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AUSTROADS RESEARCH REPORT

Guide Information for Pedestrian Facilities



Austroads

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Guide Information for Pedestrian Facilities

Austroads

Sydney 2013

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- promote improved Australian and New Zealand transport outcomes
- provide expert technical input to national policy development on road and road transport issues
- promote improved practice and capability by road agencies.
- promote consistency in road and road agency operations.

Austroads membership comprises the six state and two territory road transport and traffic authorities, the Commonwealth Department of Infrastructure and Transport, the Australian Local Government Association, and NZ Transport Agency. Austroads is governed by a Board consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

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- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Transport Northern Territory
- Department of Territory and Municipal Services Australian Capital Territory
- Commonwealth Department of Infrastructure and Transport
- Australian Local Government Association
- New Zealand Transport Agency.

The success of Austroads is derived from the collaboration of member organisations and others in the road industry. It aims to be the Australasian leader in providing high quality information, advice and fostering research in the road transport sector.

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SUMMARY

The purpose of this project was to identify from overseas and local research and practice new information on the provision of pedestrian facilities that should be incorporated into the current Guide to Traffic Management. The project did not include the development of detailed procedures for the selection of particular pedestrian facilities but the report outlines the general approach that should be adopted as an alternative to reliance upon traditional numerical criteria.

The need for provision and assessment of facilities for pedestrians has not been well-recognised until recent years. As a result there is an emerging need to cater for pedestrians in transport planning and traffic management in Australia and New Zealand to a greater extent than previously. For the development of walking strategies, associated guidance documents are required.

The main features identified from the review of literature, emerging practice and recent guideline developments are summarised as follows:

- greater recognition of the importance of walking, from health, social, environmental, transport and economic perspectives
- greater emphasis in road network planning and urban design on providing facilities for pedestrian activity
- enhanced understanding of walking activity, not just as a transport mode, and the need to reflect this in associated measurement and survey techniques
- acknowledgement of the need for guidance on pedestrian facilities which takes into account the needs and perceptions of pedestrians themselves
- development of tools and techniques for assessing the quality of the walking environment, which lead to improved methods for determining the level of service and facilities provided to pedestrians in the road environment
- development of a multimodal approach – considering pedestrian, cyclist and public transport issues in addition to vehicular traffic – for assessing the level of service of roadway facilities.

The material on pedestrian facilities in the Austroads Guides would be enhanced by including a greater emphasis on accommodating pedestrian activity in planning and design, emphasising the vulnerability of pedestrians in the Safe System context, presenting the basics of pedestrian level of service, and outlining methods for assessing walkability.

The primary need is for amendment to the Guide to Traffic Management, taking into account the pedestrian mode in determining the level of service of roadway facilities. Greater attention needs to be paid to pedestrian activity needs and perceptions in assessing the quality of their environment, and the consequences for selecting and managing related facilities. Appendices to this report contain the additional or revised text that is proposed for insertion into the relevant sections of Guides.

The need to develop a comprehensive tool for the assessment and evaluation of pedestrian facilities, applicable to Australia and New Zealand, has been identified. The features and proposed development of such a tool, based on walkability, level of service and safety considerations, have been outlined.

1 INTRODUCTION

1.1 Project Objectives

Most transport trips involve walking at the start and end of trips. The need for provision and assessment of facilities for pedestrians has not been well-recognised until recent years. As a result there is an emerging need to cater for pedestrians in transport planning and traffic management in Australia and New Zealand to a greater extent than previously. For the development of walking strategies associated guidance documents are required.

The superseded publication Austroa*ds Guide to Traffic Engineering Practice Part 13: Pedestrians (*referred to here as GTEP 13) was produced in 1995 to summarise current practice amongst road agencies in addressing this need. Some material from GTEP Part 13 has been incorporated in the new Austroads Guide to Traffic Management (GTM) and Guide to Road Design (GRD). This material requires review and revision, particularly with regard to the inclusion of Level of Service concepts for pedestrian facilities available from the revised US Highway Capacity Manual.

The purpose of the project is to identify from international and local research and practice new material on the provision of pedestrian facilities that should be incorporated into the current Austroads Guides, particularly the Guide to Traffic Management. Such enhanced guidance will be important in developing and promoting the use of an integrated and multi-modal transport system.

The project does not include the development of detailed procedures for the selection of particular pedestrian facilities (walkways, footpaths, crossings, refuges, signals, etc.) but does outline the general approach that should be adopted as an alternative to reliance upon traditional numerical criteria. It is intended that the detailed procedures will be developed in association with the further review of specific Parts of the GTM in future.

1.2 Project Approach

1.2.1 Scope

The project includes recommendations for additional or amended text to be incorporated into the GTM to better reflect contemporary guidance on pedestrian facilities. Cyclist facilities are not included as they are dealt with in separate projects, but reference is made as required to shared pedestrian-cycle path facilities. A report detailing the information in Austroads Guides on the planning, design and traffic management of cyclist facilities is available (Austroads 2010).

The emphasis is on developing replacement text for GTM Part 3, and for Parts 6 and 9, which are under review in separate Austroads projects:

- NP1695 – Review of GTM Part 3: *Traffic Studies and Analysis*
- NP1676 – Review of GTM Part 6: Intersections, Interchanges and Crossings, and Part 9: Traffic Operations.

Amendments that could be included in future reviews of other Parts of the GTM are outlined. Implications for other Austroads Guides, particularly the Guide to Road Design (GRD), the Guide to Road Safety (GRS) and the Guide to Road Transport Planning (GRTP) are also identified.

1.2.2 Tasks

This project comprised a literature review and the development of proposals for amendments to the Guides. The following tasks were undertaken and the results are presented in this report:

- review of material in the former GTEP Part 13 to determine the extent of its capture in the guides
- review of literature (including the US Highway Capacity Manual and NZ Pedestrian Planning & Design Guide) and processes used to select and assess appropriate pedestrian facilities
- review of the GTM to identify possible amendments to incorporate the level of service (LoS) concept for pedestrians
- review of the relevant Guides to identify amendments regarding pedestrian facilities
- consultation with jurisdictions, via workshop activity with relevant road transport and planning authorities to determine how new developments could be, or are being, incorporated into their current policies and practices, and to identify any jurisdiction-specific factors
- development of recommendations for necessary amendments to the Guides.

1.3 Background

There is a need to reflect new perspectives in guidelines for pedestrian facilities. Traditionally, the approach to consideration of pedestrian activity and the provision or assessment of facilities for walking has been very vehicle-centric. The translation to pedestrian traffic of concepts and measurement of vehicular traffic flow is questionable as there are many other factors at play.

A new focus has emerged in best practice advice on transport planning and traffic management, based on reviews and studies of pedestrian issues. This has led to development of initiatives and guidance in many jurisdictions specifically on the provision and management of pedestrian facilities. Pedestrian activity and safety is increasingly reflected in guidelines and standards for road design, traffic management and road transport planning.

1.3.1 Walking and Health

There has been considerable work done internationally, particularly in developed countries, aimed at understanding, measuring and providing for walking generally, in the context of health, social, economic, environmental and transport perspectives. Examples of global initiatives are:

- the Walk 21 Conference movement, which provides an international forum for the discussion and development of measures to address walking issues
- development of the International Charter for Walking, which provides a pedestrian focus for cities and countries in the planning and development of their infrastructure
- the European Pedestrian Quality Needs (PQN) project addressing a comprehensive range of issues related to walking and the walking environment
- the OECD project on Pedestrian safety, Urban Space and Health (PUSH) addressing the importance of walking as an integral part of the transport system and the need for policies to promote walking in planning.

In Australia, the Heart Foundation Australia has developed a guide from a health perspective, *Healthy by design: a planner's guide to environments for active living* (Sutherland, Murphy & Carlisle 2006). This guide was developed in response to local government requests for practical guidance in designing walkable and more liveable communities. Local governments are utilising

the guide to increase the priority on walking in the municipality and to support the development of a municipal walking strategy.

Also at a national level, planning and health authorities and institutions have addressed the need to plan for more sustainable communities, with a particular emphasis on the benefits to people's physical and mental health from active or healthy living. A guide *Healthy Spaces and Places* has been produced (Planning Institute of Australia 2009) to help understand and respond to issues around planning and health. It highlights the importance of planning and designing communities for people movements, not just car movements, and provides tools for doing this. It supports and complements planning and design initiatives of state, territory and local governments.

Further information on the Heart Foundation's state-based collaborations for developing physical activity initiatives and improving the physical and social environment is available at www.heartfoundation.org.au/active-living/coalitions/Pages/default.aspx.

Such developments reflect a shift from primarily planning for roads (private car oriented policy) towards planning more for other modes such as public transport and non-motorised modes. This shift in transport planning policy includes influencing people's attitudes towards travel, and encouraging the use of alternatives to the private car. A useful resource in this area is the on-line *TDM Encyclopedia* developed in Canada (VTPI 2010). Based on information and resources from across the globe, this material provides advice on the many aspects of transportation demand management and argues for a comprehensive approach to transport planning. It includes chapters on non-motorised transport planning, walking and cycling encouragement, and managing non-motorised facilities.

Road and planning authorities in Australia and New Zealand are also developing policies, strategies and guidelines giving greater recognition to the importance of walking as an activity and as a transport mode. These are discussed in the main body of this report (see Section 2.1.8).

1.3.2 Pedestrian Safety

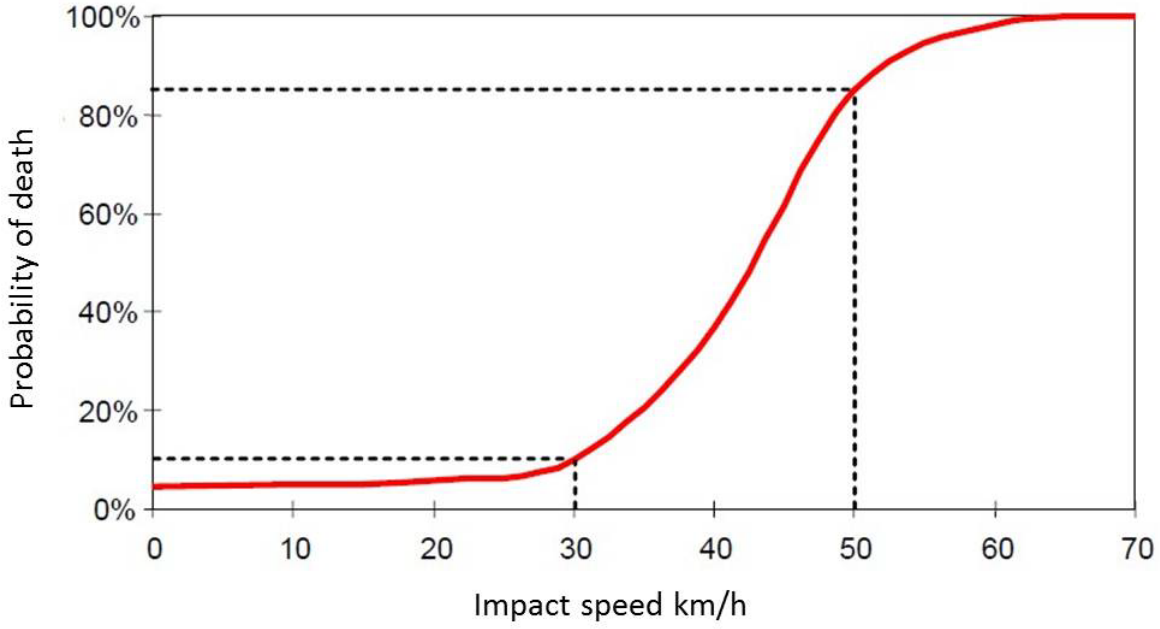
Improving the information on pedestrian facilities in the guidance documents is in line with the Safe System approach to road safety, which recognises the vulnerability of pedestrians in the road environment.

The Safe System approach was first adopted in the National Road Safety Action Plan in 2005 and reiterated in the National Road Safety Strategy 2011–2020 (ATC 2011). This approach is the guiding principle to managing and improving road safety and underpins the national road safety strategies in Australia and New Zealand. The approach aims to provide a safer road and traffic environment in which alert and responsible road users should not be killed or seriously injured as a result of a crash. It is structured around the basic pillars of safer roads, safer speeds, safer vehicles, and safer road users.

Safety is a prime objective in traffic management, and pedestrians are particularly vulnerable to serious injury. In a vehicle-pedestrian collision, the probability of survival for the pedestrian decreases dramatically at impact speeds above about 30 km/h (Figure 1.1). Results from on-scene investigations of collisions involving pedestrians and cars show that about 90% of pedestrians survive being hit by a car at speeds of 30 km/h; whereas less than 20% survive at speeds over 50 km/h (OECD & ECMT 2006).

The Safe System approach to road safety management recognises that humans make errors, that crashes will continue to occur and that humans have a limited tolerance to impact forces. It aims to ensure that the road/traffic environment does not present opportunities for that tolerance to be

exceeded. In the pedestrian context this means ensuring that facilities provided for pedestrians do not expose them to the likelihood of serious injury or death; that vehicles and pedestrians are separated physically or temporally, or that the speed environment is controlled to keep potential impact speeds within survivable limits.



Source: OECD & ECMT (2006).

Figure 1.1: Probability of death to pedestrian in a collision with a motor vehicle

2 GUIDANCE ON PEDESTRIAN FACILITIES

2.1 Australia and New Zealand

2.1.1 Austroads Guidance

The range of facilities provided in the road and traffic system to accommodate pedestrian activity includes footpaths along urban streets, crossing facilities at midblock and intersection locations (signalised or unsignalised), off-street pathways (exclusive pedestrian use or shared with bicycle traffic), stairs, ramps, waiting or queuing areas, specific pedestrian streets or malls and shared zones.

Guidance on the provision and management of pedestrian facilities was previously provided in the Austroads *Guide to Traffic Engineering Practice Part 13: Pedestrians* (referred to here as GTEP 13). That volume contained information specifically on pedestrians and other Guides in the GTEP series made reference to it as required.

In the current series of Austroads Guides the advisory material on pedestrian issues is distributed across three of the Guides, primarily in the Guide to Traffic Management (GTM) and the Guide to Road Design (GRD), with some material in the Guide to Road Safety (GRS). See references Austroads 2008-2009, 2006-2009 and 2009 respectively.

An analysis of the distribution of the GTEP 13 material, section by section, in the Austroads Guide series is presented in Appendix A.

It is clear that almost all the information in GTEP 13 has been incorporated into the relevant Austroads Guides. There is however some material which could not be directly identified, or only partly so, within the Guides. Table 2.1 outlines this material and indicates the possible implications for amendments or additions to the Guides.

Table 2.1: GTEP 13 material not directly identified in Austroads Guides

GTEP 13 section	Information	Possible guide implication	Comment
1.4	Area per person based on land use. Table presenting pedestrian space requirements (m^2/person) based on Building Code of Australia 1990.	GTM 7, 12	Could be updated if better data available and incorporated into GTM 7 re Transit Oriented Developments (TOD) or GTM 12 re accommodation of pedestrian trip generation.
1.4	'Accident profile' for pedestrian crashes. Summary statistics indicating extent and features of pedestrian crash situation.	GRS 2	Updated information (and trends) would be a useful addition to GRS 2 to emphasise the vulnerability of pedestrians, especially young and elderly, and give greater recognition of the need to address pedestrian issues.
1.6	Pedestrian capacity and level of service, after Fruin (1987). Basic pedestrian speed, space and flow requirements related to LoS.	GTM 3	Include as basic information in GTM 3 re pedestrian capacity and LoS, as an introduction to more recent considerations of pedestrian needs and analysis of LoS.
4.1.1	Location of pedestrian signs. General information on location of signs within pedestrian field of view.	GTM 7, 10	Could be added to GTM 10 re signing for pedestrians and GTM 7 re catering for pedestrians in activity centres.

GTEP 13 section	Information	Possible guide implication	Comment
4.2.1	Classification of guidance devices. Brief simple grouping of cues for people with disabilities.	GTM 5, 6, 10 GRD 6A	Not found specifically but is incorporated in reference to facilities for pedestrians with disabilities in GTM 6 and 8. Possible addition to GRD 6A.
6.2	Pedestrian facilities at work sites. General advice on catering for pedestrians at roadworks and building construction sites.	GTM 10	Could include in brief discussion on traffic management for temporary situations (GTM 10). Possibly incorporate into future guidance (new Guide?) on traffic management at roadworks.
9	Complementary activities and programs. Advice on role of programs such as crossing supervisors and general pedestrian safety programs.	GRS 4	Could be a useful addition to discussion on local government based programs in GRS 4.

The new Austroads Guides have captured the vast majority of the GTEP 13 material, and have introduced some additional aspects of pedestrian issues. Table 2.2 provides a summary of the general pedestrian topics covered in the Guides.

Table 2.2: General pedestrian topics in Austroads Guides

Pedestrian topic	Guide	Part
General	Road Design	Part 4
Pedestrian design parameters	Road Design	Part 6A
Implications for design	Traffic Management	Part 7, section 3.8.2
Geometric requirements	Road Design	Part 6A
Features of facilities	Traffic Management	Part 5 Table 3.2
Surface treatments	Road Design	Part 6A
Driveways and footpaths	Traffic Management Traffic Management	Part 7, sections 3.5.3 and 3.8.2 Part 11
Access to buildings	Traffic Management	Part 7, section 3.8.2
Joint pedestrian/cycle facilities	Traffic Management	Part 5
Road crossings	Traffic Management	Parts 5 and 6
Pedestrian guidance measures	Traffic Management Traffic Management	Part 10 Part 6 Table 3.3
Access to public transport	Traffic Management	Part 5 Table 3.2
Pedestrians at roundabouts	Traffic Management Road Design	Parts 6 and 8 Part 4B
Pedestrians at rail crossings	Traffic Management	Part 6
Shared zones	Traffic Management Traffic Management	Parts 6, 7 section 3.6.2 Part 8
Parking and pedestrians	Traffic Management	Part 11

Details of the coverage of pedestrian issues in individual Austroads Guides are given in the following sections.

2.1.2 Guide to Traffic Management

The Guide to Traffic Management contains integrated advice and guidance on pedestrian issues. This material is presented as required throughout the several Parts of the guide, as it relates to the traffic management of roads, streets, intersections, local areas or adjacent land use developments. The material is based primarily on the material published in the previous GTEP series, particularly GTEP 13 as noted in Section 2.1.1.

Guide to Traffic Management Part 3 – Traffic Studies and Analysis

Advice on designing and conducting pedestrian surveys is given in this Guide, acknowledging the increasing focus on providing for pedestrians in the road network; details are given in an appendix. This is based on advice in the previous publication GTEP Part 3 (Traffic Studies).

The material on analysis of level of service also acknowledges the importance of giving explicit consideration to pedestrian activity, including safety and amenity. However, advice on detailed analysis of level of service is provided solely from the perspective of vehicular traffic.

Guide to Traffic Management Part 4 – Network Management

This Guide provides guidance on traffic management at a network level. It addresses the network needs of the various categories of user, including pedestrians, and the characteristics of various types of network. It outlines a planning process for balancing or prioritising the competing needs of different users. A section on pedestrian networks provides advice on the road hierarchy context in which these should be developed, and considerations in providing facilities for pedestrians, especially those with disabilities.

Guide to Traffic Management Part 5 – Road Management

This Guide deals with traffic management on sections of road between major intersections. Detailed information and guidance is given on factors to be considered in applying traffic management techniques and treatments to various road types. It considers the needs of all road users including pedestrians, cyclists, motorcyclists, heavy vehicles and public transport. Detailed advice is given on road space requirements for these different road user groups. For pedestrians, advice on traffic management covers general facilities in the road environment, pathways and crossing facilities.

Guide to Traffic Management Part 6 – Intersections and Crossings

This covers traffic management at locations where traffic and road user streams intersect, including all types of road intersections (signalised, unsignalised, roundabouts), grade-separated interchanges, rail crossings and pedestrian and bicycle crossings of roads. Advice on pedestrian needs at roundabouts, signalised intersections and midblock crossings is given. The Guide presents detailed information and advice on factors to be considered in the selection and functional design of intersections. It describes the appropriate use and design of various intersection types and traffic management techniques, and considers the needs of all road users including pedestrians, cyclists, motorcyclists, heavy vehicles and public transport.

Guide to Traffic Management Part 7 – Traffic Management in Activity Centres

This Guide outlines the basic approach to planning and management of centres with high levels of internal activity, especially pedestrian activity. It addresses the need for balance between providing for normal vehicle traffic and facilities for other traffic such as public transport, pedestrian and cycle traffic. Pedestrian streets are covered as a type of activity centre, and examples of them in Australian cities are given.

This Guide recognises the need to meet pedestrian mobility requirements and to address the level of service provided for pedestrians, including the general quality of the pedestrian environment. It presents the planning context for providing for walking within activity centres and contrasts that with the approach needed at the local road level. Objectives are outlined for developing pedestrian plans.

Transit-oriented developments (TOD) are described particularly with regard to their potential for generating pedestrian activity, both within the centres and in connecting with public transport facilities.

Pedestrian implications for traffic management practice in activity centres are outlined in terms of access, environment quality and amenity, design of elements and managing vehicle-pedestrian conflict. Special reference is made to speed management for pedestrian safety. A directory to relevant material on pedestrian issues within other Parts of the Guide, and in other Austroads Guides, is included.

This Guide also includes a commentary on the need for placing some emphasis on pedestrian needs when defining, developing and managing a functional road hierarchy.

Guide to Traffic Management Part 8 – Local Area Traffic Management

Accommodation of pedestrian needs within local areas is a basic focus in this Guide. It provides advice on the planning and management of road space within a local area, to reduce traffic volumes and speeds in local streets, to increase amenity and improve safety and access for residents, especially pedestrians and cyclists. It presents a systematic approach to traffic management in local areas, including the design, development and management of residential precincts. It provides guidance on the planning, selection, design, application and effectiveness of traffic control measures and devices on an area-wide basis.

Guide to Traffic Management Part 9 – Traffic Operations

This provides guidance on the routine operations that underpin the provision of road services to road network users. The material on traffic signal systems includes advice on pedestrian signal phasing.

Guide to Traffic Management Part 10 – Traffic Control Devices

This covers the various control devices used to regulate and guide traffic, including signs, traffic signals, pavement markings, delineators, and traffic islands. It provides guidance on the design and use of traffic control devices, and advice on the functions, suitability and correct use of devices to create a more efficient and safer road traffic environment for all users. Signs and markings for facilities such as pedestrian crossings are included. The material on traffic signals provides advice on pedestrian displays.

Guide to Traffic Management Part 11 – Parking

The Guide provides a broad coverage of the parking management process. It includes advice on the demand for and supply of parking facilities, and the parking policy framework in which it should be addressed. Parking policy objectives include consideration of pedestrians. The implementation of on-street and off-street parking for all road users, including parking controls in urban centres is addressed, as are park-and-ride facilities. Since all occupants of parked cars are also pedestrians, particular attention is paid to the needs of pedestrians within and around off-street parking facilities.

Guide to Traffic Management Part 12 – Traffic Impact of Developments

The Guide presents advice on identifying and managing the impacts on the road system arising from land use developments. It provides guidance associated with the design and management of a variety of land use developments, including the need to accommodate pedestrian activity within and around the developments. Advice is given on the generation of pedestrian traffic and the need to avoid pedestrian-vehicle conflict. The implications of land use planning for issues such as pedestrian road-crossing needs, pedestrian routes, connectivity and access to developments including public transport facilities and parking facilities are outlined.

Guide to Traffic Management Part 13 – Road Environment Safety

This Guide presents the principles and practice for ensuring a safe road environment within a traffic management context, under the Safe System philosophy. It considers the role of traffic management in influencing road user behaviour and emphasises the need for the road system to provide an environment which assists all road users to behave effectively and safely. Consideration of all road user types is basic to this approach. The advice includes basics such as separating vehicular and pedestrian traffic, and outlines the role of road design and traffic management in providing road and roadside safety.

Summary

A directory to the coverage of pedestrian issues in the Guide to Traffic Management is provided in Appendix B.

2.1.3 Guide to Road Design

There is substantial consideration of pedestrian issues in the Guide to Road Design, as summarised in the following sub-sections.

Guide to Road Design Part 2 – Design Considerations

This Part provides guidance on the range of objectives likely to apply to a road design project, including recognition of transport demands, safe and efficient traffic operations and achievement of balanced provision for the needs of all road users, including pedestrians. Context sensitive design and functional road classification are considered, and the vehicular, human and road factors influencing design are discussed. This includes specific advice on providing for pedestrians.

Guide to Road Design Part 3 – Geometric Design

This outlines general advice on providing for pedestrians in considering the various elements of geometric design.

Guide to Road Design Part 4 – Intersections and Crossings – General

This Part covers topics that are common to intersection design such as road design considerations, the design process, choice of design vehicle, provision for public transport and property access. It also provides guidance and information on the design of pedestrian and cyclist crossing treatments.

Guide to Road Design Part 4B – Roundabouts

This covers design principles and provides guidelines for all the key elements to develop safe and efficient layouts. It provides design advice for pedestrian and cyclist treatments at roundabouts and related topics such as pavement markings, signs, and landscaping.

Guide to Road Design Part 6 – Roadside Design

Roadside design relates to the areas between the outside edge of the shoulder or kerb and the road reservation boundary and the provision of road furniture, utilities, roadway lighting, pedestrian facilities, bicycle facilities, landscaping, noise attenuation structures, architectural features, rest areas and median strips. It also covers roadside safety and the provision of safety barriers.

Guide to Road Design Part 6A – Pedestrian and Cyclist Paths

This Part provides the main guidance on design of paths for safe and efficient walking and cycling. It includes a brief introduction to planning and the need for a path, describes the types of path and the requirements of path users. The main focus of this Guide is the geometric design of paths and related facilities such as intersections between paths, and terminal treatments. Detailed guidance is provided on path location, alignment, width, clearances, crossfall, drainage and sight distance requirements. This Guide provides complementary advice to that contained in the *Guide to Traffic Management* in relation to traffic management devices and requirements that may need to be accommodated within a roadside or may otherwise influence the design.

