this review. The midblock facility types are generally 'on-road' (meaning that motorised traffic can interact with cyclists) or they are physically separated from the motorised traffic (meaning they are not on the road or have a barrier that prevents motorised traffic interacting with the cyclists).

Figure 5.1
Diagram of Cycle Facility Types



This section discusses each facility in the order outlined above in **Figure 5.1**, starting with cycle lanes. Trails are not part of the review as these are generally associated with projects such as the National Cycleway. A design guide for trails was developed by the Ministry of Tourism[4], and this is considered to be the best practice guidance available.

[4]Cycle Trail Design Guide (3rd Edition)", August 2011, http://www.nzcycletrail.com/sites/default/files/uploads/NZCT-Cycle-Trail-Design-Guide-v3-Aug-2012.pdf

5.2 Guidance sources

Austroads is generally considered to be national guidance wherever no New Zealand specific guidance is available. Prior to the new suite of Austroads guides being developed a NZ Supplement to the Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles had been developed in reflect NZ specific traffic regulations and context. The supplement is available on the NZTA website and still referred to by some practitioners, however some practitioners may not be aware of it as it is not referred to in the Austroads guides. As will be discussed throughout this section most of the supplement guidance is still relevant today and it is considered it needs a new home such as being incorporated in the relevant chapters of the Traffic Control Devices Manual.

At a national level **NZS 4404:2010, Land Development and Subdivision Infrastructure** (Standards New Zealand 2010) provides guidance for design of infrastructure however this refers readers to Austroads and the CNRPG for cycle infrastructure design.

The Agency have developed an urban design guidance manual, '**Bridging the Gap'** (NZ Transport Agency 2014a)**,** this generally refers readers to the Pedestrian Planning and Design Guide, the Cycle Network and Route Planning Guide and Austroads for walking and cycling guidance. It does however provide some dimensions as a "*rough guide"*. The gap analysis for each facility type has not reviewed any associated urban design guidance but it is acknowledged that where new guidance is required to be developed that urban design should be considered in the guidance.

Also at a national level there is **Agency supported industry training**, this provides guidance but it is not compiled as part of any 'guidance' document. The industry training is referred to throughout the best practice review where it may be contributing to filling guidance gap.

The key **national design guidance documents** and legislation reviewed in this section are:

- Austroads: Guide to Road Design Part 3 Geometric Design (Austroads 2010a)
- Austroads Guide To Road Design Part 6A Pedestrian and Cyclist Paths (Austroads 2009b)
- Austroads: Cycling Aspects of Austroads[5]
- NZ Supplement to Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles (Transit 2008)
- Traffic Control Devices Manual
- MOTSAM Parts 1 and 2 (Transit New Zealand et al 1992)
- NZTA Pedestrian Planning and Design Guide (NZ Transport Agency 2009)
- Land Transport Road User Rule 2004
- Traffic Control Devices Rule (Bunting 2013)

The **local design guidance documents** reviewed in this section are listed below. This list is based on what is publically available or has been provided to the project team; it is acknowledged that other RCAs may have developed cycle specific design guidance that we are not aware of.

- Christchurch City Council Infrastructure Design Standards [IDS] (Christchurch City Council 2013)
- Christchurch Cycle Design Guidelines (Christchurch City Council 2013)

[5] 'Cycling Aspects of Austroads Guides' contains key information relating to the planning, design and traffic management of cycling facilities and is sourced from Austroads Guides, primarily the Guide to Road Design, the Guide to Traffic Management and the Guide to Road Safety. It is not guidance itself but directs users to the relevant Austroads guide where the guidance can be found.

- Christchurch Construction Specifications [CSS]: Part 6, Roads (Christchurch City Council 2015b)
- Christchurch City Council Major Cycleways Design Guide: Part B, Design Principles Best Practice Guide: Revision A (Christchurch City Council 2014)
- Auckland Transport (AT) Code of Practice, Chapter 13: Cycling Infrastructure Design (Auckland Transport 2013)
- Nelson Land Development Manual (Land Development Manual. 2010)

At an international level, the review has focused on guidance from countries that are similar to New Zealand in terms of traffic environment, planning framework and cultural attitudes with respect to cycling. The purpose of this review was to identify where national guidance may not be in-line with best international practice; this will also be useful for Stage 2 of the project where national gaps are to be filled.

The key **international design guidance documents** reviewed were generally from Australia, the United States and the United Kingdom.

- Urban bikeway design guide (NACTO 2014) from the United States of America (accepted as the USA cycle design guidance as AASHTO is not up-to-date in terms of cycling provision).
- Design manual for bicycle traffic (CROW 2007) from the Netherlands, a country with an important history of being leaders in providing for cyclists
- Cycle Infrastructure Design Note (Department for Transport et al 2008) from the United Kingdom (with mention to other relevant notes where necessary)
- National Cycle Manual (National Transport Authority 2011) from Ireland
- Queensland Manual of Uniform Traffic Control Devices
- VicRoads Traffic Engineering Manual (VicRoads 1999)
- Separated Cycleways Guideline (TMR Separated Cycleways) (Queensland Government, Department of Transport and Main Roads 2014b)

5.3 Cycle Lanes

Description

Cycle lanes are marked lanes within the carriageway "*designated generally for the exclusive use of cyclists, except that motor vehicle drivers may use the lane in certain circumstances such as to access parking or to turn at intersections or driveways, for example"* (Transit 2008). Cycle lanes can be located next to parking as shown in **Figure 5.2** or located next to the kerb.

Figure 5.2 *Cycle Lane on Maidstone Road, Christchurch*

Legal status

The rules relating to cycle lanes in the Road User Rule are:

- cycle lanes are longitudinal strips within a roadway designed for the passage of cycles and defined by signs or markings;
- drivers, other than cyclists must not drive in a marked cycle lane (clause 2.3) unless the size of the vehicle or load means it is impracticable to stay outside the cycle lane and there is a road obstruction and these movements can be done safely and without impeding other traffic;
- drivers may also drive on a cycle lane to make a turn, park their vehicle, enter or leave the road or pick up or drop off bus or taxi passengers provided they give way to cyclists (clause 2.3)
- road users must not park on a marked cycle lane or cycle path (clauses 6.6 and 6.14).

There is no road user rule which specifically states cyclists must use a marked cycle lane when one is provided. Clause 2.1(1) states, however, that a driver (note that the definition of 'driver' includes cyclists) must at all times drive as near as practicable to the left side of the road. This implies when a cycle lane is marked on the left hand side of the road a cyclist should use it.

In the Land Transport Rule: Traffic Control Devices (2004) a cycle lane is classified as a 'special vehicle lane'. A road controlling authority must, at the start of every special vehicle lane and after each intersection along its length, mark on the road surface a white symbol defining the class or classes of vehicle for which the lane has been reserved. It must also, if for other than a 24-hour restriction, install a special vehicle lane sign defining the class or classes of vehicle for which the lane has been reserved; and stating the periods for which the reservation applies. Whilst in some parts of Australia there are cycle lanes that operate as another space during certain hours, this practice is not possible under the NZ rules and is not considered best practice. .

Guidance

A summary of existing local, national and international guidance is shown in **Table 5.1**. Section 6 reviews the design of cycle lanes at intersections.

Table 5.1 *Existing Guidance for Cycle Lanes*

	National	NZ Local Guidance	International
Width of cycle lanes	**Austroads GTR3 (Table 4.17)** • Desirable minimum 1.5m for 60km/h speed limit, 2.0m at 80km/h and 2.5m at 100km/h • Acceptable range of 1.2 – 3.0m dependent on vehicle speed. • 1.6 – 2.5m adjacent to parking dependent on speed • Contra-flow cycle lane desirable minimum width is 1.8m with an absolute minimum of 1.5m. **MOTSAM Part 2 (2.10.02)** • Refers to the Austroads Supplement (now superseded) • Suggests that kerbside lanes of 4.5m or greater should have cycle lanes. **NZ Supplement (Table 4.1):** • Desirable minimum of 1.5m for <=50kmhr, 1.9 for 70km/h 2.5 for 100km/h. • Acceptable range 1.2-2.5m dependent on speed, • 1.6-2.5 next to parking with a desirable minimum of 1.8m. **Bridging the Gap Urban Design Guidelines** 1.5m minimum provided the speed limit is 50km/h At least 2.0m if the speed limit is 70km/h or more	**CCC MCR Design Guide (3.4.2) :** • Desirable width is 1.8m **ATCOP (Table 34):** • Kerbside cycle lane widths of 1.5-1.9m dependent on speed (up to 70km/h only). • Reductions in width of up to 0.2m over short distances (e.g. 20m) are permitted but not desirable. **The Nelson Land Development Manual (Section 4.3.13.1):** • 1.5-2.5m dependent on speed • 1.8-2.2m next to parking, dependent on speed.	

	National	NZ Local Guidance	International
Width of traffic lanes adjacent to cycle lanes	**MOTSAM Part 2 (20.10.02 a):** • Lane widths of 3.5m adjacent to cycle lanes with reduction to 3.0m acceptable. If the lane is adjacent to a flush median then the minimum lane width can be further reduced to 2.8m • Kerbside lanes of 4.5m or greater should have cycle lanes. **NZ Supplement** As a note to Table 4.2, it is suggested that it is often preferable to narrow traffic lanes to a width less than 3.5m to facilitate desired widths for cycle lanes but depends on likely presence of trucks.		
Width of cycle lanes adjacent to parking	**Austroads GTR3 (Tables 4.17, 4.18 and 4.19)** • Table 4.17 for exclusive cycle does not specify widths next to parking • Table 4.18 lists overall cycle/parking lane adjacent to parallel parking of 4.0m desirable at 60km/h), 4.5m at 80km/h. Acceptable range 3.7 – 4.7m. • Overall cycle lane adjacent to angle parking lane dimensions listed in Table 4.19. **MOTSAM Part 2 (2.10.02 d)** • Refers to NZ Supplement (Superseded) **NZ Supplement (Table 4.2 and 4.3)** • Sets out widths for cycle lanes next to parallel and angle parking **Bridging the gap Urban Design Guidelines** • 1.8m minimum	**ATCOP (Table 35):** • Minimum widths adjacent to parallel parking are 1.8-2.2m dependent on speed. • Cycle lanes next to angle parking, not desirable. Minimum clearance between cycle lane and angle parking is 2.0m for 45º-3.0m for 90º parking. Cycle lane widths should be 1.5 to 2.0m. **Nelson Land Development Manual (Section 4.3.13.1):** • 2.0-3.0m clearance from angle parking.	

	National	NZ Local Guidance	International
Markings	**NZ Supplement to Austroads (9.8)** • No stopping lines not normally required on kerbside cycle lanes because stopping within a cycle lane is prohibited. **MOTSAM Part 2 (2.10.03)** • Edgeline to be a continuous white line. • Cycle lane symbols to be marked at the start of the cycle lane and immediately beyond each intersection or other break and not more than 100m spacing between symbols. • Cycle lanes marked adjacent to the kerb are not legally required to have no-stopping lines. However several Road Controlling Authorities have found this to not be sufficient and it may thus be desirable to continue marking no-stopping lines. Having a mixture of some kerbside cycle lanes with, and some without no stopping lines in the same district should be avoided.	**CCC IDS (8.14.8)** • Where a cycle lane is against the kerb no stopping lines should be marked.	
Surface Colour	**Austroads GTR3 (Figure 4.24)** • Green surfacing to be used sparingly. MOTSAM (2.10.03) • Symbols can be marked in a rectangle of coloured surface. • Green surfacing to increase awareness of cyclists or at conflict points (e.g. on curves) is recommended. **NZ Supplement (Table 4.2 and 4.3)** • Green surfacing appropriate in a range of listed locations.		

	National	NZ Local Guidance	International
Signage	**MOTSAM Part 1 (2.28)** • RG-26 signs may be erected to supplement a full time cycle lane (but not compulsory)		
Bus Stops	**MOTSAM Part 2 (2.10.09)** • Allows bus stops to 'break' the cycle lane where there are fewer than 10 buses per hour.	**CSS Part 6 (Roads)** • SD644 states that where a cycle lane is marked adjacent to a bus stop reduce the width to 2.5m and mark a 1.2m minimum cycle lane alongside.	
Timing	**Austroads GTR3** • Makes some provision for 'part time cycle lanes' e.g. during peak periods only.		
Gradients and cross fall	**Austroads GTR3** • Recommends that where steep gradients are unavoidable additional width should be provided.	**The Nelson Land Development Manual (Section 4.3.13.1)** • Allows cycle lanes to be excluded in the downhill direction	
Kerbs, Grates and other Detailed Design Considerations	**Austroads GTR3 (Table 4.17)** • Recommends that the channel is not included as part of the cycle lane width measurement to avoid pedals striking the kerb		Sloping/mountable/semi-mountable kerbs used in the Netherlands where cycle lanes are adjacent to the kerb to increase useable width.

Studies and relevant research

Cycle lane width

As cycle lanes have been used for a relatively long time as a means of providing for cyclists consensus on the size of these facilities generally aligns with current New Zealand guidance. Generally international practice is to provide cycle lanes of 1.5m width with an additional 0.5m buffer adjacent to parking in some constituencies (Dales and Jones 2014). Walton et al (2012) found that cyclists prefer a minimum of 1.5m of space but concluded that this can be reduced to 0.5m for less than 5m at pinch points. It should be noted cyclists included in the study likely fall into the 'strong and fearless' or top end of the 'enthused and confident' user types and that this recommendation is not something that should be accepted as 'best practice'.

Cycle lanes that do not follow the desire line of cyclists (e.g. around kerb extensions or unusual alignments) were found to not be used by cyclists, even though the objective of implementing these facilities is often to reduce risk to cyclists (Walton et al 2012).

Parkin and Meyers (2010) showed that cycle lanes of sub-standard width are more dangerous as drivers take their cues from the lane lines and don't think as much about what the comfortable passing distance really is.

Dales and Jones (2014) suggest that cycle lanes only provide sufficient subjective protection from motor vehicles where they are sufficiently wide and the adjacent traffic lane is also appropriately wide. Marking cycle lanes on the kerbside of parked vehicles assists with them being used for double parking and remaining useable for cyclists at all times. However in Munich the key objective is visibility of cyclists, therefore marking lanes on the trafficable side of parking is preferable (Dales and Jones 2014).

Low-profile separators research

Koorey et al (2013) investigated the effect of the implementation low-profile separators and vertical posts on motor vehicle encroachment in cycle lanes. The study used two trial sites, one of which was at a corner and one was an intersection approach. The study found that "*the combination of low-profile separators and vertical posts is a relatively inexpensive way (especially compared with kerb reconstruction) to increase the effectiveness of cycle lane separation"*. Koorey et al (2013) highlight that cycle lanes should be of adequate or greater width before separators are installed and that they are well suited for locations where vehicles often 'cut' the corner and at the approach to intersections.

Cycle lane colour

Skilton and Morris (2006) investigated the impact of marked and coloured cycle lanes. Skilton and Morris found that by marking cycle lanes: cyclists were generally found to ride inside the lane, cars did not cross the centre line, cars were perceived to drive slower and cars were perceived to park closer to kerb. When colour was used in the lane, the drivers appeared to be more of cyclists as they gave cyclists more space. Cyclists also appeared to feel safer as they were found to ride further from the kerb (generally riding in the middle of the lane instead of the nearer the kerbside marking as they did on un-coloured lanes) (Skilton and Morris 2006).

Skilton and Morris also investigated the cost of implementing coloured cycle lanes. Maintenance of coloured surfaces varies with the traffic volume over cycle lane (e.g. at intersections), colour retention of the product used, future roadworks and laying conditions. Thermoplastic was found to be the most cost effective product over a 20 year period.

No stopping lines

Wilke and Ferigo (2009) investigated the issue of drivers parking in cycle lanes. They found that "*parking in kerbside cycle lanes is a prevalent occurrence that needs to be prevented*". They concluded that some motorists might be confused about the legal situation, and it doesn't help when some kerbside cycle lanes have broken yellow lines (BYLs) marked while others don't. Meanwhile they found there are other motorists will deliberately flout the law. They found that motorists readily know what BYLs mean and acceptance of them is generally good and recommended that, within a district, there should not be a mixture of marking styles.

Wilke and Ferigo point out that not marking BYLs is also fraught with difficulties as a result of Land Transport NZ (now NZTA) having never communicated the 2005 rule change in a comprehensive manner, even though this is arguably their responsibility. It should be noted that at the time of writing the paper , the Road Code did not tell drivers that they couldn't park in cycle lanes; this was however added to the Road Code in the section 'where not to park' in 2010. They found that the manner in which kerbside cycle lanes are managed differs widely amongst the different road controlling authorities, despite the design guidance in MOTSAM being clear. The authors supported the MOTSAM approach and recommended that kerbside cycle lanes be marked with broken yellow lines. It may be acceptable to re-mark BYLs only after several years. The authors do not recommend installing cycle lane signs as a parking management tool.

Discussion

The NZ Supplement to Austroads Part 14 offers the current best practice guidance with respect to cycle lanes however this content was not incorporated into the recent Austroads guides. If NZ designers are not aware of the supplement then cycle lanes may not be designed to NZ best practice. It was found in the best practice review that designers require better clarification for many aspects in the supplement. For example, when it is appropriate to apply the absolute minimum cycle lane width of 1.2m; this clause is currently only related to the speed environment and could be applied over long lengths of road although this is not the original intention of this clause. The general consensus from all guidance is that 1.5m is the minimum width for a kerbside cycle lane in speed environments up to 50km/h, however it is considered that where the kerb and channel profile is conducive to cycling, widths lower than 1.5m may be applicable by exception even though the general consensus from all guidance is that 1.5m is the minimum width for a kerbside cycle lane in speed environments up to 50km/h.

With updates to the content of MOTSAM and the NZ Supplement it is considered the majority of the gaps below can be easily resolved. It is likely that most of this can then be included in the TCD Manual chapter 'Between Intersections'.

Gap Identification

Gaps identified in the cycle lane design guidance are identified in **Table 5.2**.

Table 5.2 Cycle Lane Gap Identification Table

Gap	Type	Comments
G16. Minimum cycle lane widths are not consistent	Inconsistency	Minimums allowed in Austroads much lower than local guidance deems appropriate. Consider providing more caveats on when widths lower than desirable minimum can be used.
G17. Widths of traffic lanes next to cycle lanes	Lack of clarity	Austroads and the NZ Supplement touch on this but further clarification is required
G18. No-stopping lines in cycle lanes	Lack of clarity	Austroads and the NZ Supplement touch on this but further clarification is required as to when it is important to mark the no-stopping restriction that exists by default as parking in special use lanes is prohibited.
G19. Bus Stop Treatments	Minimal Guidance Exists	Provide options for dealing with conflicts between cycle lanes and bus stops on high frequency routes.
G20. Detailed Design considerations	Minimal / inconsistent guidance	Inconsistencies between various codes of practice from around the country.

5.4 Shared Traffic Lanes

Description

Cyclists can share the traffic lane with motor vehicles. The roads included in this section are generally arterial or collector type roads, or roads through town centre environments but not roads that have been specifically designated as 'neighbourhood greenways' (which are covered in Section 5.6). The sharing can either be when the cyclist and motor vehicles travel side by side in a wide traffic lane (wide kerbside lane) or when motor vehicles follow the cyclist in a narrow traffic lane (with the possibility for overtaking when there is no oncoming traffic) which is known as 'vehicular cycling'.

The difference between a wide kerbside lane and narrow traffic lane in the context of shared traffic lanes is shown clearly in **Figure 5.3**, noting that this diagram is from a country where vehicles travel on the right-hand side of the road and where 'sharrow' markings are used. Sharrows have recently been trialled in NZ and could be a useful marking for shared lanes, however they are not yet a legal traffic control device (Bunting 2013).

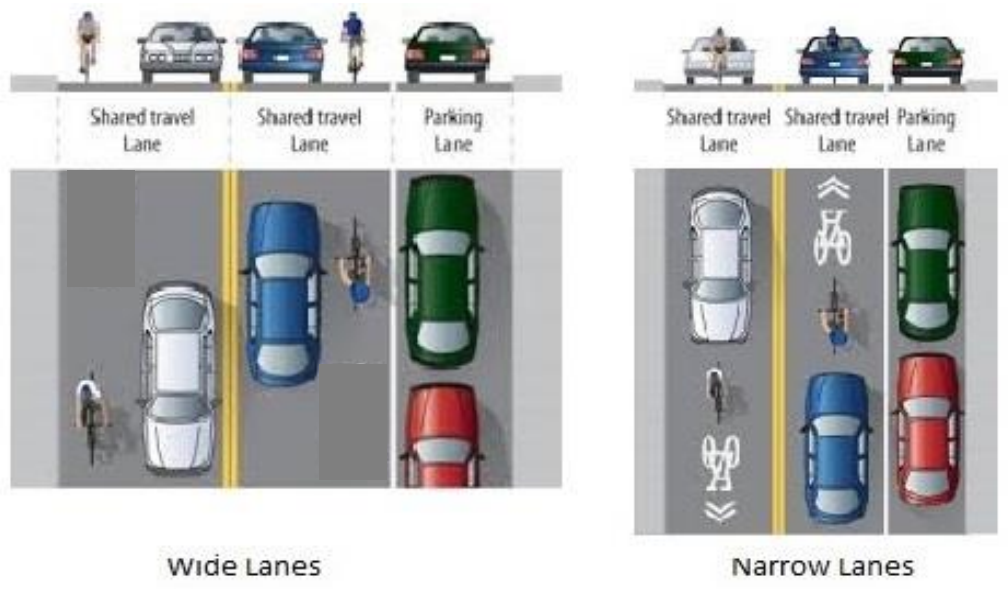


Figure 5.3
Diagram showing difference between two types of shared traffic lanes

Guidance

A summary of existing guidance for wide kerbside lanes is shown in **Table 5.3.**

There is currently no guidance in Austroads or the NZ Supplement regarding narrow traffic lanes. Transport for London specified that narrow lane widths for cycling should be less than 3.5m and that lane widths between 3.5 and 4.0m should be avoided. The NZ industry training (Wilke and Fowler 2015) recommends that narrow lanes where intended to be shared by cyclists and motor vehicles should only be considered under the following conditions:

- The traffic lane is no more than 3.0m wide,
- Traffic must operate at slow speeds (30km/h or less),

The ability to use narrow lanes also depends on other factors, such as the traffic composition – on a route with buses or heavy vehicles it may be necessary to provide wide lanes.

It should be noted that even with the right conditions it may be off-putting for inexperienced cyclists to share a 3.0m wide traffic lane, particularly if the lane is directly adjacent to a high turnover parking lane. The important aspect of sharing the lane is that traffic lanes widths of between 3.0m and 4.2m should be avoided. These widths result in an unsafe arrangement where cyclists are 'squeezed' by traffic overtaking within the same lane when there is insufficient width for this to occur safely.

Table 5.3 Guidance for Wide Kerbside Lane

	National	NZ Local Guidance	International

Width	**Austroads GTR3 (Table 4.20)**
	• Posted speed limit, 60km/h
	  • Desirable Minimum: 4.2m
	  • Acceptable Range: 3.7m-4.5m
	• Posted speed limit, 80km/h
	  • Desirable Minimum: 4.5m
	  • Acceptable Range: 4.3m-5.0m
	• If kerbside parking is significant in the off-peak period: Minimum width is 4.0m
	
	MOTSAM Part 2 (2.10.02 a)
	• Lanes where cyclists share with motorised traffic should ideally be between 4.1 m and 4.5 m wide
	
	NZ Supplement (Table 4.4)
	Without Parking
	• 50km/h Speed Limit:
	  • Desirable Minimum Width: 4.2m
	  • Acceptable Range: 4.0m-4.5m
	• 70km/h Speed Limit:
	  • Desirable Minimum Width: 4.5m
	  • Acceptable Range: 4.2m-5.0m
	With Parking
	• 50km/h Speed Limit:
	  • Desirable Minimum Width: 4.5m
	  • Acceptable Range: 4.3m-4.8m
	• 70km/h Speed Limit:
	  • Desirable Minimum Width: 4.8m
	  • Acceptable Range: 4.5m-5.3m
		Nelson Land Development Manual (Table 4.14)
		On classified roads, desired widths are:
		• Speed ≤ 50km/h:
		  • Parking: 4.5m
		  • No parking: 4.2m
		• Speed = 70km/h:
		  • Parking: 4.8m
		  • No Parking: 4.5m
		
		ATCOP (Table 40)
		Minimum Widths
		• Speed Limit/85th Percentile Speed 50km/h:
		  • Parking (not all times): 4.2m
		  • No parking: 4.2m
		• Speed Limit/85th Percentile Speed 70km/h:
		  • Parking (not all times): 4.8m
		  • No Parking: 4.5m
		• The minimum lane width may be reduced by 0.2m at “pinch points” over a short distance
		• Where greater width is available than identified here, consider a cycle lane.
		
