Guide to Traffic Management Part 8

Local Area Traffic Management

Austroads

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Austroads

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Guide to Traffic Management Part 8: Local Area Traffic Management

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Abstract

The Austroads *Guide to Traffic Management* has 13 parts and provides a comprehensive coverage of traffic management guidance for practitioners involved in traffic engineering, road design, town planning and road safety.

Part 8: Local Area Traffic Management is concerned with the planning and management of road space usage 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 provides guidance for planners and engineers associated with the design, development and management of residential precincts.

Part 8 presents a systematic approach to traffic management in local areas, outlining the principles and practice of influencing driver behaviour in local streets – both directly by physical changes to the environment, and indirectly by influencing driver perceptions of what is appropriate behaviour. It provides guidance on the selection, design, application and effectiveness of traffic control measures on an area-wide or at least whole-of-street basis, including effects such schemes may have on local and arterial road networks.

Keywords

Traffic management, traffic calming, traffic planning, traffic control, local area, LATM, neighbourhood traffic management, traffic control devices, road hierarchy, speed control, speed based design, public participation, community consultation, street design, design of residential areas.

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This latest edition of the Guide has been updated to:

- reflect new design concepts and approaches to safety and local area traffic management
- incorporate new evidence on the advantages and disadvantages of some LATM treatments
- highlight that all four pillars of a Safe System should be central to the design of any LATM scheme
- recognise that new LATM treatments have been developed and successfully trialled, and that the LATM treatments in most common use have changed
- reflect the increased amount of information reported in relation to the management of pedestrians and cyclists within LATM treatments, particularly at lower speeds
- recognise the increasing role of technology.

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About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Roads and Maritime Services New South Wales
- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of State Growth Tasmania
- Department of Transport Northern Territory
- Territory and Municipal Services Directorate, Australian Capital Territory
- Australian Government Department of Infrastructure and Regional
- Australian Local Government Association
- New Zealand Transport Agency.

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Contents

Tables

Figures

1. Introduction

1.1 Scope of this Guide

Part 8 of the Austroads *Guide to Traffic Management* has the title *Local Area Traffic Management* (LATM) to define the limitations on its scope within the context of:

- the 13 different Parts of the *Guide to Traffic Management*
- the 9 different Guides spanning the range of Austroads publications.

The structure and content of the *Guide to Traffic Management* is discussed in *Part 1: Introduction to Traffic Management.* The 13 Parts are listed in Table 1.1.

In the context of the *Guide to Traffic Management,* Part 8 is restricted to measures for traffic (especially speed) management and physical changes to the environment of streets within local areas. Whilst Part 8 refers to issues covered in other parts, it is distinguished from:

- Part 4 – covers issues considered at the network level such as provisions for specific road users in the network
- Part 5 – refers to related management issues but in the context of the broader network
- Part 6 – deals with traffic management issues relating to the use and design of intersections, interchanges and pedestrian, bicycle and other crossings
- Part 7 – includes reference to the needs of road users in activity centres
- Part 9 – covers traffic operational matters such as traffic signals and incident management
- Part 10 – provides guidance on the design and use of traffic control and communication devices
- Part 12 – deals with issues related to development impacts
- Part 13 – provides guidance on road environment and safety in a broader context.

The scope of this Guide is therefore **traffic management within localities** and thus it focuses on local streets, which are primarily the responsibility of local government. The primary emphasis is on physical changes to the local street environment, with associated traffic management and enforcement, on an area-wide or at least whole-of-street basis to improve the community space, amenity, and safety within a residential precinct. Some standard traffic management measures, such as signs and road markings, have LATM application and may be included in the LATM 'tool box'. Where not referred to here, the reader should consult other parts of the *Guide to Traffic Management*, the general traffic engineering literature and appropriate codes for guidance on these techniques. Additionally, the Guide does not deal with those wider aspects of 'traffic calming' that relate to traffic reduction or roads beyond local areas. Measures to reduce the total level of traffic in cities are discussed in Austroads (2007), and guidance on traffic management techniques suitable for arterial roads and other roads with a significant traffic function is given in Austroads (1998a, b).

In the context of the other Guides within the Austroads range of publications, this Guide is restricted to traffic management advice specific to local streets, and refers only briefly to issues more appropriately addressed in other Guides. It is recognised that it is difficult, if not impossible, to discuss many aspects of local area traffic management without reference to road design and/or safety issues. Therefore the view is taken that within the *Guide to Traffic Management* any consideration of such issues should be brief and be supported by references to the *Guide to Road Design* and/or the *Guide to Road Safety*.