Summary

Table 2.3 provides an outline of the coverage of pedestrian issues in the Guide to Road Design.

Table 2.3: Coverage of pedestrian issues in the Guide to Road Design

Part of guide	Section	Material presented
Part 2 – Design Considerations	1.9	Providing for pedestrians in design
	2.4	Pedestrian activity and road functional use, influence on design
Part 3 – Geometric Design	1.5	Pedestrian safety in design for Safe System
	4.7	Various references to providing for pedestrian space in cross-section
	4.9	Pedestrian issues near public transport HOV lanes
	4.10	Pedestrian issues in on-street parking
	4.11	Footpaths
	Table 8.1	Vertical clearances for pedestrian paths
	Commentary 3	Pedestrian issues in operating speeds
Part 4 – Intersections and Crossings – General	Table 3.2	Pedestrian considerations in intersection design
	6.3.4	Pedestrian considerations at bus stops
	8	Pedestrian crossings – mid-block, refuges, kerb extensions, kerb ramps
	Table 8.1	Crossing features and considerations
	Commentary 5	Pedestrian refuges
	Commentary 6	Extended footpaths
Part 4B – Roundabouts	5	Pedestrian treatments at roundabouts
	Commentary 1	Pedestrian safety at roundabouts
Part 6 – Roadside Design	6.5.2	Road safety barriers for pedestrians
Part 6A – Pedestrian and Cyclist Paths	All	Planning and geometric design of pedestrian paths

2.1.4 Guide to Road Safety

The Guide to Road Safety addresses road safety management across a broad spectrum. There is little coverage of pedestrian issues. Table 2.4 summarises the most specific material.

Table 2.4: Coverage of pedestrian issues in the Guide to Road Safety

Part of Guide	Section	Material presented
Part 3 – Speed limits	3.2	Shared spaces and speed limits; reference is made to the fact that pedestrians have priority in shared zones
Part 4 – Local Government and Community Road Safety	1.5.1	Brief mention of responsibility for managing vegetation in the road environment so as not to force pedestrians off footpaths onto roads
	1.5.2	Duty of care includes ensuring pedestrian safety is not compromised, so there is a basic need to supply adequate lighting, and separation from vehicular traffic
	Table 1.1	Summary of local government contributions to road safety; includes matters above, and refers to role in developing policy for pedestrian safety
	1.9.3	Passing reference to supervised school crossing programs
	7.3.3	Brief mention of exploring the driver-pedestrian relationship as part of examining social capital outcomes and measures
Part 6 – Road Safety Audit	7.6	Coverage of pedestrian issues in auditing land use developments
	8.4	Brief general advice, in audit context, on designing for pedestrians, including acknowledgement of pedestrians with disabilities

2.1.5 Guide to Road Transport Planning

The Guide (Austroads 2009) develops a map of jurisdictional road transport planning processes with a particular focus at the road route and link level. It provides a best practice framework against which current road transport planning practice in Australasia may be assessed. It discusses elements and current trends in transport planning, and best-practice principles required to achieve environmentally and socially sustainable transport solutions. There is some limited consideration of pedestrian activity included in general discussion, but the focus is primarily on vehicular traffic.

2.1.6 Australian Standards

The Austroads Guides provide general advice and guidance on agreed best practice. Aspects of practice which are mandatory are specified in the relevant standards, and the Austroads Guides make reference to these standards for details where required.

The primary reference here is the Australian Standard AS 1742 *Manual of uniform traffic control devices (2009)*. Several Parts of that standard provide information on matters related to pedestrian facilities, as summarised below.

AS1742.10-2009 Pedestrian control and protection, specifies requirements for traffic control devices for the control and protection of pedestrians at facilities on roads including pedestrian and children's crossings, mid-block pedestrian actuated traffic signals, pedestrian refuges and malls.

AS1742.3-2009 Traffic control for works on roads, covers advice and requirements for pedestrian control at roadworks. This 2009 version has new material which needs to be referenced in GTM (Part 10). The new material covers:

- Introduction of the concept of mobile speed limits with special reference to protection of workers on foot during mobile works.
- Safety management of traffic and pedestrians on roadways temporarily converted from one-way to two-way traffic.

Pedestrian matters are covered in other Parts of AS 1742 as summarised in Table 2.5:

Table 2.5: Pedestrian matters covered in Australian Standards

Standard	Title	Pedestrian matters covered
AS 1742.4	Speed controls	Shared zones, school zones
AS 1742.7	Railway crossings	Pedestrian facilities at railway crossings
AS 1742.9	Bicycle facilities	Shared pedestrian/bicycle paths
AS 1742.14	Traffic signals	Pedestrian crossings at signalised intersections

The Australian Standard *AS 1428.1 Design for Access and Mobility – General Requirements for Access (2009)* specifies the design requirements for new building work, with particular attention to paths of travel, access and facilities for people with ambulatory and sensory disabilities and who use wheelchairs. *AS 1428.4.1 (2009)* sets out the requirements for the design and application of tactile ground surface indicators (TGSIs) to ensure the safety of people who are vision impaired.

2.1.7 New Zealand Guidance

The *NZ Pedestrian Planning and Design Guide* (NZTA 2007) is a comprehensive guide to planning and design for walking. This material represents the major regional development in guidance on pedestrian facilities since the *Guide to Traffic Engineering Practice – Part 13.*

The purpose of this Guide is to:

- improve the NZ walking environment
- provide a process for selecting pedestrian facilities
- provide design advice.

The Guide promotes a consistent world best practice approach to planning, design, operation and maintenance of walking network infrastructure. It applies to all new or existing, walking/pedestrian infrastructure along or across roads and off-road facilities. It is well illustrated with photographs and diagrams.

Reference to the *NZ Pedestrian Planning and Design Guide* is included in several Parts of the GTM as follows:

- GTM (Part 5), Table 3.1: Road space requirements for general traffic use – pedestrian space.
- GTM (Part 6), Table 3.3: Issues for different road user categories – issues and treatments for pedestrians; Table 8.1: Benefits of treatments – treatments, benefits and considerations for different categories of crossing facilities.
- GTM (Part 7), Section 3.3.1: managing travel demand and travel behaviour change.

Substantial reference is made to the NZ Guide in Austroads GRD Part 6A with regard to the planning and design of footpaths, in terms of physical requirements (space, clearances, dimensions).

Comparison of the content of the NZ Guide with related coverage of issues across the Austroads Guides is summarised in Table 2.6.

Table 2.6: Comparison of content – NZ Guide vs Austroads Guides

New Zealand Pedestrian Planning and Design Guide			Coverage in Austroads Guides		
Section	Chapter	Details	Traffic Management (GTM)	Road Design (GRD)	Road Safety (GRS)
Context	Planning and policy context (Ch.2) What is the environment for planning for pedestrians?	Transport and related strategies. Walking strategic plans.	Part 4 Part 7	Part 2	
Principles	Pedestrian characteristics, preferences and activity (Ch.3) How do pedestrians differ, and who walks, where and why?	Pedestrian speeds, space requirements, abilities, disabilities. Pedestrian activity – travel, recreation. Traffic safety issues – pedestrian vulnerability. Slips, trips, falls. 'Wheeled pedestrians'.	Part 4 Part 5 Part 7 Part 8 Part 10 Part 13	Part 3	Part 3 Part 4
	Community walkability (Ch.4) What makes walking attractive within communities?	Aspects of 'walkable' communities. Urban form issues and effects. Personal security issues.			
	Approaches to providing for pedestrians (Ch.5) What are the underlying ways to accommodate walking?	Road user hierarchy. Facilities inside and outside the road corridor. Environments – precincts, shared zones, main streets.	Part 4 Part 7 Part 11 Part 12	Part 2	Part 3
	Pedestrian network components (Ch.6) What type of facility can be used to provide for pedestrians?	Traffic reduction and calming. Footpaths, ramps, steps, shared paths, crossings. Selecting crossing facilities – level of service, safety, speed limits, access issues. School crossings. Islands, refuges, medians, platforms, zebra and signalised crossings, intersections, roundabouts, grade separation, rail crossings.	Part 3 Part 5 Part 6 Part 7 Part 8	Part 3	Part 3
Process	Planning for pedestrians (Ch.7) Which planning approach should be used?	Community plans. Workplace travel plans. School travel plans. Resource consent issues.	Part 7 Part 8 Part 12		

New Zealand Pedestrian Planning and Design Guide			Coverage in Austroads Guides		
Section	Chapter	Details	Traffic Management (GTM)	Road Design (GRD)	Road Safety (GRS)
Process (continued)	Pedestrian planning process (Ch.8) How do we implement the plan?	Objectives, stakeholders. Action plans. Implementation and monitoring.			
	Community involvement in scheme development (Ch.9) Does the walking environment meet the needs of pedestrians?	Techniques for community involvement in walking plans.			Part 4
	Assessing demand for walking (Ch.10) How many pedestrians want to walk and where?	Methods for assessing current and future demand for walking.			
	Measuring walkability (Ch.11) How is walkability assessed?	Desktop and on-site methods for assessing walkability. Community street reviews.			
	Prioritising schemes (Ch.12) Which walking schemes should be done first?	Methods for prioritising schemes for pedestrians.	Part 4		
	Implementation (Ch.13) How should the walking schemes be implemented?	Establishment and management of walking-related projects.			
Design	Footpaths (Ch.14) How do pedestrians move around?	Provision and detailed design of footpaths, ramps, steps, driveways, shared paths. Geometry, gradient, surfaces, clearances, landscape, street furniture.		Part 3 Part 6A	
	Crossings (Ch.15) How do pedestrians cross major obstructions?	Detailed design of crossing points, kerb crossings, islands, refuges, kerb extensions, platforms, zebra crossings, signalised crossings, intersections, roundabouts, school crossings, rail crossings.	Part 5 Part 6 Part 8 Part 9 Part 10	Part 4 Part 4B Part 6A	Part 6
	Measures to guide pedestrians (Ch.16) How are pedestrians guided to their desired destination?	Pedestrian signs (route, information). Physical channelling and fences.		Part 6 Part 6A	Part 4
	Lighting the pedestrian network (Ch.17) How is the pedestrian network illuminated?	Lighting for footpaths, off-road paths and crossing points.	Part 13	Part 6A	
	Maintaining the pedestrian network (Ch.18) How are pedestrian facilities kept in good order?	Maintenance of facilities. Pedestrian diversions at work sites.			

New Zealand Pedestrian Planning and Design Guide			Coverage in Austroads Guides		
Section	Chapter	Details	Traffic Management (GTM)	Road Design (GRD)	Road Safety (GRS)
Post-design	Monitoring pedestrian activity (Ch.19) Do walking schemes achieve their objectives?	Methods for measuring activity. Pedestrian surveys.	Part 3		
	Making best use of facilities (Ch.20) How can people be encouraged to walk?	Approaches to promotion and encouragement for walking.			
Appendices	Appendix 1 Characteristics of pedestrians	Characteristics of elderly, child, mobility-impaired, sensory-impaired, wheeled pedestrians.	Part 6 Part 7 Part 10	Part 6	
	Appendix 2 Signface design details	Details of sign lettering and symbols for pedestrian signs.			
	Appendix 3 Issues to address in district plans	General issues to be addressed from pedestrian facilities perspective.			
	Appendix 4 References	Comprehensive list (178 items) of relevant literature.			
	Appendix 5 Index	Alphabetical index with Section references.			

While the majority of the NZ Guide content is reflected in the Austroads Guides, omissions or lack of detail are noted in the following areas:

- pedestrian requirements and characteristics in terms of space, density and speeds
- the vulnerability of pedestrians to serious injury in traffic, and the extent of pedestrian injuries and deaths
- walkability issues – assessing the walking environment from the pedestrian and community perspective
- determining practical levels of service for pedestrians at various facilities
- developing and implementing walking strategies and plans, including community involvement
- promotion and encouragement of walking activity
- signposting of off-road pedestrian paths and routes
- maintenance of pedestrian facilities.

Some of these differences reflect the fact that the NZ Guide is in effect a manual for all aspects of walking and pedestrian facilities for that particular jurisdiction, whereas the Austroads Guides provide general guidance on road and transport issues (which include pedestrian matters) across the Australasian region.

Details of approaches to engaging the community in the development and implementation of strategies will need to be pursued in the context of policies specific to the jurisdictions concerned.

Similarly, jurisdictional strategies for encouraging walking need to be developed in alignment with the relevant government policies.

Pedestrian characteristics

As noted in Table 2.1, the Austroads Guides contain limited information on pedestrian characteristics, in terms of speeds and space requirements, as an input to pedestrian capacity considerations. The NZ Guide provides more comprehensive information on this, plus data (albeit for NZ only) on typical pedestrian journey times and distances.

Pedestrian safety

The NZ Guide presents useful summary and trend information on pedestrian traffic fatalities and injuries as recorded in NZ. The particular risk situations for children and the elderly are summarised. The Austroads guides would benefit from inclusion of similar information.

The vulnerability of pedestrians to serious injury in traffic is highlighted by reference to the probabilities of survival for different vehicle-pedestrian impact speeds, and the implications for speed limit setting and the provision of lower speed environments. There is no direct reference to the 'Safe System' approach, the basis of road safety strategies across Australia and NZ, as the NZ Guide predates the formal declaration of that approach in national road safety strategies.

The Austroads GRS provides the main source of information and guidance on the 'Safe System' approach – including specific reference to pedestrians – and this is reflected generally in the other Guides. However, it is acknowledged that there are further opportunities in the GRD and GTM to emphasise the approach in respect of pedestrian facilities and safety management.

Walkability

Of the above listed issues, the material on walkability is considered to be one of the more important in the context of defining areas for enhancement of the Austroads GTM. 'Walkability' is a descriptor used to indicate the extent to which the built environment is regarded as suitable or acceptable, in terms of physical and perceived attributes, for walking; that is, an indication of the quality of the walking environment.

The NZ Guide contains useful guidance on measuring walkability. It points to the need to combine both desktop analyses (of pedestrian desire lines and route connectivity) and on-site assessments (involving technical audits and pedestrian ratings) of routes and facilities. This has led to the development of community street reviews (NZTA 2010). These reviews combine the community street audit approach, which identifies deficiencies and opportunities for improvements, with a user perceptions rating system. The procedure rates the environment with respect to overall walkability, as well as more detailed characteristics such as safety, security, obstacles, delay, impedance by others, directness of route, and ambience.

Further work (Abley & Turner 2011) has been undertaken for NZTA to assist in quantifying the quality of a walking environment. That research has provided formulas for predicting the quality of the walking environment from the perspective of pedestrians, using operational and physical variables. These were derived by combining the perception data gathered from participants in community street reviews with measurements of the walking environment, and covered both walking along a street and crossing the street.

Level of service

Another issue of importance for enhancement of the GTM is the assessment of factors for determining relative levels of service for pedestrians, as input to the selection of appropriate crossing facilities. The NZ Guide presents useful information on the development of an approach to this going beyond the traditional method of using numerical warrants based only on traffic and pedestrian flows. A more comprehensive and context sensitive approach is outlined, considering also safety and delay issues.

Further discussion is presented in Section 3.5.1.

It should be noted that the information on the assessment of walkability and level of service as presented in the NZ Guide is based on research undertaken in NZ, and that further work to refine the material is recommended (Abley & Turner 2011). Its applicability beyond NZ is yet to be tested. Nevertheless, the approach is conceptually sound and the Austroads Guides would benefit by including reference to this material.

2.1.8 Developments in Australia

In recent years there have been several developments in policy and strategic planning initiatives in Australian jurisdictions aimed at giving greater recognition to walking activity in the transport sector. These have been associated with various documents giving guidance on strategies, provision and management of pedestrian facilities in the road/transport environment.

The Australian documents regarding walking strategy, and some related technical guidance documents, are presented in Table 2.7.

The approaches taken in the strategies are outlined in the material at the reference sites listed. Common features of the walking strategies are:

- a multi-agency (health, planning, transport) approach to development of an 'active living' vision
- acknowledgement of the health, social, economic and environmental benefits of walking
- the need to plan and develop infrastructure facilities which increase the appeal for walking as a transport mode and recreational activity.

It is to be noted that several of the substantive documents are in draft format and not yet formally released. In some instances, papers and reports documenting research and consultation activities contributing to strategy developments have been completed. Some of these are available through the websites listed; others have not been released and are not available for citing.

Guidelines relating to the provision of facilities and assessment of level of service for pedestrians are discussed further in Section 3.

It is acknowledged that many transport-related strategies and plans embodied in documents such as those listed in Table 2.7 are subject to changes in government policies and directions. Direct reference to these in the Austroads Guides might therefore be short-lived. A suitable approach would be to ensure that the basic strategic thrust of contemporary initiatives is captured in the Guides, with a caveat that details may change in accordance with changes in jurisdictional policies.

International guidance has been sought on the planning and development of many Australian cities with a focus on providing a better environment for 'active living' activities such as walking and cycling. For example, case studies of most Australian capital cities (Gehl Architects 2011) offer suggestions for addressing pedestrian issues in reshaping the city environments for more sustainable development.

Table 2.7: Developments in Australia regarding walking strategy

Jurisdiction	Documents	References
ACT	Transport for Canberra – Transport for a Sustainable City 2012–2031	www.tams.act.gov.au/move/sustainable_transport
NSW	NSW Walking Strategy (under development)	www.pcal.nsw.gov.au/draft_nsw_walking_strategy
	Pedestrian Access and Mobility Plans (PAMP)	www.rta.nsw.gov.au/doingbusinesswithus/lgr/downloads/programs/pedestrians.html
Vic	Walking and Cycling Literature Review	www.transport.vic.gov.au/__data/assets/pdf_file/0004/31369/WalkingCyclingLiteratureReview.pdf
	Smart Roads Connecting Communities Smart Roads Program Guidelines	www.vicroads.vic.gov.au/Home/TrafficAndRoadConditions/HowWeManageTraffic/Smartroads/
	Inner Melbourne Action Plan – Greenlight Project	www.imap.vic.gov.au
Qld	Action Plan for Walking 2008-2010	www.tmr.qld.gov.au/~/media/48567c2a-cf0c-4580-9626-255bef76378c/pdf_walking_action_plan.pdf
	Guidelines and Prioritisation Procedure for Pedestrian Facilities	www.tmr.qld.gov.au/~/media/1e04a428-c039-4b1c-9a78-ba518cd71091/3_13.pdf
WA	Walk WA: A Walking Strategy for Western Australia 2007–2020	www.beactive.wa.gov.au/index.php?id=350
	Planning and Designing for Pedestrians – Guidelines 2011	www.transport.wa.gov.au/mediaFiles/AT_WALK_P_plan_design_pedestrians_guidelines.pdf
	Walkability Audit Tool 2011	www.transport.wa.gov.au/mediaFiles/AT_WALK_P_Walkability_Audit_Tool.pdf
SA	30-Year Plan for Greater Adelaide 2011	www.dplg.sa.gov.au/plan4adelaide/index.cfm
	Streets for People – Compendium of Practice (Draft)	www.health.sa.gov.au/pehs/branches/health-promotion/21%20Watts-PHCS-HPB-20111212.pdf
	Guidelines for Disability Access in the Pedestrian Environment	www.dpti.sa.gov.au/standards/tass
Tas	Walking and Cycling for Active Transport Strategy	www.dier.tas.gov.au/passenger_transport/tasmanian_walking_and_cycling_for_active_transport_strategy

2.1.9 Pedestrian Facility Trials

The increased interest in strategic planning for walking, and provision of related facilities, has been accompanied by some further examination of details of pedestrian facilities in recent years, seeking ultimately to develop further the available guidance.

For example, pedestrian countdown timers and pedestrian signal phasing changes have been investigated at signalised facilities.

Pedestrian countdown timers (PCTs), providing users with information on the available crossing time remaining, are used widely in some European countries and are now mandated for use in the USA for all new traffic signal installations. A review of international experience (Levasseur & McTiernan 2010) indicated there was merit in trialling their application in Australia.

A trial in Melbourne (Cairney et al. 2010) included video surveys to investigate the effect of the PCTs on pedestrian behaviour and compliance, and intercept surveys to determine the views of crossing users. It was concluded that there was no reliable indication of an improvement in pedestrian behaviour or a reduction in risk to pedestrians following installation of the PCTs.

An investigation of trial PCT installations in Sydney (Levasseur & Brisbane 2011) concluded that there was no net improvement with regard to safety or compliance, but an increased amenity for pedestrians arising from reduced delay at crossings was suggested.

In NZ, a trial of PCTs was undertaken at a signalised intersection that operated using scramble pedestrian phasing. Results of the study (Wanty & Wilkie 2010) were inconclusive, but pointed to a reduction in compliance which suggested a potential reduction in safety. A further trial with amended pedestrian phase timings was recommended.

No definitive guidance for PCT installations in Australia has yet emerged. It is understood that trials of PCTs are to commence in Western Australia.

A limited trial of a Puffin pedestrian crossing installation was undertaken in NZ (King 2009). The Puffin crossing, where pedestrian presence on the crossing is detected and crossing timings adjusted accordingly, was installed with nearside displays for pedestrians. It was concluded that Puffin crossings offered advantages over normal signalised midblock crossings and that the nearside displays gave rise to better user compliance than did the usual far-side displays. A separate evaluation (Murray & Walton 2009) confirmed this.

Puffin crossings are used in Queensland (QDMR 2002) and Victoria (VicRoads 2008) and are undergoing trials in NSW.

2.2 International Guidance

2.2.1 Walk21 Movement

The Walk 21 conference proceedings over the last few years (www.walk21.com) have proven to be a valuable source of information, especially with reference to the release of major documents for the ‘Pedestrian Quality Needs’ (PQN) project and the PUSH project.

The Walk 21 movement has been instrumental in fostering the development of the International Charter for Walking (www.walk21.com/charter/default.asp), and encouraging its implementation in major world cities. The Charter identifies the needs of people on foot and provides a common framework to help authorities refocus their existing policies, activities and relationships to create a

culture where people choose to walk. It sets out strategic principles for adoption to this end, and lists actions that can be taken to encourage walking in cities and foster healthier communities.

In Australia, the ACT Government is a signatory to the International Charter for Walking and has undertaken Walk21 benchmarking for Canberra, details of which are given in SKM (2011).

During the course of this project, the opportunity was taken to attend the Walk21 Conference and discuss developments with researchers.

2.2.2 Pedestrian Needs Study

The report for the Pedestrian Quality Needs (PQN) project was finalised in November 2010, and released at the Walk 21 Conference at that time (Methorst et al. 2010). Details are available at www.walkeurope.org. The complete documentation is also available on CD, a copy of which has been obtained.

The project addressed the presence and behaviour of pedestrians in public spaces, mobility, safety and health aspects, and the physical and social environment. It showed that walking is very complex and there is more to it than just as a transport mode. The project report provides recommendations including guidelines for national/state/local governments, practitioners and non-government organisations.

Separate Working Group reports under the PQN project addressed aspects of walking as follows:

Exploring pedestrian needs and behaviour – PQN Working Group 1

Two basic types of mobility were identified – walking from A to B as a total trip, and walking as part of another trip, which may involve other transport modes. There is also the activity known as sojourning, involving the social aspects of walking such as standing, conversing, looking and resting. Safety and personal security issues also present an important influence on walking activity. It was acknowledged that comprehensive data sets are needed to measure all characteristics of walking.

Perceived needs – PQN Working Group 2

Identification of pedestrian needs was acknowledged as a complex issue from the methodological perspective, and in terms of capturing the relevant context, and physical and social interaction aspects of walking. Many factors contribute to the fulfilment or frustration for different groups of walkers. Traditional methods of measuring pedestrian activity are not always appropriate, and there is a need to engage walkers directly to understand their needs. The needs and abilities of both active and potential walkers need to be considered, and used in marketing approaches which encourage walking.

Future of walking – PQN Working Group 3

People, spaces and energy are the basic aspects emerging in consideration of the future of walking in cities. A mixture of forecasting and back-casting can be used to estimate the walking scene in 2030. Factors such as ageing societies, health/wellbeing trends, and the focus given to leisure and tourism activities need to be taken into account. Trends in urban sprawl and renewal, changes in residential density, and different foci on city centre vs peripheral development are basic considerations. A basic policy implication is to place pedestrians and walking at the centre of future visions for cities and their public spaces.

2.2.3 PUSH Project

This study (OECD & ITF 2011) assembles evidence on pedestrian activity and safety, based on a global review. It acknowledges that while walking is the most natural form of mobility, cities have not always evolved to accommodate the needs of pedestrians and walking has in many cases been neglected in the development of transport systems. The study suggests that improving the pedestrian environment can contribute significantly to meeting the challenges of climate change, air pollution and health.

The report presents evidence on the importance of walking in transport policies, and provides guidelines for developing a safe environment conducive to walking, as an essential contribution to creating liveable cities. Recommendations are made in respect of policies, planning, provision and management of walking facilities, with a particular focus on pedestrian safety, and with implications for the development of initiatives to encourage more walking.

2.2.4 AASHTO Pedestrian Facilities Guide

The '*Guide for Planning, Design and Operation of Pedestrian Facilities'* (AASHTO 2004) is a substantial compendium on planning for pedestrians (including coverage of traffic management approaches and initiatives), designing the pedestrian environment and facilities, and the operation and management of facilities such as signals, signs and footpaths.

The main sections cover planning, design of facilities, facility operations and maintenance which:

- provide guidance for pedestrian facilities along streets and highways
- identify measures for accommodating pedestrians
- recognise land use planning and site design effects on pedestrian mobility.