		ATCOP (Page 359)
		• Wide kerbside lanes should not have kerb extensions that leave inadequate room for cycling
			VicRoads Traffic Engineering Manual (5.4.2)
			• Ideally 4.2m wide
			• Maximum width of 4.5m
			• When lanes are used for parking for park of day: lanes should be 4.0m-4.2m
			
			Transport for London
			• At least 4.0m wide
			
			VicRoads Traffic Engineering Manual (5.4.2)
			• No special line markings are required

Discussion

No relevant research on shared traffic lanes has been identified.

Guidance of the desirable width of wide kerbside lanes is consistent across national, local and international guidance, except for the 3.7m minimum of the acceptable range offered by Austroads which is not considered best practice. There is no national guidance for narrow traffic lanes beyond the industry training.

It is likely that most of this can then be included in the TCD Manual chapter 'Between Intersections'.

Gap Identification

The gap identification for shared traffic lanes can be seen in **Table 5.4**.

Table 5.4 Shared Traffic Lane Gap Identification Table

Gap	Type	Comments
G21. Wide traffic lanes - Austroads acceptable minimum not considered best practice.	Guidance is not considered best practice	In Austroads the acceptable minimum width for a wide shared traffic lane is 3.7m. In NZ this is considered within the unsafe zone of 3m to 4.2m. This is taught in the industry training so should be reflected in the national guidance.
G22. No narrow lane guidance	Lack of guidance	Narrow lanes may need some supporting measures to ensure that drivers and cyclists are clear on the 'sharing of the lane'. National guidance on this is required as there are more instances of this approach being taken.

5.5 Bus/Cycle Lanes

Description

Bus lanes give priority to buses, either on a full time basis or part time. By default, bus lanes are also for cyclists, but can be designated as 'bus only'. However the sharing of bus lanes must be considered carefully due to the differences between buses and cyclists. Cyclists are small, can manoeuvre easily and travel at relatively consistent, slower speeds. Buses on the other hand are large with limited manoeuvrability, and generally travel faster than cyclists but also stop regularly (Baumann et al 2012). Similar to shared traffic lanes, bus/cycle lanes should either be wide enough for side by side travel (**Figure 5.4**) or narrow enough (**Figure 5.5**) that it is clear that overtaking is not an option.

Figure 5.4 *Wide part time bus/cycle lane, Christchurch*

Figure 5.5 *Narrow bus/cycle lane, Christchurch*

Legal status

The Land Transport Rule: Traffic Control Devices (2004) designates a bus lane as a 'special vehicle lane'. A special vehicle lane is defined as "*a lane defined by signs or markings and restricted to a specified class or classes of vehicle*" (Land Transport Part Two). Special vehicle lanes must meet requirements as outlined in Clause 11.2 of the Part Two of the Land Transport Rule. According to (NZ Transport Agency 2014b), cyclists "*may use a bus lane, as long as there are no signs or road markings forbidding this"*.

Guidance

A summary of existing local, national and international guidance is shown in **Table 5.5**.

Table 5.5 *Bus/Cycle Lane Guidance*

	National	NZ Local Guidance	International

Width	**Austroads GTR3 (Table 4.22)**
	• Bike/Bus lanes are appropriate for routes that carry 50-100 cyclists or where bus headways are between 15-30mins in the peak hour
	  • Speed zone 60km/h
	  ○ Minimum width 3.7m
	  • Speed zone 70km/h
	  ○ Minimum width 4.0m
	  • Speed zone 80km/h
	  ○ Minimum width 4.3m
	
	NZ Supplement (4.4.8)
	• If bus speeds are about 50km/h and bus stops are infrequent
	  • 4.2m wide is appropriate
	• Bus speed 50km/h-60km/h:
	  • Minimum 4.5m required
	• Bus speed 60-70km/h:
	  • Minimum 5.0m required
		ATCOP (Page 361)
		• Kerbside wide bus/cycle lanes must have a minimum width of 4.2m
		• Kerbside narrow bus/cycle lanes must have a maximum width of 3.2m
		• Avoid lane width of 3.3m-4.1m
			London Cycling Design Standards
			It is preferable the lane is at least 4.0m wide if parking and loading is permitted outside of the operational hours of the bus lane.
			• Alternatively can have a narrow bus lane of 3.0-3.2m
			• If the bus lane is 4.5m or wider a cycle lane of at least 1.5m could be included especially if there is a substantial distance between bus stops and side roads or where it would provide a fit for purpose cycle facility outside of operational hours.
			• Avoid bus lane widths between 3.2-3.9m

Surface colour and markings	**Traffic Control Device Rule (Clause 11.2)** • At the start of the special vehicle lane and at the point the lane starts again after an intersection, the road must be marked with a white symbol that defines the class(es) of vehicle for which the lane is reserved. • Additional white special vehicle lane symbols may be placed along the length of the lane • Surface treatment which provides a contrasting colour or texture to that of adjacent lanes may be used a locations along the length of the lane or along the length of the lane.		

	National	NZ Local Guidance	International
Signage	**Traffic Control Devices Rule** • If the bus lane is not a 24hour restriction, a special vehicle lane sign must be installed at the start of the lane and after an intersection when the lane starts again. The sign must comply with Schedule 1, defining the class(es) of vehicles for which the lane has been reserved and the period for which the reservation applies. • Signs detailed above may also be provided along the length of the lane • Special Vehicle lane signs can be used if the lane has a 24hr restriction		
Bus stops in bus/cycle lanes	No guidance		

Studies and relevant research

Bus lanes in Auckland

A post-implementation study of bus lanes in Auckland investigated whether the introduction of bus lanes changed or created new types of hazards for cyclist and motorcyclists. Of particular interest was the effect of turning vehicles 'let through' by drivers queuing in the opposing lane. Drivers of these turning vehicles have reduced visibility of the bus lane due to the opposing queued traffic and could pose a risk to cyclists and motorcyclists in the adjacent bus/cycle lane. The study found that found that at three of the four sites bus lanes had no discernible increase in crashes after implementation but at the Dominion Road site an increase was recorded. All of the sites experienced a reduction or 'effective reduction' (based on increased traffic/cyclist volumes) in crashes except for Dominion Road which had a 30% increase in crashes. It should be noted that these crashes include both cyclists and motorcyclists. The study concluded that there was a link between bus lane width and crash rates, as Dominion Road was the narrowest bus lane (3.0m) the other three bus lanes were 3.25m, 3.25m and 4.5m wide (Newcombe and Wilson 2010).

Discussion

There is limited guidance available on accommodating cyclists within bus lanes. The guidance that is available is also limited to the width that should be provided. Austroads and the NZ Supplement to Austroads Part 14 give widths based on bus speeds however local and international guidance state fixed minimum and maximum widths regardless of bus speeds. Widths for bus lanes are either provided for wide lanes or narrow lanes.

Guidance is available for the minimum width of 'wide' bus/cycle lanes, based on the width required for a bus to pass a cyclist. If the minimum requirement cannot achieved, local and international guidance suggest that best practice is to create a narrow shared lane with a maximum lane width of approximately 3.2m. As with shared traffic lanes, lanes of width above the minimum for a narrow lane and below the maximum for a wide lane should be avoided as they can be ambiguous as to whether there is sufficient space for a bus to pass a cyclist. An update to MOTSAM and the NZ Supplement, for inclusion in the 'Between Intersections' chapter of the TCD Manual could help address the gaps below.

Gap Identification

The gap identification for bus/cycle lanes is shown in **Table 5.6**

***Table 5.6** Gap Identification Table for Bus/Cycle Lanes*

Gap	Type	Comments
G23. Minimum Width	Not Best Practice	The Austroads minimum width for a 60km/h and 70km/h speed environment are below the NZ-accepted best practice of at least 4.2m for travelling side by side.
G24. Minimum width	Inconsistent guidance	Austroads states minimum widths should be based on bus speeds. Local and International guidance however states fixed minimums.
G25. Markings	No Guidance	The TCD rule requires that the lane is marked to show the class of vehicles allowed to use the lane. There is currently no guidance in MOTSAM on bus lane markings.
G26. Bus stops	No Guidance	Cyclist provisions at bus stops, no guidance on diversions etc. when a bus is using the stop

5.6 Neighbourhood Greenways

Description

Neighbourhood greenways, also known as 'quiet streets', 'slow streets' and 'bicycle boulevards', are streets with low volumes of vehicle traffic travelling at low speeds where no specific cycle facility is required. Neighbourhood greenways generally incorporate lower speed limits, traffic calming / restraints, way-finding signage / markings and crossing treatments. They are often used to connect community facilities such as schools, parks, shops and key destinations (Koorey 2012). **Figure 5.6** and **Figure 5.7** show a range of neighbourhood greenway treatments that strengthen the message that cyclists will be present and provide a higher level of service to cyclists.

Figure 5.6 *Example of a Neighbourhood Greenway (http://www.miabirk.com/blog/?paged=2)*

Figure 5.7
Neighbourhood Greenway with restricted vehicle access (https://www.flickr.com/photos/garyseven/8578570241/)

Guidance:

Austroads does not specifically identify neighbourhood greenways as an option for providing for cycling, but does offer guidance on traffic management devices and diversion to support local area traffic management schemes. The predominant neighbourhood greenway guidance available is that of the Christchurch City Council Major Cycleway Design Guide (Christchurch City Council 2014) and the NACTO Urban Bikeway Design Guide (NACTO 2014). A summary of the guidance these sources provide is shown in **Table 5.7**.

Table 5.7
Guidance Table for Neighbourhood Greenways

	Christchurch City Council	NACTO
Requirements for Neighbourhood Greenway	Design the street and its appearance to encourage low traffic speeds and low volumes *Speeds:* Less than 30km/h *Volumes:* 1000vpd desirable 1500vpd maximum	Speed and volume management techniques shall be implemented *Speeds:* 85th percentile speeds of no more than 25mph (40km/h) - 20mph (32km/h) is preferred *Volumes:* 3000vph is acceptable (1500vph preferred)

	Christchurch City Council	NACTO
Speed treatment options	Lower speed limits Raised platforms Raised tables Narrow lanes Chicanes with cycling bypasses Vertical elements e.g. trees or street furniture (they provide visual enclosure to the street, reducing sight lines and therefore speed)	Speed humps Speed cushions Speed tables Kerb extensions/bulb-outs Edge islands Neighbourhood traffic circles (roundabouts) Chicanes Pinchpoints (midblock narrowing) Neckdowns (intersection narrowing Short Centre Island Skinny/Queuing Streets
Volume reduction	Street entrance or exit restrictions Mid-block or street-end closures for vehicles with by-passes for cycling Diagonal diverters at intersections to prevent through traffic Median islands at intersections with cycle gaps	Forced turns at intersections Channelised left-in, left out Partial closure Median island diverters Diagonal diverters Full diverters
Lane Width	Lane width should either be wide enough to allow a car to pass a cyclist or narrow enough that a vehicle must wait behind a cyclist to pass Prioritise cyclists and pedestrians in designs over other traffic, so that cyclists can comfortably share the full carriageway of the street Road width: Desirable: 6.26m (likely typo) Desirable Maximum: 6.5m Length of straight section must not exceed 400m if cars do not have sufficient space to pass cyclists.	
Parking	Parking should be designed in bays of fewer than 6 vehicles to provide a break for cyclists passing parked cars ≤50% of the length of the street should include on street parking (this is maximum value, ≤40% is desirable) Parking could be provided in opposing locations Parking bays could be staggered along the street to reduce risk of 'dooring'	

	Christchurch City Council	NACTO
Signs and Markings	No marked lanes (no centre line) Signs and markings should be compliant with Traffic Control Device Manual Incorporate major cycleway route signage Specify landscaped areas, trees and/or contrasting surface textures to re-enforce the 30kmh zone A high standard of design and features including landscaping, surfacing, furniture and lighting	Centre line stripes (if present) shall be removed or not repainted, except for short sections on intersection approaches that have a stop line or traffic circle Signs and pavement markings shall be utilised to identify the corridor as a neighbourhood greenway Way-finding signs and pavement markings should be used to tie the bicycle boulevard to nearby land uses Where the bicycle boulevard turns or jogs onto another street, signs and/or markings shall be provided to indicate how users can remain on the route CCC have developed a bicycle network sign design manual
Surface	Smooth surface type that retains traction	Pavement quality should be fair to good and the street should be prioritized for repaving and other maintenance activities over other local streets
Intersections	Neighbourhood Greenways for Major Cycleway should take priority for side roads At main road crossing traffic signals should be provided Kerb extensions Raised Platforms Central Islands	Intersections should minimize bicyclist delay and maximize bicyclist safety and comfort. Treatment options include: Supplementary signs and markings Geometric design features Traffic control devices Median refuge (major intersection) Traffic island (major intersection) Beacons or signals (major intersection)
Detailed Design Considerations	Avoid blind corners Street furniture should no cause obstructions Limb up street trees A high standard of design and features including landscaping, surfacing, furniture and lighting	Green infrastructure, including swales and other storm management techniques, street trees, and pocket parks, may be provided.

Relevant Research

Portland

Portland has an extensive neighbourhood greenway network. In Portland the posted speed limit for these neighbourhood greenways is generally 20mph (32km/h) and they strive for an average volume of less than 1500vpd. From the 14th of April 2014, Portland has been installing signs on neighbourhood greenways to "help people better understand the type of road they are using". The sign is shown below in **Figure 5.8** and is placed below the speed limit sign (Portland Bureau of Transportation 2015).

Figure 5.8
Neighbourhood Greenway Signage in Portland

A survey of residents along the SE Salmon Street bicycle boulevard in Portland, Oregon was conducted, the majority of respondents felt that it had a positive impact on home values, quality of life, sense of community, noise, air quality, and convenience for bicyclists; a negative impact on convenience for drivers; and no impact on safety for children, convenience for pedestrians, and the amount of traffic collisions. Additionally, 42% of respondents said living on a bicycle boulevard makes them more likely to bike, the majority of whom did not self-select to live on a bicycle boulevard. The survey also identified a need to improve cyclist visibility at night, traffic diversion and traffic calming measures and communication about: the purpose of bicycle boulevards, traffic laws and expected courteous behaviours (VanZerr 2009).

It is noted that Portland have done some work on how people use the neighbourhood greenway system and that a report is due in early 2015.

Discussion

Low speeds and low volumes characterise a neighbourhood greenway. Both CCC and NACTO provide guidance as to what constitutes "low speed" and "low volume" however the thresholds given by the two sources are quite different. CCC have developed guidance for the provision of the acceptable amount of on-street parking in neighbourhood greenways and the required carriageway width. However it is not clear from the CCC guidance as to whether cyclists should use the full width of the carriageway or whether vehicles should be able to pass them.

CCC and NACTO have consistent guidance relating to road marking, signage and intersections. However, NACTO does appear to put a greater emphasis on the importance of signage for way-finding along the route and connecting with local destinations.

Gap Identification

Gap identification for neighbourhood greenways can be seen in **Table 5.8**.

Table 5.8 Gap Identification Table for Neighbourhood Greenways

Gap	Type	Comments
G27. Lack of national guidance	Lack of guidance	Austroads provides guidance on traffic calming but does not identify neighbourhood greenways as a type of provision for cycling and therefore has no guidance tailored for this. This would include guidance around which traffic calming devices are preferred for the context and are cycle friendly, carriageway widths, signs and markings.

5.7 Shared Spaces

Description

The 'shared space' concept is a European approach to urban design which aims to eliminate the segregation of road users. Unlike '*shared paths*' which are just for pedestrians and cyclists, '*shared spaces'* include motor vehicles as well.

This type of treatment is becoming more common in NZ; national examples of shared space can be seen in **Figure 5.9** and **Figure 5.10**. The concept relies on the removal of typical street elements including line marking, signage and kerbs resulting in a suitable amount of driver ambiguity, with the intention of reducing vehicle speeds and establishing a road environment that all users can negotiate safely.

Shared spaces are designed to operate at very low speeds to enable pedestrians to move freely and to have right of way over vehicles (including cycles). They are well suited for intensely-developed shopping streets or town centres. The low speeds can provide a comfortable environment for cyclists. In a shared space cycle racks should be provided and form part of the street furniture in shared zones (Auckland Transport 2013).

Figure 5.9 Photo of a Shared Space in Hamilton

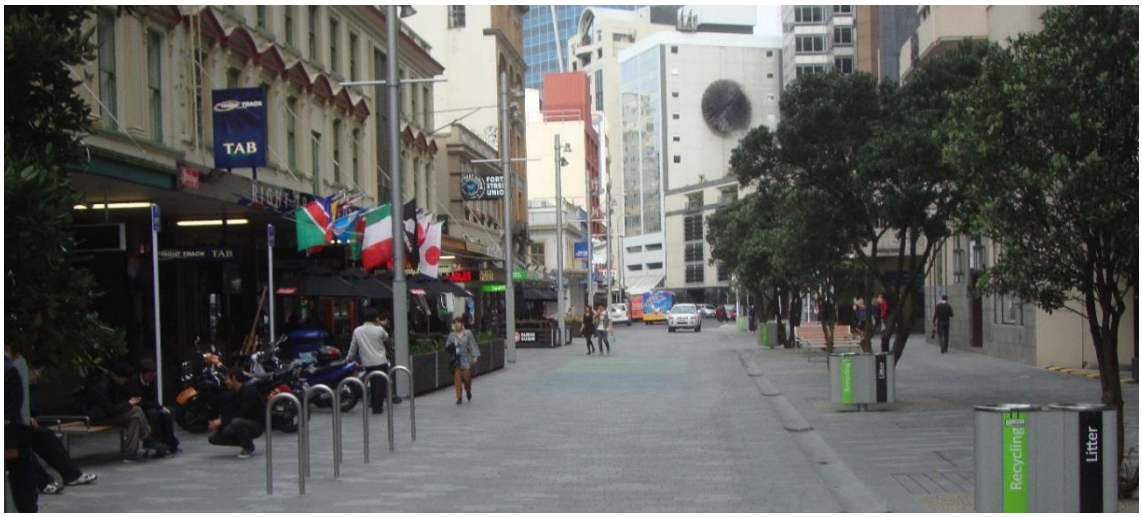


Figure 5.10 *Photo of Shared Space, Fort Street Auckland*

Legal Status

A form of shared space with specific legal recognition in New Zealand is the 'shared zone'; which is defined in the Land Transport (Road User) Rule 2004 (Austroads 2014b) as simply "a length of roadway intended to be used by pedestrians and vehicles". The interaction between different road users in a shared zone is controlled under the Rule as follows:

Clause 10.2 Shared zone

1) A driver of a vehicle entering or proceeding along or through a shared zone must give way to a pedestrian who is in the shared zone.
2) A pedestrian in a shared zone must not unduly impede the passage of any vehicle in the shared zone.

This definition of shared zone might be seen to apply in a range of situations where pedestrians and vehicles share an area, for example an off-street car park without specific footpaths or where a vehicle crossing intersects a footpath. However, to be classed as a 'shared zone' an official designation is required. A traffic bylaw can include resolutions to specifically designate a space in a road as a shared zone. A bylaw can also specify that by default parking is prohibited in such shared zones. For example the Auckland Transport traffic bylaw (2012) states:

Clause13 Shared Zones

1) Auckland Transport may by resolution specify any road to be a shared zone
2) Except where Auckland Transport has by resolution specified otherwise, no person may stand or park a vehicle in a road specified as a shared zone.
3) A person must not use a shared zone in a manner contrary to any restriction made by Auckland Transport.

Guidance

A NZ guidance note (Joyce 2012) for the design of shared space was developed as an initiative from the IPENZ Transportation Group. The note concluded that "*In general it is considered that cyclists should be considered in the design of streets involving shared space principles in the same way in which they are considered in all streetscape designs. Connectivity to the surrounding cycling network should be considered as well as on street facilities such as cycle".*

Austroads do not have any guidance documents specifically relating to shared space but they do make reference to shared space through the guidance as summarised by the table in **Figure 5.11** (Maynard et al 2014).

Figure 5.11 *Austroads References to Shared Zones/Spaces*

Table 2 Austroads References to Shared Zones/ Shared Spaces

Austroads References	Shared Zones	Shared Spaces
Guide to Traffic Management Part 5 (2014)	▪ 'integrating pedestrian and vehicle traffic, with priority for pedestrians' ▪ speed limits typically of 10km/h and 20km/h ▪ typically installed in pedestrian malls and car parks	▪ 'integration by removing demarcation of vehicular and pedestrian areas'
Guide to Traffic Management Part 6 (2013)	▪ 'pedestrians may share the traffic lanes longitudinally with vehicles' and will have priority. ▪ design encourages low vehicle speeds and increase awareness of road environment ▪ ARR signage required ▪ improved safety for pedestrians ▪ reduces user conflicts ▪ suitable levels of parking maintained	▪ reduced traffic control ▪ reduced dominancy of vehicles ▪ reduction of demarcation of road users (similar to car parks) ▪ no legal provision ▪ typical priority configurations
Guide to Traffic Management Part 7 (2009)	▪ pedestrian priority area ▪ removal of footpaths could reduce safety and amenity for mobility impaired pedestrians, elderly and parents with children ▪ reduce traffic speeds in activity centres ▪ related to the winkelerf (retail) and woonerf (residential) principles	▪ designed with very little traffic control devices ▪ similar to car parks and private traffic areas ▪ reduce traffic speeds in activity centres ▪ preferred for pedestrian streets, rather than traffic routes ▪ relies on uncertainty ▪ considered with speeds less than 40km/h and less than 5000 vehicles per day

Available post implementation studies

An evaluation of shared space in the Fort Street Area, Auckland NZ raised no issues in relation to the provision of cyclists or safety of cyclists.

Gap Identification

The gaps identified can be seen in **Table 5.9**.

Table 5.9 Gap Identification Table for Shared Spaces

Gap	Type	Comments
G28. Lack of specific guidance for providing for cyclists within shared spaces	Lack of Guidance	The focus of design guidance is the interaction between motor vehicles and pedestrians. The IPENZ TG Research (Joyce 2012) recommended that cyclists should be considered in the design of shared spaces in the same way as they are considered in all streetscape designs (in terms of principles). However more specific guidance may be required (e.g. how to provide for cyclists in one-way shared spaces).

5.8 Sealed Shoulders

Description

Shoulders are the part of the carriageway on the outside of the edge lines, as shown in **Figure 5.12**. Often the shoulders are sealed and utilised on rural roads to provide space for cycling. When the shoulder is intended to be used by cyclists it is important that the shoulder is of adequate width based on the speed environment and traffic composition. If the shoulder is part of a cycle route then particular attention needs to be paid to the quality and maintenance of the shoulder (Auckland Transport 2013). Provision for cyclists should be maintained through intersections, past driveways, and at those locations where kerbs are present along short lengths of road otherwise treated with sealed shoulders (such as at an urban/rural speed threshold). Where chipseal is used to seal the shoulders, consideration should be given to the surface quality (Austroads 2014b).

Guidance

A summary of existing national, local and international guidance is shown in **Table 5.10**.

Figure 5.12 Photo of Sealed Shoulder (Source: CNPRG Chapter 6)

Table 5.10 Guidance Table for Sealed Shoulders

	National	NZ Local Guidance	International

Width	**AustroadsGTR3 (Table 4.5 and 4.6)**
	• One lane road (Table 4.5)
	  • Design AADT 1-150
	  ○ Total Shoulder: 2.5m
	  ○ Minimum Shoulder Seal: 0.0m
	  • Design AADT 150-500
	  ○ Total Shoulder: 1.5m
	  ○ Minimum Shoulder Seal: 0.5m
	  • Design AADT 500-1000
	  ○ Total Shoulder: 1.5m
	  ○ Minimum Shoulder Seal: 0.5m
	  • Design AADT 1000-3000
	  ○ Total Shoulder: 2.0m
	  ○ Minimum Shoulder Seal: 1.0m
	  • Design AADT >3000
	  ○ Total Shoulder: 2.5m
	  ○ Minimum Shoulder Seal: 1.5m
	• Divided Carriageways (Table 4.6)
	  • Design AADT <20,000
	  ○ Total Shoulder: 2.5m
	  ○ Minimum Shoulder Seal: 1.5*m
	  • Design AADT >20,000
	  ○ Total Shoulder: 3.0m
	  ○ Minimum Shoulder Seal: 3.0*m
	*Wider seals may be appropriate depending on requirements for cyclists etc.
		ATCOP (Section 13.2.4 and Table 35 NB. AT COP wrongly refers to Table 41)
		• Minimum widths should not go below 1.0m
		• If speed limit/85th percentile speed of 50km/h
		  • 1.8m minimum
		• If speed limit/85th percentile speed is 70km/h
		  • 2.2m minimum
		
		Nelson Land Development Manual (Table 4.3)
		• Sealed shoulder is to be widened to 1.5m where the road is defined as a cycle route
		
		CCC IDS (8.13.7)
		• Refers to Austroads Guide to Road Design: Part 3: Geometric Design.
			Queensland Manual of Uniform Traffic Control Devices
			• Have a graph which uses 85th percentile speeds of trucks to guide width of sealed shoulder required. Widths range from 1.5m-3.0m
			• 1.5m sealed shoulder widths are appropriate when truck speeds are 60km/h or less.
			