A final issue in relation to scope is that this document provides *guidelines* to good practice in traffic management, rather than specifying mandatory practice. Where appropriate, it makes reference to statutory and advisory documents that may apply in various places, but the practitioner remains ultimately responsible for maintaining an up-to-date awareness of current requirements in a given jurisdiction.

Table 1.1: Parts of the Guide to Traffic Management

Part	Title	Content
Part 1	Introduction to Traffic Management	• Introduction to the discipline of traffic management • Breadth of the subject and the relationship between the various parts of the Guide.
Part 2	Traffic Theory	• An introduction to the characteristics of traffic flow and the theories, models and statistical distributions used to describe many traffic phenomena • Processes that practitioners should consider.
Part 3	Traffic Studies and Analysis	• Traffic and transport data collection surveys and studies • Traffic analysis for mid-block situations (including freeways/motorways) • Analysis of signalised and unsignalised intersections, including roundabouts.
Part 4	Network Management	• Broader issues and aspects of managing networks of roads to provide effective traffic management for all road users • Network needs of freight, public transport, pedestrians, cyclists and private motor vehicles • Tools and systems available to inform road users and manage systems.
Part 5	Road Management	• Is focussed on managing mid-block traffic conditions • Addresses good practice for: – access management – allocation of space to various road users – lane management – speed management.
Part 6	Intersections, Interchanges and Crossings	• Types of intersection • Selection of type – appropriate use • Traffic considerations in traffic management for intersections, interchanges and other crossings.
Part 7	Traffic Management in Activity Centres	• Planning and traffic management of activity centres and associated transport nodes • Principles for various types of centre.
Part 8	Local Area Traffic Management	• Principles and processes • Issues and resources • Selection of schemes and treatments • Design of schemes and devices.
Part 9	Traffic Operations	• Integration of transport modes • Traffic signals – use, design and co-ordination • Incident management • Transport information (road and other modes) • Management of road use (e.g. freight).
Part 10	Traffic Control and Communication Devices	• Signing and marking schemes • Traffic signs, static and electronic • Pavement markings and delineation • Traffic signals and islands.
Part 11	Parking	• Parking policy • Demand and supply • Data and surveys • On-street and off-street • Types of parking and parking control.
Part 12	Traffic Impacts of Developments	• Relationship to road level of service and access management • Development profile and trigger points for treatment • Traffic impact assessment.
Part 13	Road Environment Safety	• Describes and discusses the safety of road environments within a traffic management context • Provides references to relevant sections of the Austroads *Guide to Road Design* and the Austroads *Guide to Road Safety*.

1.2 Purpose of the Guide

The Guide has been prepared to encourage a rational and orderly approach to LATM, and to provide technical guidance and further source material for the practitioner.

Since the 1980s, there has been considerable experience with traffic management at the local level, especially speed management, in Australia and New Zealand and many other countries. There has also been much research and reporting. This experience and research has been drawn on in preparing the Guide, and many local government bodies have contributed material and comments.

1.3 How to Use the Guide

The Guide is not intended to be read sequentially, but rather to be used as a reference.

The practitioner is advised to be aware of the principles outlined in Section 2, as a rationale and background for the planning process.

In Section 3, the practitioner should decide which elements of the LATM process are appropriate to the case in hand.

Assistance on the use of warrants for LATM schemes are offered in Section 4.

Information relating to community consultation and issues relating to duty of care and other legalities is given in Sections 5 and Section 6 respectively.

The selection and application of specific treatments are outlined in Section 7.

Basic guidance on the design of LATM treatments is given in Section 8 including details pertinent to different road user groups.

Throughout the Guide, reference is made to many documents, which are valuable sources of additional reading.

1.4 Defining LATM

Local area traffic management is concerned with the planning and management of the usage of road space within a local traffic area, often to modify streets and street networks which were originally designed in ways that are now no longer considered appropriate to the needs of residents and users of the local area. LATM can be seen as a tool of traffic calming at the local level (Brindle 1991; O'Brien & Brindle 1999 p. 259). It involves the use of physical devices, streetscaping treatments and other measures (including regulations and other non-physical measures) to influence vehicle operation, in order to create safer and more pleasant streets in local areas. It is consistent with approaches such as self-explaining streets and context-sensitive urban design.

[see Commentary 2]

For the purpose of distinguishing between LATM and other aspects of traffic management, a 'local (traffic) area' is an area containing only local access streets and collector roads, and is usually bounded by arterial roads or other roads serving a significant road transportation function, or other physical barriers such as creeks, railways, reserves or impassable terrain.

[see Commentary 3]

The first tentative modern programs of local traffic restraint were established in the UK and elsewhere in Europe in the late 1960s and early 1970s. These programs were based on the assumption that the 'problem' was caused by intruding non-local traffic exploiting highly-connective local street networks. By the end of the 1970s, various techniques for both network modification and speed management had gained widespread use in Europe and Australia, and were being promoted in the US. The term 'local area traffic management' was already being used in Australia to describe these actions. LATM is now widely applied in both Australia and New Zealand.