The Guide also provides good general guidance and refers to other major US documents such as:

- The 'Greenbook' – *Policy on Geometric Design of Highways and Streets* (AASHTO 2011) - for general direction and road design context on facilities design
- The *Manual of Uniform Traffic Control Devices* (FHWA 2009) for general direction on relevant traffic control devices, warrants, design for pedestrian signs/signals
- The *Highway Capacity Manual* (TRB 2010a) for direction on LoS for pedestrians on various facilities
- The *Uniform Vehicle Code* (NCUTLO 2000) for traffic laws for pedestrians.

It is noted that there are now available more recent editions of the documents than those referred to in the 2004 pedestrian facilities guide. The most recent references are listed above.

The guide is based on all US reference material and represents a North American parallel to material covered in the earlier GTEP Part 13.

The content is well documented and illustrated, including basic design information for existing and new facilities, and advice on neighbourhood traffic management and traffic calming.

2.2.5 Pedestrian Safety Manual

A pedestrian safety manual is currently being developed by a consortium of global organisations led by the World Health Organisation (WHO). It is intended to be an addition to the series of Good Practice Manuals published by the Global Road Safety Partnership (see www.grsproadsafety.org/our-knowledge/good-practice-manuals).

It will consolidate and summarise material from many countries, primarily those with well-developed safety management experience, and offer guidance to practitioners and decision makers on pedestrian safety management.

It will cover the transport and planning context of the pedestrian safety situation, and summarise the current extent of the problem area. In a structure similar to that of other global safety manuals, the manual will provide advice on the preparation, implementation and evaluation of pedestrian safety programs. It is understood that the manual is scheduled to be released in late 2013.

2.2.6 UK Guides

A notable example of initiatives addressing the pedestrian environment is the report *Transport for London, Improving Walkability* (Transport for London 2005). This guide highlights the importance of securing high quality improvements to the walking environment, including all streets and spaces that are used by the public, and shows how new developments provide opportunities to achieve such improvements. It is a good practice guide to improving the 'walkability' of the streets, squares and other public spaces.

In the residential context, the UK Manual for Streets (DfT 2007) emphasises that streets should be places in which people wish to live and be active, not just transport corridors. In particular, the manual aims to reduce the impact of vehicles on residential streets and gives a high priority to the needs of pedestrians, cyclists and users of public transport. It sets out an approach to residential streets that recognises their role, shows how the design of residential streets can be enhanced and demonstrates the benefits of good design to the users. While its scope is limited to residential and other lightly trafficked streets, some of its principles may be applied to other road types where appropriate.

A variant on the shared zone concept, known as a 'shared space', has been developed in recent years. Shared spaces are typified by removal, or at least reduction, in traffic control devices, and the reduction or removal of clear demarcation of separate vehicle and non-motorised areas. The concept has been applied across a broad range of street types in the UK, and details of design features have been similarly varied. Normal priorities between vehicles and pedestrians apply, but the design and appearance of the environment encourages sharing. Recent developments in application of shared spaces in the UK are documented in a comprehensive guide (DfT 2011) which presents the principles of the facilities, the needs and behaviour of the road users (pedestrians, cyclists, vehicle drivers), the development of shared space schemes, and detailed advice on design.

3 GUIDANCE ON LEVEL OF SERVICE

3.1 Definition

The Austroads Guide to Traffic Management Part 3 defines Level of Service (LoS) as a 'qualitative measure for ranking operating conditions, based on factors such as speed, travel time, freedom to manoeuvre, interruptions, comfort and convenience'. Definitions are provided defining six levels of service designated A to F (Table 3.1).

The definitions provided in this table are defined using drivers or vehicles, and are taken to be generally applicable to other types of users and traffic units. However, the increasing attention being paid to the provision of pedestrian facilities, together with better understanding of pedestrian needs and perceptions of the walking environment, raises basic questions as to how well the LoS for pedestrians can be assessed from the traditional approach.

Table 3.1: Level of Service definitions

LoS	Description
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with level of service A.
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.
F	In the zone approaching forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

Source: Austroads (2008–2009).

3.2 LoS Guidance in GTM

GTM Part 3 provides further guidance for determining LoS for different types of traffic facilities, including uninterrupted conditions (i.e. single lane flow, two-lane two-way road, multi-lane roads and freeways), interrupted conditions (i.e. those with control features or geometry which force vehicles to stop or queue) and intersections (signalised, unsignalised and roundabouts). This guidance is based on material in the US Highway Capacity Manual (HCM).

The HCM is the predominant reference used internationally to define LoS and provides details on associated measurement and analysis. The material on LoS provided in the existing edition of GTM Part 3 is based on the guidance contained in the 2000 edition of the HCM (TRB 2000).

GTM Part 3 contains no direct guidance on LoS for pedestrians other than a table adapted from HCM 2000 which indicates the general service and performance measures to be considered for pedestrians (space, speed and delay). This reflects the general treatment of pedestrian LoS material in HCM 2000 where pedestrian traffic is considered in a manner primarily in parallel with that for vehicular traffic.

A brief discussion is also included in GTM Part 3 on the need to consider pedestrian traffic in the planning and design of networks, in the context of its effect on road capacity.

The 2010 version of the HCM has recently been published (TRB 2010a) and presents significant additional material on determination and analysis of LoS, particularly for pedestrians, as discussed in Section 3.4.

3.3 Highway Capacity Manual 2000

3.3.1 Pedestrian Flow

The Highway Capacity Manual 2000 defines the concepts of capacity and level of service (LoS) and presents methods for analysing these for a broad range of facilities across streets and highways, intersections and pedestrian and cyclist facilities.

For pedestrians, the primary material is:

- Chapter 11 which defines the concepts for pedestrian activity and LoS
- Chapter 18 which provides methodologies for assessing pedestrian facilities.

Chapter 11 outlines the principles of pedestrian flow, and defines the basic variables (see Table 3.2).

Table 3.2: Key terminology for pedestrian flow

Term	Description and units
Pedestrian speed (S)	Average pedestrian walking speed, measured in metres per second (m/s)
Pedestrian flow rate	Number of pedestrians passing a point per unit of time, expressed as pedestrians per minute
Pedestrian unit flow rate (v)	Average flow of pedestrians per unit of effective walkway width, expressed in pedestrians per minute per metre v = S * D = S / M
Pedestrian density (D)	Average number of pedestrians per unit of area within a walkway or queuing area, expressed as pedestrians per square metre
Pedestrian space (M)	Average area provided for each pedestrian in a walkway or queuing area, expressed in terms of square metres per pedestrian. This includes the basic plan ellipse plus consideration of forward space.

Source: TRB (2000).

Other measures relating to pedestrian flow include interaction with crossing or opposing main stream flows, and delays at intersections. Additional factors contributing to the perceived LoS for pedestrian facilities are acknowledged as:

- comfort (weather protection, climate control, shelter)
- convenience (walking distance, path directions, grades, signing information)
- economy (costs from delays and queuing)
- safety (physical and temporal separation from vehicular traffic)
- security (lighting, open sight lines).

The relationships between pedestrian space requirements, flow rates and walking speeds are presented, and indicative practical values for these and start-up times and capacity are given. The effects of bunching and platooning of pedestrians are also outlined. Pedestrian platoons are defined in a manner similar to that for vehicle flow.

The LoS criteria for pedestrians are developed primarily in terms of space, flow rates, speeds and delays – which are readily measurable – and input data requirements also include geometric features such as footpath length and width, corner radii and crosswalk dimensions. While the more subjective aspects of the walking environment such as those listed above are acknowledged, they are not taken directly into account in determining pedestrian LoS.

HCM sets out the LoS criteria for pedestrians on a walkway, in terms of space and average flow rates (see Table 3.3) following the traditional approach used for vehicular traffic. This is based on the original theoretical work of Fruin (1987), an earlier version of which appears in the previous Austroads GTEP 13.

Table 3.3: Pedestrian levels of service on a walkway

Level of service	Description
A	*Pedestrian Space* > 5.6 m^2/p *Flow Rate* ≤ 16 p/min/m At a walkway LoS A, pedestrians move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely.
B	*Pedestrian Space* > 3.7–5.6 m^2/p *Flow Rate* > 16–23 p/min/m At LoS B, there is sufficient area for pedestrians to select walking speeds freely, to bypass other pedestrians, and to avoid crossing conflicts. At this level, pedestrians begin to be aware of other pedestrians, and to respond to their presence when selecting a walking path.
C	*Pedestrian Space* > 2.2–3.7 m^2/p *Flow Rate* > 23–33 p/min/m At LoS C, space is sufficient for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.
D	*Pedestrian Space* > 1.4–2.2 m^2/p *Flow Rate* > 33–49 p/min/m At LoS D, freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse flow movements face a high probability of conflict, requiring frequent changes in speed and position. The LoS provides reasonably fluid flow, but friction and interaction between pedestrians is likely.
E	*Pedestrian Space* > 0.75–1.4 m^2/p *Flow Rate* > 49–75 p/min/m At LoS E, virtually all pedestrians restrict their normal walking speed, frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Cross- or reverse flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow.
F	*Pedestrian Space* ⩽0.75 m^2/p *Flow Rate* varies p/min/m At LoS F, all walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrians. Cross- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Source: TRB (2000).

3.3.2 Pedestrian Facilities LoS

Chapter 18 deals with the capacity and LoS analysis of pedestrian facilities. These include walkways, footpaths, queuing areas, off-street paths, crosswalks and facilities along urban streets.

These are categorised by uninterrupted-flow facilities (pedestrian paths, shared paths and queuing areas, where pedestrians are not disrupted by other vehicular traffic) and interrupted-flow facilities (signalised and unsignalised intersections, and footpaths along urban streets which have elements of both interrupted and uninterrupted flow).

Methods of analysis are provided for these different facilities and LoS criteria are derived for each facility type. The procedures include determination of walking speed and the effective walkway width, and LoS criteria are presented in terms of space, flow rates, speed and/or delay, as applicable. Worked examples – with worksheets – are included.

The calculations do not include any direct consideration of the factors which contribute to pedestrian perceived levels or quality of service. However, it is acknowledged that input data may be estimated or derived to reflect local conditions (and this may well capture some elements of perceived LoS) rather than using the default values in the HCM.

3.4 Highway Capacity Manual 2010

3.4.1 Overview

The HCM 2010 was released in March 2011. The 2010 edition incorporates the results of considerable research activity undertaken in the decade since the publication of the 2000 edition. This has come largely from extensive National Cooperative Highway Research Program (NCHRP) work that has focused on HCM methods and procedures.

It should be noted that whereas a metric unit version of the HCM 2000 had been available, there is no metric version of the HCM 2010 edition.

A major input of direct relevance to pedestrian LoS assessment has been provided by NCHRP Project 3-70, *Multimodal Level of Service Analysis for Urban Streets*, documented in NCHRP Report 616 (TRB 2008). The objective of that project was to develop a framework and enhanced methods for determining levels of service for cars, public transport, bicycle and pedestrian modes on urban streets, with particular reference to the interaction among the modes.

An overview of the development of material for HCM 2010, with a particular focus on LoS, is given by Roess et al. (2010) It is pointed out that one of the main motivations for the NCHRP 3-70 research project was the need to consider the role of user perceptions in determining LoS for various facilities. This recognised that user perceptions are heavily influenced by non-operational factors, such as environmental and aesthetic considerations – especially for pedestrians.

Further details of studies relevant to the assessment of pedestrian facilities and the determination of pedestrian levels of service are given in the literature review in Section 4 of the present report.

HCM 2010 is divided into four volumes (concepts, uninterrupted flow, interrupted flow and an applications guide). There are no chapters dealing exclusively with pedestrians (or other single modes). The main chapters relating to pedestrians are outlined in Table 3.4:

Table 3.4: Pedestrian LoS information in HCM 2010

Chapter	Content
Chapter 3 – Modal characteristics	Section 3 (Pedestrian Mode) summarises the needs of pedestrians, pedestrian facilities and interactions with other modes.
Chapter 4 – Traffic flow and capacity concepts	Section 3 (Pedestrian Mode) summarises pedestrian calculations, flow parameters, pedestrian facility calculations and capacity concepts.
Chapter 5 – Quality and LoS concepts	Outlines quality of service from traveller perspectives, and factors affecting those. Provides a basic outline of LoS for different modes, and measurements, for specific modes and different facility and roadway types, especially including urban streets and off-street facilities.
Chapter 16 – Urban street facilities	Outlines a multimodal approach to LoS on urban street facilities including an overview of the method and required input data for different modes. Describes a method for evaluating performance of urban street facilities for pedestrians in terms of space, speed and other considerations.
Chapter 17 – Urban street segments	Provides a method for determining capacity and quality of service for travelling along an urban street. Considers different travel modes, LoS criteria and required input data for different modes. Includes an evaluation method for segments.
Chapter 18 – Signalised intersections	Describes methods for evaluating the performance of signalised intersections related to pedestrian service (similar to the HCM 2000 method).
Chapter 19 – 2-way stop-controlled intersections	Provides a similar method to Chapter 18, but for this type of facility (similar to the HCM 2000 method).
Chapter 21 – Roundabouts	Includes limited discussion regarding pedestrians and suggests using the Chapter 19 method, considering results with a degree of caution.
Chapter 23 – Off-street pedestrian and bicycle facilities	Provides capacity and LoS estimation procedures for off-street facilities (e.g. walkways, paths, ramps, plazas, stairways and shared paths with cyclists, runners, skaters, or other user types).

3.4.2 Determining Level of Service

HCM 2010 considers assessment of the LoS of road or highway facilities from a substantially different approach. The substantial change is inclusion of a multimodal level of service approach, which recognises that different mode users could perceive the quality of service differently due to their different perspectives and experiences. This approach considers the different road user perspectives for vehicles (cars), public transport, pedestrians and cyclists.

A facility can be assessed by determining the LoS score for each of the modes, and comparing the numerical scores against the LoS criteria. An overall LoS is not calculated. Judgments on the selection or development of the facility must be made on the basis of the different modal scores, and additional relevant information (e.g. safety performance), depending on the function intended for the roadway concerned. This necessarily involves consideration of how one mode affects the service quality of other modes, and trade-offs between modes.

The method includes a complete street analysis approach for interrupted flow facilities (segments and crossings, including at roundabouts). Emphasis is placed on ‘quality of service’ to consider how well a facility or service operates from a user’s perspective.

The HCM 2010 presents pedestrian LoS criteria in the context of the multimodal LoS approach, with underlying calculations incorporating factors reflecting pedestrian perceptions, preferences and behaviour as indicated by research studies. Less emphasis is placed on pedestrian density and space factors than was previously the case. Details of the computational methods are given in the NCHRP Report 616 (TRB 2008) and in the electronic Volume 4 *Applications Guide* of the HCM 2010.

3.5 Local Guidelines

The LoS concept for facilities from the pedestrian perspective has been developed in some jurisdictions as outlined in the following sections.

3.5.1 New Zealand

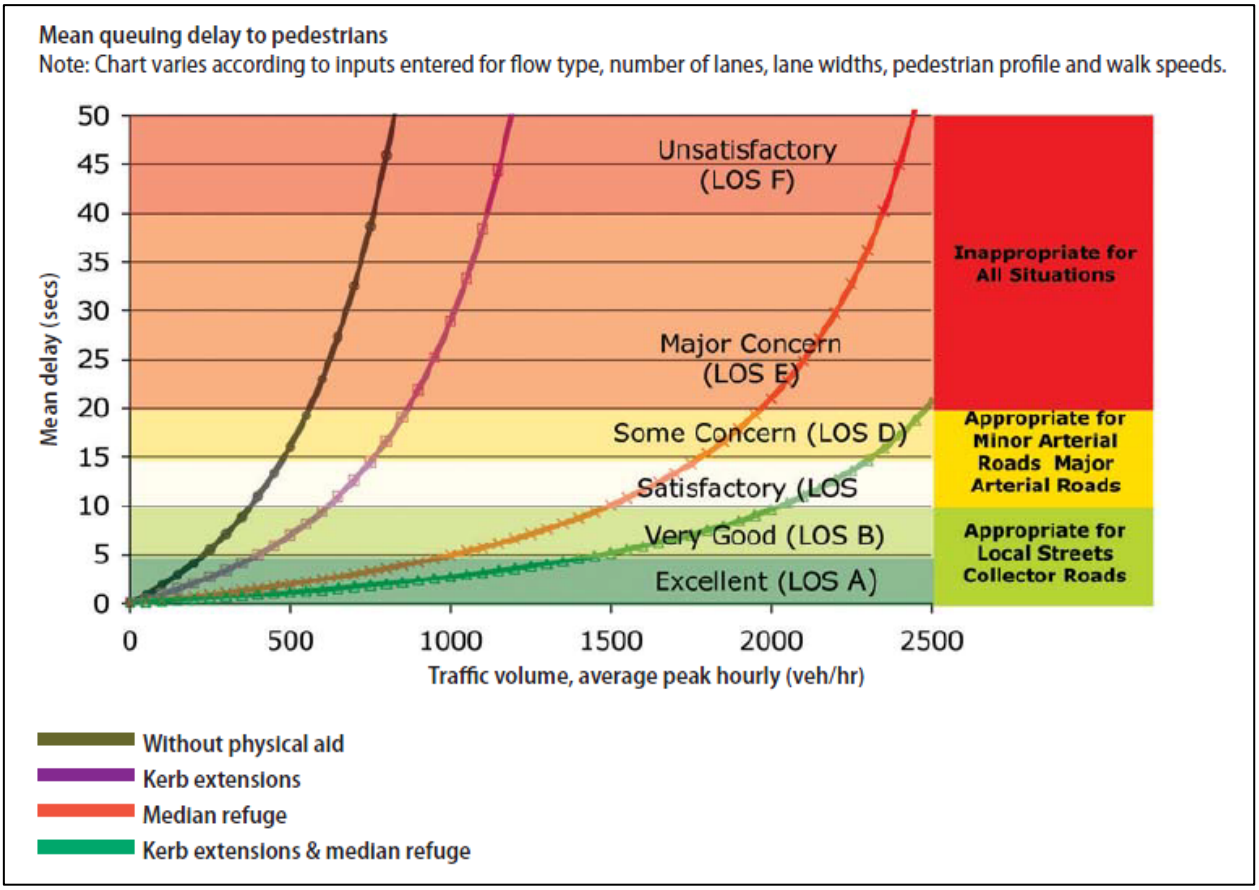
The NZ Pedestrian Planning and Design Guide is summarised in Section 2.1.7, with an outline given in Table 2.6.

The Guide includes (Chapter 6) a description of the procedures developed for selecting appropriate crossing facilities, based firmly on the LoS concept. The approach considers a wide range of factors and involves a complex system of decision trees and calculations. This led to the development of a spreadsheet tool (Tate & Waibl 2007) to calculate and compare levels of service for various proposed crossing facilities or improvements.

The guide contains example figures emanating from the spreadsheet analysis, based on inputs for flow type, lane numbers and widths, pedestrian characteristics and walk speeds. These present the relationships between pedestrian delay and traffic volume for various crossing facilities and enable an assessment of levels of service in terms of pedestrian delay. An example is reproduced as Figure 3.1.

Relative crash reduction factors for the various facilities may be used also to assist in selection of the most appropriate facility.

This approach differs from the traditional method of numerical warrants based primarily on traffic and pedestrian flows. It allows judgments to be made from a broader perspective, considering safety and delay issues. Further NZ work on development of measures to assess walkability of the pedestrian environment and information from community street reviews (see Section 2.1.7) will allow incorporation of additional user perceptions and a refinement of the procedure and the LoS criteria.



Source: NZTA (2007).

Figure 3.1: Mean delay for various crossing facilities on a two-lane, two-way urban road (uninterrupted flow)

3.5.2 Queensland

A procedure for the assessment and selection of pedestrian crossing facilities and prioritisation of sites for treatment has been developed in Queensland, and incorporated into a technical manual (QTMR 2011). A description of the initial approach and development of the procedure is given in Setter and Stewart (2002).

The procedure uses a series of spreadsheets to define levels of service in terms of the primary factor of delay to pedestrians attempting to cross the road (see Table 3.5), and to capture information on features of the location and facility under consideration. Points are generated for the defined LoS, and additional points are generated to modify the scores to account for other factors such as pedestrian volumes, pedestrian characteristics, crash history, restricted visibility, proximity of other crossings, network and connectivity factors, and local traffic impacts.

Guidelines are provided relating the point scores to various crossing facilities, and giving guidance on the application of the facilities, their advantages and disadvantages. Judgments may then be made on the selection of an appropriate facility or treatment of the location.

The procedure provides a more comprehensive and meaningful method of selecting or assessing a pedestrian facility than does the traditional method of numerical warrants based only on vehicular and pedestrian volumes.

Table 3.5: Pedestrian Level of Service for uninterrupted traffic flows

Average time between suitable gaps (s)	LoS	Classification	Description
< 10	A	Excellent	Pedestrians are able to cross almost immediately upon arrival at the crossing point.
10 – 20	B	Very good	Most pedestrians are able to cross with little delay. Average ped delay ≤ 10 sec. 95-percentile worst case delay ≈ 40 sec.
20 – 30	C	Satisfactory	Most pedestrians are able to cross within an acceptable period. Average ped delay ≤ 15 sec. 95-percentile worst case delay ≈ 60 sec.
30 – 40	D	Some concern	Some pedestrians have to wait longer than desirable for a gap. Average ped delay ≤ 20 sec. 95-percentile worst case delay ≈ 80 sec.
40 – 80	E	Major concern	Most pedestrians have to wait longer than desirable for a gap. Average ped delay ≤ 40 sec. 95-percentile worst case delay ≈ 160 sec.
> 80	F	Unsatisfactory	Most pedestrians have to wait longer than acceptable for a gap. Average ped delay > 40 sec.

Source: QTMR (2011).

3.5.3 Victoria

The SmartRoads program developed in Victoria (see Table 2.7) aims to better manage the use of roads and better link transport to adjacent land use. Guidelines for the implementation of SmartRoads (VicRoads 2010) set out a road user hierarchy and present guiding principles for the different transport modes (public transport, freight, pedestrians, cycling, general traffic, etc.). The different modes have different operating objectives, and these influence the applicable Level of Service definitions. For pedestrian LoS the approach taken is to consider crossing opportunities and ease of crossing, which can be defined in qualitative and quantitative terms. The SmartRoads guidelines describe the LoS for pedestrians as shown in Table 3.6.

Table 3.6: Level of Service for pedestrians

LoS	Description
A	Crossing opportunities are within 25 m of demand. Minimal delay in crossing.
B	Crossing opportunities are within 50 m of demand. Average delay before being able to safely cross is less than 30 sec.
C	Crossing opportunities are within 100 m of demand. Average delay before being able to safely cross is less than 45 sec.
D	Crossing opportunities are within 200 m of demand. Average delay before being able to safely cross is less than 60 sec. Significant numbers of pedestrians start crossing illegally.
E	Crossing opportunities are within 400m of demand. Average delay before being able to safely cross is less than 90 sec.

LoS	Description
F	Crossing opportunities are more than 400m from demand. Average delay before being able to safely cross is more than 90 sec.

Source: VicRoads (2010).

3.6 Implications for Austroads Guides

The primary implication arising from consideration of the material available on pedestrian level of service is that the Austroads Guides need to present more advice and guidance. This needs to cover the following:

- basic considerations of pedestrian flow in determining pedestrian LoS
- acknowledgement of the influence of other factors which significantly influence pedestrian perceptions of LoS
- reference to the multimodal approach to LoS contained in the HCM 2010
- summary material on Australian and New Zealand work in developing practical LoS criteria for pedestrian facilities, and related procedures for selecting and assessing those facilities.

The main implications are for the Guide to Traffic Management (GTM) Part 3, which presents the basic material on capacity and LoS, and Part 6, which presents material on pedestrian crossings of roads. Additional material would also be relevant in GTM Part 5 on allocation of space in the road corridor, and in GTM Part 8 on pedestrian facilities in local area traffic management.

4 LITERATURE REVIEW

4.1 Scope

The main focus for the literature review was the provision and assessment of pedestrian facilities with regard to 'level of service' (or 'level of comfort') provided.

The review was conducted using the resources of ARRB Group's M.G. Lay Library, the leading land transport library in Australia.

The purpose of this literature review was to identify published research or related developments and practices regarding the planning, provision and assessment of pedestrian facilities, their adoption (or potential for inclusion) in relevant guidance documents and to assist in determining possible amendments necessary to Austroads Guides.

The literature search covered two main areas of interest:

- studies undertaken in recent times on pedestrian perceptions of service, comfort, security, attractiveness, walkability, etc. and how best to incorporate such issues into quantifiable measures of levels of service, and into design guidance
- the concepts and tools for measuring and assessing levels of service and capacity of pedestrian facilities.

The keywords and scope used to examine the extensive literature included the following:

- facilities such as footpaths, sidewalks, shared paths, pedestrian precincts/malls, queuing areas, crossings (midblock, intersections)
- development of algorithms, formulae relating pedestrian perspectives to physical characteristics of facilities
- pedestrian perspectives to cover level of service, level of comfort, safety (both road safety and personal safety/security)
- possible climatic/weather influences on pedestrian behaviour and use of facilities
- derivation/measurement of pedestrian speed/flow relationships and behaviour for different facilities
- considerations for pedestrians with disabilities
- techniques to assess/evaluate pedestrian facilities from efficiency, comfort, space, safety viewpoints
- special considerations at roundabouts, intersections (signalised and unsignalised), rail crossings and tram stops
- multi-modal assessment of traffic facility capacity
- latest developments in pedestrian LoS-related matters.

4.2 Sources

The M.G. Lay Library resources included the library's own comprehensive collection of technical land transportation literature and information retrieval specialists with extensive experience in the transport field, as well as access to the collections and expertise of other transport related libraries throughout Australia and internationally.