			Government of South Australia: Shoulder Sealing on High Speed Roads
			• Design AADT <1500
			  • Total Shoulder: 1.5-2.0m
			  • Minimum Shoulder Seal: 1.0m
			  • Desirable Shoulder Seal: 1.2m
			• Design AADT >1500
			  • Total Shoulder: 1.5-2.0m
			  • Minimum Shoulder Seal: 1.0m
			  • Desirable Shoulder Seal: 1.2m

	National	NZ Local Guidance	International

	NZ Supplement to Austroads Part 14 (4.4.4)
	• Speed limit/85th percentile speed ≤50km/h
	  • Desirable Minimum: 1.5m
	  • Acceptable Range: 1.2*-2.2m
	*1.2 m is the absolute minimum width and should only be used in low speed environments (85th Percentile speed of 40 km/h and below)
	• Speed limit/85th percentile speed 70km/h
	  • Desirable Minimum: 1.9m
	  • Acceptable Range: 1.6-2.5m
	• Speed limit/85th percentile speed 100km/h
	  • Desirable Minimum: 2.0m
	  • Acceptable Range: 2.0-2.5m
	• Care must be taken to ensure that the continuity of cycling facilities is maintained and narrowing of any shoulders does not put cyclists at risk.
	• Shoulder widths should be maintained along passing lanes
	
	MOTSAM Part 2 (Section 4)
	• Shoulder widths clear of audio tactile profiled (ATP) edge lines must be a minimum of 1.0 metres to provide for cyclists
	• On very narrow roads without shoulders, where ATP edge lines would provide significant safety benefits, they may be placed hard against the edge of seal where cyclists are unlikely to ride.		

Parking	**NZ Supplement Part 14 (4.4.4)** Parking on rural road shoulders in areas of tourist interest should generally be discouraged and off-road parking provided, to maintain safety for cyclists using the shoulder.	**ATCOP (Section 13.2.4)** If the sealed shoulder is to be available for cycling, then parking in areas with ad-hoc parking and around sharp bends should be prohibited through broken yellow lines or no stopping at any time signs.	

	National	NZ Local Guidance	International

Markings	**Austroads Cycling on Higher Speed Roads (Table 3.4)**
	• Rural - Not Divided
	  ○ Sealed pavement <5.5m wide: No edge lines
	  ○ Sealed Pavement 5.5m-6.8m: Edge lines generally not used unless conditions are poor e.g. alignment. No edge line to be used unless dividing lane is also marked and the lane widths within the edges are at least 3.0m (3.2m if high proportion of HV)
	  ○ Sealed pavement ≥6.8m
	• Rural - Divided
	  ○ Edge lines must be marked
	• Urban - Not Divided
	  ○ Two lane unkerbed: Edge lines shall not be used unless the lane widths within the edge lines are at least 3.0m (3.2m if high proportion of HV)
	  ○ Multilane kerbed: Edge lines may be used to separate a parking lane from a running lane
	• Urban - Divided
	  ○ Edge lines normally required but may be subject to road authority practice
	  ○ If edge lines are provided they shall be placed on both edges of an unkerbed one-way roadway
	  ○ Edge lines are not required if the kerbs provide adequate edge delineation		

Surface Material / Treatments	**Austroads GTR3 (Table 4.5)** Where significant numbers of cyclists use the roadway, consideration should be given to fully sealing the shoulders. Suggest use of a maximum size 10 mm seal within a 20 km radius of towns		

	National	NZ Local Guidance	International
Signage	**TCD Part 2: Direction** **Table 4.13** Cyclist information signs Type of cyclist information / Use / Sign examples Use left shoulder — Recommends cyclists to use the shoulder rather than the general traffic lane —  Use ramp — Recommends cyclists use the provided ramp to help avoid conflicts with high speed following vehicles at an off-ramp —  Crossing point — To indicate the recommended location for a cyclist to cross – typically used at the on and/or off ramps away from the merging entry/diverging exit point — 		
Kerbs, Grates and other Detailed Design Considerations	**MOTSAM Part 2 (Section 4)** • Gaps of at least 20 metres must be left in audio tactile profiled (ATP) edge lines where-ever cyclists may have a need to cross them, e.g. on bridge approaches, near narrow shoulders, near intersections or junctions with off-road facilities		

Relevant Research

Austroads Research: Higher Speeds Roads (Eady and Daff 2012)

In 2012 Austroads undertook research into cycling on higher speed roads (defined as having speed limits of 70km/h and greater). It is noted that research found that international best practice for providing a cycling network on high speed roads is to provide cyclist with space separated from motor vehicles that forms part of a complete network. Where shoulders are considered appropriate, the research report refers to Guide to Road Design: Part 3: Geometric Design.

NZTA Research Report 432: Minimum design parameters for cycle connectivity (Walton et al 2012)

The NZTA Research Report 432 (Walton et al 2012) found that for sealed shoulders, the width must be so that a cyclist has at least 0.4m of clear space to the left of the edge line at a pinch point. It also found that where objects encroach at the level of a cyclist's handlebars, 1.0m of clear space should be provided and that if the far left of the roadside has an object higher than 0.1m to impede the pedal then 0.1m of extra width clearance should be provided. 1.5m of space was identified as the width preferred by cyclists.

Balancing the needs of cyclists and motorists (Walton et al 2005).

The authors of this paper identified that cyclists compete with other road users for the surface over which they travel. Often the road shoulder or far left side of the road is not designed or maintained to promote the interests of cyclists and consequently cyclists often move on to the roadway and into conflict with other traffic. Cyclists face a number of obstacles such as utility access covers, wind from passing trucks, gravel, and thermoplastic road markings. The authors recommended that:

- Where shoulder space is narrow (<1m) truck speeds should be limited to 50km/h or less. If this cannot be achieved then facilities should be provided for cyclists.
- Rough ground, a round utility access cover, oversized thermoplastic lines (7 mm thick), and an audio-tactile line show significant effects on the stability of cycles

Discussion

Guidance available for sealed shoulder design is predominantly based on minimum width. Other design considerations are not explicitly mentioned in most local and international guidance when considering designing the shoulders for use by cyclists.

With regards to sealed shoulder width, Austroads GRD Part 3 categorises the minimum widths of seal and minimum total shoulder widths for roads depending on whether they are one-laned or have a divided carriageway and depending on the annual average daily traffic (AADT) on the road. Similarly, the Government of South Australia Department of Transport (Stratton 2011) define total shoulder widths and minimum seal widths based on AADT, however they do not distinguish widths based on the number of lanes. Local guidance on the other hand approaches width specifications differently, with the Nelson Land Development Manual stating a fixed value if the road is part of a cycle route and Auckland Transport stating minimum shoulder widths depending on speed. The Queensland Manual of Uniform Traffic Control Devices (Queensland Government 2013) also uses speed for determining widths, however it focuses on truck speeds rather than general vehicle speeds.

Gap Identification

Gaps identified in the guidance for sealed shoulders can be seen in **Table 5.11**.

Table 5.11 Gap Table for Sealed Shoulders

Gap	Type	Comments
G29. Basis for determining the seal width	Inconsistent guidance	There is variation in the guidance as to whether traffic volumes or speed should be used to determine the appropriate shoulder seal width for cyclists.
G30. Minimum width of sealed shoulder for providing for cyclists	Lack of clear guidance	National guidance (Austroads) is unclear on what a minimum shoulder width should be if catering for cyclists.

5.9 Protected Cycle Lanes

Description

Protected cycle lanes are a facility that provide cyclists with physical separation from motor vehicles. The form of protection between the facility and adjacent traffic/parking lanes can be kerbs, islands, vertical flexi-posts or landscape treatments such as planter boxes.

The term 'protected cycle lane' includes facilities known as: 'protected cycle lanes' (Auckland Transport), 'separated (bi)cycle lanes' (Christchurch City Council and Austroads), 'buffered bicycle lanes' (Queensland Transport and Main Roads), 'cycle tracks' (NACTO), 'separated cycle paths' (Christchurch City Council). As discussed earlier establishing a consistent term for this type of facility is considered necessary.

An example of a one-directional facility with non-continuous kerb separators on Ilam Road (Christchurch) is shown below in **Figure 5.13**. The facility can also be bi-directional and provided on one side of the road, such as the Beach Road (Auckland) and St Vincent Street (Nelson) examples shown in **Figure 5.14** and **Figure 5.15**.

Figure 5.13 One-way Protected Cycle Lane, Ilam Road Christchurch

Figure 5.14 *Two-way Protected Bicycle Lane, Beach Road, Auckland*

Figure 5.15 *Two way Protected Bicycle Lane, St Vincent Street, Nelson (prior to the addition of a separator)*

These facilities provide cyclists with a greater degree of separation and protection from motor vehicles than standard cycle lanes, however they inevitably involve locations where bicycles and motor vehicles must interact, for example at intersections and driveways; these locations require careful consideration.

Another consideration is the interaction between pedestrians and cyclists at bus stops, pedestrian crossing facilities and where a cycle facility runs between an area of high-turnover parking and the footpath. The choice of mitigation measure for these conflicts is a function of how much space is available; ideally people stepping off buses, or out of parked cars should not step directly into the protected bicycle facility.

When providing for cyclists in both directions of travel, it is generally preferred to provide two one-way facilities (i.e. on either side of the road) over one bi-directional facility because the risk of crashes is higher at driveways and intersections where cyclists are travelling in both directions (Queensland Government,

Department of Transport and Main Roads 2014). Motorists entering or exiting driveways or side roads don't instinctively expect to encounter cyclists coming from the opposite direction to that of the adjacent traffic lane. The preference however depends on the adjacent land-use; if one side of the road has no driveways (e.g. a large park or reserve) it may be safer to provide a bi-directional facility.

Another form of protected cycle lane is the raised cycle lanes also known as the 'Copenhagen style' lanes. Although adjacent motorised traffic could still drive into the cycle lane the height difference between the road and the cycle lane is a physical deterrent. A Christchurch example is shown in **Figure 5.16**. The raised cycle lanes are on each side of Colombo Street (between St Asaph Street and Lichfield Street) where projected traffic volumes are expected to be relatively high compared to the adjacent section of Colombo Street where cyclists need to share the narrow traffic lanes.

Figure 5.16
Copenhagen Style Cycle Lane, Colombo Street, Christchurch

Legal Status

Protected cycle lanes are not expressly mentioned in the Road User Rule. Furthermore, the give way rules at intersections are based on giving way to traffic already on a 'roadway'. As protected cycle facilities are not on a roadway ('roadway' means 'that portion of the road used or reasonably usable for the time being for vehicular traffic in general' RUR Clause 1.6 Interpretation). Due to the definition of a roadway, cyclists are required to give way to motor traffic when entering an intersection from a protected bicycle facility, which is contrary to road user expectations (Wilke, 2014b).

Guidance

At a national level Austroads Guide Road Design Part 3 covers separated facilities and thus includes protected facilities (as well as paths). At a local level guidance has been developed by Auckland Transport and Christchurch City Council. Internationally the NACTO guide appears to be the most comprehensive for these facilities.

In Australia many protected cycle lanes have been implemented in the last 5 years and guidance has been developed by the road controlling authorities, such as Queensland Government's 'Separated Cycleways Guideline, Transport and Main Roads, January 2014'.

A summary of the existing guidance is shown in **Table 5.13**.

Table 5.13 *Guidance Table for Protected Cycle Facilities*

	National	NZ Local Guidance	International

Width (one way)	**Austroads GTR3 (Figure 4.20 and Table 4.22)**
	• One way (Figure 4.20)
	  – 1.8m-2.0m
	• One way next to bus stop (Table 4.22)
	  • 1.2m (60km/h zone)
	  • 1.5m (70km/h zone)
	  • 1.8m (80km/h zone)
		ATCOP (Table 38)
		• Minimum Width of 1.8m (island separator)
		• Minimum Width 1.5m (bollard separator)
		
		CCC MCR Design Guide (Table 7.2)
		• Desirable: 2.1-2.3m
		• Desirable Minimum: 2.0m for a maximum distance of 100m
			Making Space for Cycling (London)
			• Minimum width: 2.1m
			• Ideal width: 2.5m
			
			NACTO Guide
			• Desired minimum: 1.5-2.1m
			• Separation desired minimum: 0.9m
			• When adjacent to parking lane: facility + buffer should be 3.4m.
			
			London Cycling Design Standards
			• 2.0m wide wherever possible to allow one cyclist to overtake another comfortably
			• 1.5m width may be appropriate on a Quietway or a route with a moderate cycle flow
			• 1.5m (low flow*)
			• 2.2m (medium flow*)
			• 2.5m (high flow*)
			*flow categories for cyclists are defined based on volumes at peak hr/6am-8pm or 24hr periods
			
			TMR Separated Cycleways
			• Widths range from 2.0m to 4.5m depending on peak hour cyclist volume

	National	NZ Local Guidance	International
Width (two way)	No Guidance Provided	**CCC MCR Design Guide (Table 6.2)** • Desirable: 3.5m • Desirable Minimum: 3.0m **ATCOP (13.2.2.7)** • 2.3m (island separator) • 2.0m (bollard separator)	**NACTO Guide** • Desired width: 3.7m • Minimum width: 2.4m **London Cycling Design Standards** • 2.0m (low flow*) • 3.0m (medium flow*) • 4.0m (high flow*) *flow categories are defined based on volumes at peak hr/6am-8pm or 24hr periods **TMR Separated Cycleways** • Widths range from 3.0m to 4.0m depending on peak hour cyclist volume (minimum 2.4m for low volumes).

	National	NZ Local Guidance	International

Clearance (one way)
Separator width
	Austroads GTR3 (Figure 4.20)
	• 1.0m clearance
		ATCOP (Table 38)
		• 0.6m (without parking)
		• 1.0m (adjacent to parking)
		
		CCC MCR Design Guide (Table 7.2)
		• Adjacent to traffic lane –
		  • desirable 0.6m
		  • desirable minimum 0.5m
		• Adjacent to parking
		  • desirable 1.0m
		  • desirable minimum 0.8m
			Transport for London
			• 0.5m or above
			• 1.0m or above where speed limit is 40mph (64km/h) or above
			• 1.8m or above where a pedestrian refuge is needed
			• 2.0-3.0m where the strip accommodates parking or loading bays
			• More than 0.3m is required if signal poles or bollards are provided on islands/segregating strips (0.45m is recommended on traffic side)
			• For grade separation, a kerb height of 50mm is suggested between traffic lane and cycle track, and between cycle track and footpath
			
			Making Space for Cycling
			• If adjacent to parking and width is less than 2.5m a 0.5m buffer zone is required
			
			NACTO Guide
			• If adjacent to parking, a minimum buffer of 0.9m is required
			
			TMR Separated Cycleways
			• 0-1.0m+ without parking
			• 0.75-1.5m+ with parking

Clearance (two way)	No Guidance Provided	**CCC MCR Design Guide (Table 6.2)**
		• Adjacent to traffic lane or parking
		  – desirable 1.0m,
		  – desirable minimum 0.85m
			TMR Separated Cycleways
			• 0.4m-1.0m+ without parking
			• 0.4m-1.5m+ with parking

	National	NZ Local Guidance	International

Surfacing colour and markings	No guidance	**CCC MCR Design Guide (Table 7.1:5)**
		• Use coloured surfacing to highlight conflict points e.g. at intersections
		• Provide cycle symbols in the cycle lane at the start, end and intermittently in accordance with MOTSAM standards.
		• Use directional signage for cycle network users.
		• Use directional arrows where necessary.
			NACTO Guide
			• One way
			  • Bicycle lane word, symbol, and/or arrow markings at the beginning of a cycle track and at periodic intervals based on engineering judgment.
			  • Colour, yield lines, and “Yield to Bikes” signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic
			  • “Bike Only” or coloured pavement could be used
			• Two way
			  • A dashed yellow centreline should be used to separate two-way bicycle traffic and to help distinguish the cycle track from any adjacent pedestrian area.
			  • Bicycle lane word, symbol, and/ or arrow markings shall be placed at the beginning of a cycle track and at periodic intervals along the facility to define the bike lane direction and designate that portion of the street for preferential use by bicyclists

	National	NZ Local Guidance	International

Signage	No guidance	**CCC MCR Design Guide (Tables 6-1:5 and 7-1:5)**
		• Provide appropriate signage and marking to ensure path users are clear on priority
		• Specify signs and markings compliant with Traffic Control Devices Manual.
			NACTO Guide
			• One way
			  • A “Bike Lane” sign may be used to designate the portion of the street for preferential use by bicyclists. A supplemental “No Cars” selective exclusion sign may be added for further clarification.
			• Two way
			  • If configured on a one-way street, a “ONE WAY” sign with “Except Bikes” plaque shall be posted along the facility and at intersecting streets, alleys, and driveways informing motorists to expect two-way traffic.
			  • A “DO NOT ENTER” sign with “EXCEPT BIKES” plaque shall be posted along the facility to only permit use by bicycles.

Surface material/ treatments	**Austroads GTR3 (4.8.5)** • Provide a smooth riding surface.	**CCC MCR Design Guide (Tables 6-1:5 and 7-1:5)** • Smooth surface types that retain traction. • Sealed paths (such as asphalt or aggregate concrete) are preferred.	**NACTO Guide** • Cycle tracks should be maintained in order to be free of potholes, broken glass and other debris.

	National	NZ Local Guidance	International

Intersection treatments	Also refer to Intersection section	**CCC Major Cycleway Design Guide Part B**
		• One way (Table 7.1:5)
		  • Cyclists should have right of way over minor roads at T-intersections
		  • Traffic signals on arterials, kerb build outs, medians and raised platforms are desirable minimum
		• Two Way (Table 6.1:5)
		  • Side Roads
		  ○ Desired: Cyclist have priority over side roads
		  ○ Desirable Minimum: Raised Crossings.
		  • Collector/Arterials
		  ○ Desired: Traffic Signals
		Desirable Minimum: Median island and kerb extensions (retain suitable width on crossing link for on-road cyclists)
			Transport for London
			• Can continue seamlessly across side roads, providing a greater sense of priority for cyclists.
			Need to become on-carriageway lanes through junctions

Driveway treatments	No guidance	**CCC MCR Design Guide (Table 7.2)** • One way No parking within 5.0m of a driveway for visibility	
Bus stops	**Austroads Guide to Road Design: Part 3: Geometric Design (4.8.5)** • Consider the treatment of both on-road and indented bus stops to provide a safer facility for both cyclists and bus patrons. The separated bicycle lane can be taken around the back of the bus stop or transitioned back onto the road pavement as an exclusive bicycle lane.	**CCC MCR Design Guide (Tables 6-2 and 7-2)** • Desired: Bypass path around bus stop retaining priority • Desirable Minimum: Bypass path around bus stop with raised treatment to slow cyclists. Consider bus bulb out if infrequent route (bus in traffic lane)	**NACTO Guide** • At transit stops, consider wrapping the cycle track behind the transit stop zone to reduce conflicts with transit vehicles and passengers. Bicyclists should yield to pedestrians **Making space for cyclists** • The cycle track must be continuous, away from the pedestrian waiting area (‘floating bus stop’)
Lighting		**CCC MCR Design Guide (Tables 6-1:5 and 7-1:5)** Specify good lighting, where appropriate to CPTED and consider blue and white light.	

	National	NZ Local Guidance	International
Gradients and cross falls	**Austroads GTR3 (4.8.5)** • Minimise gradients **Austroads GTR6A (7.4)** • Maximum of 3% however can have shorter lengths of steeper gradient for uphill travel as per Figure 7.1 Gradients steeper than 5% not desirable for downhill unless unavoidable		
Kerbs, grates and other detailed design considerations	**Austroads GTR3 (4.8.5)** • Separator should be semi-mountable kerb and channel unless flush treatment is required for drainage – then use 600mm wide flush kerb or edge strip • Wherever practicable locate drainage pit lids outside of the lane; otherwise construct with (concrete in-filled) cast iron covers to ensure a flush finish.	**ATCOP (13.2.2.6)** • Raised separators should have standard kerb heights. Kerb design should be standard semi-mountable kerbs on the cycling side or conventional vertical kerbs with an additional 300 mm of width in the protected cycle lane **CCC MCR Design Guide (Table 7.1:5)** *Two Way* • Street furniture should be set back from the cycle path. • Street trees should be limbed up. • Ensure there is sufficient width to allow for refuse collection from the delineator • Separator should be solid kerbs/separators/vertical height difference.	**NACTO Guide** • The buffer space should be used to locate bollards, planters, signs or other forms of physical protection. • Gutter seams, drainage inlets, and utility covers should be configured so as not to impede bicycle travel and to facilitate run-off. • Sidewalk curbs and furnishings should be used to prevent pedestrian use of the cycle zone. Cycle track width should be larger in locations where the gutter seam extends more than 12 inches from the curb **Transport for London** • If possible, cyclists should run opposite to the direction in which the car doors open, thereby reducing the severity of any collision with car doors as they are opened • use a minimum radius of 14m on links • use a minimum external radius of 4m at intersections where the cyclist may not need to stop • consider local widening and super-elevation (banking) on bends, particularly where cycle speeds are likely to be high • If posts/bollards are used to separate the facility, they should be placed no less than 2.5m and no more than 10m apart.

Available post implementation studies, application examples and feedback from survey

Post construction evaluations and safety audits are available for Ilam Road (Christchurch), Beach Road (Auckland) and St Vincent Street (Nelson). The key points were that there is inherent risk with bi-directional facilities at intersections and driveways due to motorists failing to notice cyclists from the unexpected contraflow direction. Also that physical separation requires a vertical element, not just paint marking.

Discussion

Austroads distinguishes minimum widths based on whether the facility is next to a bus stop of not. If the facility is next to a bus stop the minimum facility width depends on the speed limit of the area. When it is not adjacent to a bus stop a fixed minimum width applies. Auckland Transport specifies minimum width depending on whether the facility is two-way or one-way and the type of separator used (facilities with island separators must be wider). CCC simply bases minimum widths on whether a facility is two-way or one-way. NATCO on the other hand suggests that the minimum width is dependent on whether the facility is adjacent to parking or not (although CCC and AT cover the parking component through separator widths). Other international guidance (London and Queensland) uses the volume of cyclists to determine the appropriate minimum width.

The CCC minimum width for a one-way facility is greater than that suggested by AT and Austroads. CCC states that if a facility reduces to 2.0m it must be for a distance of less than 100m. Austroads however states that the width should be a minimum of 1.8-2.0m and AT states that the width should be a minimum of 1.5m or 1.8m (depending on separation type). International guidance for minimum widths is generally 2.0m of higher. However, NACTO states a width of 1.5-2.1m is appropriate if the facility is not adjacent to parking. London guidance does also suggest that a minimum width of 1.5m could be appropriate in situations where either the cycle volumes are low or the vehicle volumes are low (e.g. quiet street).

There is no clear guidance for minimum widths of two way facilities. There is no consistency between the various local and international guidance documents. There is the same variation in methodology for determining widths as there for one-way facilities (e.g. using fixed values verses basing widths on cyclist volumes).

With regards to separation, local guidance distinguishes between whether there is adjacent parking or not but national guidance has a fixed separation requirement regardless of adjacent parking. The national guidance separation value is consistent with the width stated by local guidance for when parking is present. There is limited guidance on the types of separation and any specifications that could be applied such as height of islands.

Finally, local, national and international guidance are all consistent with regards to bus stops, where it is recommended that a protected facility should deviate behind a bus stop (‘floating bus stop’) should be considered so the facility remains separated from pedestrians waiting at the stop.

Gap Identification

The gap identification for protected cycling facilities is shown in **Table 5.14**.

Table 5.14 Gap Identification Table for Protected Cycling Facilities

Gap	Type	Comments
G31. National guidance on protected bicycle facilities	Limited / insufficient guidance	Guidance is required for facility width, separator devices, separation width/height, where to use one-way vs two-way facilities etc.
G32. Definition of roadway with respect to protected cycle facilities	Legalisation	Legal changes required.
G33. Current give way rule at intersections is counter intuitive	Legalisation	Legal changes required.

5.10 Cycle Paths

Description

A cycle path is a path intended for use of cyclists only. It can be located alongside a within the road reserve, alongside a river, lake, park or railway line. An example of a cycle path can be seen in **Figure 5.17**, this path is behind the kerb and parallel with the footpath.