[see Commentary 4]

LATM is essentially system-based and area-wide. It considers neighbourhood traffic-related problems and their proposed solutions in the context of the local area or a group of streets within it, rather than only at isolated locations. In addition, it requires that physical traffic measures be seen as a sequence of interrelated devices rather than individual treatments. Much of the material in this Guide will assist practitioners in selecting and implementing single countermeasures at isolated sites, where there are localised problems needing spot treatment. Many street closures, channelisations, pedestrian crossings and small roundabouts, for example, are valid stand-alone treatments at problem locations. However, the installation of such isolated measures is not truly local area traffic management, and practitioners will need to be alert to their potential problems, and to reference the applicable guidance relating to the installation of traffic control devices in that context.

The following additional source material is recommended for reference on this topic: Main Roads WA (2013) and NZ Transport Agency (2013).

1.5 Why Consider LATM?

The primary target of LATM is **to change driver behaviour**, both directly by physical influence on vehicle operation, and indirectly by influencing the driver's perceptions of what is appropriate behaviour in that street. Part 8 should be considered in the context of road safety and the contribution that the Guide can make to the design of safer roads. The objective is to reduce traffic volumes and speeds in local streets to increase amenity, liveability, and improve safety and access for all road users.

[see Commentary 5]

The need for LATM usually arises from:

- an intent to reduce traffic-related problems
- orderly traffic planning and management
- a need to modify 'transport' behaviour
- a desire to improve the community space and sense of place
- a desire to improve environmental, economic and social outcomes
- traffic interventions associated with new development or the implementation of pedestrian and bicycle plans and other local policies (e.g. RTA 2002).

[see Commentary 6]

Traffic-related problems concern mainly:

- improved traffic safety and security, leading to programs for speed moderation and other changes in driver behaviour
- protection or improvement of local amenity focussing on appropriate allocation, design and use of street space, as well as driver behaviour.

Orderly traffic planning and management involves:

- coping with the pressure of traffic growth
- the need to reduce impacts on urban life
- spill-over from traffic routes – restraints on 'rat-running'
- direction of traffic to the most appropriate routes.

Pedestrian and cycle planning involves:

- the creation of compact, mixed use, accessible centres around public transport stops
- the use of walking and cycling catchment mapping, accessibility zoning and integration of regional walking and cycling networks.

Improvement of environmental and social outcomes includes:

- meeting targets in policy areas such as greenhouse gas, air quality, health and social capital.

Proactive traffic interventions include:

- providing for traffic associated with new development and changing land uses, to minimise impacts on nearby areas
- minimising the use of LATM devices in new development areas by ensuring local streets are designed properly so as to encourage low speed environments
- creating conditions for safe and comfortable cycling and walking.

1.6 Providing for a Safe System

Adopting a Safe System approach to road safety recognises that humans, as road users, are fallible and will continue to make mistakes, and that the community should not penalise people with death or serious injury when they do make mistakes. In a Safe System, therefore, roads (and vehicles) should be designed to reduce the incidence and severity of crashes when they inevitably occur.

The Safe System approach requires, in part (Australian Transport Council 2011):

- designing, constructing and maintaining a road system (roads, vehicles and operating requirements) so that forces on the human body generated in crashes are generally less than those resulting in fatal or debilitating injury
- improving roads and roadsides to reduce the risk of crashes and minimise harm: measures for higher-speed roads include dividing traffic, designing 'forgiving' roadsides, and providing clear driver guidance. In areas with large numbers of vulnerable road users or substantial collision risk, speed management supplemented by road and roadside treatments is a key strategy for limiting crashes
- managing speeds, taking into account the risks on different parts of the road system.

Safer road user behaviour, safer speeds, safer roads and safer vehicles are the four key pillars of a Safe System. In relation to speed, the Australian Transport Council (2011) reported that the chances of surviving a crash decrease markedly above certain speeds, depending on the type of crash, namely:

- pedestrian struck by vehicle: 20 to 30 km/h
- motorcyclist struck by vehicle (or falling off): 20 to 30 km/h
- side impact vehicle striking a pole or tree: 30 to 40 km/h
- side impact vehicle-to-vehicle crash: 50 km/h
- head-on vehicle-to-vehicle (equal mass) crash: 70 km/h.

These speeds are indicative and recent research suggests that lower impact speed thresholds apply in the context of both fatal and serious injuries. Austroads (2015a) suggests a non-severe injury threshold of around 20 km/h for vulnerable road users, and 30 km/h in vehicle-to-vehicle crashes. Safe System focussed LATM design should be conscious of these speed thresholds.