Used in this literature search were the Australian Transport Index (ATRI), TRANSPORT and Transportation Research Information Services (TRIS) databases, whose content is coordinated by ARRB, the OECD/ECMT and the U.S. Transportation Research Board respectively. Use of these databases ensured wide coverage of quality research material within the subject area from national and international resources.

4.3 Pedestrian Activity

4.3.1 Defining and Measuring Walking

Walking is a complex activity and its measurement has been the subject of considerable development under the PQN project (Methorst et al. 2010). Refer to www.measuring-walking.org for details.

Sauter and Wedderburn (2008) aimed at developing a set of international guidelines for the collection, analysis and dissemination of qualitative and quantitative techniques for measuring walking. They examined the characteristics of walking to identify implications for the type of data needed and the methodology for data collection.

Pedestrian counts

There are two main purposes for pedestrian counts:

- monitoring and management of pedestrian activity
- project management – design, planning, appraisal, evaluation of facilities.

What needs to be measured depends on the purpose of the project. Measurement of time exposed in walking may be required, not just the distance travelled.

Sojourn activities

Walking is not simply moving from A to B. It involves several other aspects, known as 'sojourn activities' – wandering, standing, meeting, greeting, etc. Sojourning is based on the intent of being there (whether the activity is static or not) and may relate to a main purpose such as recreation, shopping or other activity; social interaction is a strong theme. The health perspective also needs to be considered.

Measuring

There is a need to have core data for each purpose, and it may not be appropriate to consider simply pedestrian counts. Surveys may need to be extended beyond the front door or gate into private property. Safety (e.g. stumbling) and security aspects should be included where relevant. Instructions to surveyors are important for consistency and comparison.

A useful tool is video which provides a rich source of re-analysable information from different perspectives.

GPS technology is also becoming more widely used for tracking movements, including pedestrian activities. A study by Van der Spek (2010) observed walking patterns of people with GPS devices in the city of Delft, obtaining extensive individual and collective data on route characteristics. Such data have great potential for influencing the design of cities and open spaces.

Travel data/surveys

Understanding the reasons for the surveys is required, which will then allow different measurement techniques to be used together. The technical, social and cultural aspects of walking and walking facilities need to be addressed. Some techniques and types of measurements to be considered include:

- time spent walking
- different types of walking – voluntary/forced, stroll/hike/sport
- 'walking trip' vs. combined purpose trip
- complementary surveys, e.g. household interview to get representative details, to add to more general survey results
- internet surveys which have fewer errors than phone surveys or home visits.

4.4 Pedestrian Perceptions of Facilities

In the decade between the release of the 2000 and 2010 editions of the Highway Capacity Manual (HCM) there was a substantial research effort in the USA aimed at exploring the many factors that contribute to pedestrian perceptions and assessment of the walking environment. This approach recognised that user perceptions are heavily influenced by non-operational factors, such as environmental and aesthetic considerations – especially for pedestrians – and was aimed at clarifying the role of user perceptions in determining LoS for various facilities (Roess et al. 2010).

4.4.1 Crossing Facilities

A study of pedestrian perceptions of crossing facilities (Sisiopiku & Akin 2003) was conducted in East Lansing, Michigan. This area had recently been refurbished in order to facilitate both vehicle and pedestrian flow, and consideration had been given to increasing pedestrian safety.

Pedestrians' perceptions were surveyed and their crossing related behaviour videoed at signalised and unsignalised intersection crosswalks and unsignalised midblock crosswalks. Intercept surveys at the sites were considered too costly, so 5000 surveys were sent via email to randomly chosen staff and students of Michigan State University as the campus runs the entire length of one side of the test site. Respondents were asked about their behaviour at signalised crossings.

The number of useable surveys returned was 711. Only 9.6% indicated that they crossed when the green pedestrian signal was showing. Of the remainder, 45.2% indicated they did so when an acceptable gap occurred and 45.2% when the traffic had cleared. These figures are for a signalised crossing that has traffic light phasing where one lane stays stationary while the other lane turns, thus making it possible to cross half of the road on the red pedestrian signal. Video data was gathered for the whole street at the peak times of 10.30 am to 1.00 pm and 2.30 pm to 6.00 pm on weekdays and Saturdays. Analysis of the video data showed that 59% of observed pedestrians crossing the road did so at designated crossings.

Familiarity may play a part for pedestrians who choose to cross at undesignated areas. It was noted that respondents who did not cross the road daily were more likely to do so at a designated crossing (82%) than those who crossed on a daily basis (66%). When respondents were asked their main reason for crossing at undesignated areas 39.5% said it was more convenient, 25.9% that it was to save time and 28.7% said that there was no risk associated with crossing when the traffic was not heavy.

Respondents indicated whether any of eight pedestrian features (or barriers) influenced their crossing locations (existence of pedestrian signal, presence of midblock crossing, red coloured brick pavement, shelter over a midblock crossing, 'cross only when traffic clears' signs, presence of other pedestrians that attempt to cross, distance to the desired location and vegetation or barriers on median). Distance to their desired location was the factor identified by 90% of respondents as influencing their decision about where to cross (90%). Midblock crossings and pedestrian signalisation were also highly influential (83% and 74% of respondents, respectively). The presence of vegetation or barriers did influence pedestrian behaviour to some extent (65%) but due to the manner in which the survey was constructed there is no way to know if this influenced respondents to cross at designated locations, encouraged them to skirt around the obstacles or to move to another undesignated area. The treatments few respondents regarded as having an influence on their crossing locations were median shelters (34%) and coloured paving (41%). There were no gender effects but there was a finding for age effects involving the influence of distance of desired location on crossing location. Statistically significantly fewer of those in the 55 and over age group (74%) felt that the distance of their desired location influenced where they crossed compared with those aged 20 years and younger (92%) and 21 to 55 years (90%).

The ability to generalise these results to the general populace may be compromised due to the way in which the survey participants were recruited. Not only did it limit respondents to those who were in the immediate vicinity for work or study, it also limited the age distribution and other factors such as education level and socio-economic status.

Chu and Baltes (2001) document a research project that developed a model of mid-block crossing difficulty as perceived by pedestrians. Four aspects of the research are reported: research design issues; selection of potential determinants; data collection; and statistical analysis. This model was developed through a statistical calibration and validation process involving collecting actual site characteristics and stated levels of crossing difficulty by a sample of persons at a sample of sites in Florida. For traffic operations applications, this model may be used as a screening tool to determine whether pedestrian mid-block crossing facilities, such as crosswalks or pedestrian signals, may be needed at particular locations. This model also has a number of applications for planning purposes. The model included selection of potential determinants of perceived pedestrian quality of service for midblock crossings from a theoretical analysis of behaviour, and a practical analysis of planning needs (Chu & Baltes 2003).

Part of the development process involved participants visiting and rating 31 midblock crossing sites in the USA. The sites differed in terms of whether there were traffic signals at the intersections, presence of a marked pedestrian crossing or signals, length of the signal cycle, the number of lanes to cross and if there was a treated median. The participants were informed about the purpose of the study and given a definition of crossing difficulty. Each participant was taken to five sites where they approached the crossing and observed the traffic flow, traffic gaps and signal cycles for three minutes between 9 am and 2.30 pm. Ratings were then made ranging between 'A' (no difficulty in crossing) to 'F' (extremely difficult to cross).

The following variables were used in the model (+ indicates an increasing level of difficulty crossing, – indicates a decreasing level of difficulty crossing, ± effect unknown):

- + aged 65 or over
- + volume of vehicles per hour (near and far side)
- + number of vehicles turning per hour (near and far side)
- + average speed
- + width of crossing (near and far side)

- – width of raised median
- – width of painted median
- – pedestrian crossing
- ± pedestrian signal
- ± signal cycle length in seconds (near and far side)
- ± spacing of signals (in feet).

The model explained 34% of the variance in the data. Only average speed and width of painted median were non-significant and most variables in the model behaved as predicted. More specifically, wide painted medians, presence of a pedestrian crossing and a high volume of vehicles were associated with an increased perception of crossing difficulty. The most important variables in judging crossing difficulty were signal cycle length and how closely signals were spaced. These are the primary factors in deciding traffic flow and how long and frequently gaps occur in the traffic.

Results from this study should be viewed with caution, given that the recruited participants may or may not have been familiar with the crossings, that participant ratings may have been influenced by making comparisons between crossings they had seen earlier in the day, and that rating drift is likely to have occurred. As seen in Sisiopiku and Akin (2003) those who regularly crossed at a particular location treated crossings in a different manner than those who crossed less frequently.

Guardrails and fences

Guardrails and similar devices can be used to channel pedestrian crossing behaviour to particular crossing points. The main purpose of guardrailing is to improve safety by trying to prevent pedestrians from crossing the road at an inappropriate place or from straying into the road inadvertently. Guardrailing or fencing can also be used to offer some protection to pedestrians at locations where the swept path of large vehicles, such as buses and heavy goods vehicles, takes the vehicles close to the footway.

The use of guardrail can be inconvenient to pedestrians, and lead to an unattractive and cluttered environment, and people may be deterred from walking by inappropriate placement of barriers. Revised guidance on guardrail fencing (DfT 2009) suggests that local authorities should be encouraged to develop a more pedestrian-friendly environment by using traffic calming and complementary measures, rather than fencing, to improve the street environment and its accessibility. This reflects increasing calls for providing better pedestrian facilities, eliminating street clutter and improving the streetscape, including a reduction in the use of guardrailing.

The guide provides advice and a procedure for assessment of the need for the installation or removal of pedestrian guardrail fencing on the existing road network, particularly at pedestrian crossings and road junctions.

4.4.2 Signalised Intersections

In a study of pedestrian perceptions of safety at crossings at signalised intersections in Sarasota, Florida (Lin & Boudreau 2003), 266 respondents were asked to pick one signalised intersection they considered to be the safest out of 15 chosen by the authors. Frequency of use of their chosen signalised intersection was also assessed. Just over a quarter (25.9%) used the intersection they identified as the safest less than once a week, 60.2% used it 1 to 10 times per week, 6.0% 11 to 20 times a week and 7.9% more than 20 times a week.

The survey presented 14 reasons that were thought might impact on feelings of pedestrian safety at a signalised intersection. Respondents were asked to choose and rank their top five reasons. This process was repeated for the signalised intersection respondents chose amongst the 15 as being the least safe to cross. Respondents then chose the five improvements amongst 14 options they believed would make signalised intersections safer.

Pedestrians ranked signalisation with a marked crossing and good visibility (including lighting) as the two most important aspects of a safe signalised intersection. Poor visibility was ranked eighth in the dangerous crossing reasons. The number of lanes to cross and traffic volumes were fairly consistently placed for the safe and dangerous signalised intersections.

Of the 14 options for improving safety, respondents gave the top ranking to installation of pedestrian signals and a marked crossing. Good lighting was ranked second and provision of a median was third. While the study provides valuable information, providing a fixed list of factors was a weakness in the design. Providing respondents with the opportunity to add their own reasons may have uncovered aspects to feelings of safety or danger not identified by the authors.

In Australia, the Inner Melbourne Action Plan (IMAP) includes a series of projects aimed at understanding the effectiveness of interventions to encourage walking by improving safety and comfort. This includes examination of measures to improve safety and convenience for pedestrians at identified signalised crossings. The IMAP Greenlight project examines signal design to provide for priority pedestrian movement at periods of high demand. This supports a key element of the SmartRoads approach (VicRoads 2010) which is the better use of signals to provide for efficient movement of people and goods throughout the transport system.

The Greenlight project investigated how signal re-design could deliver safer, more comfortable journeys for pedestrians at key crossing points at 20 intersections across the inner Melbourne area (Hutchinson 2011). It examined changes in pedestrian behaviour and perceptions at sites which had changes to signal operations. These changes included late introduction of pedestrian signal activation, increased pedestrian clearance time, Puffin signal operation, pedestrian head start, automatic pedestrian signal activation, and changed SCATS phasing.

Treatments were assessed in relation to providing improved access for pedestrians and addressing the barrier effect created by arterial roads and traffic. Most treatments were also assessed in terms of their ability to improve safety as a prerequisite for encouraging more walking. Minor improvements in signal timing were shown to improve pedestrians' comfort and increase crossing opportunities. Effective signal treatments to addressing the barrier effect included:

- increased clearance time and green time for pedestrians to improve the feeling of safety
- Puffin crossing operation to provide safe crossing for the elderly or people with mobility aids
- late introduction of pedestrian phase activation at long traffic cycle times, or if time does not permit automatic introduction of the pedestrian phase
- removal of pedestrian fencing in some situations to increase the perception of safety
- direct, wider crossing areas with enough time to cross in a single phase, to significantly increase pedestrian demand.

4.4.3 Safety for Different Crossings

Research into pedestrian perceptions of safety at different types of crossings has been undertaken on behalf of VicRoads (Kerryn Alexander Research 2006). Pedestrians were surveyed at 15 locations in Melbourne for three days during four time periods (8.00 to 9.00 am, 3.00 to 4.00 pm,

4.30 to 5.30 pm and 6.00 to 7.00 pm). A total of 917 pedestrians were surveyed at zebra crossings with flashing lights (Z, six locations), midblock pedestrian operated signals (POS, three locations), Pelican (PEL, one location), Puffin (PUF, one location), standard intersections (SI, three locations) and complex intersections (CI, two locations). When asked how unsafe they felt crossing at their particular location, responses for Z ranged from 7% to 32%, POS between 1% and 19%, PEL 8%, PUF 7%, SI between 1% and 29% and CI between 5% and 52%.

This range demonstrates very clearly that the type of crossing provided is not the only factor affecting perceptions of safety while crossing the road. Traffic flow at the time of crossing was also estimated to investigate its effects on perceptions of safety. At the CI where 52% of respondents felt unsafe the traffic flow was heavy 61% of the time while at the CI where 5% of respondents felt unsafe it was heavy 34% of the time. This pattern was not seen at the SI intersections where one that had heavy traffic flow 61% of the time was regarded as unsafe by 26% of respondents and another that had light traffic flow 61% of the time was regarded as unsafe by 29% of respondents.

A respondent's age was only related to perceptions of safety at either end of the spectrum; 32% of those aged 80 or over felt unsafe while crossing compared with only 9% of teenagers. Twelve to 19% of those aged 20 to 79 felt unsafe when crossing the road. The majority of respondents felt they had enough time to cross the road (85% to 100%). Only three sites fell below the 85% level. These sites were at the only PUF crossing, one CI and one POS crossing (67% to 73%).

It can be concluded from this study that many factors, not just crossing design, impact upon pedestrians' perceptions of safety.

4.4.4 Roundabouts

Candappa et al. (2005) endeavoured to make a roundabout in Port Philip (Melbourne, Victoria) more pedestrian friendly. The roundabout had pedestrian refuges and these were altered to become wombat crossings, thus giving priority to pedestrians. Various before and after data were recorded, including a survey of pedestrian's perceptions of the safety and ease of crossing. There were 169 respondents in the before period and 157 in the after period.

Perceptions of safety while crossing rose significantly, from 24% to 64%. Significantly more respondents felt that travel speeds were satisfactory after the treatment compared with previously (47% and 66% respectively), and that drivers were giving pedestrians priority (30% before and 78% after). Over half (54%) of respondents felt that the crossing was easy to use before the treatment and this rose to 89% after the treatment. Waiting times were deemed to be adequate by only 15% of respondents before the treatment, while 76% felt this was the case after the treatment. The proportion of pedestrians crossing within the designated crossing zone rose from approximately 55% to 93%.

There were some concerns expressed by respondents. Some thought the treatment might confuse people and this might make it dangerous for pedestrians if drivers were unsure about who had priority. Others suggested that flashing lights should be installed. There was also concern that rear end crashes may result from increased congestion.

A significant reduction in mean speeds both 30 m (from 32.7 km/h to 30.7 km/h) and 5 m (from 19.1 km/h to 16.31 km/h) from the crossing occurred, and the potential consequences for vehicle occupants in a rear end crash were reduced.

A recent US publication (TRB 2010b) provides information and guidance on roundabouts, for designs suitable for a variety of typical conditions in the United States. It provides general information, planning techniques, evaluation procedures for assessing operational and safety performance, design guidelines, and principles to be considered for selecting and designing roundabouts.

A separate publication (TRB 2011) provides practitioners with specific guidance on establishing safe crossings at roundabouts for pedestrians with vision disabilities. It identifies the conditions under which pedestrians with vision disabilities may experience problems with crossing performance, and suggests specific treatment solutions. It also includes advice on conducting pedestrian/vehicle studies related to these problems, and on quantifying pedestrian accessibility at crossings.

4.4.5 Route Choice

In order to understand and quantify the influence of the overall level of service of the urban walking environment on pedestrian route choice behaviour, a method for estimating the overall LoS of pedestrian walkways and crosswalks was developed (Muraleetharan & Hagiwara 2007). This was based on the concept of total utility value, which comes from a stated preference survey. Each sidewalk and crosswalk link was assigned an overall LoS according to its operational and geometric characteristics determined from field measurements. For analysis of pedestrian behaviour, this study used data from a revealed preference survey on individual route choice behaviour. A geographic information system network database was used to store the characteristics of the routes that pedestrians used. Network analysis was used to analyse the routes, which included determination of the shortest-path routes and the optimized-LoS-path routes between origin-destination pairs. A comparative analysis of the actual routes and the estimated alternative routes was performed. A multinomial logit model was developed to express the route choice behaviours of pedestrians quantitatively. It was indicated that pedestrians choose routes not only for distance but also for the overall LoS of sidewalks and crosswalks. On longer travel paths, pedestrians divert from the shortest-path route and are found to use sidewalks and crosswalks with high LoS. On shorter routes, pedestrians tend not to avoid sidewalks or crosswalks with low LoS. The results lend further support to the idea that accommodating pedestrians in urban areas should focus on improving the walking environment of the road network.

Schlossberg et al. (2007) undertook a survey investigating community walkability in areas with train stations in San Francisco, California (two stations) and Portland, Oregon (three stations). They approached people who were walking to the stations were approached and given a survey and a map on which they were to trace the route they had taken. Based upon the assumption that pedestrians would be influenced in their choice of route by factors such as distance, ease of access and pleasantness, only locations where the streets were on a grid pattern were chosen. The grid pattern locations also offer pedestrians a larger number of routes than other street patterns. This makes it more likely that pedestrians will choose routes not solely based on the shortest distance to their destination.

A total of 328 people filled out the survey. The majority (64%) of surveys returned were from the two San Francisco stations and results are therefore more representative of this population. Often respondent's self-reported distance walked was inaccurate compared to the route traced on the map. The actual distances estimated from the map are discussed here: the average distance walked (converted from miles to kilometres) was 0.84 km. The minimum was 0.03 km and the maximum was 3.03 km (25^{th} percentile was 0.43 km; 50^{th} percentile was 0.76 km; 75^{th} percentile was 1.09 km).

Respondents were also asked to give three reasons why they chose their particular route. This was followed by a list of eleven factors the authors had chosen as affecting route selection and respondents were asked to rate their influence on a three point scale (very important, somewhat important, not important).

A total of 52% of respondents gave the first reason for their route choice as being the shortest or fastest route; 10% gave this as their second reason. The second reason with the highest percentage (14%) of respondents saying that this was a primary factor in their route choice was 'safety'. In common with the volunteered reasons for choosing their route, the factor respondents rated the highest from the authors was shortest route (82% very important, 17% somewhat important). The three factors rated between 85% and 87% (when combining very important and somewhat important) were: traffic devices are present, traffic drives at safe speeds and footpaths are in good condition. Other factors were presence of attractive buildings, trees and landscaping (79%), no traffic lights where it takes a long time to cross (68%), other people out walking (60%) and shops/businesses to stop in (56%, again these all combined very important and somewhat important). The three factors falling below the 50% level when combining very important and somewhat important were: shops/businesses with windows to look in (38%), benches/places to sit (26%) and having a friend/neighbour along the route (25%).

Schlossberg et al. (2007) also carried out an audit of the area surrounding two of the stations using both objective and subjective measures of walkability. Intersections and blocks were audited as separate features, with a view to combining audit data (which was mapped) with the data where respondents plotted their route on a map. There were few differences between the routes people chose or avoided and their audited features in terms of engineering features or traffic volumes. This could be due to the fact that these respondents were headed to a rail station, so the shortest route would be the most likely route. As the authors note, the pedestrian environment on the routes people chose were all of a fairly good standard. However, routes using arterial and collector roads were rated as worse than those primarily using residential roads.

Ovstedal and Ryeng (2002) surveyed pedestrians in Belgium, Finland, France, Italy, Norway and Switzerland about their perceptions of their current walking experience. They surveyed 1092 pedestrians at a total of 22 sites. Approximately 90% of the respondents walked the route fairly frequently. Most (nearly 60%) had walked for their entire journey in Italy, France, Finland and Norway, whereas the minority did so in Belgium (23%) and Switzerland (8%). In countries where respondents had lower levels of having walked the entire journey, they had been making a multi-modal trip. Usually this involved public transport and walking, or cycling and walking.

When asked why they had chosen that particular route 71% of respondents said that it was the quickest or shortest way to their destination. The factor deemed to be most important on their current routes was that it felt safe. This gained the highest score in all six countries. The next three reasons deemed the most important were: air quality (especially lack of odour), comfort (this leaned more toward weather factors and surroundings) and ease of wayfinding (as the majority of respondents were familiar with their route this may have had more to do with practice effects than good signage).

In general this study adds weight to other studies that have found that distance is the most important factor in pedestrian trips. It does, however, suggest that pedestrian level of service ratings may be influenced by factors other than the built environment such as odour and weather.

4.4.6 Walking for Pleasure

Five areas in Montgomery County, Maryland were used by Livi Smith (2009) to investigate whether perceptual and objective measures of the walkability of an area showed any relationship to one another. Three recruitment methods were used: mail outs, telephone calls and home visits. In total 293 participants were recruited for the study (no demographic details were given).

Participants filled out a travel diary and completed a survey which focused on their immediate neighbourhood (defined as 1 to 20 minutes from home). Most questions were taken from the Neighborhood Environment Walkability Survey (NEWS) (Saelens, Sallis, Black & Chen, as cited in Livi Smith), which has been tested for reliability. Not all of the perceptual data collected was used. Only those that had a corresponding measure on the pedestrian auditing instrument (objective) were included. The reverse was also true: if there was an objective measure with no corresponding perceptual measure this too was dropped from the analysis.

Various models were used to analyse the data. The one with the best fit included dummies for the study areas, perceptual and objective measures. The demographics of age and employment status were not significant but gender was significant, as was the number of vehicles owned. The greater the number of vehicles owned, the less walking was undertaken. In terms of the gender effect, women had a greater likelihood of walking than men. It was noted that this is not the usual pattern seen in the reviewed literature, and it was hypothesised that this may have been an indicator of walking for pleasure rather than for reaching a particular destination.

Tree cover was significantly positively associated with walking on the perceptual measure. This was not significant in the objective measure but cleanliness of the environment was significantly positively associated with walking. Footpaths (presence/absence and quality) were significantly negatively associated with walking only on the objective measures. Land use (commercial, residential, mixed) was only significantly positively associated with walking on the perceptual measure.

Another factor where perceptions and reality seemed to differ is motorised transport (presence of three or four way intersections, number of lanes, bus stops). Objective measures showed that walking was significantly positively associated, whereas the perceptual measures show that it was significantly negatively associated. The in-text explanation of the results differed from the table outlining the results. This showed the objective measure as being significantly negatively associated with walking.

If, as theorised in the paper, the participants in this study were primarily walking for pleasure it would indicate that factors other than the shortest route are important to pedestrians as was seen in Schlossberg et al. (2007). More research is required into the perceptions of level of service amongst this group if walking for pleasure is to be encouraged.

4.4.7 Effects of Weather

Aultman-Hall, Lane and Lambert (2009) collected pedestrian volume data at a location in the CBD of Montpelier, Vermont for one year along with corresponding weather information to investigate the effects of weather on pedestrian volumes.

Between January and April (winter) volumes were significantly lower than other months. December is also a winter month but lower volumes were not observed – probably due to increased shopping activity in the Christmas period. Significantly fewer pedestrians were recorded on the CBD footpath on weekdays and Saturday in inclement weather. When it was raining pedestrian volumes dropped by 13% and when it was snowing they dropped by 16% compared

with times of no rain. This was not the case for Sundays or on holidays. While weather does influence pedestrian volumes in Montpelier's CBD, other factors also heavily influence walking.

Attaset et al. (2010) carried out a study in Alameda County, San Francisco Bay area of California into the effects of weather on pedestrian volumes. One pedestrian counter was present in its location for one year while the other counters were shifted between 12 locations where recordings covered between three and four months' worth of data. The counters were installed at intersections but recorded pedestrian volumes on the footpath. While extremes of weather do have an effect on pedestrian volumes in this part of the world they are not pronounced – most likely due to the mild nature of weather variation in this location.

Burke et al. (2006) took walking trip data from the South East Queensland Travel Survey for late 2003 and early 2004 and matched it with the corresponding weather data. This limited the weather variability for the period in which walking trips occurred. A total of 10 931 people took part in the survey throughout South East Queensland. No route information was included in the survey and Burke et al. (2006) chose to focus on the number of trip stages reported rather than the distance as the survey assumes respondents chose the shortest route for each trip stage. Additionally, no information was gathered about weekend travel.

Although the study shows that extreme weather has no effect on walking rates care should be taken given the limitations of the study. The data used was not fine-grained as the trips were aggregated and there was no way to separate walking to commute, which will suffer less due to weather, from walking for pleasure or exercise which will be more likely to be affected by weather. Nor was the study able to target specific times of day which would have given a broad indication of trip purpose. Only weekday walking trips were captured.