Figure 5.17 Cycle Path, North Parade Christchurch

Legal Status

A 'cycle path' (as defined in the Road User Rule, Part 1 rule 1.6) means 'part of the road that is physically separated from the roadway that is intended for the use of cyclists, but which may be used also by pedestrians; and includes a cycle track formed under section 332 of the Local Government Act 1974'.

Guidance

A summary of existing national, local and international guidance is shown in **Table 5.15**.

At a national level Austroads Guide to Road Design Part 6A covers cycle paths. At a local level guidance has been developed by Auckland Transport and Christchurch City Council.

Table 5.15 *Guidance Table for Cycle Paths*

	National	NZ Local Guidance	International

Width (One Way)	**Austroads GTR 6A (Table 7.3)**
	• Local Access Path:
	  • Desirable Minimum 2.5m
	  • Typical Maximum 3.0m
	• Major Path:
	  • Desirable Minimum: 3.0m
	  • Typical Maximum 4.0m
	• Minimum width could be reduced if cyclist volumes and operational speeds are low, or a greater width may be required if cyclist numbers are very high
		ATCOP (13.4.1)
		• Minimum width: 2.0m
			VicRoads Traffic Engineering Manual (5.5.3)
			• Minimum of 2.0m
			
			Making Space for Cycling
			• Minimum Width of 2.1m
			• Ideal Width: 2.5m
			
			London Cycling Design Standard
			• 1.5m (low flow*)
			• 3.0m (high flow*)
			*flow categories are defined based on volumes at peak hr/6am-8pm or 24hr periods

Width (Two Way)		**ATCOP (13.4.1)**
		• Minimum width: 3.0m
		
		CCC MCR Design Guide (Table 5.3)
		• Use Bike Path if peak pedestrian + cycle two way volumes >500/hr:
		  • 90/10 directional split: 2.5m
		  • 50/50 directional split: 3.0m
			VicRoads Traffic Engineering Manual (5.5.3)
			• Local Access: Minimum of 2.5m
			• Major Path: Minimum of 3.0m
			
			Making Space for Cycling
			• Should be 5m wide

	National	NZ Local Guidance	International

Clearance	**Austroads GTR 6A (7.7.1)**
	• Clearance between opposing bicycle operating spaces
	  • Commuter: 1.0m
	  • Recreational, if speeds <20km/h are expected: 0.4m
	• Between edge of path and an obstacle (incl parking and moving vehicles)
	  • Desired: 1.0m
	  • Absolute minimum: 0.5m
	• Clearance from property boundary varies. Desirable 1.5m where boundary fence is high and driveways exist.
		Nelson Land Development Manual (Section 4.3.13.3)
		• Between Driveways and Path
		  • Minimum of 1.5m if visibility splays are sufficient
		  • Otherwise 3.0m.
		• Between Carriageway and Path
		  • Minimum buffer: 0.7m
		• Between obstacle and path edge
		  • Minimum buffer: 0.5m
		  • Desirable buffer: 1.0m
		
		CCC MCR Design Guide (Table 5.2:5)
		• 0.5 metre buffer between path and fence
		• Provide 1.0m on either side of the path
			VicRoads Traffic Engineering Manual (5.5.3):
			• Lateral clearance: 1.0m
			• Vertical Clearance: 2.4m
			
			Making Space for Cycling
			• At least 1.0m of greenspace between carriageway and path

Markings	Limited guidance		
Surface Colour	**Austroads GTR6A** Suggests differing pavement surfaces/colour to delineate use e.g. concrete for pedestrians and asphalt for cyclists.	**ATCOP (13.4.1)** No/minimal signs and markings should be employed on cycle paths.	**Making Space for Cycling** Should have a distinct colour, using coloured tarmac (not painted).
Signage	Limited guidance		
Surface Material/Treatments	**Austroads GTR6A (B.4.1)** • Hard weatherproof surface. • Either a flexible or rigid concrete pavement. • Sub-grades must be compacted to a satisfactory standard and soft areas are treated. • Paths by river banks should provide greater resistance to scour by flood water.	**ATCOP (13.5.1.3)** • Cycle paths should be constructed with weather-proof surfaces such as asphalt or concrete. The usage of wooden surfaces for cycle paths should be avoided where possible **Nelson Land Development Manual (Section 4.3.13.3)** Paths must be surfaced as per the minimum requirements of Section 4.4.12 Footpaths.	**Making Space for Cycling** Cycle tracks should be laid to the same quality as roads.

	National	NZ Local Guidance	International
Path alignment	**Austroads GTR6A (5.3)** • Outlines factors influencing location of path in road reserve, e.g. Adjacent to property boundary, adjacent to kerb, intermediate point. • Guidelines for clearance from driveways		
Driveways	**Austroads GTR6A (C6.2)** *One Way* • Limited number of driveway crossings (preferably less than 1 per 100m)		
Intersections (also see Section 6)	**Austroads Cycling Aspects of Austroads (5.3)** • Separated cycle crossings should ideally be provided, including detection and lanterns for cyclists. • The width of marked crossing should match the width of the paths on approach. • In large intersections hook turn boxes can be provided	**AT COP (13.3.5):** • It is desirable to convert cycle paths alongside carriageways to cycle lanes prior to intersections, so that cyclists have priority through the intersection	**Making Space for Cycling** • At driveways and junctions the cycleway should not change height. • All cycle tracks along primary streets should have priority over side roads, including junctions with secondary streets.
Gradients and cross fall	**Austroads GTR6A (7.4)** • Provide flattest practicable gradient (e.g. 2%), gradients steeper than 5% should not be provided • Provides desirable maximum gradients (Figure 7.1) • Must not have sharp horizontal curves or fixed objects at bottom of hills (especially when approach gradient is steep and straight) • A crossfall of 2-4% should be adopted • On straight sections crowning of the pavement is preferable		

	National	NZ Local Guidance	International
Lighting	**Austroads GTR6A (7.9)** Where bicycle paths carry a substantial number of cyclists during periods of darkness (i.e. dawn, dusk and at night) consideration should be given to the provision of path lighting. Lighting should be designed in accordance with AS/NZS 1158.3.1:2005	**ATCOP (13.4.5)** Refers to AS/NZS 1158	
Kerbs, Grates and other Detailed Design Considerations	**Austroads GTR6A (7.8)** • Sight distance between opposing cyclists should be equivalent to at least twice the stopping sight distance. • Cyclists must be able to: • negotiate path entrances with ease not be distracted by overly restrictive barriers	**ATCOP (various locations)** • Kerbs on to and off cycle paths should be less than 10mm. • The kerb entry should be designed with a radius minimum of 2.0 m • Kerb entry should have a maximum gradient slope of 1:10. • Bollards and street markings are recommended instead of gates. • Bollards spacing should be 1.4m • Bollards should be a minimum of 1.2m high • If gates/barriers are used, layout should be arranged so a cyclist can navigate through at low speed without wobbling. **Nelson Land Development Manual (Section 4.3.13.3):** • Where a path is provided within a road reserve that has frequent driveways, a buffer between the property boundary and the path must be provided	**Making Space for Cycling** • Unobstructed routes: No trees, wheelie bins, utility boxes, or lighting poles should be on the path • Where bollards are used, only use an odd number of simple bollards spaced about 1.8 metres apart • Bollard should be arranged to separate opposing flows, not to obstruct them or force them into conflict. • Never use gates, chicanes, or similar pinch points. • Design should facilitate easy maintenance, to avoid overgrowing vegetation and enable winter treatment.

Available post implementation studies

Tennyson Street Review, Christchurch (Macbeth et al 2009)

The review identified a number of design and operational issues. These included: lack of intervisibility between drivers and cyclists at driveways; the fear of colliding with opening car doors; concerns with motor vehicle drivers failing to give way to cyclists; discomfort when cycling across driveways and intersections; and rubbish bags and recycling boxes obstructing the cycle paths. Because of these issues, some cyclists choose to cycle on the road carriageway (even though it has narrower traffic lanes than before) rather than on the cycle paths. The cycle path design was found to not satisfy the design criteria for one-way off-road cycle paths in Austroads Guide to Traffic Engineering Practice Part 14 Bicycles, because of the frequency of driveways and the lack of separation between the paths and the road carriageway.

Discussion

There is a variety of methods available for determining the path width. Austroads and VicRoads use path hierarchy whereas CCC uses directional split to determine the minimum width. The guidance is consistent for widths of one-way cycle paths, however the minimum width for two-way paths generally varies between 2.5m or 3.0m; the exception being Making Space for Cycling (Heydon and Lucas-Smith 2014) which suggests a minimum of 5.0m for two way paths, which is well above the other recommendations.

The guidance for clearance (i.e. width of the separation device) is consistent when considering the desired clearance values in the national and local guidance. However, it should be noted that the national and local guidance have minimum values of 0.5m which is half of the desired width (1.0m).

Guidance on the appropriate markings and designs for paths crossing side roads and driveways is also varied. National guidance recommends markings at intersections and installing cycle crossings. Local guidance on the other hand recommends minimal markings, and that paths are converted to on-road cycle lanes prior to intersections. Finally, international guidance recommends that cycle paths have priority over side roads, and that coloured pavement is used on the paths. Driveways along a cycle path, whilst located in what is considered to be the midblock, are effectively intersections and should be treated with care, especially for two-way paths, as for similar reasons to those discussed for two-way protected cycle facilities in Section 5.9.

Gap Identification

The gap identification for cycle paths is shown in **Table 5.16**.

Table 5.16 *Gap Identification Table for Cycle Paths*

Gap	Type	Comments
G34. Cycle Path Widths	Inconsistent guidance	Widths are determined using different methods. Austroads and CCC use volumes, AT have a minimum.
G35. Markings and signage	Inadequate / insufficient/ inconsistent guidance	Develop national guidance around when and what markings and signage should be used on cycle paths.
G36. Intersection' design for side roads and driveways (also covered in section 6)	Inconsistent guidance	Variations as to whether paths should have separate crossing signals, should terminate prior to intersection or should have priority over side roads - legal implications regarding cycle paths having right of way over side roads.

5.11 Shared Paths

Description

Shared paths can be located adjacent to a roadway or separated from the road network. They are shared between cyclists, pedestrians and users of mobility devices and wheeled recreational vehicles. Shared paths require careful consideration as the different speeds of pedestrians and cyclists can lead to conflicts. Some pedestrians, for example older people with sensory or mobility impairments, feel insecure walking among faster cyclists. As the volumes of all user types increase, conflicts between their needs can significantly affect the quality of provision for both pedestrians and cyclists.

The ability of a path to cater for cyclists' requirements depends on the target audience to be catered for and the path alignment. Some cyclists (e.g. strong and confident on the Geller scale) will not choose to divert from a roadway that provides a more direct route, fewer obstacles (which may include pedestrians on a shared path) or lower delays. So paths may not completely replace the need for on-road provision. Conflicts between path users can be mitigated to some extent by allowing cyclists to conveniently exit the path prior to intersections.

Figure 5.18
Shared Path, Toi Toi Street, Nelson

Legal Status

They are allowed under the Traffic Devices Rule 11.4 if the facility is signposted in accordance with the rule. The Traffic Control Devices Manual defines a Shared Path as: "*A path intended to be used by both pedestrians, cyclists, mobility devices and wheeled recreational devices*."

Guidance

A summary of existing national, local and international guidance is shown in **Table 5.17**. In lieu of any definitive NZ guidance Austroads is referred to as the national guidance.

Austroads Guide of Road Design Part 6A – Pedestrian and Cyclist Paths defines a Separated Path as: *"A path on which cyclists and pedestrians are required to use separate designated areas of the path"*.

Table 5.17 Guidance Table for Shared Paths

	National	NZ Local Guidance	International
Width	**Austroads: GTR6A (Section 7.5.3)** • Local Access path: 2.5m-3.0m • Commuter path: 2.5m-4.0m • Recreational paths: 3.0m-4.0m NB. Lesser/wider widths may be required if cyclist volumes and operational speeds are low or if the number of cyclists and pedestrians are very high **NZTA Pedestrian Planning and Design Guide (Table 14.13)** • Local Access Path: 2.0-2.5m (2.5m desirable) • Commuter Path: 2.0-3.5m(3.5m desirable) • Recreational Path: 3.0-4.0m (3.5m desirable) • Where use uncertain, provide 3.0m **Bridging the Gap Urban Design Guidelines** • No less than 3.0m	**ATCOP (13.4.2)** • 3.0m desirable minimum. • 2.5m absolute minimum • Providing less than 2.5m should be done in exceptional circumstances only and for a short distance only (e.g. 10m). • Where a high number of users (including pedestrians) are expected wider paths should be considered. **The Nelson Land Development Manual (Table 4.15)** • Local Access (travel between local roads): 2.0m • Community Access (travel from road to community facility e.g. shops or school): 3.0m	**Making Space for Cycling (London)** • 3.0m minimum width in parks, 2.5m minimum width on key routes between major areas or in rural areas. **VicRoads Cycle Notes 21** • A graph is available for determining the width of shared paths (2.0m-3.0m) or whether separated facilities are required – the graph uses peak hour pedestrian and cyclist volumes **London Cycling Design Standards** • 2.0m (low flow*) • 3.0m (medium flow*) *flow categories are defined based on volumes at peak hr/6am-8pm or 24hr periods
Clearance to obstructions/adjacent activities	**Cycling Aspects of Austroads (Section 7.5.7)** • Between edge of path and an obstacle – Desired: 1.0m – Absolute minimum: 0.5m **NZTA Pedestrian Planning and Design Guide** • Provide lateral clearance of 1.0m on either side of the path • Provide overhead clearance of 2.4m • Ideally provide 1.5m separation between path and road	**CCC MCR Design Guide (Table 5.2:5)** • 0.5m buffer between path and fence • Provide 1.0m on either side of the path	**VicRoads Traffic Engineering Manual (5.5.1)** • Minimum lateral clearance to obstructions and traffic lanes: 1.0m • Minimum vertical clearance: 2.4m

	National	NZ Local Guidance	International
Separation of users	**Cycling Aspects of Austroads (Section 7.5.7)** • Clearance between opposing bicycle operating spaces – Commuter: 1.0m – Recreational, if low speeds (<20km/h) are expected: 0.4m		**VicRoads Cycle Notes 21** • Separating cyclists from pedestrians increased capacity and improves pedestrian amenity. • Recommend physical separation or contrasting surface materials, rather than paint marking.
Surface Colour and markings	**Cycling Aspects of Austroads (Section 9.3.2)** • Separation lines on shared paths and bicycle paths should be marked in accordance with AS 1742.9-2000. **MOTSAM Part 2 (2.10.04)** • If a cycle lane symbol is used on a shared cycle and pedestrian pathway it should have the following dimensions: • 360mm wide • 560mm high	**ATCOP (13.4.3)** • No or minimal use of markings should be employed. • Generally separating cyclists and pedestrians using a painted line is not preferred. • Arrow markings or “Keep left” marking in areas where conflicts have been identified or may be expected **Nelson Land Development Model (Section 4.3.13.3)** • Shared Use Paths must be marked with a 20m long centreline at the entry points, conflict points and at intervals no less than every 300m. **CCC MCR Design Guide (Section 5.3.4 and Table 5.2:5)** • Pavement symbols (bicycle, pedestrian and arrow) and centreline should be located adjacent to path access points. • Markings should be used to encourage users to keep left unless passing • Refers to VicRoads Cycle Notes No. 10; July 2001 • States that signs and markings must comply with Traffic Control Devices Manual • Green coloured surfacing should be used to highlight conflict points e.g. where shared path intersects road	**VicRoads Traffic Engineering Manual (5.5.1)** • Standard pavement arrow shapes are used in conjunction with the pedestrian symbol and bicycle symbol • Can also use markings to provide advance warning of a hazard or a divider in the centre of the path. **VicRoads Cycle Notes 10** • Path users can be advised to keep left, by marking a centre line on the path, along with pavement logos of a bicycle, a pedestrian, and a directional arrow. It is recommended that these are used at beginning of paths and adjacent to path access points • Refers to Australian Standard AS 1742.9 Manual of Uniform Traffic Control Devices, Part 9, Bicycle Facilities for shared path centre lines (white, 80mm wide, 1m long and 7m spacings) and bicycle, pedestrian and arrow pavement symbols. • Recommends that a white 80mm wide unbroken line should be used on curves where sight distance is poor, high volume locations and at approaches to path/path intersections

	National	NZ Local Guidance	International
Signage	**TCD Manual, Part 2 (Direction)** • Two types depending on whether users are separated on the path or not. No guidance regarding location, frequency of signs.  **NZTA Pedestrian Planning and Design Guide (14.12)** • Provide adequate signing to indicate presence of pedestrians and cyclists	**ATCOP (13.4.3)** • Signs indicating the start and finish of a shared path should be used. • Signs advising of courtesy codes may be considered if needed **CCC MCR Design Guide (Table 5.2:5)** • Provide appropriate signage and marking to ensure path users are clear on priority at intersections. • Minimise unnecessary signage • Ensure signs and markings are compliant with the Traffic Control Devices Manual.	**VicRoads Traffic Engineering Manual (5.5.1):** • Shared paths must have signs indicating the start and end of the shared path **Vic Roads Cycle Note 10** • "Keep Left" signs may be used • To encourage path users to warn others when they are going to overtake them, the "Warn when approaching" sign can be used • Path users can be encouraged not to stop on the path by installing "Move Off Path When Stopped" signs • To encourage people to minimise their dogs' impact on other path uses, a "Control Your Dog" sign can be used. • Excessive signs should be avoided as they increase visual clutter, have reduced effectiveness and are an unnecessary capital and maintenance cost

	National	NZ Local Guidance	International
Surface Material / Treatments	**Cycling Aspects of Austroads (Section 10.2)** • Smooth, debris-free surfaces are a fundamental requirement. **Austroads GTR6A** • Section 4.2.3 provides detailed specifications for both new and existing (Table 4.1) pavement surfaces of a bicycle lanes or paths e.g. for new paths the maximum stone size should be less than 14 mm	**ATCOP (various locations)** • Asphalt or Concrete should be used. • Joints should be smooth and edges should be flush with adjacent surfaces • No Barriers • Bollards + street markings can be used if suitable distance apart and height are used • If gates or staggered barriers are used, should be easily navigated by cyclist • Kerb crossings should require minimal speed reductions by cyclists. • The kerb entry radius should be a minimum of 2.0 m and have a maximum gradient of 1:10. • Kerbs on to and off shared paths should be less than 10mm. **CCC MCR Design Guide (Table 5.2:5)** • Specify smooth surface types that retain traction. Sealed paths are preferred but materials other than asphalt could be considered, in addition to adjacent pedestrian paths (crusher dust etc).	**VicRoads Cycle Notes 21** Cyclists prefer asphalt or concrete due to smoother ride. Gravel surfaces favoured in natural settings although may present difficulties for wheel chairs or other aids.
Intersections (also see Section 6)	**Austroads: Cycling Aspects of Austroads** • Arterial Road(Section 7.6.3) – Cyclists should cross at a shared pedestrian/cyclist crossing • Roundabouts (Section 5.5.5) – Reduce relative speed between entering and circulating vehicles, minimise the number of circulating lanes, and maximise the distance between approaches For multi lanes, high volume routes it is preferable to have signalised intersections or grade separated cyclist facilities	**AT COP (13.3.5)** • Standard Intersections • Suggests converting paths to cycle lanes prior to intersections. • Roundabouts • Refers to Austroads **CCC Major Cycleway Design Guide Part B (Table 5.2:5)** • Cyclists should have right of way over minor roads at T-intersections and cross-roads.	**VicRoads Traffic Engineering Manual (5.5.1)** A shared path is terminated by a road, so a pedestrian crossing cannot be signed as a shared path.

	National	NZ Local Guidance	International
Gradients and cross fall	**Cycling Aspects of Austroads (pg. 95.96)** • Must not have sharp horizontal curves or fixed objects at bottom of hills (especially when approach gradient is steep and straight) • Max Gradient – Max gradient is 3%. – If 3% can't be achieved then up to 5% can be used if short flatter sections (e.g. 20 m long) are provided at regular intervals • Cross fall – For shared paths a crossfall of 2-2.5% should be adopted to dispose of surface water whilst still catering for people with a disability AS/NZS 1428.4.1-2009		N/A
Lighting	**Austroads GTR6A (Section 7.9)** • Where bicycle paths or shared paths carry a substantial number of cyclists during periods of darkness (i.e. dawn, dusk and at night) consideration should be given to the provision of path lighting. If it is decided to light a bicycle path or shared path the lighting should be designed in accordance with AS/NZS 1158.3.1-2005	**ATCOP (13.4.5)** • Refers to AS/NZS 1158. • Lights should be located at each end and at not more than 50m centres along the length of the access way. Path lighting should minimise light shining upon residential windows or into the eyes or drivers/pedestrians/cyclists **CCC MCR Design Guide (Table 5.2:5)** • Ensure the path is visible both during the day and at night in terms of passive surveillance and lighting, to CPTED guidelines where appropriate.	• N/A
Kerbs, Grates and other Detailed Design Considerations	**Cycling Aspects of Austroads (Table 7.3 and Table 7.4)** • Has guidance for the minimum radii of horizontal curves based on design speed and superelevation	**CCC MCR Design Guide (Table 5.2:5)** • Limit number of intersections and driveways • Consider the buffer distance from the driveway, inter-visibility • Fences should be considered where there is a steep batter or vertical drop close to the path or if the path crosses a bridge or culvert.	• N/A

Research

Auckland Transport

Auckland Transport is currently pursing changes to the signage regulations for shared paths in locations where multiple exclusive cycle paths and footpaths merge to form short sections of shared path. These locations, which would be more appropriately thought of as 'areas' rather than 'paths' due to their complexity, exist because it would not be suitable to provide segregated facilities where multiple directions of travel are possible. The current signage regulations result in such locations being cluttered with regulatory signs; it is assumed that this is neither effective in portraying the signs' intended messages, nor necessary from a safety perspective, nor appropriate from an urban design perspective. Thus alternative approaches will be developed and proposed to be trialled.

Discussion

Existing guidance often relates the required width of the shared path to the intended type of usage of the path e.g. local connection vs. commuter path. An alternative method is to use cyclist and pedestrian volumes to determine path width. Auckland Transport simply states a desired minimum width and an absolute minimum width, and suggests instances where the path can be narrower and encourage wider paths when a high number of users is expected. CCC on the other hand gauges widths as 'unsuitable', 'tolerable', 'desired' or 'excellent'. The other key discrepancy is around appropriate path markings.

The guidance documents are generally consistent regarding: when lighting must be provided (and in the NZ national and local guidance which standard any such lighting must adhere to); the clearance requirements from obstacles; and the specification of asphalt or concrete as the preferred surface material.

CCC allowable gradients are steeper than the national guidance maximum (although the gradients stated in the 'excellent' category are consistent, the CCC states that designs should aim for acceptable level)

At intersections, Austroads (the default national guidance) indicates that shared path users should cross at a shared pedestrian/cyclist crossing. VicRoads however states that shared paths are terminated at intersections and pedestrian crossing facilities cannot be signed as shared paths. AT recommends conversion to cycle lanes prior to an intersection. At signalised crossings, Auckland and Christchurch practice is to provide separate pedestrian and cycle crossings.

Gap Identification

The gaps identified for guidance on the design of shared path can be seen in **Table 5.18**.

Table 5.18 *Gap Identification Table for Shared Paths*

Gap	Type	Comments
G37. Minimum widths are determined using different criteria	**Inconsistent guidance**	Different criteria used to assess width requirements. Different widths are therefore recommended. Widths are determined using different methods. Austroads and NZTA Pedestrian Planning and Design guide use 'user type', Vic Roads and CCC use volumes, AT has a minimum and maximum but state that when a high number of users are expected wider paths should be considered.
G38. Surface Markings on Path	**Inconsistent Guidance**	National guidance (Austroads) states markings are necessary however there is no/minimal legal requirement in NZ. AT states no or minimal markings should be used. Nelson states markings must be used to separate the direction and finally VicRoads suggests using markings to promote courteous behaviour and warn of hazards. CCC suggest markings at entrances to the shared path and that markings can be used to encourage users to keep left on the path. CCC also suggest using coloured pavement at conflict points.
G39. Signage for shared paths	**Overly onerous requirement**	The sign clutter resulting from short sections of shared path / area formed where multiple exclusive cycle paths and footpaths merge, is considered unnecessary and counter-productive.

6. Best Practice Review: Intersection and Crossing Design

6.1 Introduction

Cyclists are often required to interact with motorised traffic and pedestrians at intersections and crossings which creates a higher-risk situation than when travelling along a midblock facility. The form of interaction depends on the intersection type, midblock facility type and how cyclists are provided for through the intersection or crossing. Intersection design is strongly linked to midblock facility type and the target users of the facility. Any interaction with vehicles can be perceived as unsafe for the least confident and youngest cyclists in the population.