4.4.8 Pedestrians with Disabilities

Sanderson (2005) gathered opinions from two groups about the criticality of 18 features of crossings for mobility impaired pedestrians: those who are mobility impaired (or advocate on their behalf) and local government authority designers of pedestrian facilities. Questionnaires were sent to the Engineering Department (LGE) of each of the 72 Victorian local government authorities, and 35 of these were returned. Focus groups were held with Disability Advisory Committees or Groups representing Frankston, Wyndham, Boroondara and Glen Eira. Group size ranged from 7 to 12 people. Individual interviews were held with four students from Monash University.

Sanderson chose 18 features of pedestrian crossings for participants to rate in terms of criticality (critical, desirable, not desirable, important, not important). The group representing the needs of mobility impaired pedestrians rated more features as being critical (12, as compared to 6 by LGE). Of the 6 features LGE did not rate as critical, 4 were rated as important and 2 as desirable features. This disparity possibly results from differing concerns between the groups: LGE were more likely to be balancing criticality with available funding, whereas the mobility impaired representatives were more likely to be focusing on making crossing the road as easy as possible. Focus groups were asked to come to a consensus about what was the single most critical feature for crossings. This task produced much discussion and two groups were not able to reach a consensus.

It should be noted that the focus groups provided a criticality rating as a group rather than, for instance, gathering individual ratings and tallying these to determine a rating for each feature. Future studies should consider asking the mobility impaired representatives to rank each rating. This would have enabled a ranking of importance for each of the critical features. It may be necessary to do this on an individual basis rather than as a group given the experience in this study.

Kerryn Alexander Research (2006) surveyed 22 mobility impaired pedestrians amongst their 917 respondents. They found that 37% indicated that they were not given adequate time to cross at signalised intersections. Some respondents had experiences in the past where they had to wait in the painted centre line on the road (i.e. no pedestrian refuge had been provided). Other issues raised were the gradient being too steep at curbs and refuges, issues negotiating tram and train tracks, difficulties with rough surfaces and cobblestones, and issues with users being seen.

No vision impaired pedestrians used the crossings included in the Kerryn Alexander Research's (2006) study. Data about their perceptions concerning what constitutes a safe or unsafe crossing was gathered in a focus group. Of primary concern to this group was the availability at pedestrian crossings of both tactile and auditory cues. The most helpful auditory cues were those using different sounds for each direction. Signalised crossings were, by far, their most preferred type of facility and that the pedestrian signal button was on the traffic light pole.

Another highly valued feature at crossings was the ramped kerb, or 'pram ramp'. This was invaluable to the vision impaired pedestrians for indicating where to cross as well as which direction to take. Issues were found with pram ramps that 'pointed' at an angle. It was mentioned that those with vision impairments find yellow the most easily seen. Ensuring that road and pavement markings were not worn was another important factor to consider in the provision of crossings for this group.

Raised pedestrian refuges were preferred as they made people in this focus group feel safer (which is at odds with the needs of those with mobility issues) and they preferred refuges to have no plants on them as they were likely to walk into them. Pedestrian refuges were also able to provide one of their favoured crossing features: narrow crossing points where they had to cross traffic moving in one direction only.

4.5 Level of Service for Pedestrians

Level of Service for pedestrians should be defined in terms of pedestrian needs, preferences and perceptions, not just in terms of traffic related quantities such as flow rates and delays. It needs to extend beyond 'service' to cover other aspects such as comfort, security, etc., to represent a broader Level of Quality (LoQ) approach.

4.5.1 Addressing Pedestrian Needs

Changes in approach have been developed, especially with the new HCM 2010. The commissioning of substantial research, providing background leading to revised treatment of LoS (especially for modes other than automobiles), are included in HCM 2010.

Summary of approach

Roess, Vandehey, and Kittelson (2010) discuss the concept of level of service (LoS) which was introduced in the 1965 edition of the Highway Capacity Manual (HCM). It provided for the familiar letter-grade system for characterising the quality of operations on a variety of traffic facilities from intersections to freeways. The LoS concept in the 2010 edition of the HCM, introduces material directly related to user perceptions. Discussions surrounding LoS have raised interesting issues that may result in more extensive changes in the future. This paper attempts to address some of these issues in the context of the history of the LoS concept and its use in the planning, design, and analysis of traffic facilities. Among the major issues that should be thoroughly examined in the future is whether the concept is needed with the rapidly advancing state-of-the-art, which produces many quantifiable measures of service quality. The application of LoS to corridors, networks, and multimodal systems needs to be addressed, as it will differ from previous applications to points and

uniform segments. Incorporating the results of research concerning user perceptions into the LoS framework has also raised interesting issues as the HCM 2010 has been developed. With the forthcoming HCM 2010 as a starting point, this paper explores current issues and makes suggestions as to how to address them while moving toward the editions that will follow the HCM 2010.

The report by Dowling et al. (TRB 2008) presents the results of a 2-year investigation into how users of urban streets perceive the multimodal quality of service provided by the streets. A preliminary investigation was conducted to determine the key factors influencing traveller perceptions of urban street LoS from the perspective of auto drivers, bus riders, bicycle riders, and pedestrians. The results of this preliminary investigation were used to design a series of video laboratories (for auto, bicycle, and pedestrian modes) and field surveys (for the bus mode). Four separate LoS models (one for each mode) were then fitted to the video laboratory and field survey data. All four LoS models were sensitive to the street design (e.g. number of lanes, widths, and landscaping), traffic control devices (signal timing, speed limits), and traffic volumes. The models incorporated directly and indirectly the interactions of the various users of the street.

The LoS models are ideal for evaluating the benefits of 'complete streets' and 'context sensitive' design options because the models quantify the interactions of the modes sharing the same street right-of-way. The models enable the analyst to test the tradeoffs of various allocations of the urban street cross-section among autos, buses, bicycles, and pedestrians. The method enables the analyst to compute the before and after levels of service for auto, bus, bicycle, and pedestrians. A spreadsheet software engine was written to assist analysts in applying the LoS methods. A User's Guide was written explaining the LoS models and their application, in a format suitable for incorporation into the *Highway Capacity Manual*. The Final Report describes the development of the LoS models, while the User's Guide focuses on explaining the application of the models with detailed descriptions of each model and example applications.

4.5.2 Multimodal Approach

The purpose of the research project by Phillips, Karachepone and Landis (2001) was to develop a quality of service analysis for transit, pedestrian, and bicycle modes. The four major objectives that shaped the research agenda were:

- to perform a national literature search of multi-modal level of service methodologies in order to implement the best possible methodology in Florida
- to apply and validate bicycle level of service and roadside pedestrian condition techniques to measure the performance of corridor segments in two districts
- to apply and test new Highway Capacity Manual performance measures for transit in test districts
- to refine and evaluate latent bicycle and pedestrian demand model processes in order to determine that adequate demand exists for proposed facility improvements.

The goal of the Crider, Burden and Han (2001) study was to extend the multimodal LoS research effort addressing specific measures that affect the user at the 'points' of their journey. For the transit user, this relates to the actual bus stop, the point where they embark or disembark on their journey. For the bicyclist and pedestrian, this is the point of transition, from segment to segment or to destination, and generally relates to a crossing point either midblock or at an intersection. Techniques for identifying measures were garnered through an extensive literature review and appropriate measures were selected and identified for transit, bike and pedestrian modes. Additionally, a transit infrastructure (amenities) use survey was distributed to 500 bus riders and analysed for weighting of importance of various transit infrastructure.

Over the decade 2000 to 2010, the pedestrian level of service model for roadway segments, developed for the Florida Department of Transportation in 2001, has become a leading method for evaluating walking conditions along roadways throughout North America. The model has been tested and applied on hundreds of thousands of miles of roads, sometimes under conditions atypical of the original dataset. Two examples include central business districts in very large metropolitan areas and very low volume collector/local streets. Focused testing in these environments occurred during the evaluation of the model as part of National Cooperative Highway Research Program 3-70 (TRB 2008). Petritsch, McLeod, Landis and McLeod (2010) discuss proposed refinements to the pedestrian LoS model for urban streets which may be included in the next Highway Capacity Manual. Their application should be considered by practitioners for ongoing evaluations of urban street pedestrian LoS.

Petritsch, Landis, Huang and Dowling (2008) developed and tested a framework and enhanced methods for determining levels of service for the automobile, transit, bicycle, and pedestrian modes on urban streets. This paper presents the proposed LoS model for arterials. This effort represents a progressive shift in evaluating the quality of service from a provider based measure (how many vehicles/pedestrians can we move and how fast) to a user based measure (how well do drivers/pedestrians feel the facility meets their needs). To obtain feedback from potential pedestrian facility users, data for the model were obtained from participants in video simulation laboratories. The participants watched video clips of roadways and intersections and provided their ratings as to how well the depicted roadways and intersections would meet their needs as pedestrians. The proposed model consists of a pedestrian density LoS and a pedestrian non-density LoS. The density LoS is computed according to the methods provided in the Highway Capacity Manual. The non-density LoS is a function of the pedestrian LoS of roadway segments, the pedestrian LoS of intersections, and the roadway crossing difficulty factor.

The Danish Road Directorate sponsored a study, Jensen (2007) to develop methods for objectively quantifying pedestrian and bicyclist stated satisfaction with road sections between intersections. The results provide a measure of how well urban and rural roads accommodate pedestrian and bicycle travel. To determine how existing traffic operations, geometric conditions, and other variables affect pedestrians' and bicyclists' satisfaction, 407 randomly selected Danes were shown video clips from 56 roadway segments filmed by a pedestrian walking and a bicyclist riding along the road. Respondents rated the roadway segments on a six-point scale ranging from very dissatisfied to very satisfied. This resulted in 7724 pedestrian ratings and 7596 bicyclist ratings. Roadway segments and video clips were described by 150 variables. Pedestrian and bicyclist satisfaction models were developed by cumulative logit regression of the ratings and the variables. The models included variables that related significantly to the satisfaction ratings. Variables that significantly influenced the level of satisfaction were motorised traffic volume and speed; urban land uses; rural landscapes; the types and widths of pedestrian and bicycle facilities; the numbers and widths of the drive lanes; the volumes of pedestrians, bicyclists, and parked cars; and the presence of medians, trees, and bus stops. The models returned the percentage splits of the six levels of satisfaction. These splits were then transformed into a level of service. The models provide traffic planners and others the ability to rate roadways according to pedestrians' and bicyclists' satisfaction and may be used in the process of evaluating existing roads, designing new roads, or redesigning existing roads.

Landis et al. (2001) acknowledged that a method is needed to objectively quantify pedestrians' perceptions of safety and comfort in the roadside environment. This quantification, or mathematical relationship, would provide a measure of how well roadways accommodate pedestrian travel. Essentially, it would provide a measure of pedestrian LoS within a roadway environment. Such a measure of walking conditions would greatly aid in roadway cross-sectional design and would help evaluate and prioritise the needs of existing roadways for sidewalk retrofit

construction. The measure can be used to evaluate traffic-calming strategies and streetscape designs for their effectiveness in improving the pedestrian environment. Such a measure would make it possible to merge pedestrian facility programming into the mainstream of transportation planning, design, and construction. To meet the need for such a method, as well as to fulfil a state mandate to establish levels of service standards for all transportation modes, the Florida Department of Transportation sponsored the development of the Pedestrian LoS Model. The model was developed through a stepwise multivariable regression analysis of 1250 observations from an event that placed 75 people on a roadway walking course in the Pensacola metropolitan area. The model incorporates the statistically significant roadway and traffic variables that describe pedestrians' perceptions of safety or comfort in the roadway environment between intersections. It is similar in approach to methods used to assess automobile operators' level of service established in the Highway Capacity Manual.

Flannery, Ali and Cristei (2010) state that complete street designs are becoming increasingly popular and sought by engineers and planners to accommodate all users on urban arterials. To address analysis needs, National Cooperative Highway Research Program Project 3-70 was developed to assist engineers and planners understand the implications of design and operational choices on the perceived level of service of travellers on urban arterials. This was a six year project that gathered input from four modes of travel on urban arterials: auto, pedestrian, bicycle, and fixed route transit. Data were gathered for the pedestrian, bicycle, and auto modes using video simulation techniques from four locations: Oakland, CA; Chicago, IL; New Haven, CT; and College Station, TX. The study included 145 participants ranging in age and gender. Models were developed for each of the modes and an overall methodology developed to analyse multimodal level of service for urban arterials. This study seeks to utilise a new modelling approach for the pedestrian level of service data to develop a cumulative logistic model that describes the entire distribution of pedestrian level of service under a given set of conditions. Previous models utilised simple linear regression with mean observations to estimate pedestrian level of service. The advantages of the newly developed model include a simplification of the required input variables and the ability to better estimate pedestrian level of service as is demonstrated in the validation process.

Hubbard, Awwad and Bullock (2007) indicate that the Highway Capacity Manual provides two methods, based on delay and space, for the assessment of pedestrian level of service at signalised intersections. Current procedures for evaluating pedestrian LoS are examined, and results indicate that these procedures do not adequately reflect the negative impact of turning vehicles. Pedestrian LoS measures are proposed to reflect not only pedestrian delay and space but also traffic interruptions, freedom of movement, and comfort. These measures are consistent with LoS measures currently used for freeway segments and ramp merge areas. The percentage of compromised pedestrian crossings is proposed as a means to quantify the negative impact of turning vehicles on pedestrian service and as a LoS measure at signalised intersections. A pedestrian crossing is designated as compromised if a pedestrian is delayed or is forced to change travel path or speed in response to a turning vehicle. The percentage of compromised pedestrian crossings was assessed for 13 crosswalks. Results of the assessments illustrate that as right-turn volumes increase, the percentage of compromised pedestrian crossings increases. The proposed method provides an objective engineering tool for measuring the impact of turning vehicles on pedestrian service. It may be appropriate to use this measure to quantify the need for pedestrian improvements (for example, if the percentage compromised exceeds 15%, then it may be appropriate to implement a leading pedestrian interval or other enhancement).

Hubbard, Bullock and Mannering (2009) indicate that traditional pedestrian level of service measures at signalised intersections are based on pedestrian space and pedestrian delay. However, these measures may not adequately reflect the negative impact of right-turning traffic on

pedestrians. This paper presents a statistical analysis using a binary logit model that provides new insights into the factors that affect the likelihood that a pedestrian is compromised (delayed, altered their travel path, or altered their travel speed) in response to traffic turning right (on green) during concurrent vehicle/pedestrian signal timing. The statistical analysis indicates that a number of factors affect the likelihood of a pedestrian being compromised including pedestrian direction of travel, right-turn traffic volume, number of pedestrians crossing, whether the pedestrian arrived late and began crossing after the end of the walk interval, and the crosswalk characteristics including location (downtown versus suburban) and one-way/two-way streets.

The Kim et al. (2008) study is an extension of work done for the Waikiki Business Improvement District Association related to measuring the impacts of changes in the physical environment on pedestrian level of service. The study estimates the impacts of various types of street furniture – both fixed and movable items – on pedestrian level of service. The authors consider typical items such as benches, bicycle racks, planter boxes, trees, mail boxes, brochure bins, trash cans, as well as other potential additions to the sidewalk areas such as vending and coffee carts and tables and chairs. These various types of street furniture were measured and observational surveys were conducted to estimate the volume of use during the peak times. Using a typical high volume pedestrian location with observed volumes, the impact of the street furniture on pedestrian level of service is estimated. Estimates are provided for the following: 1) the maximum pedestrian volume that can be accommodated with the added street furniture and still maintain a passable LoS rating of B; 2) the minimum sidewalk width necessary to maintain LoS rating B with increases of pedestrian volumes of 10%, 20%, and 30%; and 3) for coffee carts and vending carts, the number of customers that can be accommodated and still maintain a LoS rating of B. The findings suggest that different street furniture has different types of impacts and that designers and planners need to consider not only the dimensions of the street furniture, but also the sidewalk width, pedestrian volumes, and the potential number of users or customers.

Sisiopiku and Byrd (2006) describe how the level of service concept has been traditionally used to assess quality of operations of transportation facilities. The 2000 Highway Capacity Manual (HCM 2000) offers level of service criteria for pedestrian facilities based on measures similar to those used for motorised LoS. However, the multi-faceted aspects involved in pedestrian movements can be more intricate than the movements of other modes. This paper reviews, compares, and contrasts some of the more commonly accepted methods for determining pedestrian LoS for sidewalks to see if they are comparable or relatable, as well as to determine which methods are more reliable, or easier to use. A case study was performed in which field data were collected and used to implement the procedures described in the reviewed methodologies and to compare the LoS obtained from each. The comparison provides useful information on the consistency of outcomes from the various methodologies, and identifies needs for modifications and improvements.

Sarkar (2003) developed a method for the qualitative evaluation of comfort levels offered among walkways in major activity centres. A comfortable pedestrian circulation system within the street network is the focus. Healthy street circulation systems should offer choices for the movement of people, particularly for walking and bicycling modes. The paper examined the attributes of comfort in a pedestrian circulation system and developed an evaluation method by conducting qualitative explorations and drawing on existing literature along with examples of comfortable pedestrian spaces in the United States and Europe. This method involved two evaluation components: (1) service levels give standards for the overall desirable and undesirable comfort conditions at the macro level; and (2) quality levels look at finer details of comfort of pedestrians at the micro level. The method was tested in several streets in Philadelphia. It is suggested that the evaluation method is useful in providing analysis of the macro- and micro-level comfort conditions on the walkways, enabling professionals to assign priority for renovation and redesign of the surveyed

streets, providing useful information to transit agencies, and generating information for geographic information system maps.

Baltes and Chu (2002) developed a level-of-service methodology for pedestrians crossing streets at midblock locations. The methodology can provide a measure of effectiveness that indicates pedestrians' perceived quality of service in crossing roads at midblock locations. An objective was to determine what variables are correlated with pedestrians' perceived quality of service for midblock crossings. A statistical calibration and validation process involved the collection of actual site characteristics and stated levels of quality of service by a sample of persons at a selection of midblock crossing locations. The variables included those that are most important to state and local governments for the purpose of improving pedestrian mobility, safety, and liveability. Results showed that the levels of crossing difficulty tend to increase with the width of painted medians, signal spacing, and turning movements. They also showed that both the presence of pedestrian signals and cycle length are statistically significant, although they were hypothesised to be indeterminate. Finally, the results further indicated that people tend to find that the presence of pedestrian signals lowers their level of crossing difficulty.

Winters et al. (2001) focussed on identifying the feasibility of, and methods toward, a LoS system that can be assessed equally for the motor vehicle, bicycle, pedestrian, and transit modes. Interviews conducted with key stakeholders were used to identify how LoS measures found could be used to assess existing conditions, identify roadways in need of improvement, and prioritise construction projects. It was concluded that the current methods of describing levels of service are appropriate for their mode, understandable by broad audiences, and professionally defensible. It was also agreed that a system of measuring level of service equally across modes would be of significant value to policymakers, developers and the transportation industry. A systematic creative thinking technique was applied to identify and assess different concepts and approaches to use to develop a common LoS system. An approach for a pilot project to identify, construct and apply a transportation system user hierarchy of needs was proposed.

Unlike the case with airport terminals or the central business district, the quality of suburban pedestrian facilities is most likely affected less by congestion and more by safety, the walking environment, and aesthetics. Miller, Bigelow and Garber (2000) proposed innovative rating scales to explicitly capture such factors when measuring pedestrian level of service. These scales use either measurable characteristics, such as walkway width, median openings, and signalisation parameters, or user perceptions, such as continuity and convenience, to rate a pedestrian facility. A scaling system was developed for pedestrian LoS and calibrated using visualisation (computer-aided modelling techniques consisting of still photographs and animations). Subjects' perceived ratings of a pedestrian facility after they viewed still pictures and animations of the facility were compared with the computed rating of the facility from a LoS scale. This method helps ensure that pedestrian crossing needs are systematically considered and that engineers, planners, and the public agree on the calibration of a pedestrian LoS scale. The methodology is also applicable in urban areas where pedestrian needs beyond physical capacity are to be explicitly considered. The approach is original in that visualisation as a simulation and data analysis tool was used to calibrate a pedestrian LoS scale.

4.5.3 Tools, Evaluation and Assessment

In New Zealand the Community Street Review (CSR) process has been developed to assess the level of walkability of footpaths and road crossings (Abley & Turner 2011). This method involves taking a group of pedestrians along a route consisting of a number of footpath sections and road crossings and asking them to rate across a number of factors (e.g. safe from falling and safe from traffic) how they felt on a scale of 1 to 7. Based on the ratings across the group and each factor, each section is given an average walkability score.

Reid (2006) describes the challenges associated with assessing the quality of pedestrian networks and facilities, in particular the diverse nature of pedestrians and their sensitivity to subjective influences. It describes the ways in which those challenges were addressed during development of the pedestrian environment review system (PERS) by the Transport Research Laboratory (TRL). The paper describes PERS and gives examples of its application and use to conduct pedestrian network quality analysis. The benefits and limitations of the approach and lessons learnt in applying pedestrian reviews are discussed in a number of contexts. The paper concludes that the diversity of pedestrian capabilities and purposes in the public realm requires that subjective factors be incorporated into a review system; this, however, poses substantial difficulties for an objective and replicable review system

Allen and Clark (2007) discuss the use of PERS, its capabilities, perspectives on walking and the lessons learned from applying the tool extensively across Greater London in the past year. Pedestrian movement and the importance of streetscapes have been recognised within national and local UK policy and a method was required to effectively assess these types of environment and to identify ways to encourage people to use them. The PERS provides local authorities with a quick and effective method for reviewing all types of pedestrian space and identifying where improvements are most needed. TRL has worked with Transport for London (TfL) to further expand upon the capabilities of PERS. PERS reviews have been applied across Greater London as part of TfL's drive to better understand the condition of all pedestrian environments.

The PERS audit tool has been applied to an assessment of the quality of the pedestrian environment along an arterial road in Melbourne (Kartsidimas & Ronquillo 2010). It was concluded that the tool could be adapted for use in such conditions, but that further refinement to details such as parameter weightings would be needed for more universal application. PERS has also been examined in NZ, but development of walkability assessment tools in that country has concentrated on refinement of the Community Street Review (CSR) process and its quantification (Abley & Turner 2011).

Kelly et al. (2007) present the results of a research project conducted in the UK designed to increase understanding of the factors which influence levels of walking and pedestrian route choice. It describes a number of techniques that were used to assess the pedestrian environment from a pedestrian's perspective. These techniques included a computer based tool developed using stated preference surveys to determine the relative values of a range of factors in the pedestrian environment; an on-street survey that was designed to investigate values and attitudes towards different attributes of the pedestrian environment along a route; and finally an 'on the move survey' where pedestrian volunteers were interviewed while walking along the route in order to get an account of their experiences as they walk. A case study was then used to show the benefits and disadvantages of using these different techniques and compare the results of the three techniques along a pedestrian route in the City of Leeds. This comparison showed that there were a number of pedestrian attributes considered important by pedestrians when walking including pavement cleanliness, safe crossing places, and good connectivity.

The Gallin (2001) study in Western Australia aimed to develop guidelines for assessing the level of service of pedestrian facilities in Western Australia. Guidelines existed for assessing vehicular traffic LoS and cycling LoS, and the formulation of LoS guidelines for pedestrians was aimed at completing the LoS framework. Pedestrian LoS was defined as an overall measure of walking conditions on a route, path, or facility, and was linked directly to factors that affect mobility, comfort, and safety, reflecting pedestrians' perceptions of the degree to which the facility is 'pedestrian friendly'. These factors fall into three categories: physical characteristics, location factors, and user factors. These factors were weighted by relative importance and a LoS scale was developed to describe the LoS of pedestrian routes. Pedestrian conditions are described through a LoS grade

from LoS A (ideal pedestrian conditions) to LoS E (unsuitable pedestrian conditions), based on an assessment of the factors affecting LoS. The assessment includes desktop and on-site assessment of LoS factors. The development of the model was an iterative process that involved testing and refinement. The research undertaken and the LoS model developed provide a sound basis for the ongoing measurement of LoS for pedestrians. The model not only provides the opportunity to test the LoS provided by a pedestrian route, but also determines which factors contribute to low and high LoS.

Setter and Stewart (2002) stated that warrants for the installation of pedestrian facilities used in Australia and overseas, have traditionally been based upon vehicular and pedestrian volumes, but do not address the complexities of other relevant variables. Following a comprehensive literature review on pedestrian guidelines within Australia and overseas, a new set of warrants *Pedestrian Facility Guidelines & Prioritisation Point System* was developed, including new guidelines and a point allocation system based, primarily, on pedestrian waiting time. The guidelines also take into account varying road widths, vehicular arrival patterns, impact on the road network, community sizes, crash history, sight distances and other factors relevant to the provision of adequate pedestrian facilities. The priority point system is an innovative quantitative and qualitative analysis, and involves the allocation of points to each of these factors, according to the conditions and characteristics of the selected site, allowing for the assessment and quantification of the pedestrian crossing difficulty at a particular location. It is incorporated into a technical manual (QTMR 2011), as discussed in Section 3.5.2.

4.6 Summary

The main features identified from the review of literature, emerging practice and recent guideline developments may be summarised as follows:

- greater recognition of the importance of walking, from health, social, environmental, transport and economic perspectives
- greater emphasis in road network planning and urban design on providing facilities for pedestrian activity
- enhanced understanding of walking activity, not just as a transport mode, and the need to reflect this in associated measurement and survey techniques
- acknowledgement of the need for guidance on pedestrian facilities which takes into account the needs and perceptions of pedestrians
- development of tools and techniques for assessing the quality of the walking environment, which lead to improved methods for determining the level (or quality) of service provided to pedestrians in the road environment
- development of a multimodal approach – considering pedestrian, cyclist and public transport issues in addition to vehicular traffic – for assessing the level of service of roadway facilities.

5 REVISED GUIDANCE

5.1 Areas of Need

The material on pedestrian facilities in the current Austroads Guides has certain deficiencies, of which the primary elements are:

- Some of the original guidance material from GTEP 13 has not been captured, particularly the material on pedestrian level of service; other details are given in Appendix A.
- The more recent developments in provision and analysis of pedestrian facilities, as discussed in Section 3 and Section 4, are not included or need greater emphasis.