As noted by in the Cycle Safety Panel Report (Leggat et al 2014) intersections and driveways in urban areas are by far the highest risk areas for cyclists. Over the 2003 – 2012 period only 26% of serious and fatal crashes in urban areas did not occur at an intersection or driveway, see **Table 6.1** reproduced from Leggat et al (2014). Therefore guidance on how to design these safely is key to a successful cycle network. Legget et al (2014) calls for a shift away from designing intersections for motor vehicles and more consideration of cyclists. The report states that large safety benefits could be achieved by treating intersections alone.

Table 6.1
Proportion of Cyclist Crashes by Location Type 2003-2012

	Rural	Urban
Driveway	7%	14%
Roundabout	4%	9%
Traffic Signals	0%	9%
Other X Intersection	4%	10%
Other T Intersection	15%	32%
Not an Intersection	70%	26%

The shift towards a greater focus on separated facilities in Australasia has created challenges in intersection design which has not traditionally included these facilities. Design in New Zealand is also currently constrained by the existing legislation which was not developed with consideration of separated facilities. This creates challenges particularly in relation to the existing give way rules, which are based on vehicles travelling on the 'roadway':

- Definition of the 'roadway' - that portion of the road used or reasonably usable for the time being for vehicular traffic in general.
- Interpretation: Cyclists entering the roadway from a protected facility (or any facility that motor vehicles cannot physically access) must give way to all other traffic already on the roadway.

Intersection and Crossing Facility Types Considered

The facility types considered in this section are shown in **Figure 6.1**.

Figure 6.1
Intersection and Midblock Crossing Facility Types Considered

Intersections	Midblock Crossings
•Unsignalised Intersections •Signalised Intersections •Roundabouts •Interchanges	•Unsignalised At Grade Crossings •Signalised Crossings •Grade Separated Crossings

6.2 Guidance Sources

The following resources have been considered in the review of current intersection and crossing design practice:

National Design Guidance:

- Austroads: Cycling Aspects of Austroads Guides (Austroads 2014b)
- Austroads: Guide to Road Design Part 3 Geometric Design (Austroads 2010a)
- Austroads: Guide to Road Design Part 4 Intersections and Crossings (Austroads 2009)
- Austroads: Guide to Road Design Part 4A Unsignalised and Signalised Intersections (Austroads 2010b)
- Austroads: Guide to Road Design Part 4B Roundabouts (Austroads 2011)
- Austroads: Guide to Road Design Part 4C Interchanges (Austroads 2009a)
- Austroads Guide To Road Design Part 6A Pedestrian and Cyclist Paths (Austroads 2009b)
- Austroads: Guide to Traffic Management Part 6 Intersections Interchanges and Crossings (Austroads 2013)
- Austroads: Guide to Traffic Management Part 9 Traffic Operations (Austroads 2014a)
- Bridging the Gap: NZTA Urban Design Guidelines (NZ Transport Agency 2014a)
- Manual of Traffic Signs and Markings [MOTSAM] (Transit New Zealand et al 1992)
- National Traffic Signal Specification Version 3 draft (SNUG 2012)
- Land Transport (Road User) Rule 2004
- Land Transport Rule: Traffic Control Devices 2004 (Bunting 2013)
- NZ Transport Agency Pedestrian Planning and Design Guide (NZ Transport Agency 2009)
- NZ Supplement to Austroads Guide to Traffic Engineering Practice, Part 14: Bicycles (Transit 2008)

Local Design Guidance:

At a local level the local authority guidance reviewed was the Christchurch City Council (CCC) and Auckland Transport (AT) guides. It is acknowledged that there may be other local cycle design guides however these were not publically available. Many local authorities have Codes of Practice but as with NZS 4404 they refer to Austroads.

- Auckland Transport Code of Practice, Chapter 13: Cycling Infrastructure Design [ATCOP] (Auckland Transport 2013)
- Christchurch Cycle Design Guidelines (Christchurch City Council 2013)

- Christchurch City Council Major Cycleways Design Guide: Part B, Design Principles Best Practice Guide Revision A (Christchurch City Council 2014)

  Christchurch City Council Major Cycle Routes Signalised Intersection How To (Revision 4) Draft (Christchurch City Council 2015a)

International Design Guidance:

- National Association of City Transportation Officials (US) Urban Bikeway Design Guide (NACTO)
- Department of Transport and Main Roads (Queensland) Separated Cycleways Guideline (TMR Separated Cycleways)
- Department for Transport (UK) Design Manual for Roads and Bridges Volume 6 (UK DMRB)
- Department for Transport (UK) Local Transport Note 2/08 Cycle Infrastructure Design (UK LTN 2/08)
- National Cooperative Highway Research Program Report 672 Roundabouts: An Informational Guide (NCHRP 672)

6.3 Priority/Uncontrolled Intersections

Description

Priority controls are generally used for intersections of minor roads and major roads. At priority intersections, the side road(s) has either a 'Give Way' or 'Stop' control. An uncontrolled intersection is generally used where two low-order roads meet; no control is implemented and normal give way rules apply. Note that this section considers road intersections – crossings where paths intersect roads and have priority controls or are uncontrolled are considered in Section 6.8. An example of a priority intersection is shown in **Figure 6.2**.

Priority and uncontrolled intersections are the most common intersections in the transport network. Cyclists on the major road travelling through priority/uncontrolled intersections generally travel on the kerbside of the traffic lane and are opposed by vehicles emerging from side roads and turning into the side road from the major route. Where the major route is congested cyclists travelling past stationary traffic are put at further risk where gaps in the traffic have been left for vehicles to turn into side roads. Cyclists on the major route rely on drivers undertaking the opposing movements seeing them and giving way. Cyclists emerging from side roads also need to be considered in design. Of all cycle crashes that occurred from 2003-2012, 57% occurred at uncontrolled or priority intersections (Leggat et al 2014). Some components of driveways, especially commercial driveways are also similar to priority intersections and are considered in this section.

Figure 6.2
Example of a Priority Intersection

Legal Status

As discussed in section 6.1 the current give way rules in particular with regards to the definition of roadway limit the available options for providing for cyclists at priority and uncontrolled intersections.

Guidance

A summary of existing local, national and international guidance is shown in **Table 6.2**.

Table 6.2 Guidance Table for Priority/Uncontrolled Intersections

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Design Approach	**Austroads GRD4A** Cyclists should be considered at all intersections and space be provided for them even if there is no specific facility.		
Facility Provision/ Level of Protection	**Austroads GRD4A** Guidance for providing cycle lanes on major road. **Austroads GRD4** Some consideration of transitioning major road facility to cycle lanes vs retaining separation through intersection.	**CCC MCR Design Guide** Guidance on when priority vs Signalised intersections may be appropriate. Requires no uncontrolled intersections on major cycle routes. Generally considers protected facilities only.	**NACTO Guide** Generally considers cycle lanes through intersections, some reference to protected facilities.
Major Road	**Austroads GRD4A** Notes that where a cycle facility is provided it should always be continued through the intersection on the major road. Provides layout guidance on various cycle lane layouts (with/without parking and at channelised turns). Gives options for cycle path layout past side roads: Bent out, Straight, bent in.	**CCC MCR Design Guide** Cyclists on the major leg should always have priority over motor vehicles on the minor leg. Straight treatments preferred over bent in and bent out. Bent out should be considered for bi-directional facilities. Suggests use of hook turns/two stage turn facilities for right turning cyclists. Provides a series of options for increasing visibility, reducing vehicle speeds, banning turns and transition out of protected facility across intersection. **ATCOP** Cyclists on the major leg should have priority over motor vehicles on the minor leg. **MOTSAM Part 2** Shows layouts for cycle lanes along Major Road	**NACTO Guide** Cyclists on the major leg should have priority over motor vehicles on the minor leg. **TfL** Suggests continuity across side roads and requires protected facilities to become on-road cycle lanes through intersections. **TMR Separated Cycleways** Prefers straight facilities on platforms however gives guidance on when other arrangements may be appropriate.

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Minor Road	**Austroads GRD4** Shows layout for cycle lane continuing across major road via a refuge island.		**NACTO Guide** Provides options of refuges in the centre of major road (to ban motor vehicle turns and provide protection for cyclists to make a 2 stage crossing) and HAWK beacons (priority for cyclists) to enable crossing of the major road.
Detailed Design Guidance	**Austroads GRD4** Provides guidance on: dimensions including setbacks for bent out crossings, refuge island widths, curve radii **MOTSAM Part 2** Recommendations for the use of green surfacing and cycle symbol requirements.	**CCC MCR Design Guide** Guidance on Wayfinding signage, use of green surfacing, parking setbacks and transition lengths to unprotected facilities. **ATCOP** Recommends green surfacing, refers to MOTSAM. **MOTSAM Part 2** Guidance on continuity and marking details.	**NACTO Guide** Provides guidance on parking setbacks, marking, refuge island layout.

Relevant Research

Monsere et al (2014) trialled additional low-mounted signage on the through route at minor intersections to raise turning motorists' awareness of the presence of through cyclists. The responses to the effectiveness of this signage were mixed with only 63% of respondents stating that the sign raised their awareness. No observations of motorist behaviour were undertaken.

Post implementation studies, application examples and feedback from survey

Nelson City Council has implemented a bi-directional facility on Vincent Street, Nelson (see **Figure 6.3**). Users of this facility are required to give way at all priority intersections along its length due to the roadway definition within the Road User Rule. The post-implementation safety audit report notes that the resulting situation is very complex for cyclists as they must essentially survey 270° to look for opposing traffic and determine whether they must give way. The safety audit report notes that over time, as cyclist volumes increase and legislation changes, it may be appropriate to change the priority of the facility at intersections.

Christchurch City Council introduced off-road cycle paths on Tennyson Street in 2001. These paths transition to cycle lanes across intersections in order to allow cyclists right of way under current give way rules. This design is described as 'clumsy' in the post implementation review however it is noted that it is necessary due to the current legislation (Macbeth et al 2009). There is insufficient cyclist crash data to draw any real conclusions about the safety performance of these intersection layouts.

Figure 6.3
Intersection of a bi-directional facility and a side road, St Vincent Street, Nelson

Discussion

The design approaches taken by Nelson City Council and Christchurch City Council to establishing the priority of separated facilities with respect to side roads are very different, however both methods have been developed to work within the current legal context. If the issues around the give way rule are resolved (Wilke 2014b) the way in which side roads at protected cycle facilities are designed is likely to change.

Very little guidance is available in New Zealand for providing for cyclists on the minor approach to priority intersections. It is noted that there is a wide range of scenarios that any guidance may need to cover, however guidance on key points could be considered. When the primary cycle route is provided along roads that are not part of the strategic motor vehicle network, delays and unnecessary crossings of the

side road can be introduced for cyclists (see **Figure 6.4**). NACTO recommends a 'hybrid beacon' or HAWK crossing (High-intensity Activated CrossWalk) as a more efficient alternative to traffic signals. This is different to a signalised crossing in that the facility can be provided through at a minor side road where cyclists share the general traffic lanes or remain in their facility on the left side of the road, rather than having to provide a signalised midblock crossing adjacent to the intersection, which limits the deviation required for cyclists (as shown in **Figure 6.4**). HAWK crossings are used as an alternative to a fully signalised intersection/crossing due to the fact that they result in lower delays for motorists on the major road. HAWK crossings allow motorists to 'proceed when clear' during the flashing red stage but provide more protection to cyclists than an unsignalised crossing, this is somewhat similar to the flashing amber phase used at pelican crossings in the UK. HAWK crossings can be used at intersection or at midblock crossing locations. It is unlikely that a feature resembling the HAWK crossing will ever be used in New Zealand, instead it is recommended that further guidance about the use of signalised intersections and crossings for major road crossings on cycleways is considered in the context of the target audience.

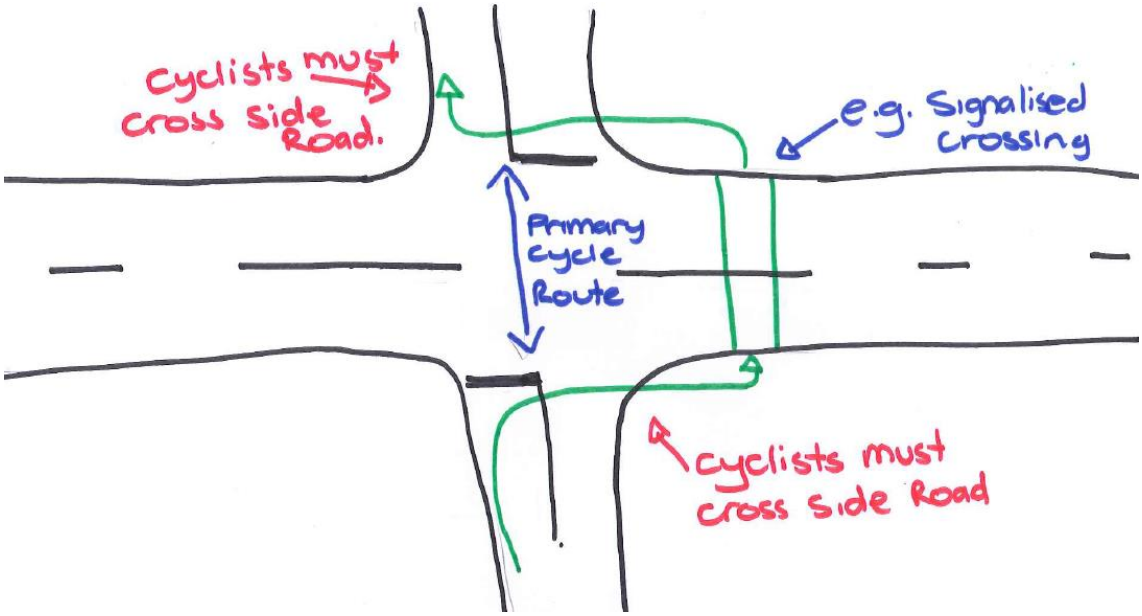


Figure 6.4
Scenario where primary cycle route crosses a major road along a minor road

Major commercial driveways and operate in a very similar manner to minor side roads. Guidance about how to mark off-road cycle paths and SBFs past driveways does not currently exist. It is recommended that a nationally consistent standard for this is developed, including where and how to apply symbols, coloured surfacing, horizontal deflections and vertical deflections. Commentary on the use of vertical deflection past side roads is also needed. Currently Austroads GRD4 recommends platforms on side roads for comfort and continuity, although safety considerations are not mentioned. Furthermore, consideration of how to alert cyclists to the potential conflict through either visual or tactile/physical means is also required.

Gap Identification

Gaps identified in the guidance related to priority and uncontrolled intersections are identified in **Table 6.3**.

Table 6.3 *Gap Identification Table for Priority/Un-controlled intersections*

Gap	Type	Comments
G40. Treatment of SBFs past priority Intersections	No guidance exists / Inconsistent Guidance	No nationally approved guidance exists for this scenario. Designs where this scenario exists differ between local authorities. This is a scenario where changes to legislation may be required to allow the best practice solution to be implemented within the legal framework. Trials of different intersection layouts are needed to inform best practice guidance development. Some commentary on the use of platforms should also be incorporated.
G41. One-directional vs bi-directional facilities	No guidance exists	Risks at intersections and driveways are a major factor in terms of the relative safety of one directional vs bi-directional facilities. Guidance to support designers in choosing between facilities should be developed. (see **Section 5**)
G42. Treatments at Driveways	No guidance exists	Develop nationally consistent guidance and consider where thresholds lie for use of coloured surfacing. (see **Section 5**)
G43. Auxilliary lanes and slip lanes	Current guidance is not best practice	More thought is required around the types of lane layouts that are not acceptable along key cycle routes. For example CCC does not permit auxiliary lanes on MCRs

6.4 Signalised Intersections

Description

At signalised intersections different movements are separated in time and therefore the risk to compliant cyclists is lower than at unsignalised intersections. However, if signal operation allows for filter-turning, cyclists are still exposed to risk from turning traffic that shares their approach leg and often also turning traffic from the opposing approach. Signalised intersections are generally used for intersections of major roads and consequently often involve several approach lanes.

Turning right can be difficult for cyclists at signalised intersections where several lanes must be crossed to get into the right turning lane and several lanes of opposing traffic must be negotiated to get through the intersection. The alternative is a hook turn manoeuvre which allows cyclists to retain a kerbside position and cross in two stages, but the waiting period may still be uncomfortable for some cyclists.

Research by Turner et al, (2011) shows that shared through and left lanes on intersection approaches pose a high risk to cyclists as they generally travel on the left of these lanes and are therefore in the path of turning traffic. Of all fatal and serious crashes involving cyclists at intersections from 2003-2012 12% occurred at signalised intersections. An example of a signalised intersection with approach and storage cycle facilities is shown in **Figure 6.5**.

Figure 6.5 *An example of a typical signalised T-intersection with cycle facilities (Northside Dr/Tahi Rd Auckland)*

Cycles are considered a vehicle in New Zealand legislation and therefore cyclists must comply with standard traffic signal displays. Cyclists can be provided for separately using signal aspects that show a cycle symbol which override the circular disc display for general traffic when illuminated (TCD Rule). The 'B' aspect used for buses also applies to cyclists when they are lawfully using a bus lane (Road User Rule).

Legal Status

Currently some clauses within New Zealand legislation impede the full range of best practice cycle design being implemented, especially at signalised intersections. Wilke (2014b) identified that current legislation impedes cycle design, as follows:

- Meaning of the green cycle aspect - The road user rule clause 3.2 Traffic signals in the form of a cycle symbol states: *"While a green cycle symbol is illuminated, cyclists may proceed straight ahead, or turn left or right*." Using this symbol in conjunction with a green disk can/could lead to legal conflicts.
- Size of signal aspects showing cycle symbols: currently cycle aspects must be the same size as the green disk, this leads to inflexible and at times ineffective/confusing mounting positions.
- Definition of the Roadway and how this relates to give way rules – as discussed in Section 6.1.

Guidance

A summary of existing local, national and international guidance is shown in **Table 6.4.**

Table 6.4 Guidance Table for Signalised Intersections

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Design Approach	**Austroads GRD4A** Six elements of intersection design for cyclists: Midblock, Transition, Approach, Storage, Through, Departure.		**CROW Manual** Main requirements for intersections: Directness (Distance and Time), Safety, Comfort, Attractiveness **TMR Separated Cycleways** Focus on reducing severity of conflicts through reducing turning speeds and using green surfacing.
Facility Provision/ Level of Protection	**Austroads GRD4A** Considers cycle lanes vs no facility and provides a threshold for cycle lane provision. **Austroads GTM6** States that if midblock facility is an off road path then the path should be continued through the intersection. **Austroads GRD4** Provides guidance for cycle crossings at intersections. **MOTSAM Part 2** Suggests removal of arrows in left turn lane to legally accommodate through cyclists where no facility is provided.	**CCC MCR Signalised Intersections** Shows typical section and layout for continuing SBF to limit line and lesser protection on secondary route. Requires consideration of access to the MCR from all legs. Presents pros and cons of sharrows/mixing lane concept however notes concerns in relation to MCR target audience. **ATCOP** Considers cycle lanes, SBFs and Cycle paths at intersections.	**NACTO Guide** Includes separated facilities, mixing lanes and cycle lanes. **TMR Separated Cycleways** Considers cycle lanes vs separated facilities using a speed threshold. Where a cycle lane and SBF meet the intersection should provide SBFs on all approaches.

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Transition, Approach and Storage	**Austroads** Provides options for different lane configurations and space allocation including: • Wide kerbside lanes • Right turn cycle lanes (with commentary on when appropriate) with weave right transition • Kerbside cycle lanes (including cyclists outside through and left lane with no commentary on safety etc) • Car side cycle lanes with straight and offset left transition • Advanced Stop Boxes and Advanced Stop Lines (and combinations of both). Notes that ASBs can be used without cycle lanes. • Some commentary of consideration of phasing and storage design. • Treatment of channelised left turns/slip lanes **MOTSAM Part 2** Requires cycle lanes at intersections to be continuous to the stop line. Suggests advanced stop lines and advanced stop boxes. Some commentary on cycle lane layout.	**CCC MCR Signalised Intersections** Suggests advanced stop lines (within SBF) **ATCOP** Recommends considering: Use of riley kerb on approach, Termination of SBF on approach, Converting cycle paths to cycle lanes on approach.	**NACTO Guide** Provides many options and associated commentary, including: • Advanced stop boxes • Cycle lanes including continuous and discontinuous weave lanes • Mixing lanes • Separated facility to stop line with cycle phase **TMR Separated Cycleways** Focus on left turn conflict specifically recommends the removal of slip lanes.

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Movement Through Intersection	**Austroads GRD4A** Suggested tools include: • Hook turns (with notes regarding phasing compatibility) • Marking of cycle lanes through intersection – where vehicle lanes also marked. • Left turn bypass and T-intersection bypass for cyclists **Austroads GRD4** Provides guidance on cycle paths crossing intersection adjacent to pedestrians. **MOTSAM Part 2** Guidance on use of hook turns **Road User Rule** Cycle and Bus aspect meanings – provides option for separate cycle phase.	**CCC MCR Signalised Intersections** Presents options for: • 'Dutch' style intersection where cyclists make 2-stage turn and remain on kerbside at all times with physical protection at corners – notes that this is difficult to accommodate at most existing intersections. • Banning Motor vehicle movements • Hook turns • Layouts show continuity marking of cycle facility using green paint through intersection. • Cycle specific signals and phasing • Cyclist Barnes Dance • Cyclist Bypass (left turn and at T)	**NACTO Guide** Provides many options and associated commentary, including: Marking of cycle lanes through intersection, Hook turns – marked as separate boxes or using ASBs, Cycle signal phases where separator continues to intersection. **TMR Separated Cycleways** Specific focus on through element including: • Continuation of coloured surfacing • Time separation of vehicles and signals (provides thresholds) e.g. barnes dance/head start for cyclists • Reducing wait times at signals through a series of methods and countdown timers for cyclists • Alerting cyclists to potential conflict where turning vehicles filter through through cyclists • Corner protective islands (similar to 'dutch' style intersections) • Reducing turning speeds to <30km/h • Cyclist Bypass **Department for Transport (UK) LTN 2/08** Recommends marking cycle lanes through intersections, cycle bypasses and advanced stop lines.
Departure	**Austroads** Provides options for different lane configurations including: Kerbside cycle lane, Carside cycle lane (outside parking), Offset – from kerbside past parking **MOTSAM Part 2** Recommends deliberate space for cyclists where cycle lane merges with traffic.	**CCC MCR Signalised Intersections** Recommends reinstatement of separator midblock.	

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Detailed Design Guidance and Phasing	**Austroads GRD4A** Provides guidance on: Hook turn box dimensions, ASB and ASL dimensions and layout, Cycle lane/ widths, Refers to high entry angle slip lanes but does not specifically recommend them. **Austroads GTM6** Recommends use of handrails. Brief explanation of appropriate marking including recommending green surfacing for delineation especially in complex situations. **Austroads GTM9** Brief guidance/mention of: Cyclist detection (loops and push buttons), Need to consider cyclists when determining phasing, Option for cyclist head start, Extended intergreen time for cyclists (Austroads method not applicable in NZ due to cycle aspect definitions), Cycle Barnes Dance (not applicable under current NZ legislation), Possibility of signal coordination for cyclists **MOTSAM** Provides guidance on:, Cycle and traffic lane widths, Taper lengths, Marking of cycle symbols and directional arrows in cycle lanes, Hook turn box dimensions (different to Austroads), Coloured Surfacing – including suggested locations **NZ Supplement** Builds on/replaces Austroads guidance in terms of widths, detection (loops and push button only), phase extension, ASB dimensions, requirements for high entry angle slip lanes.	**CCC MCR Signalised Intersections** Specifies requirements for: • Vehicle tracking • Lane widths • Cycle times to be limited to 90seconds	**NACTO Guide** Recommends vehicle turning lanes that cross cycle lane are as short as possible. Provides guidance on widths (desirable widths are wider than Austroads or NZ supplement), lengths, markings (including mixing lanes and coloured surfacing), gradients for ramps/transitions, cycle signal aspects (including nearside signals) and phases, cycle detection **TMR Separated Cycleways** Recommends handrails and footrails

Relevant Research

Colouring cycle lanes in the transition, approach and storage stages of intersections has been found to substantially increase cyclist safety and cyclist perception of safety (Turner et al 2011). Turner et al (2011) specifically state that where an exclusive left turn lane exists "*Any cycle lanes provided need to use colour from the transition across the diverge area to the limit line*". Koorey and Mangundu (2009) also found that coloured surfacing has a positive impact on the operation of cycle facilities at intersections especially in reducing vehicle encroachment. Koorey and Mangundu (2009) found that it was most important to colour advanced stop lines (compared to advanced stop boxes) especially where approaches are wider.