This has implications for revision of material in several volumes of the Guides. The general requirements for areas of guidance are summarised in Table 5.1.

Table 5.1: Requirements for areas of guidance

Area of guidance needing enhancement	General approach	Relevant Guides
Consideration of pedestrians in planning, provision and management of facilities.	Provide greater emphasis on accommodating pedestrian activity in planning and design. Provide summary description of the Safe System concept, and emphasise the vulnerability of pedestrians.	GTM Parts 3, 4, 5, 6, 7, 8 GRD Parts 2, 6A GRS Parts 1, 2, 4 GRTP
Assessing quality of walking environment and determining level of service of facilities.	Outline basic determination of pedestrian level of service. Outline pedestrian activity and perceptions, and methods for assessing walkability. Outline pedestrian aspects of multimodal approach to determining level of service.	GTM Parts 3, 5, 6 GRD Parts 2, 6A
Details for the design and management of pedestrian facilities.	Provide more detail regarding pedestrian activity and facility needs.	GTM Parts 5, 6 GRD Part 4 GRS Part 2
Measuring pedestrian activity.	Outline improved methods for planning and undertaking surveys of pedestrian activity.	GTM Part 3

5.2 Amendments to Documents

5.2.1 Approach

The proposed overall approach to enhancing the pedestrian facilities guidance given in the Austroads Guides is to ensure that the most recent developments are included. Essential elements of guidance should be presented, and reference made to other documents for details where necessary. Where there are separate technical documents developed by agencies in Australia or New Zealand, and their content is potentially applicable more broadly, this should be summarised and duly referenced, rather than providing a repeat of material.

The main focus in this report is on the amendments necessary for the Guide to Traffic Management (GTM), the details of which are presented in the following section. Those proposed for Parts 3 and 6 of the GTM are drafted in a form ready for insertion into those Parts, in view of the general reviews of those documents being undertaken via concurrent projects. Those

amendments proposed for other Parts of the GTM are similarly drafted but may undergo further development when those Parts are subject to detailed reviews in future.

The major new material for the GTM will be:

- reference to recent local developments in providing for pedestrian activity in road network planning
- measurement of walkability as an essential element in assessing quality of the pedestrian environment
- description of the multimodal approach, especially the pedestrian component, in assessing the level of service of roadway facilities.

A general requirement has also been identified: to ensure that the various Parts of the GTM present information on the Safe System philosophy underlying contemporary road safety management. While the fundamentals of the approach and its implications for traffic management are presented in GTM Part 13 (Road Environment Safety), it is appropriate to emphasise it in other Parts of the Guide. In the context of the present review of pedestrian-related guidance, there are opportunities to outline the Safe System approach as the basis for addressing the particular vulnerability of pedestrians in the traffic environment.

Related amendments to other Austroads Guides (GRD, GRS and GRTP) are also identified. These are drafted and included in this report for consideration when the relevant Parts of those Guides become due for detailed review.

5.2.2 Proposed Revised Material

Details of specific sections within the relevant Guides that need to incorporate amended or additional text are outlined in Table 5.2.

The proposed draft material for incorporation into the Guides is included in Appendices to this report as follows:

- the Guide to Traffic Management (GTM) – Appendix C
- the Guide to Road Design (GRD) – Appendix D
- the Guide to Road Safety (GRS) – Appendix E
- the Guide to Road Transport Planning (GRTP) – Appendix F.

Table 5.2: Sections of Guides for enhanced pedestrian guidance

Area of guidance needing enhancement	General approach	Relevant Guides/Parts		Guide sections for enhanced material
Consideration of pedestrians in planning, provision and management of facilities.	Provide greater emphasis on accommodating pedestrian activity in planning and design. Provide summary description of the Safe System concept, and emphasise the vulnerability of pedestrians.	GTM	Part 3	Section 2.5.5 – add material on active living strategic context for pedestrian facilities, plus broad definition of walking activities.
			Part 4	Section 4.7.1 – add material on broader approach to walking and implications for facilities; add material on Safe System approach as related to pedestrians.
			Part 5	Section 1.2 – add material on active living strategic context as factor in balancing road functions.
			Part 6	Section 1 – add new sub-section (1.3) on Safe System approach as related to intersections and vehicle-pedestrian conflicts.
			Part 7	Commentary C3.6 – add material on recent developments in shared spaces.
			Part 8	Section 7.5.7 – add material on shared spaces compared with shared zones.
		GRD	Part 2	Section 1.4 – add material on Safe System approach as related to pedestrians. Section 1.9 – add material on active living strategic context for pedestrian facilities; and note on need for sharing facilities in some cases. Section 2.4.1 – add material on need to consider road user hierarchy also, and influence on road design.
			Part 6A	Section 1.3 – add material on Safe System approach as specifically related to pedestrians.
		GRS	Part 1	Section 2.3 – add material on importance of measuring safety for different road user groups, use pedestrians as example; add note on need for specific travel/activity exposure data.
			Part 2	Section 3.4 – add material on increased walking focus and need for data on walking activity. Section 3.7 – add material on health/active living strategic focus. Appendix A – add material about particular vulnerability of pedestrians.
			Part 4	Section 1.3 – add material on particular implications for pedestrians in managing local roads.
		GRTP		Section 1.3 – add material on active living strategic context for change in transport planning policy direction.

Area of guidance needing enhancement	General approach	Relevant Guides/Parts		Guide sections for enhanced material
Assessing quality of walking environment and determining level of service of facilities.	Outline basic determination of pedestrian level of service. Outline pedestrian activity and perceptions, and methods for assessing walkability. Outline pedestrian aspects of multimodal approach to determining level of service.	GTM	Part 3	Add new section (3.4) on pedestrian LoS, developments in HCM 2010 and assessment of walkability, plus tools for auditing/assessing facilities.
			Part 5	Table 3.2 – add material on selection of facilities on basis of LoS and other factors; correct reference to warrants.
			Part 6	Section 8.2 – add material on selection of pedestrian facilities based on LoS.
		GRD	Part 2	Commentary T – add material on pedestrian LoS and need to include other factors; update HCM references to 2010 edition.
			Part 6A	Section 6.2.1 – add note that pedestrian LoS involves more than space and volume factors.
Details for the design and management of pedestrian facilities.	Provide more detail regarding pedestrian activity and facility needs.	GTM	Part 5	Table 3.1 – add material on shared spaces. Table 3.2 - add material on signalised pedestrian crossing facilities.
			Part 6	Section 4.5.3 – add material on pedestrians at roundabouts. Section 8.1.2 - add material re catering for pedestrians with disabilities. Table 8.1 – add material on shared spaces. Add new sub-section in 8.2 on signalised facilities - pelican and puffin crossings, countdown timers. Section 8.3 – add reference to pedestrian-cyclist conflict on shared paths.
		GRD	Part 4	Section 8.2.4 – amend material on kerb ramp design.
		GRS	Part 2	Section 3.4 – add material on need for additional data on walking travel characteristics.
Measuring pedestrian activity.	Outline improved methods for planning and undertaking surveys of pedestrian activity.	GTM	Part 3	Appendix E – add material on survey techniques, including technologies, for measuring walking.

6 FURTHER DEVELOPMENT

The work undertaken in this project did not include development of detailed procedures or tools for the selection and assessment of particular pedestrian facilities. However, the general approaches that should be adopted in emerging best practice have been outlined. These include:

- taking greater account of the perceptions and preferences of pedestrians in assessing facilities and
- adapting the major developments in assessing pedestrian facilities, particularly in terms of the levels of service (LoS) provided for pedestrians.

Further work is required for the development of a comprehensive tool for assessing all possible types of pedestrian facilities.

6.1 Considerations for Development of a Tool

The primary relevant advances in assessing pedestrian facilities were identified as:

- the HCM 2010 material on pedestrian LoS in the multimodal LoS context
- the NZ Guide material (and underlying spreadsheet analysis) focusing on LoS and the CSR approach
- the Queensland point score, spreadsheet analysis and prioritisation approach
- the UK evaluation system PERS.

The essential features of these tools have been summarised and referenced in this report.

Each system is based on a (different) mixture of measured data and professional judgment, and tackles only part of the pedestrian facility environment. The focus for the above approaches has been primarily in terms of LoS rather than safety *per se*, although safety issues have been included in some approaches.

The NZ system appears to be the most comprehensive, and the NZ work to date has identified further work to measure essential inputs and validate the system, but it is understood that no such further work is current.

The HCM approach is developed primarily for a footpath in parallel with a road facility, and for crossing at a signalised facility. Application of the HCM approach and the PERS system to the Australian and New Zealand setting is untested in detail.

6.2 Development of an Assessment Tool

A comprehensive assessment tool which combines elements of the separate approaches identified above may be envisaged. The applicability of the elements to the Australian and New Zealand context would need to be assessed, initially on the basis of available data and professional experience, and ultimately through objective validation.

Development of a tool along these lines, as a further project, would involve the following:

- examining the details of the separate approaches listed above
- determining the range of pedestrian facilities to which the separate approaches apply

- determining the applicable algorithms and the data (or other information) requirements needed for the models
- assessing the various models and comparing their outputs, using available input data
- integrating crash reduction factors into the LoS-based models associated with implementation of various facilities
- documenting the potential for a combined model, including gaps needing to be addressed
- assessing the scope and further development of a combined model via a workshop of experienced practitioners
- identifying gaps in the applicability of the combined model
- identifying further work necessary to extend and validate the combined model.

Any detailed validation of the model for local application would be a further separate piece of work beyond the above.

It is envisaged that an 'Australian/NZ Pedestrian LoS Assessment Tool' would be applicable to a range of sites including road lengths, midblock locations and intersections, and would contain mechanisms for the following:

- entering relevant data and other information for a specific site
- refining criteria for pedestrian LoS outputs pertinent to the site
- adjusting weightings for particular types of site
- calculating LoS scores or indices for particular pedestrian facilities under consideration
- integrating crash or casualty reduction potential for facilities under consideration
- presenting predicted outcomes for different pedestrian facilities.

The output from the project would be:

- the tool, envisaged as a spreadsheet-based electronic software system
- an accompanying user guide for the tool
- a project report documenting the development of the tool, its application and limitations.

7 CONCLUSION

7.1 Enhanced Guidance

A review of recent developments in the consideration of pedestrian activity and facilities has confirmed the need for incorporating enhanced guidance in the Austroads Guides.

There has been an increasing recognition of walking as a mode of travel in planning elements of the road network, important developments in the measurement of pedestrian activity and the emergence of enhanced guidance for the provision and assessment of pedestrian facilities. These developments need to be reflected in revisions to the Austroads Guides.

Several volumes in the various guides need to be amended to ensure that an appropriate recognition of pedestrian activity is included and that details of related design, management and analysis procedures are outlined.

The primary need is for amendment to the Guide to Traffic Management Part 3, particularly with respect to taking account of the pedestrian mode in determining LoS. Greater attention needs to be paid to pedestrian needs and perceptions in assessing the quality of their environment, and the consequential changes for providing and managing related facilities.

There is also a need for some amendment to other guides to emphasise the importance of considering pedestrian activity. Those volumes and sections of guides in need of amendment are identified and additional or revised text is proposed.

7.2 Assessment Tool

A review of the tools and techniques emerging for assessing the pedestrian environment and evaluating proposed or existing pedestrian facilities has identified the need to develop a comprehensive tool.

Developments in tools focusing on the quality of the walking environment, pedestrian level of service and safety considerations have been identified in New Zealand, Australia, UK and US. There is a need to develop these approaches further, integrating and adapting the techniques for application in Australia and New Zealand.

The development of such a tool, applicable to a range of pedestrian facilities, has been outlined. It is envisaged that the tool would comprise a spreadsheet-based electronic software system with facilities for data input and adjustment factors pertinent to the types of pedestrian facilities being considered.

7.3 Recommendations

It is recommended that:

- the relevant volumes of the Austroads Guides be amended as proposed in Appendix C to Appendix F of this report, and
- a comprehensive pedestrian facilities assessment tool be developed as outlined in Section 6.

REFERENCES

AASHTO 2004, *Guide for planning, design and operation of pedestrian facilities,* American Association of State Highway and Transportation Officials, Washington DC, USA.

AASHTO 2011, *A policy on the design of highways and streets*, 6th edn, American Association of State Highway and Transportation Officials, Washington DC, USA.

Abley, S & Turner, S 2011, *Predicting walkability,* report 452, NZ Transport Agency, Wellington, NZ.

Allen, D & Clark, S 2007, 'New directions in street auditing: lessons from the PERS audits'*, International conference on walking and liveable communities, 8th, 2007, Toronto, Ontario, Canada,* Access Associates, UK, 10pp.

ATC 2011, *National road safety strategy 2011-2020*, Australian Transport Council, Canberra, ACT, viewed 21 May 2012, <www.atcouncil.gov.au/documents/atcnrss.aspx>.

Attaset, V, Schneider, RJ, Arnold, LS & Ragland, DR 2010, 'Effects of weather variables on pedestrian volumes in Alameda county, California*', Transportation Research Board 89th annual meeting*, Transportation Research Board, Washington DC, USA, 18pp.

Aultman, HL, Lane, D & Lambert, RR 2009, 'Assessing the impact of weather and season on pedestrian traffic volumes'*, Transportation Research Board 88th annual meeting*, Transportation Research Board, Washington DC, USA, 21pp.

Austroads 2006. *Pedestrian-cyclist conflict minimisation on shared paths and footpaths*, AP-R287/06. Austroads, Sydney, NSW.

Austroads 2008-2009, *Guide to traffic management*, AGTM set: parts 1-13, , Austroads, Sydney, NSW.

Austroads 2008-2011, *Guide to road design*, AGRD set: parts 1-8, Austroads, Sydney, NSW.

Austroads 2006-2009, *Guide to road safety*, AGRS set parts 1-9, Austroads, Sydney, NSW.

Austroads 2009, *Guide to road transport planning*, AGRTP09, Austroads, Sydney, NSW.

Austroads 2010, *Cycling aspects of Austroads guides,* AP-G88/11, Austroads, Sydney, NSW.

Baltes, MR & Chu, X 2002, 'Pedestrian level of service for midblock street crossings*', Transportation Research Record*, no.1818, pp. 125-133.

Burke, M, Sipe, N, Evans, R & Mellifont, R. 2006, 'Climate, geography and the propensity to walk: environmental factors and walking trip rates in Brisbane'*, Australasian Transport Research Forum (ATRF), 29th, 2006, Gold Coast, Queensland, Australia*, Queensland Transport, Brisbane, QLD, 17pp.

Cairney, P, Zivanovic, A, Pyta, V & Walsh, K 2010, 'Trial of countdown timers: pedestrian behaviours and perceptions', contract report 002189, ARRB Group, Vermont South, Vic.

Candappa, N, Fotheringham, N, Lenne, M, Corben, B, Johansson, C & Smith, P 2005, 'Evaluation of an alternative pedestrian treatment at a roundabout'*, Australasian Road Safety Research Policing Education Conference, 2005, Wellington, New Zealand*, Ministry of Transport, Wellington, NZ, 10pp.

Chu, X & Baltes, MR 2001, *Pedestrian mid-block crossing difficulty,*NCTR-392-09, National Center for Transit Research (NCTR), University of South Florida, Tampa, Florida, USA.

Chu, X & Baltes, MR 2003, 'Measuring pedestrian quality of service for midblock street crossings: selection of potential determinants', *Transportation Research Record*, no.1828, pp. 89-97.

Crider, LB, Burden, J & Han, F 2001, *Multimodal LoS: 'point' level of service project: final report,* Department of Urban and Regional Planning, University of Florida., Gainesville, Florida, USA.

DfT 2007, *Manual for streets,* Department for Transport, London, UK.

DfT 2009, 'Pedestrian guardrailing', *Local Transport Note*, no. 2/09, Department for Transport, London, UK.

DfT 2011, 'Shared space', *Local Transport Note*, no. 1/11, Department for Transport, London, UK.

FHWA 2009, *Manual on uniform traffic control devices for streets and highways*, MUTCD-10, Federal Highway Administration, Department of Transportation, Washington DC, USA.

Flannery, A, Ali, A & Cristei, C 2010, 'Cumulative logistic regression model for pedestrian level of service rating'**,** *Transportation Research Board 89th annual meeting*, Transportation Research Board, Washington DC, USA, 19 pp.

Fruin, JJ 1987, *Pedestrian planning and design*, 2nd edn, Elevator World, New York, USA.

Gallin, N 2001, 'Quantifying pedestrian friendliness: guidelines for assessing pedestrian level of service', *Road and Transport Research*, vol.10, no.1, pp.47-55.

Gehl Architects 2011, *Major projects in Australia and Asia,* webpage*,* Gehl Architects, Copenhagen, Denmark*,* viewed 22 May 2012*,* < www.gehlarchitects.com/#/159799/>

Hubbard, SML, Awwad, RJ, Bullock, DM 2007, 'Assessing the impact of turning vehicles on pedestrian level of service at signalized intersections: a new perspective', *Transportation Research Record,* no.2027, pp.27-36.

Hubbard, SML, Bullock, DM, Mannering, FL 2009, 'Right turns on green and pedestrian level of service: statistical assessment', *Journal of Transportation Engineering*, vol.135, no.4, pp.153-9.

Hutchinson, N 2011, 'Improving pedestrian access across arterial roads', *State of Australian cities national conference, Melbourne, Vic*, Australian Sustainable Cities and Regions Network, viewed 22 May 2012, <www.soac2011.com.au/full-papers-list.php>.

Jaskiewicz, F 2000, 'Pedestrian level of service based on trip quality', *Transportation Research Circular*, no 501, 14pp.

Jensen, SU 2007, 'Pedestrian and bicyclist level of service on roadway segments', *Transportation Research Record*, no.2031, pp.43-51.

Kartsidimas, P & Ronquillo, J 2010, 'The use of Pedestrian Environment Review System (PERS) software to assess the quality of pedestrian environments', *Australian Institute of Traffic Planning and Management (AITPM) national conference, 2010, Brisbane, Queensland,* AIPTM, Blackwood, SA, 20pp.

Kelly, CE, Tight, MR, Page, MW & Hodgson, FC 2007, 'Techniques for assessing the walkability of the pedestrian environment', *International conference on walking and liveable communities, 8th, 2007, Toronto, Ontario, Canada,* Access Associates, Tewkesbury, UK,13pp.

Kerryn Alexander Research 2006, *Pedestrian service at traffic signals and pedestrian crossings*, research report, VicRoads, Kew, Vic.

Kim, K, Settachai, N, Yamashita, EY & Hallonquist, L 2008, 'Sit, stand, or sell: the impact of street furniture on pedestrian level of service', *Transportation Research Board 87th annual meeting*, Transportation Research Board, Washington DC, USA, 22pp.

King, W 2009, *Trial of a new traffic control device: PUFFIN pedestrian crossing*, Hutt City road & traffic report June 2009, Hutt City Council, Wellington, NZ.

Landis, BW, Vattikuti, VR, Ottenberg, RM, McLeod, DS & Guttenplan, M 2001, 'Modeling the roadside walking environment: pedestrian level of service', *Transportation Research Record*, no.1773, pp.82-8.

Levasseur, M, & Brisbane, G 2011, 'Trial of pedestrian countdown timers in the Sydney CBD: final report', contract report 002878, ARRB Group, Ultimo, NSW.

Levasseur, M & McTiernan, D 2010, 'Research into the application of pedestrian countdown timers in the Sydney CBD', contract report 001893, ARRB Group, Ultimo, NSW.

Lin, PS, Boudreau, AJ 2003, 'Walk versus don't walk - improving the pedestrian experience', Institute *of Transportation Engineers (ITE) 2003 technical conference and exhibit, Fort Lauderdale, Florida*, Institute of Transportation Engineers, Washington DC, USA, 18pp.

Livi Smith, A 2009, 'Contribution of perception in analysis of walking behavior', *Transportation Research Board 88th annual meeting*, Transportation Research Board, Washington DC, USA, 19pp.

Methorst, R, Monterde i Bort, H, Risser, R, Sauter, D, Tight, M & Walker, J 2010, *Pedestrians' quality needs,* final report COST project 358, Walk21, Cheltenham, UK.

Miller, JS, Bigelow, JA & Garber, NJ 2000, 'Calibrating pedestrian level-of-service metrics with 3-D visualization', *Transportation Research Record,* no.1705, pp.9-15.

Muraleetharan, T & Hagiwara, T 2007, 'Overall level of service of urban walking environment and its influence on pedestrian route choice behavior: analysis of pedestrian travel in Sapporo, Japan', *Transportation Research Record*, no.2002, pp.7-17.

Murray, SJ & Walton, D 2009. *Evaluation of a near-side PUFFIN display*, report 09-528041, Opus Central Laboratories, Lower Hutt, NZ.

NCUTLO 2000, *Uniform vehicle code 2000, millennium edition,* National Committee on Uniform Traffic Laws and Ordinances, Alexandria, VA, USA, viewed 22 May 2012, <www.ncutlo.org/index.html>

NZTA 2007, *Pedestrian planning and design guide,* NZ Transport Agency, Wellington, NZ, viewed 22 May 2012, <www.nzta.govt.nz/resources/pedestrian-planning-guide/>.

NZTA 2010, *Guide to undertaking community street reviews*, NZ Transport Agency, Wellington, NZ, viewed 22 May 2012, <www.nzta.govt.nz/resources/community-street-reviews/docs/csr-guide.pdf>.

OECD & European Conference of Ministers of Transport (ECMT) 2006, *Speed management*, OECD Publishing, Geneva, Switzerland.

OECD & International Transport Forum (ITF) 2011, *Pedestrian safety urban space and health*, OECD Publishing, Geneva, Switzerland.

Petritsch, TA, Landis, BW, Huang, HF & Dowling, RG 2008, 'Pedestrian level-of-service model for arterials', *Transportation Research Board 87th annual meeting*, Transportation Research Board, Washington, DC, USA, 29pp.

Petritsch, TA, McLeod, PS, Landis, BW & McLeod, DS 2010, 'Pedestrian level of service model for urban streets'*, Transportation Research Board 89th annual meeting*, Transportation Research Board, Washington, DC, USA, 12pp.

Phillips, R, Karachepone, J & Landis, B 2001, *Multi-modal quality of service project,* Florida Department of Transportation, Tallahassee, Florida, USA.

Planning Institute of Australia, 2009, *Healthy spaces and places - a national guide to designing places for healthy living,* Planning Institute of Australia, Kingston, ACT, viewed 22 May 2012, <www.healthyplaces.org.au/site/>.

Queensland Department of Main Roads (QDMR) 2002, *Pedestrian detectors at midblock signalised pedestrian crossings*, Traffic and Road Use Management (TRUM) manual 2.6, Transport and Main Roads, Brisbane, Queensland

Queensland Department of Transport and Main Roads (QTMR) 2011, *Pedestrian crossing facility guidelines and prioritisation system user guide*, Traffic and Road Use Management TRUM manual 3.13, Transport and Main Roads, Brisbane, Queensland.

Reid, S 2006, 'Fit for purpose: evaluating walkability'*, Proceedings of the Institution of Civil Engineers-Engineering Sustainability*, vol.161, no.ES2, pp.105-12.

Roess, RP, Vandehey, MA & Kittelson, W 2010, 'Level of service – 2010 and beyond'*, Transportation Research Record*, no.2173, pp.20-27.

Ovstedal, L & Ryeng, E 2002, 'Understanding pedestrian comfort in European cities: how to improve walking conditions'*, The AET European Transport conference, Cambridge, UK*, PTRC Education and Research Services, London, UK.

Sanderson, SJ 2005, 'Are we building what the mobility impaired really need?', *Institute of Transportation Engineers (ITE) annual meeting, 2005, Melbourne, Victoria, Australia*, Institute of Transportation Engineers (ITE), Washington, DC, USA, 13pp.

Sarkar, S 2003, 'Qualitative evaluation of comfort needs in urban walkways in major activity centers'*, Transportation Quarterly,* vol.57, no.4, pp. 39-59.

Sauter, D & Wedderburn, M 2008, 'Measuring walking. Towards internationally standardised monitoring methods of walking and public space', *8th International conference on survey methods in transport, Annecy, France*, ISCTSC, France, viewed 22 May 2012, <http://isctsc.let.fr/papiers/workshop%20final%20version/49%20A8%20Sauter%20and%20Wedderburn.pdf>.

Schlossberg, M, Agrawal, AW, Irvin, K & Bekkouche, VL 2007, *How far, by which route, and why? A spatial analysis of pedestrian preference,* Mineta Transportation Institute, San Jose State University, San Jose, California, USA.

Setter, M & Stewart, D 2002, 'Pedestrian facility guidelines and prioritisation points system'*, Australian Institute of Traffic Planning and Management (AITPM) National Conference, 2002, Perth, Western Australia,* AITPM*,* Thornleigh*,* NSW*,* pp.43-61.

Sisiopiku, VP & Akin, D 2003, 'Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data'*, Transportation Research, Part F - Traffic Psychology and Behaviour*, vol.6F, no.4, pp.249-74.

Sisiopiku, VP & Byrd, JE 2006, 'Comparison of level-of-service methodologies for pedestrian sidewalks', *Transportation Research Board 85th annual meeting*, Transportation Research Board, Washington, DC, USA, 23pp.

SKM 2011, *Making walking count: Canberra: city results report*, SKM Colin Buchanan & Walk21, London, UK, viewed 22 May 2012 <www.environment.act.gov.au/__data/assets/pdf_file/0005/243464/Making_Walking_Count.pdf>.

Sutherland, E, Murphy, M & Carlisle, R 2006, 'Healthy by design: an innovative planning tool for the development of safe, accessible and attractive environments for people to walk in', *International conference on walking and liveable communities, 7th, 2006, Melbourne, Victoria, Australia,* Access Associates, Tewkesbury, UK, 14pp.