Turner et al (2011) found that wider (around 1.8m) cycle lanes at intersections and wider kerbside lanes, where cycling is shared in the lane, are also shown to increase safety, noting that sites with an exclusive left turn lane are preferable over shared through and left lanes for cycle safety. The total width of the kerbside lane + cycle lane was shown to be more important to cyclist safety than the actual presence of a cycle lane. However where there is insufficient room to mark a cycle lane, a transition treatment from a midblock cycle lane to a short section of a narrow shared lane was found to be successful. Koorey and Mangundu (2009) found that narrower traffic lanes were also found to have a positive influence for cyclists and lane combinations greater than 5.0m are not recommended.

New York has moved away from cycle-only phases to running cyclist and motor vehicles together and using markings to show that vehicles should give way to cyclists in the 'mixing zone' (Dales and Jones 2014). The use of different markings for mixing zones and time separation for cyclist movements has been evaluated in the US (Monsere et al 2014). This study found that green paint is useful to show where cyclists may be present but over-use in mixing lanes can confuse motorists in terms of where they should position themselves. In terms of time separation Monsere et al (2014) found that compliance with the cycle-only signal phase ranged from 67% - 98% for cyclists and was lowest at low volume intersections. Some non-compliance (2% - 6%) by motorists was also observed. The strongest perception of safety was for intersections where protection is carried through the intersection and cyclists are separated in time through the phasing.

Turner et al (2011) also showed that shared through and left lanes pose a safety risk to cyclists, and therefore it is preferable to use a left turn slip lane (or an exclusive left turn lane as noted above) over a shared through and left lane. A trial using riley kerbs and flexi posts on approaches to intersections has been conducted in Christchurch (Koorey et al 2013). The trial found that this modification was effective in assisting to protect cyclists in kerbside lanes. However there may be some legal issues around how this operates in terms of give way rules due to the cycle lane becoming a facility that is no longer for use by general traffic (Wilke 2014b).

Post implementation studies, application examples and feedback from survey

Technical Stakeholder Survey

The survey results include specific comments regarding the design of signalised intersections, including:

- Safety issues e.g. associated with designs that include cycle lanes to the left of through and left lanes.
- Integrating buses, cyclists and pedestrians at intersections.
- Overall intersection safety and efficiency are often overlooked when implementing cycle facilities.
- Importance of signal design considerations
- Clearer guidance on advanced stop box and cycle detection design

Trials

A nearside cycle signals trial has been proposed by Christchurch City Council (Fowler and Wilke 2015) to:

- "Allow the flexibility of operating cycle movements at times different to the adjacent traffic movements, without confusion between the signal displays for the two user groups.
- Improve visibility of the primary signal display for cyclists (as opposed to the configuration as per current legislation).
- Eliminate the legal ambiguities associated with the lack of directional meaning of a green cycle aspect under the current Road User Rule.
- Allow for the flexibility of operating cycle movements coming from the same approach but heading in different directions independently."

Post Implementation

Van den Dool et al (2014) reviewed the performance of cycle infrastructure in Australia and New Zealand. They reviewed one advanced stop box (ASB) and found that it improved cyclist safety, however they asserted that ASBs are not suitable for less-confident cyclists. Van den Dool et al (2014) also reviewed cycle-only approaches at signalised intersections (i.e. via an off road path) and considered these to be useful for cyclists but may require modelling to understand the impact on the intersection. No supporting or background information is provided to support these findings/learnings.

Within the wider industry (including contractors and designers) the use of hook turn boxes is not well understood. This is evident through many examples where the placement of the boxes within the road layout or the markings within the boxes are misleading or incorrect. An example of this is shown in **Figure 6.6** where the hook turn box is positioned correctly however it is marked incorrectly as if it is an advanced stop box. Furthermore guidance within NACTO allows for the use of advanced stop boxes as hook turn boxes where low pedestrian volumes exist. This practise is not included in current New Zealand guidance.

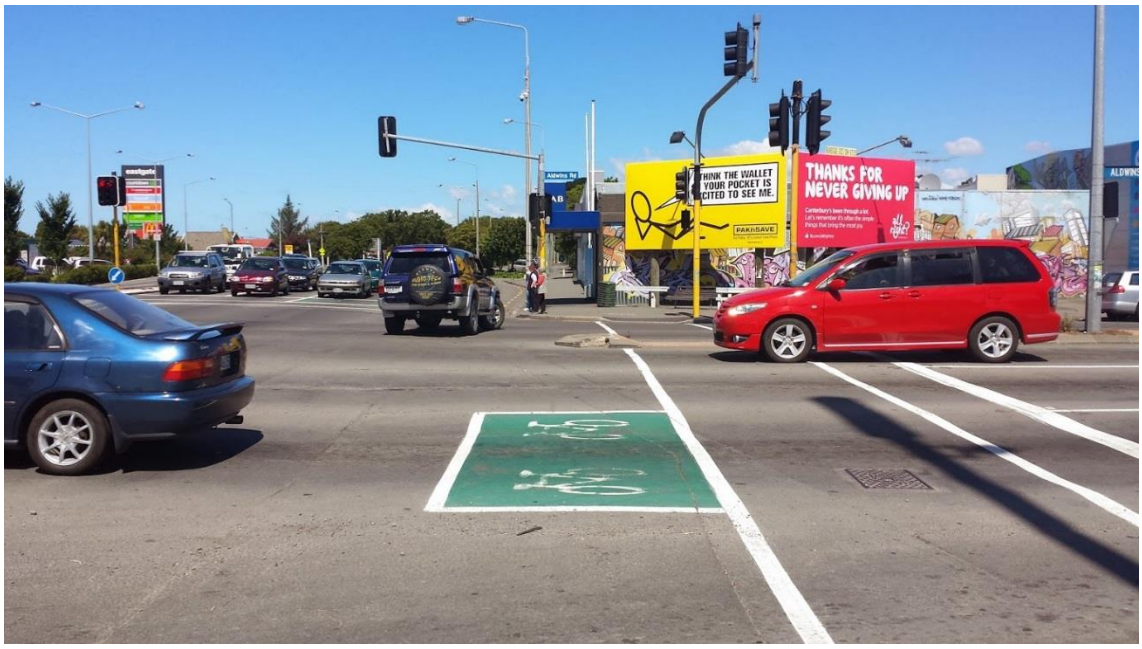


Figure 6.6 *Incorrectly marked hook turn box at Linwood/Aldwins Intersection, Christchurch*

Often in New Zealand directional arrows are removed from exclusive left turn lanes to allow cyclists to proceed straight where not cycle facility is provided. An example of where this has been done successfully is the Manchester Street/Tuam Street intersection in Christchurch. This application consisted of a relatively short, narrow left turn lane provided at the end of a cross section that includes on street parking and a cycle lane, see **Figure 6.7**.

Figure 6.7
Approach to Manchester/Tuam intersection, Christchurch

Discussion

It is important that signalised intersections are designed taking into consideration both timing and spatial elements. The physical layout of a signalised intersection should not be finalised until phasing is known. This is alluded to in some of the guidance documents however it is not specifically required.

A range of midblock facilities are included in national guidance however intersection design guidance focuses on providing cycle lanes, advanced stop lines and advanced stop boxes verses no cycle provision. The recent change to include more separated facilities in cycle networks and to provide for less-confident cyclists poses a challenge for how to appropriately design intersections. Various options exist, including separation in time and / or space through the entire intersection and separated facilities become 'mixing zones' on the approach to intersections. Current New Zealand local guidance that touches on this subject is constrained to operate within the current legal framework (summarised above). Therefore international guidance is likely to be a useful resource in shaping future design guidance if the existing legal issues are resolved. Any guidance that is developed in this area should consider the target audience, level of service and adjacent mid-block facility types.

A key difference between NACTO (American guidance) and the New Zealand guidance is that NACTO allows for 'mixing zones' whereas Austroads focuses on dedicated cycle facilities. In some locations in New Zealand, where no cycle facilities are provided, left turn arrows are removed from the left turn lane to allow cyclists to legally proceed straight from the kerbside lane. Mixing zones operate in a similar way to this, except sharrows and other markings are also included. The incorporation of mixing lanes into New Zealand guidance could be considered, especially given the recent sharrows trial, short sections of shared cycle and turning lanes were found to be a useful design solution by Turner et al (2011). The design and marking of these mixing lanes in the New Zealand context, as well as their suitability for less-confident cyclists, needs to be further considered before it is incorporated into the guidance. Furthermore Turner et al (2011) recommend that the use of shared left and through lanes should be avoided for cyclist safety; exclusive left turn lanes should be provided where possible. This research and its implications are not discussed in the existing guidance.

The report by Monsere et al (2014) found that the strongest perception of safety occurred when protection was carried through intersections and separate cycle phases are implemented. A 'cycle Barnes Dance' has been proposed by Christchurch City Council however this is not currently provided for in New Zealand legislation. It is understood that currently it is not intended that this will be allowed for in the legislation. Given the findings of Monsere et al (2014) trials of a cycle Barnes dance should be considered. It is recognised that this could only be applied in certain locations where there are significant volumes of cyclists present throughout the day to warrant the resulting delays to motorists.

It should be noted that while safety is very important, the perception of safety is also important in order to encourage more people to cycle. Therefore people's perception of facilities should also be considered alongside crash studies. Any phasing that allows for cyclist protection should be carefully considered in terms of overall cycle time, as noted by CROW (guidance from Holland) cycle times in excess of 90 seconds can result in poor compliance.

Austroads recommends that for safety it may be beneficial to provide cycle lanes across the transition to slip lanes. The New Zealand supplement took this one step further and recommended that only high entry angle slip lanes are implemented at intersections on cycle routes. TMR recommends that slip lanes on key cycle routes are removed completely where separated facilities are accommodated. In TMR where this is demonstrated, space gained from the removal of slip lanes has been used to provide protection for cyclists within the intersection in a 'Dutch' style layout. This layout may also be applicable in New Zealand.

MOTSAM specifies dimensions for some components and not others. These recommendations are not always consistent with Austroads, this creates inconsistencies in the guidance – e.g. for the size of a hook turn box. As MOTSAM is transitioned into the TCD manual it needs to be clear to designers where the most up-to-date guidance is kept and the guidance hierarchy. It is expected that the cycle design guidance framework will resolve some of these inconsistencies through directing designers to the most appropriate guidance.

The need for more guidance on providing cycle detection was raised in the survey. It is noted that currently the section that discusses this in the National Traffic Signals Specification is incomplete. Any guidance about cycle detection should consider how it is designed in order to be most effective and also the different options available and their merits.

Gap Identification

Gaps identified in the guidance related to signalised intersections are identified in **Table 6.5**.

Table 6.5 *Gap Identification Table for Signalised Intersections*

Gap	Type	Comments
G44. Definition of cycle aspects	Current Guidance is not Best Practice	Consider Wilke (2014) recommendations to change the meaning of green cycle aspect and include directional cycle aspect. This may also be included in the proposed nearside signals trial.
G45. Current give way rules	Current Guidance is not Best Practice	Consider Wilke (2014) recommendations to change the status of a cycleway in the context of the current give way rules.
G46. Merits of different lane layouts	Current Guidance is not Best Practice	Guidance is not aligned with research, in particular regarding the use of shared through and left lanes.
G47. Vehicle mixing lanes	No Guidance Exists	Best practice in this area should be determined through trials considering widths, markings (e.g. sharrows/use of coloured surfacing) and length of mixing zones. Trials should include surveys to assist with understanding level of service.
G48. Continuing separated facilities through intersections	No Guidance Exists	Austroads generally focuses on providing cycle lanes through intersections. Little guidance is available at a national level for other types of facility. This should be considered in conjunction with mixing lanes to understand which target users are being accommodated in each layout.
G49. Disconnect in guidance between time and space components of design	Lack of Clarity	At signalised intersections the phasing is an important component of how the layout will work for cyclists. However the guidance for phasing and layout sits in separate Austroads guides. A clearer link between time and space considerations would be beneficial and is necessary for safety.
G50. Use of slip lanes	Current Guidance is not Best Practice	Obsolete NZ supplement to Austroads guidance on this topic has not been adopted in updated Austroads guides. Consideration could also be given to how separated facilities are designed past slip lanes.
G51. Cycle detection	Lack of Clarity	The options for cyclist detection are alluded to within national guidance however the benefits and dis-benefits of

Gap	Type	Comments
	Current Guidance is not Best Practice	the options are not clearly stated; the national specification is not complete in this area. Other types of detection such as microwave /video could also be considered for incorporation into the guidance. Furthermore positioning of induction loops has come up as an issue in the survey.
G52. All red time extension	Current Guidance is not Best Practice	The approach recommended in the superseded NZ Supplement to Austroads to extend the inter-green period for cyclists (including an additional induction loop in the cycle path within the intersection) has not been incorporated into new guidance. No applicable method to the NZ context exists in the updated Austroads guides.
G53. Cycle Barnes Dance	No Guidance Exists	This was recommended in CCC guidance however it is understood that this has not been included as a possible legislation change. Recommended that a trial is considered.
G54. Coloured Surfacing	Current Guidance is not Best Practice	Research has shown that coloured surfacing is beneficial to improving safety. Consideration should be given to improving guidance about the use of coloured surfacing.
G55. Differing dimensions in Austroads and MOTSAM	Inconsistent Guidance	Some of the dimensions in Austroads and MOTSAM do not align. Need to be clear on status of different guidance documents (e.g. MOTSAM/TCD Manual vs Austroads) relative to each other.
G56. When to use Advanced Stop boxes and Hook Turn boxes	Lack of clarity	Some guidance is given however this needs to be strengthened.

6.5 Roundabouts

Description

At a roundabout road traffic flows in one direction around a central island (as illustrated in **Figure 6.8**). Roundabouts are typically implemented on intersections of roads with similar hierarchy status. At roundabouts, entering traffic must give way to traffic already in the roundabout. Roundabouts are often implemented to solve safety issues for motor vehicles however they can introduce other safety issues for cyclists, especially in the case of multi-lane roundabouts. According to Leggat et al (2014) roundabouts pose the highest risk of all intersections to cyclists due to higher entry speeds for motor vehicles. Roundabouts are not a treatment that can be used specifically to provide for cyclists. Cycle design guidance relating to both improving existing roundabouts and installing new roundabouts is important as it must be ensured that cyclist safety isn't compromised.

Figure 6.8
Example of a Roundabout

Guidance

A summary of existing local, national and international guidance is shown in **Table 6.6**.

Table 6.6 Guidance Table for Roundabouts

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Facility type/level of protection guidance	**Austroads GRD4B** Recommends that alternative intersection treatments are considered on key cycle routes . **NZ Supplement** Recommends advice from an expert is sought.	**CCC MCR Design Guide** Roundabouts not listed as an appropriate option for MCRs. **Christchurch Cycle Design Guide** Consider radial design. **ATCOP** Consideration should be given to signalised intersections instead of roundabouts on cycle routes.	**UK DMRB** Sets out speed and volume thresholds for different roundabout types including signalised roundabouts and grade separation. **NCHRP 672** Also includes thresholds for when some facility types are appropriate.
On Road Guidance	**Austroads GRD4B** Minimise circulating lanes and motor vehicle speeds. Layouts for cycle lanes in roundabouts shown – notes that this is currently under review. Some consideration of protected facilities and guidance for sharing the lane on approaches is also included. Recommends warning signage where cyclists share the lane. **Austroads GTM6** Consider hook turns in multilane roundabouts. **MOTSAM Part 2** Single lane roundabouts are preferable, key design consideration is minimising motor vehicle speeds. Clear statement that cycle lanes are NOT acceptable within or on the approaches to roundabouts. Also provides detailed marking guidance.	**ATCOP** States that cycle lanes should not be provided within or on the approach to roundabouts.	**NCHRP 672** Single lane roundabouts preferred. States that cycle lanes should not be installed in roundabouts. **TMR Separated Cycleways:** Compact instead of tangential design should be used. Turbo roundabouts (Holland) are also recommended for consideration. **Department for Transport (UK) LTN 2/08** Consider use of radial roundabout design, single lane roundabouts preferred. **NACTO Guide** States that cycle lanes should not be installed in roundabouts. Recommends the use of sharrows in roundabouts.

	National (NZTA/Standards/Austroads)	NZ Local Guidance	International
Off Road Guidance	**Austroads GRD4B** Guidance on bypass, path and splitter island design.	**Christchurch Cycle Design Guide** Requires off road paths at multilane roundabouts.	**UK DMRB** Recommends grade separation for some traffic conditions. Includes thresholds for when non-priority crossings are acceptable. **Department for Transport (UK) LTN 2/08** Recommends consideration of cycle tracks and signalised crossings. **TMR Separated Cycleways:** Grade separation preferred at multilane rural roundabouts. Requires cycle priority crossings on all legs and provides design guidance. **NCHRP 672** Consideration of pedestrian/cyclist conflict/confusion.

Post implementation studies, application examples and feedback from survey

The St Vincent Street cycleway in Nelson shown in **Figure 6.3**, traverses one roundabout at Gloucester Street. The safety audit recommends installing raised platforms for cyclists and pedestrians on the approach to the roundabout to reduce speeds and provide a courtesy crossing for cyclists.

In New Zealand there are examples where the guidance in MOTSAM, that states that cycle lanes should not be provided in roundabouts or on approaches, is disregarded. An example of this at the Triangle Road/Waimumu Road roundabout in Auckland is shown in **Figure 6.9** and the Church Street/Cook Street roundabout in Palmerston North as shown in **Figure 6.10**.

Figure 6.9 *Cycle lane in Triangle/Waimumu Roundabout, Auckland*

Figure 6.10 *Cycle lane on approach at Church/Cook roundabout, Palmerston North*

A digression from the MOTSAM guidance may indicate that the current disjointed layout of the guidance is not legible to its users, or that engineering judgement has been applied to achieve a satisfactory solution for a particular site. The number of cases where a digression from the MOTSAM guidance may be appropriate are limited but they do exist, consideration should be given to reflecting this in the guidance.

Relevant Research

Roundabouts are the intersection type that pose the highest risk to cyclists, due to the higher speeds approaching points of give way (Leggat et al 2014). However, the following studies show that there are methods of reducing the risk to cyclists at roundabouts.

Campbell et al (2006) conducted research that resulted in the cyclist roundabout ('c-roundabout') concept. C-roundabouts are multi-lane roundabouts where the geometry is designed to significantly reduce the speed differential between cyclists and motor vehicles. This is achieved by increasing horizontal deflection and narrowing the circulating and approach lanes to approximately 5.4m (for two approach lanes). Heavy vehicles, which are more constrained in their turning movements, need to straddle both lanes to pass through the roundabout. The desired speed through these c-roundabouts is approximately 30km/h. A C-roundabout has been implemented and monitored in Auckland and was found to be successful in reducing vehicle speeds (Campbell et al 2012). During the three year monitoring period no cycle crashes were reported, however this period is not long enough to conclude how successful the design is. The implemented c-roundabout uses non-standard traffic control devices (signs) which are not currently legal for use elsewhere in the country (Campbell et al 2012). This work has been further supplemented with the development of compact roundabout designs (Campbell 2015). Compact roundabouts ensure low vehicle speeds through the use of platforms on multi-lane approaches and constrained geometry.

The recent sharrows trial may also result in a wider range of applicable markings to assist cyclists at roundabouts by encouraging them to cycle in the centre of the lane rather than at the side where they are more vulnerable to conflict with vehicles exiting or entering the roundabout, and by alerting motorists to the likely presence of cyclists in the roundabout.

Herland and Helmers (2002) conducted research to inform roundabout design in Sweden. A key consideration of this research was the comparison of tangential and radial roundabout designs. New Zealand guidance is based on tangential roundabout design which enables higher vehicle entry and exit speeds and is therefore less safe for cyclists. (Wilke et al 2014a) recommend that radial design is explored for use in Australasia; this recommendation is repeated in the Safer Journeys for People Who Cycle report (Leggat et al 2014).

(Wilke et al 2014a) conclude that roundabouts with an operating speed is no greater than 30km/h are appropriate for cyclists in mixed traffic (i.e. cyclists share the lane). Where speeds are greater than 30km/h, physical separation is recommended. The main purpose of the research conducted by (Wilke et al 2014a) was to determine whether cycle lanes on approaches to and within roundabouts are appropriate; the conclusion was that these applications are generally not appropriate.

Discussion

Based on the available guidance, roundabouts with high vehicle volumes and speeds should be avoided on routes intended to provide for cycling. New Zealand guidance is currently not prescriptive about where these thresholds sit. This can lead to inappropriate intersection treatments along cycle routes which degrade the level of service to cyclists and compromise cyclist safety.

The research by Campbell (2015) essentially follows the same principles as stated in Austroads 4B and MOTSAM to improve cycle safety through lowering the speed differential between cyclists and motorists. It is recommended that the c-roundabout be seriously considered for inclusion in general design guidance; this would also require the legislative approval of the supporting traffic control devices. Furthermore, radial (rather than tangential) roundabout design on key cycle routes would also assist with reducing vehicle speeds and thus improving cyclist safety (Wilke et al 2014a). Further research is required to understand how radial designs that accommodate the required movements and design vehicles can fit within the space provided at typical intersections in New Zealand.

Where a roundabout is located at an intersection between busy roads Austroads GRD4B recommends that off road paths are considered. This is something that is often implemented in New Zealand with varying levels of success. No thresholds for when different crossing types over the intersection legs may be appropriate are included in the guidance. It is recommended that these thresholds are developed for use in the New Zealand context. Grade separated crossings are discussed in Section 6.7, existing New Zealand guidance does not link these to roundabouts.

The general consensus in national and international guidance is that cycle lanes within the roundabout decrease cyclist safety by putting cyclists in a less visible position for entering vehicles and cycle lanes should be discontinued before the limit line to encourage cyclists to take the lane. Austroads does not make it clear that the NZ Transport Agency does not endorse marking cycle lanes within a roundabout (see MOTSAM), although it does note that some jurisdictions do not endorse cycle lanes and that this part of the guidance is under consideration. The reason that some Australian authorities mark cycle lanes within a roundabout is that they consider this raises motorists' awareness of the presence of cyclists (Vic Roads). It is hoped that Austroads guidance will be updated following the report by (Wilke et al 2014a) which was commissioned by Austroads.

NACTO recommends that sharrows be marked in a roundabout where no cycle facility is provided. Following the recent sharrows trial in New Zealand, these may also be made available as a useful tool for single lane roundabouts.

Signalised roundabouts are not often used in New Zealand. Their merits in terms of providing for cyclists are included in the DMRB (UK) it is considered that similar guidance for the New Zealand context could be provided.

Gap Identification

Gaps identified in the guidance related to cycle facilities at roundabouts are identified in **Table 6.7**.

***Table 6.7** Gap Identification Table for Roundabouts*

Gap/Opportunity	Type	Comments
G57. Appropriate use of Roundabouts	Lack of Clarity No Guidance Exists	New Zealand guidance does not provide thresholds for when it is not appropriate for cyclists to be in mixed traffic at roundabouts. Thresholds could incorporate traffic speeds, traffic volumes, cyclist types and network hierarchy.
G58. Use of Cycle Lanes in Roundabouts	Inconsistent Guidance Current Guidance is not Best Practice	Guidance in Austroads is contrary to MOTSAM requirements and is not endorsed in New Zealand practice. Preferably Austroads should clearly state that cycle lanes in roundabouts are not endorsed in NZ; this could be included in next update.
G59. C-Roundabouts	No Guidance Exists	C-roundabouts have been trialled and monitored but have not yet been included in national guidance. Required signage and markings should also be approved and included in legislation as appropriate.