Tate, F & Waibl, GF2007, *Pedestrian crossing selection calculation spreadsheet*, Excel spreadsheet version 1.2, Land Transport New Zealand, Wellington, NZ, viewed 22 May 2012, <http://www.nzta.govt.nz/resources/pedestrian-planning-guide/resources.html>.

Transport for London 2005, *Improving walkability - good practice guidance on improving pedestrian conditions as part of development opportunities*, Transport for London, UK.

TRB 2000, *Highway capacity manual 2000*, Transportation Research Board, Washington DC, USA.

TRB 2008, *Multimodal level of service anaysis for urban streets*, NCHRP report 616, Transportation Research Board, Washington DC, USA

TRB 2010a, *HCM2010: highway capacity manual*, 5th edn, Transportation Research Board, Washington, DC, USA.

TRB 2010b, *Roundabouts: an informational guide,* NCHRP report 672, Transportation Research Board, Washington, DC, USA.

TRB 2011, *Crossing solutions at roundabouts and channelized turn lanes for pedestrians with vision disabilities,* NCHRP Report 674, Transportation Research Board, Washington, DC, USA.

Van der Spek, SC 2010,'Activity patterns in public space: a tool for assessing city centres: tracking pedestrians in the historic city centre of Delft', *Walk21 conference, The Hague, Netherlands*, Walk21, Cheltenham , UK, viewed 22 May 2012, <www.walk21.com/conferences/thehague.asp>.

VicRoads 2008,'Pedestrian operated signals', in *Traffic engineering manual: volume 1: chapter 4: pedestrian facilities*, VicRoads, Melbourne, Vic.

VicRoads 2010, *SmartRoads guidelines*, version 1.11, VicRoads, Melbourne, Vic.

VTPI 2010. *Online Transportation Demand Management (TDM) encyclopedia*, Victoria Transport Policy Institute, Victoria, BC, Canada, viewed 22 May 2012, <www.vtpi.org/tdm/tdm12.htm.>.

Wanty, DK & Wilkie, SM 2010, *Trialling pedestrian countdown timers at traffic signals*, research report no.428, NZ Transport Agency, Wellington, NZ.

Winters, PL, Cleland, F, Mierzejewski, E &Tucker, L 2001, *Assessing level of service equally across modes,* report 423-0, Center for Urban Transportation Research ,University of South Florida, Tampa, Florida, USA.

Standards Australia

AS 1742 set-2009, Manual of uniform traffic control devices.

AS 1428.1-2009, Design for access and mobility: general requirements for access: new building work.

AS/NZS 1428.4.1:2009, Design for access and mobility - means to assist the orientation of people with vision impairment - tactile ground surface indicators.

APPENDIX A MAPPING OF GTEP 13 MATERIAL INTO AUSTROADS GUIDES

GTEP 13 sections				Referenced in current Austroads Guides
1	Introduction			
	1.1	Pedestrians As Traffic		GTM3 3.3.5, GTM4 4.7.4, GRS6 8.4
	1.2	Characteristics and Behaviour		GRD6 4.1
		1.2.1	Body Dimensions - The Body Ellipses	GRD6 4.1, 4.1.2
		1.2.2	Walking Speed	GTM6 4.5.3, GTM9 7.1.3
		1.2.3	Walking Distance	Partially in GRD6A 4.1.2 Figure 4.1
	1.3	Implications for pedestrian Design		GTM7 Commentary 5
		1.3.1	People with Disabilities	GTM7 Commentary 5, GRS6 8.4
		1.3.2	Young Children	GTM7 Commentary 5
		1.3.3	Elderly Pedestrians	GTM7 Commentary 5
	1.4	Accident Profile		Partially in GRS6 8.4
	1.5	Pedestrian Demand		Partially in GTM4 4.7.1 and GTM3 3.2.3
	1.6	Pedestrian Capacity		Not found
	1.7	Pedestrian Consideration In Land Use Planning		GTM7 2.3 Policy and planning context
		1.7.1	Planning Urban Pedestrian Networks	GTM7 2.3 Policy and planning context
		1.7.2	Road Hierarchy Consideration	GTM5 Table 3.1, Table 4.1, GTM7 2.3 and Commentary 1, GTM4 5.3.2 and 5.3.3
2	Walkways and Footpaths			
	2.1	Clear Width and Height Requirements		GRD6 6.2.1, 2.2.2 and Commentary 3
		2.1.1	Width	GRD6A 6.2.1
		2.1.2	Height	GRD6A 6.2.2
		2.1.3	Obstruction Free Path	GRD6A Commentary 6 and GTM5 Table 3.2
		2.1.4	Covers and Grating	GRD6A Commentary 6
		2.1.5	Setback Distance	GRD6A Commentary 6
	2.2	Changes in Level		GRD6 6.3
		2.2.1	Kerbing and Kerb Ramps	GTM5 Table 3.2 and GRD6A 6.4
		2.2.2	Steps, Stairs and Ramps	GTM5 Table 3.2 and GRD6A 6.5 and Table 6.2
		2.2.3	Gradients	GTM5 Table 3.2 and GRD6A 6.3
		2.2.4	Crossfall	GTM5 Table 3.2 and GRD6A 6.5 and Table 6.3
	2.3	Surface Treatments		GRD6A 6.4
		2.3.1	Concrete and Asphalt	GRD6A Commentary 8
		2.3.2	Pavers and Bricks	GRD6A Commentary 8
		2.3.3	Loose Surface Materials	GRD6A Commentary 8
	2.4	Driveways Across Footpaths		GTM11 6.5.2
	2.5	Access to Buildings		GTM7 3.8.2
	2.6	Joint Footway/Bicycle Facilities		GRD6A 4.3 and 7.5.3, GTM5 Table 3.2

GTEP 13 sections				Referenced in current Austroads Guides
3	Treatments For Pedestrians Crossing Roads			GRD4 8.1.2 and Commentary 4
	3.1	Classification of Facilities for Pedestrians Crossing Roads		GTM5 Table 3.2, GTM6 Table 8.1 and GRD4 8.1.2
	3.2	Warrants and Choice of Pedestrian Crossing Facilities		GTM5 Table 3.2, GTM6 Table 8.1 and Table 8.2 and generally in GTM8 8.2
	3.3	Design Considerations		
		3.3.1	Crossing Width	GRD4 Table 8.1
		3.3.2	Crossing Length	GRD4 Table 8.1
		3.3.3	Surfaces	GRD4 Table 8.1
		3.3.4	Sight Distance	GTM6 3.3.3, GRD4 Table 8.1 and GRD4A 3.3
		3.3.5	Stop Line Location	GRD4 Table 8.1
		3.3.6	Turning Vehicles	GRD4A 10.6.6 and partially in GTM 6 Table 5.1, Table 5.2
		3.3.7	Access to Roadway Crossings	GRD4 Table 8.1 and partially GTM 6 Table 5.3
		3.3.8	Orientation	GRD4 Table 8.1
		3.3.9	Tactile Paving	GTM6 Table 3.3, GTM7 3.8.2
		3.3.10	Other issues for Midblock Crossings	GTM6 8.2
	3.4	General Crossing Treatments		GTM6 8.2
		3.4.1	Pedestrian Refuges	GTM6 Table 5.2 and 8 and GRD4 8.2.2 and Commentary 5
		3.4.2	Footpath (Kerb) Extensions/Parking Nibs	GTM6 8, GTM8 7.3.1 and GRD4 8.2.2 and Commentary 6
		3.4.3	Road Narrowing/Indented Parking	GTM6 8, GTM8 7.3.1 and GRD4 8.2.2
	3.5	Time Separated (Controlled Traffic) Facilities		GRD4 8.2.3 and Commentary 7
		3.5.1	Pedestrian (Zebra) Crossing	GTM6 8, GTM8 7.5.6 and GRD4 8.2.3 and Commentary 8
		3.5.2	Pedestrian Operated Signals	GTM6 Table 5.6 and 8 and GRD4 8.2.3
		3.5.3	Pelican Crossings	GTM6 8 and GRD4 8.2.3
		3.5.4	Puffin Crossings	GTM6 8 and GRD4 8.2.3
		3.5.5	Children's Crossings	Generally in GTM6 8, Table 8.1 and Table 8.2, GTM5 Table 3.1
		3.5.6	Provision for Pedestrians at Signalised Intersections	GTM6 Figure 5.1, Table 5.1 and Table 5.4 and GRD4A 10.6.3
	3.6	Grade (Spatial) Separation		GTM6 7.3 and 8
4	Pedestrian Guidance Measures			
	4.1	Direction and Other Guidance Signs		
		4.1.1	Location of Signs	Generally in GTM10 4.2, 4.5
		4.1.2	Legibility	Generally in GTM10 4.3
		4.1.3	Typeface	Generally in GTM10 4.3
		4.1.4	Colour	Generally in GTM10 4.3
		4.1.5	Signs for People with Impaired Vision	GTM6 Table 3.3, GTM10 2.2
		4.1.6	Signal for People who Cannot Read	GTM10 4.3
		4.1.7	International Symbol	GTM11 6.8.4 and 10.1.4 Pavement marking

GTEP 13 sections				Referenced in current Austroads Guides
	4.2	Guidance Devices		
		4.2.1	Classification of Devices	Not found
		4.2.2	Audible Clues	GTM9 7.1.7
		4.2.3	Visual Clues	GTM8 8.7, GTM6 Table 5.3
		4.2.4	Tactile and Other Physical Cues	GTM8 7.5.10
	4.3	Pedestrian Fences, Bollards and Barriers		GRD6B Table 4.1 and 4.1.6, GRD4A 10.6.3
		4.3.1	Pedestrian Barrier Types and Usage	GRD4A 10.6.3 and GRD6B 4.1.6
		4.3.2	Design Consideration	GRD4A 10.6.3
5	Pedestrian Access to Public Transport			
	5.1	Bus and Tram Stops and Shelters		Generally in GTM5 Table 3.2, GTM6 Table 3.3 and GRD3 4.12
	5.2	Public Transport Loading Islands and Safety Zones		GTM5 Table 3.2 and GTM6 Table 3.3
	5.3	Railway Stations		GTM5 Table 3.2 and GTM6 Table 3.3
6	Pedestrian Facilities At Work Sites			
	6.1	Vertical Clearance		Not found
	6.2	Roadworks and Building Construction		Partly in GRS6 8.4
7	Supplementary			
	7.1	Lighting		
		7.1.1	Objectives	GTM6 6.3.3.5, GTM13 5.2.10 and GRD6B 4.2
		7.1.2	General Standards and Practices	GTM6 6.3.3.5, GTM13 5.2.10 and GRD6B 4.2
		7.1.3	Critical Areas for Illumination	GRD6B 4.2
		7.1.4	Location of Lights and Poles	GRD6B 4.2
	7.2	Speed Limits		GTM5 5
	7.3	Skid Resistant Road Surfacing		GRD4 Table 3.2 and Commentary 8, GRD3 7.6
	7.4	Covered Walkways		Generally in GTM7 3.8
8	Special Treatments			
	8.1	Roundabout		GTM6 4.5.3, 4.6.6, Table 2.2, Table 2.4, GTM8 7.3.6, GRD4 5.2
	8.2	Pedestrian Treatments at Railway Crossings		GTM6 7.6.1
	8.3	Street with Linked Signal Systems		GTM6 5.7
	8.4	Shared Zones		GTM6 Table 5.4, 8, GTM8 2.2, 7.5.7
	8.5	Pedestrianisation		GTM7 4.5
9	Complementary Activities and Programs			
	9.1	Crossing Supervisors		GRS4 1.9.3 not specific
	9.2	Pedestrian Safety Programs		Generally in GRS4 1.5
		9.2.1	Group Meetings	Specifics not found
		9.2.2	Telephone Information Services	Specifics not found
		9.2.3	Signs/Maps	Specifics not found
		9.2.4	Brochures, Advertisements, TV, Radio, Video, Newspapers	Specifics not found

GTEP 13 sections				Referenced in current Austroads Guides
10	Vehicle Parking Layout and Design to Assist Pedestrians			GTM11 1.1 and 2.1
	10.1	On-Street Parking		GTM11 7.5 and 7.6.2 and GRD3 4.10.4
	10.2	Off-Street Parking		GTM11 6 and GRD6B 4.4
		10.2.1	Layout and Circulation	GTM11 6
		10.2.2	Pedestrian Paths/Routes in Parking Areas	GTM11 6
		10.2.3	Sight Distance in Parking Areas	GTM11 6
		10.2.4	Signage, Provision of Information in Parking Areas	GTM11 6.5.5
Note:		GRD3 = Geometric Design		GTM3 = Traffic Studies & Analysis
		GRD4 = Intersections and crossings - general		GTM4 = Network Management
		GRD4A = Unsignalised and Signalised intersections		GTM5 = Road Management
		GRD6 = Roadside Design, Safety & Barriers		GTM6 = Intersections and Crossings
		GRD6A = Pedestrian and Cyclist Paths		GTM7 = Activity Centres
		GRD6B = Roadside environment		GTM8 = Local Area Traffic Management
		GRS4 = Local Government & Community Road Safety		GTM9 = Traffic Operations
		GRS6 = Road Safety Audit		GTM10 = Traffic Control Devices
				GTM11 = Parking

APPENDIX B DIRECTORY TO PEDESTRIAN ISSUES IN GUIDE TO TRAFFIC MANAGEMENT

Part of Guide	Section	Material presented
Part 3 – Traffic Studies and Analysis	2.5.5	Pedestrian surveys
	Table 3.1	Level of service measures for pedestrians
	3.3.5	Pedestrians as a factor in planning, design and capacity
	6.1, 6.4	Pedestrian movements in capacity analysis of intersections
	Appendix E	Pedestrian surveys
Part 4 – Network Management	Table 2.1	Pedestrian trip characteristics and needs
	4.4	Pedestrian considerations in public transport networks
	4.7	Pedestrian networks – general and specific needs
	Table 4.14	Pedestrians requiring special consideration
	Table 5.1	Priorities for pedestrian routes
	Table 5.4	Pedestrian activity in commercial areas and activity centres
Part 5 – Road Management	Table 3.1	Pedestrian requirements in allocation of road space
	Table 3.2	Traffic management in allocation of pedestrian space
	5.2	Pedestrian considerations in applying speed limits
Part 6 – Intersections, Crossings and Interchanges	2.2, Table 2.4	Pedestrian considerations in intersection type selection
	Table 3.3	Pedestrian issues in intersection management
	4.2–4.5	Pedestrian issues at roundabouts
	Table 5.1	Pedestrian issues at signalised intersections
	Table 5.2	Pedestrian requirements at signalised intersections
	5.5	Pedestrian movements and signal phasing
	Table 5.6	Pedestrian needs in signal timing
	5.8	Detection of pedestrians at signals
	6.4	Pedestrian issues at interchanges
	Table 7.1, Table 7.2	Control for pedestrians at rail crossings
	7.6	Pedestrian path crossings of railways
	8	Pedestrian crossings of roads
	Table 8.1	Objectives and priorities for mid-block crossing facilities
	Table 8.2	Guide for selection of crossing facilities
Part 7 – Traffic Management in Activity Centres	1.3	Pedestrian activity in definition of activity centres
	Table 1.3, Table 1.4	Pedestrian streets
	2.2	Pedestrian needs and facilities in activity centres
	2.3	Pedestrian planning for activity centres
	Table 2.3	Guiding objectives for pedestrian plans
	2.3.3	Pedestrian activity in transit oriented developments
	3.5	Pedestrian needs in design of centres
	3.6	Speed environment for pedestrians in centres

Part of Guide	Section	Material presented
Part 7 – Traffic Management in Activity Centres (Continued)	3.8	Providing for pedestrians – access, amenity, design, vehicle conflict
	Table 3.2	Pedestrian topics in Austroads Guides
	3.10	Pedestrian issues in parking at centres
	3.11	Pedestrian connections to public transport
	4.1–4.13	Examples of pedestrian traffic management in activity centres
	Commentary 1	Road hierarchy and pedestrians
	Commentary 3	Speed management in pedestrian areas
	Commentary 5	Pedestrians with special needs
Part 8 – Local Area Traffic Management	1.4–1.6	Pedestrian safety as basic issue in LATM
	2.3–2.4	Pedestrian activity and road function
	Table 7.1	LATM devices for pedestrian safety
	7.1–7.6	Pedestrian issues in LATM devices and treatments
	7.2.4	Wombat crossings
	7.5.6	Marked pedestrian crossings
	7.5.7	Shared zones
	7.5.8	School zones
	8.12	Catering for pedestrians in LATM schemes
Part 9 – Traffic Operations	7.1.3	Pedestrian movements in traffic signal phasing
	Table 7.1	Pedestrian signal controller settings
	7.1.7	Pedestrian detector devices – push-buttons, other
	7.1.8	Pedestrian detection in signal coordination
	Table 7.6	Pedestrian detection in transit signal priority
	Appendix E	Pedestrian signal timings
	Appendix F	Pedestrian push-buttons
Part 10 – Traffic Control and Communication Devices	2.3.2	Provision for pedestrians with disabilities
	4.4.1	Fluorescent sign colours for vulnerable road users
	4.5.3	Sign location and height for pedestrians
	6.4.4	Pedestrian crossing markings
	6.6	Coloured pavements for pedestrians
	6.8.4	Tactile ground surface indicators
	8.1.3	Pedestrian signal displays
	8.3.6	Pedestrian signal layout and sequence
	8.4.3, 8.4.6	Pedestrian signal face location, mounting height
	8.7.2	Pedestrian crosswalk lines
	8.8.2	Give-way to pedestrian signs, scramble-crossing signs
	9	Pedestrian issues for traffic islands and refuges
Part 11 – Parking	5.1	Pedestrian considerations in design of parking facilities
	6.1	Pedestrian needs for off-street parking facilities
	6.5.2	Pedestrian-vehicle interaction in off-street parking facilities

Part of Guide	Section	Material presented
Part 11 – Parking (Continued)	6.6.4	Pedestrian needs in parking structures
	6.9	Pedestrian issues at special event parking
	7.4	Pedestrian issues with kerbside angle parking
Part 12 – Traffic Impacts of Developments	2.1	Pedestrian considerations in planning developments
	3.2, Table 3.1	Pedestrian elements in traffic management of developments
	3.3	Pedestrian access to and safety within developments
	4.2, 4.4	Pedestrian issues in traffic impact assessment
	5.3.4	Pedestrian safety issues in assessment
	Commentary 1	Pedestrian considerations in full transport assessment
	Commentary 3	Pedestrian connectivity in networks
Part 13 – Road Environment Safety	4.4.3	Separating pedestrians from conflict
	5.2.10	Pedestrian safety and lighting
	5.2.11	Pedestrian safety at roadworks

APPENDIX C PROPOSED MATERIAL FOR GUIDE TO TRAFFIC MANAGEMENT

C.1 GTM Part 3

Section 2.5.5

Insert the following material after first paragraph:

In recent years there have been significant developments in policy and strategic planning initiatives aimed at giving greater recognition to walking activity in the transport sector. This has arisen from policy settings in the transport and health sectors recognising the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally.

The development of strategies and plans has typically involved a multi-agency (health, planning, transport) approach to creation of an 'active living' vision. Benefits from the implementation of these strategies are envisaged from health, social, economic, environmental and transport perspectives.

Much work has been done internationally, particularly in developed countries, aimed at understanding, measuring and providing for walking generally. It is recognised that walking is not just a transport mode – it is also a recreational activity – and there is a need to reflect this in related measurement and survey techniques.

New Section 3.4

Insert a new Section 3.4 as follows:

3.4 Pedestrian Level of Service

Advice on the level of service provided to pedestrians by road segments and pedestrian facilities is presented in the Highway Capacity Manual (TRB 2010a). It outlines the principles of pedestrian flow, and defines the basic variables as shown in Table 3.2.

Table 3.2: Basic variables for pedestrian flow

Term	Description and units
Pedestrian speed (S)	Average pedestrian walking speed, measured in metres per second (m/s)
Pedestrian flow rate	Number of pedestrians passing a point per unit of time, expressed as pedestrians per minute
Pedestrian unit flow rate (v)	Average flow of pedestrians per unit of effective walkway width, expressed in pedestrians per minute per metre V = S * D = S / M
Pedestrian density (D)	Average number of pedestrians per unit of area within a walkway or queuing area, expressed as pedestrians per square metre
Pedestrian space (M)	Average area provided for each pedestrian in a walkway or queuing area, expressed in terms of square metres per pedestrian. This includes the basic plan ellipse plus consideration of forward space

Source: TRB (2010a).

The relationships between pedestrian densities, flow rates and walking speeds are presented, and indicative practical values for these and start-up times at signals are given. The effects of bunching and platooning of pedestrians is also outlined. Pedestrian platoons are defined in a manner similar to that for vehicle flow.

3.4.1 Basic Concepts

The basic concept of levels of service (Section 3.2.2) may be applied to pedestrian facilities. For pedestrian walkways, LoS criteria are described primarily in terms of space, flow rates, and speeds. Input data requirements also include geometric features such as footpath length and width. Other measures relating to pedestrian flow include interaction with crossing or opposing main stream flows.

It is possible therefore to conceive of general pedestrian levels of service in a manner parallel to that for the traditional vehicle flow basis for level of service, as set out in Table 3.3. Criteria for each of the levels can be set in terms of pedestrian density and flow rates.

Table 3.3: Pedestrian walkway levels of service

Level of Service	Description for footpaths and walkways Criteria: density, flow rates
A	Pedestrians move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely.
B	There is sufficient area for pedestrians to select walking speeds freely, to bypass other pedestrians, and to avoid crossing conflicts. Pedestrians begin to be aware of other pedestrians, and to respond to their presence when selecting a walking path.
C	Space is sufficient for normal walking speeds, and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.
D	Freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse flow movements face a high probability of conflict, requiring frequent changes in speed and position. Friction and interaction between pedestrians is likely.
E	Virtually all pedestrians restrict their normal walking speed, frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Cross- or reverse flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow.
F	All walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrians. Cross- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

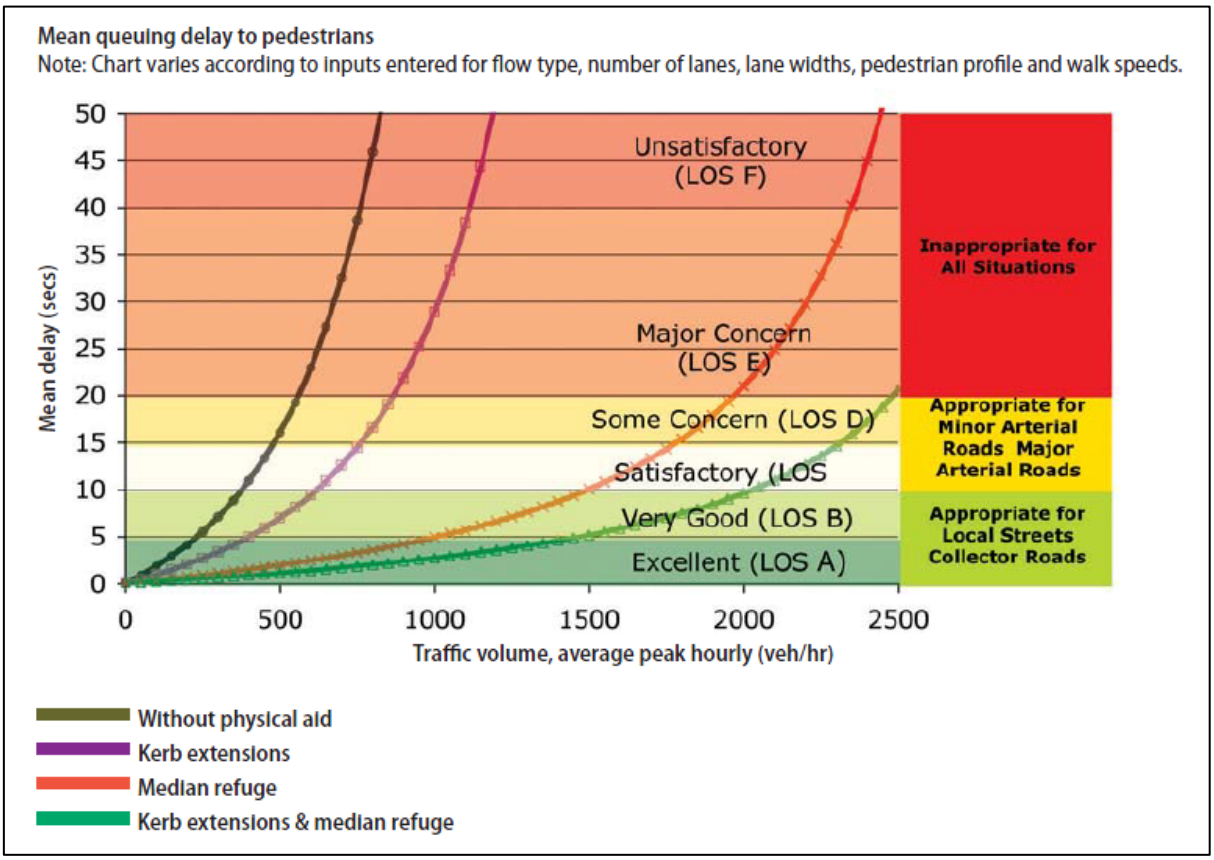
For pedestrian activity in crossing roadways, other factors contribute to level of service criteria. Delay is a prime consideration (for signalised and unsignalised crossing points) and available space for queuing (waiting) at signalised intersections can be a major consideration. At unsignalised crossing points other factors such as directness of desired route and proximity to other controlled crossing points are also relevant.

3.4.2 Using LoS in the Assessment of Crossing Facilities

The level of service (LoS) approach can be used to assist in the assessment of pedestrian crossing facilities, as demonstrated in the NZ guide (NZTA 2007) and the Queensland manual (QTMR 2011).