Gap/Opportunity	Type	Comments
G60. Sharrows	No Guidance Exists	Sharrows are recommended for use at roundabouts by NACTO. Currently their inclusion in NZ legislation is dependent on outcome of recent trial. Guidance for how to use sharrows in roundabouts should be developed/adopted from NACTO or similar guidance if their use is approved.
G61. Radial Roundabout Design	No Guidance Exists	Radial designs are used in Europe. Their appropriateness in the New Zealand context needs to be considered further.
G62. Signalised Roundabouts	No Guidance Exists	Minimal guidance exists around how signalised roundabouts could be considered as an option for providing for cyclists. A matrix similar to that of the DMRB could be developed.
G63. Path network around and across approaches	Lack of Clarity	Providing an off road option for cyclists is covered in the guidance. However often implemented designs are not ideal. Further guidance should be considered including options for grade separation and platforms on approaches as per Campbell (2015)

6.6 Interchanges

Description

A road interchange is a combination of grade separations and interconnecting roadways at the intersection of two or more roads, such as that shown in **Figure 6.11.**

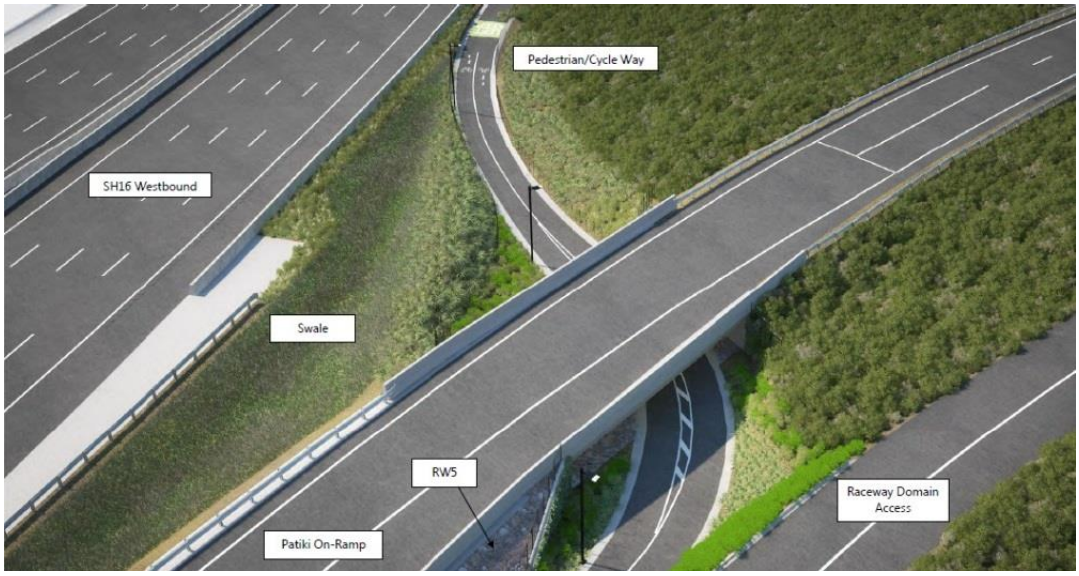


Figure 6.11
Example of an Interchange

Legal Status

A number of the legal aspects pertaining to intersections and crossings discussed throughout this section apply also to interchanges depending on how they are configured and the traffic control devices they include. In addition, it is noted that if an interchange includes a motorway the Transit NZ Act (Ministry of Transport 1989) restricts the use of motorways by pedestrian and cyclists.

Guidance

A summary of existing national guidance is shown in **Table 6.8.**

The State Highway Geometric Design Manual (SHGDM) (Transit New Zealand 2000) has a section on 'intersections and interchanges' that lists the references that should be used for the design of intersection and interchanges on New Zealand State Highways in order of preference. The first preferred guidance is Austroads series however the documents listed are the superseded Austroads guides and the manual has not been updated to reference the new Austroads design guide series. The other references are documents by AASHTO, CALTRANS, Iowa Department of Transportation, New Jersey Department of Transportation and NAASRA.

The current relevant Austroads guides for interchanges are:

- Austroads: Guide to Road Design Part 4C Interchanges (Austroads 2009a)
- Austroads: Guide to Traffic Management Part 6 Intersections Interchanges and Crossings (Austroads 2013)

Table 6.8
Guidance Table for Interchanges

	National

Approach Use/General	**Austroads GTM 6:**
	• Where cyclists are permitted to travel on roads that have interchanges (freeways, motorways or arterial roads), they should be provided with safe and convenient facilities, such as wide shoulders that have smooth, clean surfaces suitable for cycling.
	• It is important that the interchange design provides continuity of the bicycle route through the interchange and for the safe and convenient movement of cyclists across ramps and the intersecting arterial road. General issues relating to cyclists are summarised in Table 3.3 (of GTM6) and some of them will relate to interchanges between freeways and intersecting roads. The issues are
	  • Safely cross or join conflicting flows
	  • Squeeze points
	  • Lack of continuity and connectivity
	  • Gaining position to turn right
	  • Cyclists not seen by motorists, or cyclists speed misjudged
	  • Loss of access

Ramps	**Austroads GRD 4C** • 14.2.1 outlines the treatment where cyclists are required to exit and enter freeways. • Figure 14.2 provides typical treatment for crossing on and off ramps. • 14.2.2 outlines instances when grade separation of cyclists movements would be contemplated.
Further guidance	Further consideration of relevant guidance for providing for cyclists at interchanges is included in the signalised crossings and grade separated crossings sections of this report. General principles for crossing types in the context of space allocation, traffic volumes and speed considered in these sections are considered relevant to interchanges.

Available post implementation studies, application examples and feedback from survey

There was no direct feedback from the stakeholder survey with regard to design issues at interchanges. There were also no post construction audits or reviews offered with respect to projects that include interchanges. However it is understood that a common issue experienced on state highways is the crossing of high speed on and off ramps where there is a cycle demand and how to cater for this movement.

Discussion

The Austroads guidance is clear that interchanges require consideration of cyclists at the planning stage of the interchange development and requires consideration of the wider cycle network and environment. Austroads offers a range of issues to consider and also possible treatments, the issues are listed above in **Table 6.8**. These allow designers to consider aspects that are generally covered by the guidance for other intersection types or crossings.

Gap Identification

Given that interchanges are made up of different forms of intersections and crossings it is considered the any gaps are covered by the planning and design gaps identified throughout the review.

6.7 Signalised Crossings

Description

A signalised crossing provides priority for cyclists crossing busy roads through the use of traffic signals. Signalised crossings can take various forms including cyclist only crossings, pedestrian and cyclist shared crossings and pedestrian and cyclist segregated crossings. Shared crossings, similar to shared paths, provide a single crossing to be shared by cyclists and pedestrians across the carriageway; segregated crossings delineate space for cyclists and pedestrians separately across the carriageway. An example of a segregated crossing is shown **Figure 6.12**.

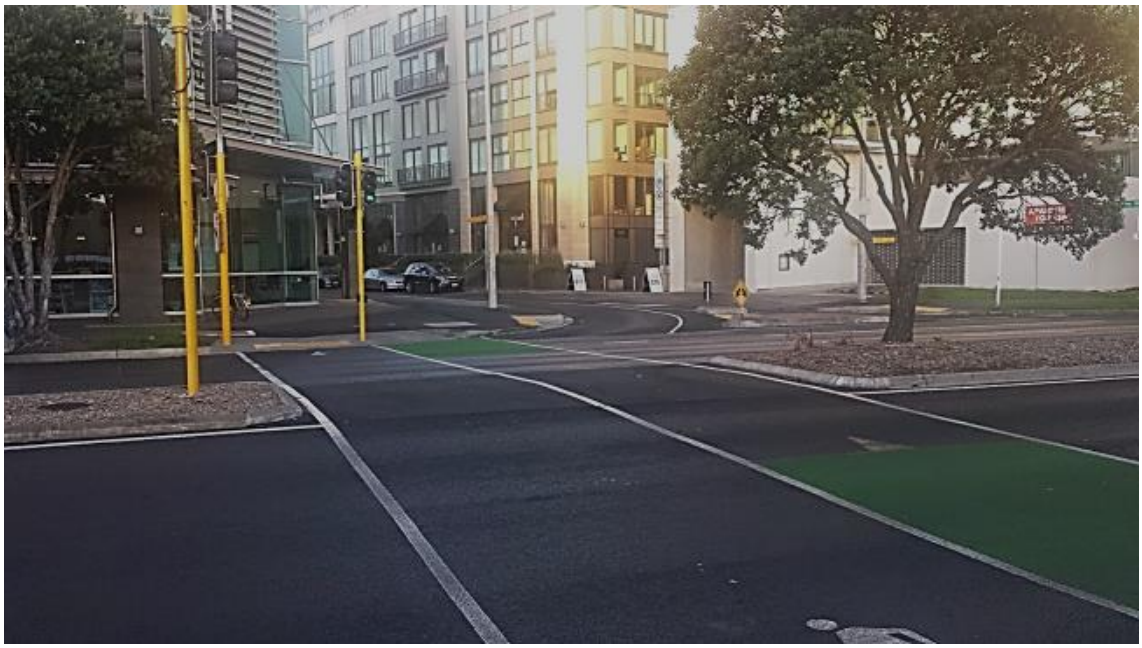


Figure 6.12 *Example of a segregated pedestrian and cyclist crossing on Quay Street, Auckland*

Legal Status

The Traffic Control Devices Rule Clause 11.4(5) Control where a cycle path route crosses a roadway states: "*When a cycle path crosses a roadway, a road controlling authority may, as appropriate, control either the movement of cycles along the cycle path or traffic along the roadway by … the installation of traffic signals, in the same manner as described in clause 10.5 for an intersection.*" Thus, where a shared or a segregated crossing is provided, separate signal aspects for cyclists and pedestrians must be installed.

Guidance

A summary of existing local, national and international guidance is shown in **Table 6.9**.

Table 6.9 *Guidance Table for Signalised Crossings*

	National	NZ Local Guidance	International
Crossing Form/ General Considerations	**Austroads GTM6** Guidance on crossing location and benefits/considerations of different crossing types. Recommends signals for higher speed zones and provides guidance on where appropriate based on road classification.	**NZ Cycle Trail Design Guide** Defines appropriate crossing type by traffic volume and speed limit. **CCC MCR Design Guide** Provides thresholds for when signalised crossing should be considered – recommends consideration for traffic volumes as low as 3,500 vpd.	**UK LTN 2/08** Provides thresholds based on traffic speed and traffic volume.
Pedestrian/Cycle interaction	**Austroads GRD4** Minimal commentary on use of shared vs segregated crossings. Recommends segregated crossings where high volumes of pedestrians and cyclists. **Austroads GRD6A** Shows layout options for when paths intersect paths – a common occurrence near crossings. All layouts show defined right of way between paths and pedestrians/cyclists.	**CCC MCR Design Guide** Includes segregated crossing guidance only Recommends consideration of separating pedestrian and cyclist crossings to allow for traffic efficiency to be retained **ATCOP** Requires separate phase timing for pedestrians and cyclists.	**Department for Transport (UK) LTN 2/08** Recommends consideration widening route/space available to address pedestrian/cycle conflict rather than installing controls.

	National	NZ Local Guidance	International
Hardware and Detailed Design Components	**Austroads GRD4** No dimension guidance. Guidance on kerb ramps and signal aspects and detection. **Austroads GTM6** Recommends consideration of pelican and puffin technology. **National Traffic Signal Specification** Some guidance on push button provision. Cycle detection guidance to be added (i.e. guide is incomplete) **MOTSAM Part 2** Dimension guidance e.g. stop line setback. **RTS 14** Guidance on the layout of tactile pavers.	**CCC MCR Design Guide** Guidance on widths and detection location. **ATCOP** Some guidance on hardware and detection.	**Department for Transport (UK) LTN 2/08** Guidance on widths.

Post implementation studies, application examples and feedback from survey

It is understood that some local authorities are currently working with the NZ Transport Agency to trial a specific style of tactile pavers at segregated crossings. Green tactile warning pavers (with no approach pavers) will be used across the threshold to the cycle crossing and yellow warning and approach tactile pavers (as is currently used at pedestrian crossings) will be used across the pedestrian crossing threshold. This has been developed to more clearly distinguish the separate crossings for pedestrians and cyclists, while ensuring that tactile warning pavers are provided across the entire width of the crossing to inform any visually impaired person who arrives there that it is a road crossing threshold.

The Pedestrian Planning and Design Guide crossing facilities tool can be easily adapted to predict the level of service for cyclists at various crossing provisions; this has been used on some MCR crossings in Christchurch to illustrate that the 3,500 vehicles per day threshold in the CCC MCR guide may be too low and that simple treatments (e.g. median refuges) would be more appropriate. However it should be noted that LOS here does not incorporate user type.

Discussion

The CCC MCR guide recommends that signalised crossings be considered for traffic volumes as low as 3,500 vehicles per day. This is much lower than other guides recommend and is likely a response to the lack of cycle priority options for medium-volume roads. Installing a signalised crossing on a low volume road can have significant safety disbenefits, as users (both motorists and cyclists) are likely to experience greater delays and choose to disregard the signals if they are stopped at a red light when it does not appear necessary. This can be mitigated for cyclists by providing advanced detection on the path leading to the signalised crossing. However, the requirements for yellow and all-red timings may still increase delays to motorists. The HAWK crossings, described in Section 6.3 are designed to reduce vehicle delay by allowing vehicles to proceed when no cyclists/pedestrians are present.

The CCC MCR guide also recommends segregated as opposed to shared crossings and the consideration of staged crossings for pedestrians separate from a single phase cyclist crossing. Segregated crossings, especially those that use green surfacing across the roadway, can be appropriate, especially where linked to an exclusive cycle facility and can provide a higher level of service for cyclists, This also makes sense given that separate signal aspects are required that separate crossings be delineated. However, it should be noted that pedestrians and cyclists may try to use the incorrect side of a segregated crossing. Consideration of detection technology (both on the crossing and in the waiting area) is needed to help inform the crossing layout design.

Gap Identification

Gaps identified in the guidance related to Signalised crossings are identified in **Table 6.10**.

Table 6.10 Gap Identification Table for Signalised Crossings

Gap	Type	Comments
G64. Cycle priority on key cycle routes	No guidance exists	Additional tools are required for cyclist priority on roads with medium volumes, dependent on target cyclist audience. Guidance on where signals might be appropriate on medium volume roads could be considered. To an extent the pedestrian crossing spreadsheet tool or the Austroads pedestrian crossing tool can be used, however this should be adjusted to ensure it can accommodate cyclists. Appropriate guidance for doing so should also be provided.
G65. Cycle detection technology	No guidance exists	Consider currently available detection technology (e.g. puffin crossings) and feed this through to layout considerations and guidance for signal design.

6.8 Unsignalised Crossings

Description

An unsignalised crossing is a location where provision is made for cyclists and/or pedestrians to cross the road and priority is not given through the use of signals. The decision as to who is assigned priority generally depends on the relative user volumes and the hierarchies of the cycle and road networks. On low volume roads cyclists can be given priority at an unsignalised crossing however on busier roads it is generally decided that cyclists must give way to road traffic. Unsignalised crossings are often provided in the form of refuges or raised tables. An example of a refuge crossing is shown in **Figure 6.13**.

Figure 6.13
Example of an un-signalised crossing (Image from https://www.cyclemanual.ie/manual/designing/4-7-crossings/)

Legal Status

The Traffic Control Devices rule states that a road controlling authority may provide a traffic island to provide protection for pedestrians, cyclists or other road users crossing a road.

A road controlling authority may provide a traffic control device, including a kerb, road hump, chicane, or slow point, on or adjacent to a road, as appropriate, to: provide a continuation of a pedestrian or cycle route and alert drivers to the presence of pedestrians or cyclists.

Priority is given to pedestrians at zebra crossings. Cyclists using zebra crossings are legally required to dismount and walk across the crossing.

Guidance

A summary of existing local, national and international guidance is shown in **Table 6.11**.

Table 6.11 Guidance Table for Un-signalised Crossings

	National	NZ Local Guidance	International
Pedestrian/Cycle interaction	**Austroads GRD4** Treatments showing cycle vs pedestrian priority included in the guidance for where paths meet. Recommends segregation where there is sufficient space. **Austroads GTM6** Recommends conflict between cyclists and pedestrians is minimised through traffic management and design.		**Department for Transport (UK) LTN 2/08** Consider widening route to address pedestrian/cycle conflict rather than installing controls. States that use of staggered refuge crossings increases cycle/pedestrian conflict.
Priority Crossings	**Austroads GRD4** Provides an example if a priority crossing (on a platform) and commentary on when priority crossings are likely to be applicable. **TCD Rule** Currently cyclists must dismount to use zebra crossings. **NZ Cycle Trail Design Guide** Gives speeds and cyclists volume threshold for provision of priority crossings.	**CCC MCR Design Guide** Requires cyclists to have priority on low volume roads and provides a volume threshold. Refers to advice in Austroads GRD4.	**Department for Transport (UK) LTN 2/08** Recommends consideration of requiring vehicles to give way to crossing cyclists – especially where cycle flow exceeds vehicle flow. **NACTO Guide** Recommends consideration of bicycle priority on minor streets. Recommends hybrid beacons/HAWK crossings for consideration on major roads to stop traffic (not included within legal TCD framework in NZ)
Non-Priority Crossings	**Austroads GRD4** Provides a threshold based on volumes for when a refuge is necessary. Refuge is only treatment considered. **Austroads GTM6** Guidance on crossing type based on road classification.	**CCC MCR Design Guide** Provides a threshold based on volumes for when a refuge is necessary.	**Department for Transport (UK) LTN 2/08** Provides traffic speed and volume threshold for use of refuge. **NACTO Guide** Aims to decrease crossing distance, increase crossing gaps, improve visibility and enhance awareness of crossing.

	National	NZ Local Guidance	International
Detailed Design Components	**Austroads GRD4** Guidance on refuge dimensions and elements (e.g. holding rail) **RTS 14** Guidance on the layout of tactile pavers. **NZ Cycle Trail Design Guide** Includes maximum crossing distance to refuge.	**CCC MCR Design Guide** Recommends some options to slow cyclists entering a crossing, e.g. rumble strips. Provides refuge dimensions and recommendations to ensure clarity of priority. **ATCOP** Includes refuge dimensions and recommends holding rails.	**Department for Transport (UK) LTN 2/08** Gives refuge dimension including consideration for cycles with trailers.

Post implementation studies, application examples and feedback from survey

St Vincent Street, Nelson

As discussed in the Section 0 with respect to roundabouts, the post-construction safety audit for the St Vincent Street cycleway in Nelson recommended a raised platform crossing near the Gloucester Street roundabout. This was to mitigate the restricted sightlines for cyclists attempting to cross near the roundabout. The platform was recommended to be a courtesy crossing rather than a priority crossing for cyclists.

Lessons learned from the Ilam Road separated bicycle facilities, Christchurch:

- Consider sightlines and develop standards for set-back of parking from cycle crossings – similar to pedestrian crossings
- Sightlines should be checked when placing signs, street furniture and planting
- At conflict points between cyclists and pedestrians spaces should be separated where possible, intervisibility is also important.

Relevant Research

Wilke and Fowler (2008) undertook research for VicRoads which considered the appropriateness of zebra crossings for use by cyclists. The research found that internationally the general consensus is that cyclists are not allowed on zebra crossings, the two examples where this is not the case is Washington State, US and Austria. Wilke and Fowler (2008) recommended that cyclists should not be allowed to ride on zebra crossings however an alternative form of priority crossing that provides for pedestrians and cyclists should be considered.

Discussion

Austroads and the learnings from the Ilam Road SBFs recommend that possible conflicts between pedestrians and cyclists should be addressed through design and segregation. This is in contrast to the UK guidance which suggests providing additional space rather than specific treatments. It is possible that providing separation in all instances could result in over-engineering and that it may be better to adopt a more simple approach. Further consideration of when it is appropriate to simply provide space for users to manoeuvre past each other as opposed to specialist or segregated designs should be considered.

Giving cyclists priority on principal cycle routes makes it more convenient for cyclists however national guidance on how to achieve this effectively is relatively minimal. As traffic volumes increase there are fewer opportunities to provide cycle priority. On busy roads signalised crossings or grade separation can be used, however the guidance does not currently provide for cycle priority on ‘medium’ volume roads.

Gap Identification

Gaps identified in the guidance related to at grade crossings are identified in **Table 6.12**.

Table 6.12 Gap Identification Table for Un-signalised Crossings

Gap	Type	Comments
G66. Treatment of conflict points between pedestrians and cyclists	Overly Onerous Requirement	Consider guidance to determine when separation of pedestrians and cyclists is needed at crossings and when a greater manoeuvre area with no segregation is most appropriate.
G67. Cycle priority on key cycle routes	No guidance exists	Consider when different types of cycle crossings are appropriate and when cyclists should be given priority over motor vehicles. Consider potential changes to zebra crossing rules/develop alternative type of priority crossing for pedestrians and cyclists.

6.9 Grade Separated Crossings

Description

Grade separated crossings provide cyclists (and possibly pedestrians) spatial separation from motor vehicles. Grade separation is generally implemented at busy intersections or across major roads. Grade separated crossings are generally in the form of overpasses or underpasses, at times existing structures (e.g. culverts) are retrofitted to provide grade separated crossings. Grade separation, when well designed and aligned with desire-lines, reduces the road safety risk of crossing a road, and can improve level of service through reducing delay to all users in comparison with at-grade crossing provisions. However, grade separation can result in other disbenefits e.g. increased travel distance, increased gradients and CPTED issues. An example of a grade separated cycle crossing is shown in **Figure 6.14**.

Figure 6.14 *Example of a Grade Separated Crossing (image from http://adrianlordcycling.blogspot.co.nz/2014/04/a-tale-of-two-cities-parlimentary.html)*

Guidance

The guidance identified for the design of grade separated crossings can be seen in **Table 6.13**.

Table 6.13 Guidance Table for Grade Separated Crossings

	National	NZ Local Guidance	International
General/Application	**Austroads GTM6** Makes suggestions of where appropriate but no specific thresholds. **Pedestrian Planning and Design Guide** Recommends consideration of grade separation of paths at roundabouts (for cyclists and pedestrians) **Austroads GRD4C** Generally considers freeways, leans toward no grade separation from vehicles unless cycle flows very high.	**CCC MCR Design Guide** Recommends consideration of desire lines and urban design. Refers to NZTA's Bridging the gap.	**Department for Transport (UK) LTN 2/08** Provides volume and speed thresholds for urban and rural scenarios.
Underpasses/Overpasses	**Austroads GTM6** Mentions security issues associated with underpasses.	**ATCOP** Considers underpasses last resort only.	**Department for Transport (UK) LTN 2/08** Guidance focuses on underpasses
Detailed Design Guidance	**Austroads GRD6A** Provides guidance on barriers, underpass dimensions, alignment and visibility, ramp gradients and lengths use of tactile pavers and for retrofitting existing culverts and steps (i.e. wheeling ramps). **Bridging the Gap** Provides a range of considerations such as CPTED.	**ATCOP** Includes guidance on ramp gradients, wheeling ramps, underpass width and radii considerations. **CCC MCR Design Guide** Guidance on handrail heights.	**Department for Transport (UK) LTN 2/08** Guidance on use of barriers to guide and slow cyclists, guidance on accommodating cycle trailers, commentary on different barrier types.

Discussion

Generally designs for these structures are relatively site specific and the minimum dimensions are already included in guidance. British guidance mentions the possibility of cycle trailers; this is currently missing from New Zealand guidance and should be included as a consideration for designers, given the increasing usage of cycle trailers and cargo-bikes in New Zealand. Additionally guidance on the use of different barrier types to restrict vehicles from entering grade separated facilities for cyclists and pedestrians is not included in New Zealand Guidance.

Gap Identification

Gaps identified in the guidance related to grade separated crossings are identified in **Table 6-14** .

Table 6-14 *Gap Identification Table for Grade Separated Crossings*

Gap	Type	Comments
G68. Consideration of type of bicycle	No Guidance Exists	As cycling becomes more popular it is likely that cycle trailers, cargo bikes and other larger bikes will become more commonplace. Commentary on the consideration of this should be included as grade separated structures have a long life and are more difficult to modify/retrofit.
G69. Barrier type guidance	No Guidance Exists	Some minimal guidance is provided within Austroads however this does not provide options for different types of barriers. Provide a toolbox of options for barriers that allow cyclist and pedestrian access but restrict motor vehicles and motorbikes

7. Gap Analysis

The Best Practice Review identified a series of 'gaps' in national planning and design guidance. The gaps were of varying nature; lack of clarity, inconsistencies, onerous requirements, not best practice, and minimal or lack of existing guidance.

A 'gap register' has been compiled in **Table 7.1** to **Table 7.4**. The register outlines how the gap might be filled by identifying the action required or a combination of the following actions:

- requires research,
- requires legislative changes,
- requires approved trials,
- requires full guidance to be developed, or
- is a 'quick win' that can be easily be addressed.

If there is more than one action required, a staged approach is recommended in the register. For example there may be instances were legislation may need to be changed before design guidance can be developed. There are also instances where Agency action such as 'policy change' is recommended.

Table 7.1 Summarised Gap Analysis Table - Planning

Type of Gap	Section	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
Lack of Clarity	4.7 Possible Cycle Route Components	G8 Coordination with NZCT routes						Update CNRPG Chapter 6 to include NZCT trails.
Inconsistency	4.7 Possible Cycle Route Components	G6 Terminology of cycle facilities and other terms						Update CNRPG Glossary and add diagram to Chapter 6; in conjunction with possible cycle route components.
	4.7 Possible Cycle Route Components	G9 Consistency with ONRC specifications	Can be done by Road Efficiency Group once a number of actions below completed					
	4.12 Monitoring	G15 Requirement to undertake monitoring	Requirement to monitor cycle facilities					Update CNRPG Chapter 13
Overly Onerous Requirement		None						
No or minimal guidance exists	4.3 Cyclists' needs	G1 Further refine definition of cyclist types for determining 'target audience' and relative importance of the design requirements						Update CNRPG Chapter 3 to include Geller approach

Type of Gap	Section	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
		relating to different types of cyclists.						
No or minimal guidance exists	4.4 Level of Service for cyclists	G2 Definition of LOS ratings for individual facilities and along routes based on NZ traffic environment and specific target audience, including factors related to presence of pedestrians on shared paths.		Step 2 Research required to determine best approach for NZ			Step 3 Guidance to be developed Based on research findings	Step 1 Provide Guidance Note referring sector to recent LOS research until NZ specific work complete
	4.4 Level of Service for cyclists	G3 Inclusion of more LOS measures for cycling in ONRC	Relies on actions above					
	4.7 Possible Cycle Route Components	G7 Consideration of separated (or "protected") bicycle facilities and appropriateness for different user types						Update CNRPG Chapter 6
	4.9 Road space allocation	G11 Practitioner "toolkit" for methods of allocating space on roads (including consideration of aspects such as parking management) and gaining the necessary stakeholder support					Step 2 Full guidance is needed but should be considered in conjunction with ONRC	Step 1 Update CNRPG Chapter 8.4 to include reference to research that provides information
	4.9 Road space allocation	G12 Better inclusion of cyclists' needs and parking in Network Operating Plans						Update CNRPG Chapter 8 - Provide best practice examples of NOPs that include cyclists.

Type of Gap	Section	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
	4.5 Possible Cycle Network Approaches	G4 Identification of appropriate planning approach(es) in conjunction with identification of target audience.						Update CNRPG Chapter 6
	4.6 Assessing Cycle Demand	G5 Models / methods to develop predict demand on facilities targeted at greater cycling population (e.g. interested but concerned cyclists).		Step 2				Step 1 Update CNRPG Chapter 7 to include reference to available tools
	4.8 Identifying and evaluating cycle route options	G10 Appropriateness of different route locations for different cyclist types						Update CNRPG Chapter 8
	4.10 The cycle network plan	G13.Sample maps - mapping techniques have advanced since the CNRPG was produced; it would be useful to give updated techniques (e.g. GIS) and some examples.						Update CNRPG Chapter 10.
	4.11 Prioritisation and Implementation	G14 Prioritisation - Provide guidance on methods that can be taken to prioritisation, whilst giving designers flexibility and supporting guidance on when the methods may be suitable.					Develop full guidance that can be referenced in CNRPG Chapter 11.	
Not Considered Best Practice		None						

Table 7.2 *Summarised Gap Analysis Table – Midblock Facilities*

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
Lack of Clarity	5.4 Sealed shoulders	G29/G30 Minimum width of sealed shoulder for cyclists and basis for determining the width						Add to TCD Manual Part 5
	5.3 Cycle lanes	G18 No stopping lines in cycle lanes						Add to TCD Manual Part 5
	5.3 Cycle lanes	G17 Width of traffic lanes next to cycle lanes						Add to TCD Manual Part 5
	5.10 Cycle paths and 5.11 Shared paths	G34/G37 Basis of determining the width and appropriate minimums						Add to TCD Manual Part 5 (refer to VicRoads Note 21)
	5.10 Cycle paths and 5.11 Shared paths	G35/G38 Surface markings				AT working on this		Add to TCD Manual Part 5
	5.5 Bus/Cycle lanes	G23 Width of bus/cycle lanes						Add to TCD Manual Part 5
	5.3 Cycle lanes	G16 Minimum cycle lane widths are not consistent						Add to TCD Manual Part 5
	5.3 Cycle lanes	G20 Detailed Design considerations for cycle lanes						
Overly Onerous Requirement	5.11 Shared paths	G39 Signage for shared paths				AT working on this		Add to TCD Manual Part 5

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
No or minimal guidance exists	5.6 Neighbourhood Greenways	G27 There is no guidance on the criteria, design aspects, signage and markings, acceptable carriageway widths, appropriate traffic calming measures					Full guidance document needed	
	5.9 Protected cycle lanes	G31 No national guidance for these facilities					Full guidance document needed	
	5.3 Cycle lanes	G19 Bus Stop Treatments for cycle lanes						Add to TCD Manual Part 5
	5.4 Shared traffic lanes	G22 No narrow lane guidance						Add to TCD Manual Part 5
	5.5 Bus/Cycle lanes	G25 Markings for Bus/Cycle Lanes						Add to TCD Manual Part 5
	5.5 Bus/Cycle lanes	G26 Cyclist provisions at bus stops for shared bus/cycle lanes						Add to TCD Manual Part 5
	5.7 Shared space	G28 Cyclists in shared spaces						Add to TCD Manual Part 5
Not Considered Best Practice	5.5 Bus/Cycle lanes	G24 Width of bus/cycle lanes (also see Inconsistency)						Add to TCD Manual Part 5
	5.4 Shared traffic lanes	G21 Austroads acceptable minimum width for a wide shared traffic lane is not considered best practice						Add to TCD Manual Part 5

Table 7.3 *Summarised Gap Analysis Table – Intersections*

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
Lack of Clarity	6.4 Signalised Intersections	G49 Disconnect in guidance between time and space components of design for signalised intersections. Guidance for phasing and layout of intersections are in separate Austroads guides						Add to TCD Manual Part 4 and update National Specification (SNUG)
	6.4 Signalised Intersections	G51 Cycle detection at signalised intersections. Benefits and dis-benefits of detection methods are not clearly stated, National specification incomplete in this area.						Add to TCD Manual Part 4 and update National Specification (SNUG)
	6.4 Signalised Intersections	G56 Lack of clarity over when to use hook turns and ASBs						Add to TCD Manual Part 4
	6.5 Roundabouts	G57 Not clear when it is not appropriate to use roundabouts						Add to TCD Manual Part 4
	6.5 Roundabouts	G63 Path network around and across approaches. Providing an off road option for cyclist is covered in designs but implementation is often not ideal. Guidance should consider grade separation and platform design/use.						Add to TCD Manual Part 4

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
Inconsistency	6.4 Signalised Intersections	G55 Austroads and MOTSAM have different dimensions for signalised intersections						Add to TCD Manual Part 4
	6.5 Roundabouts	G58 Use of Cycle Lanes in Roundabouts. Guidance in Austroads is contrary to MOTSAM. Austroads guides are not clear that cycle lanes in roundabouts are not applicable in NZ.						Add to TCD Manual Part 4
No or minimal guidance exists	6.4 Signalised Intersections	G48 Continuing separated facilities through signalised intersections. Austroads focuses on cycle lanes. Should be considered in conjunction with mixing lanes.					Part of Protected Cycle Facility Guidance recommended above –can be added to TCD Manual in the future	
	6.4 Signalised Intersections	G47 Vehicle mixing lanes. Best practice lane layouts, widths and markings need to be determined and included in guidance.				Step 2 (Transport Agency looking for RCA to trial this)	Step 3	TCD Manual Part 4 Could add Manchester South approach to Tuam Street (Christchurch) as a best practice example, and consider further examples and design guidance needed.
	6.4 Signalised Intersections	G53 Cycle Barnes' Dance			Step 1	Step 2		

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
	6.3 Priority/Uncontrolled Intersections	G40 Treatment of SBFs past priority intersections does not exist in nationally approved guidance. Local applications are inconsistent. Treatments are limited by current legislation.			Step 2	Step 3	Step 1 Interim guidance note	
	6.3 Priority/Uncontrolled Intersections	G41/G42 One-Directional vs Bi-Directional SBFs. Risk at intersections and driveways is a driving factor but guidance is needed.					Step 2	Step1 Interim guidance note
	6.5 Roundabouts	G59 C- Roundabouts, the enabling TCD components are not included in legislation. Design guidance is not currently included in national guidance.			Needs confirmation			Add to TCD Manual Part 4 that this type of roundabout exists and provide link to NZ research
	All	G60 Sharrows - guidance on the use of these at intersections will be required following recent trial and proposed legislation changes			Underway			Step1 Interim guidance note
	6.5 Roundabouts	G61 Radial designs are used in Europe and their application in NZ context should be explored		Could be a research project in the future				Add to TCD Manual Part 4 that this type of roundabout exists and provide link to research/international guides

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
	6.5 Roundabouts	G64 Signalised Roundabouts. Matrix for when these may be applicable would be useful						Add to TCD Manual Part 4 that this type of roundabout exists and provide link to research/international guides
Not Considered Best Practice	6.4 Signalised Intersections	G44 Definition of cycle aspects and inclusion of directional cycle aspects, nearside signals trial			Underway	Underway		
	All	G32/G45 Definition of Roadway/Status of cycleway as a way to clarify give way rules.						
	6.4 Signalised Intersections	G50 Use of slip lanes at signalised intersections. Design of separated facilities past slip lanes						Add to TCD Manual Part 4
	6.4 Signalised Intersections	G46 Merits of different lane layouts						Add to TCD Manual Part 4
	6.4 Signalised Intersections	G52 All red time extension for wide signalised intersections. Austroads did not adopt approach outlined in the NZ Supplement to Austroads Part 14						Add to TCD Manual Part 4
	6.3 Priority/Uncontrolled	G43 Auxiliary lanes and slip lanes, guidance is required for what is not acceptable along key cycle routes						Add to TCD Manual Part 4

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
	6.5 Roundabouts	G58 Use of Cycle Lanes in Roundabouts. Guidance in Austroads is contrary to MOTSAM. Austroads guides are not clear that cycle lanes in roundabouts are not applicable in NZ.						Add to TCD Manual Part 4
	6.4 Signalised Intersections	G54 Coloured Surfacing – strengthen recommendations for use						Add to TCD Manual Part 4 and 5

Table 7.4 *Summarised Gap Analysis Table – Crossings*

Type of Gap	Section (s)	Gap number and description	Policy or other action for Agency to consider outside of this project	Requires Research to determine best approach	Requires Legislation Review	Requires Approved Trial	Requires Full Guidance to be Developed	Quick Win
No or minimal guidance exists	All	G64/G67No guidance on cycle priority on cycle routes, especially across medium volume roads dependent on target user group.			May require this	May require this	Step 1	
	6.7 Signalised crossings	G65 No guidance on cycle detection technology e.g. puffin detection and how this relates to layout.						Discuss this with SNUG regarding appropriate place for guidance
	All	G66Treatment of conflict between pedestrians and cyclists						Will be considered in the LOS planning Quick Win
	6.9 Grade Separated Crossings	G68 Type of bicycle and associated considerations e.g. for cargo cycles	Provide feedback to Austroads					
	6.9 Grade Separated Crossings	G69 Barrier type						

8. References

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Appendix A

Stakeholder Survey Results

ConnectBetter

A1 Stakeholder Survey Results

National Cycle Network Design Guidance Project

Stakeholder Survey Results

Introduction

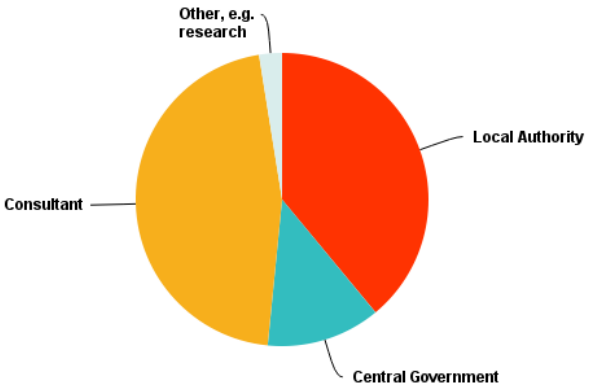
To help us inform the development of National Cycle Network Design Guidance we sent out an online survey to the sector asking for views on the current issues encountered while planning and designing cycle networks and facilities. The sector was also asked how a 'framework' could assist. A total of 160 responses were received and this document outlines the respondents' feedback.

The key messages were:

- The majority of respondents (80%) stated that the potential framework would capture the subjects that would be of value to their organisation. The remaining 20% either offered suggestions on how to improve it or sought clarification on the content.
- 'Insufficient or inadequate guidance on how to assess demand for the network' and 'Insufficient or inadequate wider transport policy to support development of a cycle network' were the two most commonly raised planning issues.
- The issue of 'Road space allocation' was the most commonly raised design issue.
- 'Insufficient or inadequate guidance on intersections' was the next most common design issue.
- Only a small proportion of respondents stated that there was guidance that they disregarded because it wasn't considered best practice.
- Respondents suggested that whatever form the framework takes it needs to be simple to use, flexible, not be too restrictive, not exclude engineering judgement and not inhibit innovation.

Question 1 – What organisation do you represent?

The majority of respondents represented the consulting sector (46%). The Local Authorities were also well represented (39%) and Central Government made up 13% of the respondents. There were 4 respondents in the 'Other' category, 3 were from research based organisations and 1 was from a regional authority.

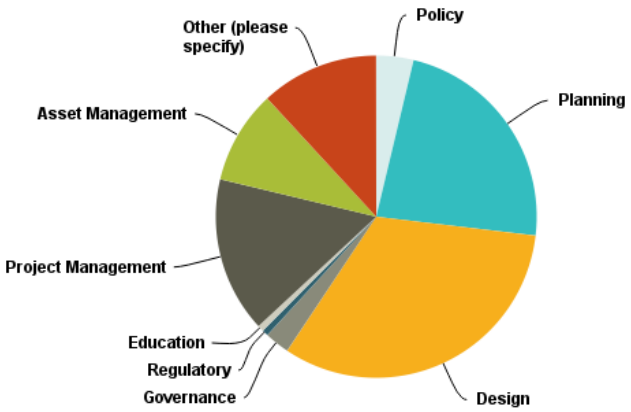


Question 2 - What is the name of your organisation?

This question enabled us to establish the range of organisations within each sector above. In particular the Local Authority representation between district councils, of which there were 16 respondents and city councils of which there were 46. Central Government was predominately NZ Transport Agency staff plus 1 respondent from the Department of Conservation. The consultant respondents were generally from large organisations however there was representation from smaller consultancies as well.

Question 3 - Please select the primary type of role you are in.

The primary role of the majority of respondents was 'design' (33%), next was planning (23%). Project Management, Asset Management and 'Other' were the next largest groups. Others were generally made up of safety, investment, research and urban design.

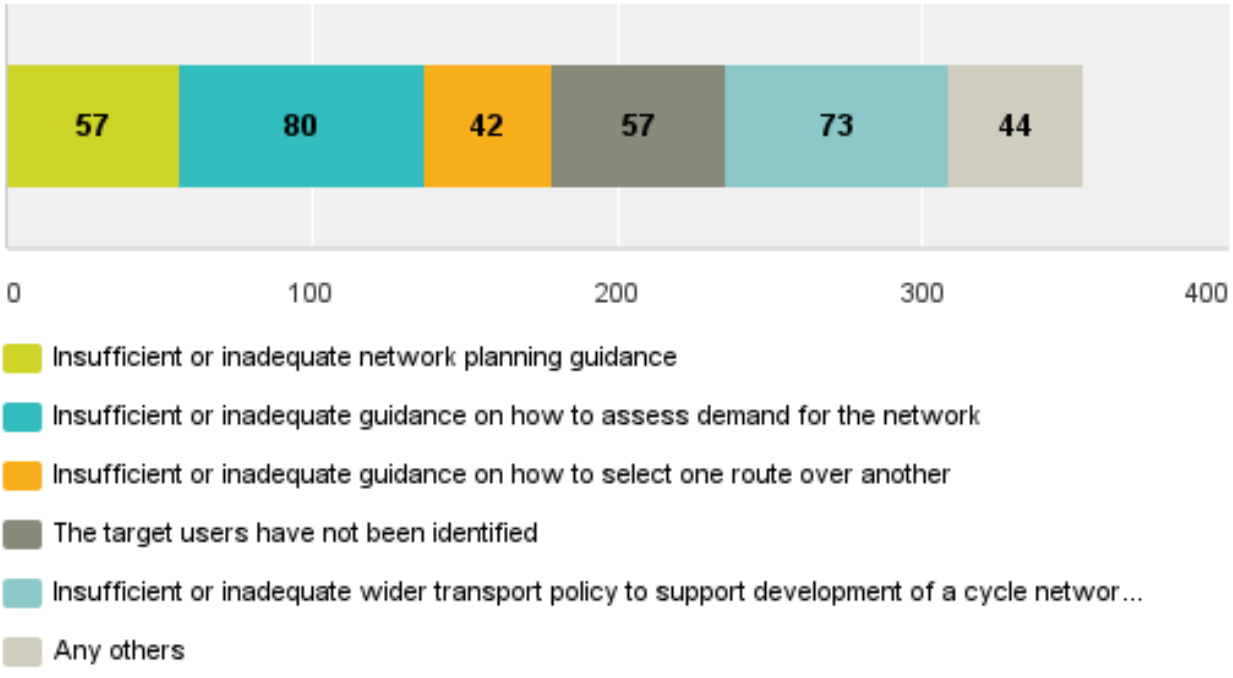


Question 4 - What are the planning issues you encounter in developing cycle routes/networks?

It was clear that people are experiencing a range of planning issues. 'Insufficient or inadequate guidance on how to assess demand for the network' (80 respondents) and 'Insufficient or inadequate wider transport policy to support development of a cycle network' (73 respondents) were the two most common issues. 'Insufficient or inadequate network planning guidance' and 'The target users have not been identified' were both identified as issues by 39% of respondents.

The 'any others' comprised of a range of issues, the key issues were:

- Funding
- Stakeholder conflicts
- Lack of expertise
- Lack of political support
- Public acceptance

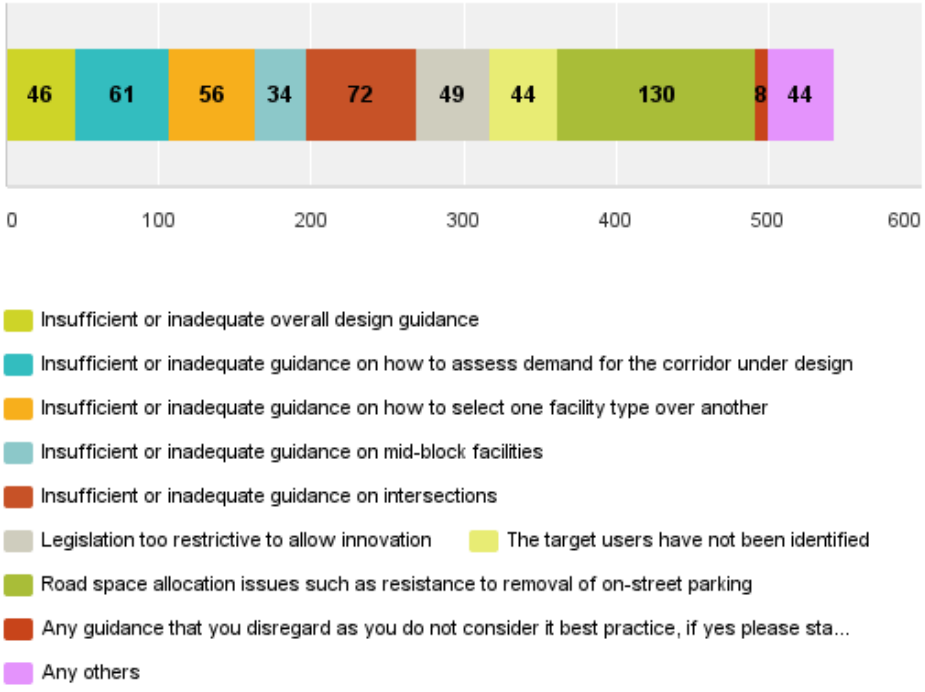


Question 5 - What are the key issues you encounter when designing/implementing a cycle facility?

It was clear that people are experiencing a range of design issues. The issue of 'Road space allocation' was the most commonly raised issue with 130 respondents (83%) stating this. 'Insufficient or inadequate guidance on intersections' was the next most common issue (46%). There was only a small proportion of respondents that stated that there was any guidance that they would disregard because it wasn't considered best practice.

The 'any others' comprised of a range of issues, the key issues were:

- Funding – uncertainty,
- Stakeholder engagement
- Conflict between corridor users and adjacent land use
- Conflicts between bus and cycle networks
- Conflicting advice on roundabout design
- Influence of cost on design particularly when implementing along existing road corridors. Cost can play a significant factor in deciding the final solution.
- A lack of commitment to achieving a continuous network.
- Guidelines / policy that allows as acceptable design that would be considered extremely sub-standard in countries with a developed cycle network.



Some other general comments were:

- The term best practice is not well understood
- Unsafe designs starting to appear e.g. cycle lanes to the left of left and through traffic lanes at traffic signals
- "One of the biggest blockers I find at the moment is that there is a lot of support for cycle facilities, as long as the implications (including parking) are minimal/zero"
- Lack of political support
- Public acceptance

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National Cycle Network Design Guidance Project

Stakeholder Survey Results

Question 6 - Do you have any research or post implementation studies/audits/reviews of cycle facilities that would be useful for this project?

A number of people kindly offered to provide post implementation audits/reviews or research that may be of use to the project. We are currently following up on these offers.

Question 7 - Does the potential content of this framework capture the subjects that would be of value to your organisation?

80% of respondents stated that the potential framework would capture the subjects that would be of value to their organisation, whilst the other 20% either offered suggestions or queried whether something was covered by the framework. The key suggestions were:

- Link to NZTA Environmental and Social Responsibility Policy and guidance
- Link with NZTA Urban Design and landscape guidelines
- Integration with other modes to develop optimised transport networks
- Place-making
- Supporting infrastructure (bike parking facilities, water fountains, work place / destination facilities
- The implications on other parts of the road/cycle/pedestrian network

Question 8 - What are the aspects that would be of most value?

The most commonly stated aspects were, in order of the number of times they were mentioned:

- Facility design
- Assessing demand
- Road space allocation
- Network Planning
- Planning and design
- Cyclists needs
- Type of facility
- Business case

Question 9 - Is there anything missing in the above diagram?

40% of respondents did not know if there was anything missing, 27% stated nothing was missing and 33% answered yes and stated what they felt was missing. This question had some overlap with Question 7 where *respondents were generally* seeking clarification on whether something was included - in most cases it was incorporated as part of the broad headings provided. Some key points of clarification and any aspects that weren't covered by the headings are listed below:

- Economic evaluation – this will be covered by 'Business Case and Funding' and links provided to the current processes. This project will not be reviewing the EEM (Economic Evaluation Manual) with respect to cycle facilities but may identify any disconnects between design and funding.
- Urban Design and Crime Prevention through Environmental Design (CPTED) – links can be provided to appropriate guidance on these matters
- Education – this wasn't intended to be covered in the framework but links to any appropriate information could be included.
- Political Engagement – this wasn't intended to be covered in the framework but links to any appropriate existing information could be included.

Question 10 - Do you have any thoughts on how the on-line framework might be shaped (e.g. flow chart, matrix based tool, a decision tree)?

There were 88 responses to this question, most had a preference for something along the lines of a flow chart, matrix, decision tree or a combination of them. Comments were made that whatever the form of the framework it needs to be simple to use, flexible, not too restrictive, not exclude engineering judgement and not inhibit innovation.

Question 11 - Do you have any other comments?

There were 64 responses to this question, the aspects not already covered in the feedback were:

- The supporting infrastructure should not be supporting - it is all a critical part of the design
- Needs of smaller towns will not need the same sort of designs likely to be needed in larger urban areas.
- What is wrong with the current Cycle Network and Route Planning Guide?
- The issues around cycle crashes is not only about design, it is fit for purpose and realising that bigger issues are around acceptance by other road users.
- Talk about CONTEXT somewhere. This is so important and is often overlooked. Talk about the future that these designs will support future users.
- I think there should be more emphasis when planning cycle networks on using parallel routes where possible, rather than trying to put all modes on the same routes.
- Consider the influence of electric/powered bikes, design for mountain bikes, tandems
- The framework must consider pedestrians given common facilities such as shared pathways
- This framework needs to integrate with a wide range of stakeholders, not just capital works areas, operational teams, safety teams, integrated with public transport hubs and services, non-cycling stakeholders etc.
- Case studies, research from other NZ cities are always useful on how problems were overcome.
- Should not contradict code of practice and/or guidelines being developed by RCAs.
- Continued emphasis needs to be on a Total Network Transport Solution noting that cycling is just one Network Transport Solution (but a very worthwhile solution). RCAs selling a single Network Transport Solution in isolation of an overall Total Network Transport Solution is not beneficial.
- Design Guidance (midblock and intersection) is particularly lacking for Neighbourhood Greenways, particularly when retrofitting an existing road.
- We need real evaluation of benefits to be collected from completed site and to be compared with calculated benefits when adding new cycling facility on a corridor.
- We have a methodological issue to resolve between demanding high quality standards of cycle infrastructure now, instead of what works now, with a promise of increasing quality as time goes on.
- The project should also consider which (if any) of the guidelines are to become "mandatory" countrywide, and to what degree they will be mandatory (i.e. for example which guideline aspects are to be followed at a minimum if a project wants to receive NZTA or UCF (Urban Cycleway Fund) funding).

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