The NZ guide includes a description of the procedures developed for selecting appropriate crossing facilities, based firmly on the LoS concept. A spreadsheet tool (Tate & Waibl 2007) is used to calculate and compare levels of service for various proposed crossing facilities or improvements.

An example figure emanating from the spreadsheet analysis, based on inputs for flow type, lane numbers and widths, pedestrian characteristics and walk speeds, is reproduced as Figure 3.2.



Source: NZTA (2007).

Figure 3.2: Mean delay for various crossing facilities on a two-lane, two-way urban road (uninterrupted flow)

Relative crash reduction factors associated with the various facilities may be used also to assist in selection of the most appropriate facility.

A similar procedure for the assessment and selection of pedestrian crossing facilities and prioritisation of sites for treatment has been developed in Queensland, and incorporated into a technical manual (QTMR 2011).

The procedure uses spreadsheet analysis to define levels of service in terms of the primary factor of delay to pedestrians attempting to cross the road, and to capture information on features of the location and facility under consideration. Points are generated for the defined LoS, and additional points are generated to modify the scores to account for other factors such as pedestrian volumes, pedestrian characteristics, crash history, restricted visibility, proximity of other crossings, network and connectivity factors, and local traffic impacts.

Guidelines are provided relating the point scores to various crossing facilities, and giving guidance on the application of the facilities, their advantages and disadvantages. Judgments may then be made on the selection of an appropriate facility or treatment of the location.

These approaches differ from the traditional method of numerical warrants based primarily on traffic and pedestrian flows and are preferred. They allow judgments to be made from a broader perspective, considering safety and delay issues.

Further work on development of measures to assess walkability of the pedestrian environment (see Section 3.4.3) will eventually lead to a refinement of the procedure and the LoS criteria.

3.4.3 Walkability and Perceived Levels of Service

The NZ guide (NZTA 2007) contains useful guidance on measuring 'walkability', an indicator of the extent to which the built environment is regarded as suitable or acceptable, in terms of physical and perceived attributes, for walking.

Combining desktop analyses (of pedestrian desire lines and route connectivity) and on-site assessments (involving technical audits and pedestrian ratings) of routes and facilities has led to the development of community street reviews (NZTA 2010). These reviews combine a street audit approach, which identifies deficiencies and opportunities for improvements, with a user perceptions rating system. The procedure rates the environment with respect to overall walkability, as well as more detailed characteristics such as safety, security, obstacles, delay, impedance by others, directness of route, and ambience.

Detailed development of the measurement of walkability (Abley & Turner 2011) is leading to predictions of the quality of the walking environment from the perspective of pedestrians, using operational and physical variables. These combine community street review results with measurements of the walking environment, for both walking along a street and crossing a street.

The HCM 2010 edition incorporates the results of considerable research activity undertaken in the decade since the publication of the previous 2000 edition. An overview of the development of material for HCM 2010, with a particular focus on LoS, is given by Roess, Vandehey, and Kittelson (2010). The research work was aimed at the need to consider the role of user perceptions in determining LoS for various facilities. This recognised that user perceptions are heavily influenced by non-operational factors, such as environmental and aesthetic considerations – especially for pedestrians.

Additional factors contributing to the perceived level of service for pedestrian facilities are acknowledged as:

- comfort (weather protection, climate control, shelter)
- convenience (walking distance, path directions, grades, signing information)
- economy (costs from delays and queuing)
- safety (physical and temporal separation from vehicular traffic)
- security (lighting, open sight lines).

The computational procedures in HCM 2010 for analysing the capacity and level of service for pedestrian facilities incorporate factors reflecting pedestrian perceptions of quality of the facilities. These are derived from the background research work.

3.4.4 Multimodal Level of Service

HCM 2010 considers assessment of the LoS of road or highway facilities from a multimodal level of service approach, derived from a major research project NCHRP 3-70 (TRB 2008). The multimodal approach recognises that different mode users could perceive the quality of service differently due to their different perspectives and experiences. This approach considers the different road user perspectives for vehicles (cars), public transport, pedestrians and cyclists.

A facility can be assessed by determining the LoS score for each of the modes, and comparing the numerical scores against the LoS criteria. An overall LoS is not calculated. Judgments on the selection or development of the facility must be made on the basis of the different modal scores, and additional relevant information (e.g. safety performance), depending on the function intended for the roadway concerned. This necessarily involves consideration of how one mode affects the service quality of other modes, and trade-offs between modes.

The method includes a complete street analysis approach for interrupted flow facilities (segments and crossings, including at roundabouts). Emphasis is placed on 'quality of service' to consider how well a facility or service operates from a user's perspective.

The HCM 2010 presents pedestrian LoS criteria in the context of the multimodal LoS approach, with underlying calculations incorporating factors reflecting pedestrian perceptions, preferences and behaviour as indicated by research studies. Less emphasis is placed on pedestrian density and space factors than was previously the case. Details of the computational methods are given in the NCHRP Report 616 (TRB 2008) and in the electronic Volume 4 *Applications Guide* of the HCM 2010.

Appendix E

Add the following material after the first paragraph in Section E.1.1:

Pedestrian activity is not always simple travel from one point to another. It may also include the activity known as sojourning, involving the social aspects of walking such as wandering, standing, conversing, looking and resting. Traditional methods of measuring pedestrian flow activity are not always appropriate. Depending on the objectives for measuring pedestrian activity (for example, to assess the capacity and attractiveness of an urban space, as compared with the capacity of a planned walkway) it might be more appropriate to measure time spent in the space and monitor routes taken within the space, in addition to counting persons crossing cordon lines at several entries/exits.

Add material to the sub-section on Video Detection; add the following after the dot points:

A prime advantage of video records of pedestrian activity is that the records can be analysed many times from different perspectives and for different purposes. This implies that careful consideration must be given to the positioning of cameras to ensure that relevant activities and locations are covered. This emphasises the basic need to have clear objectives for monitoring the pedestrian activity.

Add the following material in a new sub-section following the Video Detection sub-section:

GPS Tracking

The increasing availability, and decreasing cost, of tracking devices offers advantages in monitoring pedestrian activity. Using GPS technology to observe walking patterns in city centres, for example, offers new abilities for collecting data across a broad spectrum. It is possible to gather individual and collective data on whole trips (including interaction with public transport

facilities), routes through the network and within defined areas, access points, active and inactive time, visited locations, and intensities of use of space, as well as average speeds and flow information. Collecting data using GPS tracking can provide greater insight into pedestrian behaviour and pedestrian movement, which can be used to help define interventions to improve the walkability of public spaces.

Bluetooth wireless technology can also be used to track vehicles which are increasingly fitted with Bluetooth devices. Many pedestrians are also now Bluetooth enabled, carrying personal devices such as mobile phones and headsets.

C.2 GTM Part 4

Section 4.7.1

Add the following material after the first paragraph:

In recent years there have been significant developments in policy and strategic planning initiatives aimed at giving greater recognition to walking activity in transport planning. This has arisen from policy settings in the transport and health sectors recognising the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally.

This has led to recognition of the need for planning and designing communities for people movements, not just car movements, with an emphasis on active travel such as walking and cycling. There is a need to plan transport networks which acknowledge the potential increase in active travel. A greater emphasis will also be needed in road network planning and urban design on providing facilities for pedestrian activity.

Add the following material after the last paragraph:

Safety is a prime objective in traffic management, and pedestrians are particularly vulnerable. In a vehicle-pedestrian collision, the probability of survival for the pedestrian decreases dramatically at impact speeds above about 30 km/h. The Safe System approach to road safety management recognises that humans make errors, that crashes will continue to occur and that humans have a limited tolerance to impact forces. It aims to ensure that the road/traffic environment does not present opportunities for that tolerance to be exceeded. In the pedestrian context this means ensuring that facilities provided for pedestrians do not expose them to the likelihood of serious injury or death; that vehicles and pedestrians are separated physically or temporally, or that the speed environment is controlled to keep potential impact speeds within survivable limits.

C.3 GTM Part 5

Section 1.2

Add the following material after the second paragraph (ending with '…amenity of those areas.'):

Recent developments in policy and strategic planning initiatives are aimed at giving greater recognition to walking activity in road and transport planning. This has arisen from policy settings in the transport and health sectors recognising the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally.

This has led to recognition of the need for planning and providing a road network which caters for the potential increase in active travel such as walking and cycling. This is a fundamental factor for

consideration in striving for balance between the mobility and access functions of roads in the network.

This is particularly relevant to local roads and streets in the urban network where pedestrian activity, and the potential for conflicts, is greatest.

Table 3.1

Add material to the cell of the table dealing with Pedestrian Space/Urban local roads; replace the last item ('– urban design ..') with the following material:

- Urban design, by converting minor roads into pedestrian malls (an example of separating vehicles and pedestrians) or provision of shared zones (integrating pedestrian and vehicular traffic, with priority for pedestrians) or creation of shared spaces (integration by removing demarcation of vehicular and pedestrian areas of the street).

Table 3.2

Add material to the cell of the table dealing with Pedestrians/Crossing facilities; replace the last two dot points with the following material:

- The types of mid-block crossing that may be provided include:
  - — Pedestrian operated signals
  - — Pelican crossing (where traffic signals have a flashing yellow phase for vehicles)
  - — Puffin crossing (where pedestrian presence on the crossing is detected and signal timing for the crossing is adjusted accordingly)
  - — Pedestrian operated school signals
  - — Pedestrian (Zebra) crossing
  - — Pedestrian (Wombat) crossing
  - — Children's crossing
  - — Pedestrian refuge.

Selection of pedestrian crossing facilities on the basis of safety and pedestrian level of service is outlined in the Guide to Traffic Management Part 3. This approach is preferred to selection based only on numerical warrants, as provided in the Guide to Traffic Management Part 6.

C.4 GTM Part 6

Section 1

Add material in new Section 1.3 as follows:

1.3 Safety Objectives

Safety is a prime objective in traffic management, and is pursued in accordance with the Safe System approach which underpins the national road safety strategies in Australia and New Zealand. The Safe System approach to road safety management recognises that humans make errors, that crashes will continue to occur and that humans have a limited tolerance to impact forces.

The approach aims to provide a safer road and traffic environment in which alert and responsible road users should not be killed or seriously injured as a result of a crash. It is structured around the basic pillars of safer roads, safer speeds, safer vehicles, and safer road users.

In the context of providing and managing intersection facilities, the Safe System approach aims to ensure that potential collisions are avoided and, if they occur, that the potential crash impact forces do not exceed human tolerance. Speed in intersections is a critical factor. For a vehicle-vehicle right-angle collision, the probability of survival for the occupant of the vehicle struck in the side decreases dramatically for impact speeds above about 50 km/h. Pedestrians are particularly vulnerable. For vehicle-pedestrian collisions, the equivalent survival speed is about 30 km/h.

The provision of intersection facilities and related features on the approach roads must therefore strive to ensure that these potential impact speeds are not exceeded. From the pedestrian safety perspective, this is particularly relevant to local roads and streets in the urban network where pedestrian activity, and the potential for conflicts, is greatest.

Section 4.5.3

Add the following material immediately prior to the paragraph commencing 'The ability of vehicles to enter …'

A recent US publication (TRB 2010) provides information and guidance on roundabouts, for designs suitable for a variety of typical conditions in the United States. It provides general information, planning techniques, evaluation procedures for assessing operational and safety performance, design guidelines, and principles to be considered for selecting and designing roundabouts.

A separate publication (TRB 2011) provides practitioners with specific guidance on establishing safe crossings at roundabouts for pedestrians with vision disabilities. It identifies the conditions under which pedestrians with vision disabilities may experience problems with crossing performance, and suggests specific treatment solutions. It also includes advice on conducting pedestrian/vehicle studies related to these problems, and on quantifying pedestrian accessibility at crossings.

(References as follows):

TRB 2010 *Roundabouts: An Informational Guide.* NCHRP Report 672. Transportation Research Board, Washington, DC.

TRB 2011 Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities. NCHRP Report 674. Transportation Research Board, Washington, DC.

Section 8.1.2

Add the following material after the dot points:

The Australian Standard *AS 1428.1 Design for Access and Mobility – General Requirements for Access* specifies requirements, with particular attention to paths of travel, access and facilities for people with ambulatory and sensory disabilities and those who use wheelchairs. From the design perspective, additional guidance is given in the Austroads Guide to Road Design Part 6A, and in the *NZ Pedestrian Planning and Design Guide* (NZTA 2007).

Table 8.1

Add material to the row of the table dealing with Integrated Facilities; replace description of Shared Zone with revised material below, and add material on Shared Space, as follows:

Shared zone	Environment is adapted for low speed. Image of street changed to increase awareness of different conditions. Improves safety and amenity for pedestrians and cyclists without affecting access. Pedestrians have legal priority. Provides for flexible parking arrangements. Usually restrictions on vehicle type. High cost, motorists may not observe speed restrictions during periods of low pedestrian and cyclist use. Refer to Part 4 of the Guide to Road Design; AS1742.9, AS1742.10 & AS1742.13.
Shared space	Removal, or at least reduction, in traffic control devices. Reduction or removal of separation between vehicles and pedestrians. Vehicle-pedestrian interaction increases as level of demarcation is reduced. Improves pedestrian movement and comfort by reducing dominance of motor vehicles. Normal priorities apply, but design encourages sharing. DfT (2011) provides guidance on how physical features can influence the level of sharing.

Section 8.2.1

Add material after first paragraph as follows:

The selection of appropriate pedestrian crossing facilities should be made on the basis of safety performance and the level of service provided to pedestrians. Guidance on this approach is outlined in the Guide to Traffic Management Part 3. This approach is preferred to a selection method based only on numerical warrants arising from vehicle and pedestrian flows.

New sub-section in 8.2

Remove the Note on Pelican and Puffin crossings from Table 8.1 and place it in a new section immediately before the existing section 8.2.3, to read as follows:

8.2.3 Crossings at Signalised Facilities

Pelican and Puffin (Pedestrian User Friendly Intelligent) crossings are pedestrian operated signals with operational modifications. Pelican crossings have a flashing yellow phase that enables vehicles to proceed once pedestrians have cleared the crossing. Puffin crossings have additional detectors to monitor the progress of pedestrians on the crossing allowing the crossing time to be reduced when a pedestrian has crossed quickly, or extended for slow moving pedestrians. Refer to the Guide to Road Design Part 4 and Section 5 of the Guide to Traffic Management Part 6; Refer also to AS1742.9, AS1742.10 & AS1742.14; NZTA (2007).

A trial of a Puffin pedestrian crossing installation with nearside displays for pedestrians was undertaken in NZ. It was concluded (Murray & Walton 2009) that Puffin crossings offered advantages over normal signalised midblock crossings and that the nearside displays gave rise to better user compliance than did the usual far-side displays.

Pedestrian countdown timers (PCTs), providing users with information on the available crossing time remaining, may also be considered. These are used widely in some European countries and are now mandated for use in the USA for all new traffic signal installations. A review of international experience (Levasseur & McTiernan 2010) indicated there was merit in trialling their application.

A trial in Melbourne (Cairney et al. 2010) concluded that there was no reliable indication of an improvement in pedestrian behaviour or a reduction in risk to pedestrians following installation of the PCTs. An investigation of trial PCT installations in Sydney (Levasseur & Brisbane 2011) concluded that there was no net improvement with regard to safety or compliance, but an increased amenity for pedestrians arising from reduced delay at crossings was suggested. In NZ, a trial of PCTs (Wanty & Wilkie 2010) produced inconclusive results, but pointed to a reduction in compliance which suggested a potential reduction in safety. No definitive guidance for PCT installations in Australia has yet emerged.

Section 8.3

Add the following material to the end of the second paragraph (currently ending '… design measures') as follows:

Key conflict issues between pedestrians and cyclists on shared paths and footpaths are identified and described in Austroads (2006), and guidance on key conflict minimisation strategies and options are presented. Summary information on these conflicts is provided in the Guide to Road Design Part 6A.

C.5 GTM Part 7

Commentary C3.6

Add material on shared spaces to Commentary C3.6, as follows:

Recent developments in application of shared spaces in the UK are documented in a comprehensive guide (DfT 2011) which presents the principles of the facilities, the needs and behaviour of the road users (pedestrians, cyclists, vehicle drivers), the development of shared space schemes, and detailed advice on design.

C.6 GTM Part 8

Section 7.5.7

Add material after the end of the second paragraph dealing with shared zones, as follows:

A variant on the shared zone concept, known as a 'shared space', has been developed in recent years. Shared spaces are typified by removal, or at least reduction, in traffic control devices, and the reduction or removal of clear demarcation of separate vehicle and non-motorised areas. The concept has been applied across a broad range of street types, and details of design features have been similarly varied. Normal priorities between vehicles and pedestrians apply, but the design and appearance of the environment encourages sharing. A comprehensive guide based on UK experience is available (DfT 2011) and further comment on this emerging facility is given in the Guide to Traffic Management Part 7 (Commentary 3.6).

APPENDIX D PROPOSED MATERIAL FOR GUIDE TO ROAD DESIGN

D.1 GRD Part 2

Section 1.4.1

Add material after the first paragraph, as follows:

Safety is a prime objective in road design, and is pursued in accordance with the Safe System approach which underpins the national road safety strategies in Australia and New Zealand. The Safe System approach recognises that humans make errors, that crashes will continue to occur and that humans have a limited tolerance to impact forces. The approach aims to provide a safer road and traffic environment in which alert and responsible road users should not be killed or seriously injured as a result of a crash. It is structured around the basic pillars of safer roads, safer speeds, safer vehicles, and safer road users.

In the context of designing and providing a safer road environment, the Safe System approach aims to ensure that potential collisions are avoided and, if they occur, that the potential crash impact forces do not exceed human tolerance. On rural roads and major arterials multi-vehicle and single-vehicle crashes are the prime concern, whereas on urban local roads pedestrian activity, and the potential for vehicle-pedestrian conflicts, is greatest. Pedestrians are particularly vulnerable to serious injury. Design considerations for local roads must therefore strive to ensure that these conflicts are avoided and that design speeds are commensurate with potential impact speeds that are survivable. (See also Section 1.9)

Section 1.9

Add material at the beginning of the section, as follows:

In recent years there have been significant developments in policy and strategic planning initiatives aimed at giving greater recognition to walking activity in transport planning, particularly in urban areas. This has arisen from policy settings in the transport and health sectors recognising the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally. This has led to recognition of the need for planning and designing a road network which caters for the potential increase in active travel, and for providing facilities for safe pedestrian activity.

Add material at the end of the section, after the dot points, as follows:

It is not always possible, or desirable, to clearly separate vehicular and pedestrian activity. In some instances the provision of shared areas is a preferred approach, utilising facilities such as ‘shared zones’ and ‘shared spaces’. Further discussion of these facilities is given in the Guide to Traffic Management, Parts 5, 6 and 7.

Section 2.4.1

Add material after the first paragraph, as follows:

The recent developments in policy and planning initiatives giving greater recognition to more sustainable forms of transport (see Section 1.9) in urban areas have led to consideration of a **road user** hierarchy in addition to the traditional road hierarchy. The road user hierarchy indicates the relative priorities to be accorded to road user categories in the operations of the road network. In accordance with this, pedestrian activity is often identified for priority consideration on some

sections. This needs to be integrated and balanced with priorities arising from the prevailing functional road classifications.

Commentary T

Replace the last paragraph with the following material:

Conditions affecting level of service include the roadway, terrain, driver population, traffic mix and characteristics, and traffic controls. The concepts of 'Level of Service' are well described in the US Highway Capacity Manual (TRB 2010) and the Austroads Guide to Traffic Management Part 3, in addition to Part 3 of this Guide to Road Design.

For pedestrian facilities, the basic concept of level of service applies but the details are often more complex than a simple translation of the above 'traffic flow' approach would provide. For crossing facilities, pedestrian delay is a prime consideration. Many other factors including perceptions of quality and comfort contribute to practical (perceived) levels of service. Further advice on pedestrian level of service is given in the Guide to Traffic Management Part 3.

D.2 GRD Part 4

Section 8.2.4

Amend the third paragraph to read as follows:

The general form of kerb ramps is illustrated in Figure 8.6. AS 1428.1:2009 provides guidance regarding the design of kerb ramps. A minimum footway width of 1500 mm should be provided beyond the top of the ramp, to ensure that users of the footway along the street are not inconvenienced by the ramp. A kerb ramp gradient of 1:10 is sometimes proposed in order to address the possibility of wheelchairs tipping backwards when traversing the transition to ascending the ramp. This gradient is less than the maximum of 1:8 quoted in AS 1428.1, which should be considered as an absolute maximum ramp gradient.

The gradient of 1:8 is prescribed so that a person with a vision impairment can identify the change in grade without the aid of TGSI. With a lesser slope it is more likely that a person with a vision impairment will not detect the change in grade (possibly stumbling or tripping). This could result in more widespread use of TGSI which is also an undesirable outcome for many people who use wheelchairs. Limited field testing with wheelchair models available in the Australian market demonstrated that on the 1:8 slope none of the wheelchairs become stranded in the transition of grade or tipped backwards

D.3 GRD Part 6A

Section 1.3

Add the following material to the end of the section:

Pedestrians (and cyclists) are particularly vulnerable to serious injury. In a vehicle-pedestrian collision, the probability of survival for the pedestrian decreases dramatically at impact speeds above about 30 km/h. The speed environment where pedestrian paths, and pedestrian desire lines generally, need to cross traffic streams is therefore a critical consideration.

Section 6.2.1

Replace last sentence of the fourth paragraph (commencing 'In some instances …') with material as follows:

The planning process may involve estimation of pedestrian demands and the application of capacity analysis to ensure that the path will provide an appropriate level of service (Fruin 1987; NZTA 2007). It is to be noted that factors other than pedestrian space requirements, flow rates and path dimensions often need to be taken into account. Factors such as grade, route directness, adjacent land-use, landscaping, surface, and feelings of security and comfort may contribute to the overall perceived 'level of service' that a path might offer. Further guidance on pedestrian level of service is given in the Guide to Traffic Management Part 3.

APPENDIX E PROPOSED MATERIAL FOR GUIDE TO ROAD SAFETY

E.1 GRS Part 1

Section 2.3

Add the following material after the third last paragraph (ending ' … users are at risk'):

It is important therefore in measuring overall road safety performance and monitoring trends to consider the data for the component road user types. Decreasing overall trends in frequencies or rates may mask less favourable trends for some particular road user types. These need to be identified and understood.

In the case of pedestrians, for example, shifts in policy and planning strategies encouraging an increase in active travel modes such as walking may lead to an increased exposure to risk for pedestrians (in the absence of countervailing initiatives). This might well be reflected in an increase in injuries and deaths, and such a deteriorating situation might be offset and masked by safety gains for vehicle occupants. This in turn underlines the need for additional data on travel activity for specific road user types to measure exposure.

E.2 GRS Part 2

Section 3.4

Add the following material after the first paragraph:

Recent developments in policy and planning initiatives give greater emphasis to the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally. This is increasingly actively encouraged, and has the potential to contribute to an increased risk to safety. While preventative countermeasures can be developed, there is a basic need for relevant data on walking (distance, duration, location type, time of day, etc.) – as a transport mode and a recreational activity – in order to monitor the situation effectively.

Section 3.7

Add the following material at the end of the section:

In addition, increasing community awareness of the need for more healthy activity, as reflected in shifts in transport planning policies (see Section 3.4), has the potential to increase the proportion of active travel such as walking and cycling. This needs to be considered in developing safety strategies and programs.

Appendix A

Add material to the sub-section on Safe System Approach; add a new paragraph after the paragraph commencing 'The system is shown …' with the following material:

Pedestrians (and cyclists) are particularly vulnerable to serious injury. In a vehicle-pedestrian collision, the probability of survival for the pedestrian decreases dramatically at impact speeds above about 30 km/h. Management of the speed environment where pedestrians and vehicles interact is therefore a critical consideration.

E.3 GRS Part 4

Section 1.3

Add the following material after the dot points and immediately before the final paragraph:

Local government has responsibility for the provision and maintenance of local roads and management of the traffic they carry. In urban areas the local roads primarily provide access to residential properties, and the responsibilities include related features such as footpaths and crossing facilities, and some provision of local transport services. There are thus implications for the management of pedestrian activity associated with these facilities. Local government responsibilities therefore clearly include a central role in pedestrian safety management.

APPENDIX F PROPOSED MATERIAL FOR GUIDE TO ROAD TRANSPORT PLANNING

F.1 GRPT Section 1

Section 1.3

Add the following material after the last paragraph:

In recent years there have been significant developments in policy and strategic planning initiatives aimed at giving greater recognition to walking activity in transport planning. This has arisen from policy settings in the transport and health sectors recognising the need to move towards more sustainable forms of transport (by foot, bicycle or public transport) and towards healthier activity (walking, cycling) by the community generally.

This has led to recognition of the need for planning and designing communities for people movements, not just car movements, with an emphasis on active travel such as walking and cycling. There is a need to plan transport networks which acknowledge the potential increase in active travel, and develop infrastructure facilities which increase its appeal.

INFORMATION RETRIEVAL

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Keywords:

pedestrians, pedestrian facilities, walkways, footpaths, shared paths, pedestrian crossing, level of service, walkability.

Abstract:

This review of research, newly published material and emerging practice has identified areas where additional advice and guidance on pedestrian facilities can be incorporated into the Austroads Guides. Greater recognition of the importance of walking from health and transport perspectives, and a greater emphasis on providing pedestrian facilities in road network planning and management, are required. The development of techniques for assessing the quality of the walking environment, and for determining the level of service provided for pedestrians, is also to be addressed. Recommendations are made for amendments to the text of relevant Austroads Guides, in particular the Guide to Traffic Management, and for the development of a comprehensive pedestrian facilities assessment tool.