In the context of LATM, all four pillars of a Safe System apply and should be central to the design of any LATM scheme.

The following additional source material is recommended for reference on this topic: Austroads (2013b) and Austroads (2015a).

1.7 Local Government Focus

Since LATM, by its nature, involves actions on local street networks, local government around the world has been the principal motivator and implementer of these actions.

To varying degrees, state and national authorities have an interest in policy, standards and the specialist skills and resources that are involved (e.g. as the bodies responsible for road safety). There may be legal and procedural requirements that call on state or national government involvement. However, the primary responsibility for determining the need for action and the nature of the LATM response lies with local government. Therefore, elected representatives and staff in local government need to be familiar with the benefits and techniques of LATM, and involve the community in planning LATM to reduce the impacts of traffic on communities.

1.8 Effectiveness of LATM

The speed-reducing effects of LATM have proven to be variable, reflecting the nature and quality of the installations. The improvement in safety – the primary goal of speed management – has been consistent, if difficult to verify and scale. While the level of reporting and rigorous analysis of LATM effectiveness in Australia and New Zealand in recent years has not been great, a large body of practitioner experience has been built up. This may not constitute an evidence base for the precise effects of individual schemes, but it does provide a convincing knowledge base for LATM in general. Section 3.3.2 and Commentary 14 show how knowledge of the speed effects of specific devices can be used to simulate changes in the speed character of a street.

[see Commentary 14]

Brindle and Morrissey (1998), from a review of LATM practice and experience in Australia, reported that LATM had generally resulted in crash reductions – typically by up to 50% – but treatment selection may need to be better targeted, especially if a specific safety concern has been identified. In addition, the community generally perceived LATM as being effective in reducing crashes.

Other conclusions were:

- Speeds were generally reduced substantially. The numbers of vehicles exceeding 60 km/h were greatly reduced.
- Community perception of the effectiveness of LATM in reducing speeds varied between residents, drivers, and the wider community; around 60% of the public believed that LATM was effective in reducing speeds.
- LATM can be compatible with bicycle use if properly designed.
- Roundabouts were perceived by practitioners to be an effective and most acceptable device.
- Vertical devices were considered to be more effective in speed control and crash reduction than horizontal devices and, despite their lower popularity in the community, appeared to be more acceptable than might have been assumed.

LATM/traffic calming has consistently demonstrated safety and speed reduction benefits in many countries, many under speed limits of 50 km/h and lower, and has not resulted in crash displacement to other parts of the network (e.g. Bulpitt 1995; Chua & Fisher 1991; Engel & Thomsen 1992; Webster 1993; Webster & Mackie 1996; Zein et al. 1997). In none of the 43 international studies reviewed by Geddes et al. (1997) was there an increase in collisions after the treatments were installed.

More recent attempts to establish scientific cause-and-effect between LATM and its claimed outcomes have been hampered by the difficulties in meeting the demands of experimental design. Indications from public health and epidemiology literature are, however, supportive. Retting, Ferguson and McCartt (2003), for example, concluded that a range of changes to the physical environment ‘can substantially reduce the risk of pedestrian-vehicle crashes’. However, while the speed reduction effects of traffic calming and reductions in consequent vehicle crash rates are evident, translation into a reduction of pedestrian risk was less clear.

In a study of the secondary health effects of LATM, Morrison, Thomson and Petticrew (2004) observed:

> *There were increases in observed pedestrian activity in the area after the introduction of the traffic calming scheme. Physical health improved significantly but mental health did not change.*

They concluded that ‘the introduction of a traffic calming scheme is associated with improvements in health and health related behaviours. It is feasible to prospectively evaluate broader health impacts of similar transport interventions although poor response rates may limit the validity of results’.

As noted elsewhere in this Guide, however, LATM is rarely totally welcomed by all sectors of the community, and there may be downsides after the installation of treatments. Factors diminishing the positive achievements of LATM that were identified by the Parliamentary Travelsafe Committee Queensland (1994) will be familiar to most practitioners:

- In trying to redress the imbalance between drivers and other road users, rarely will both groups feel they have gained.
- LATM often does not target the specific safety risks in local streets, and may introduce new types of crashes (even if they tend to be less serious).
- LATM schemes are sometimes implemented in an uncoordinated, unplanned or piecemeal manner.
- It is difficult to classify and deal with those streets which have both a traffic carrying and community function.

The solution to these issues lies largely in making sure that a proper planning process as described in the Guide is followed. In summary, a competent LATM scheme can be expected to lower vehicle speeds and reduce the likelihood of crashes in the neighbourhood, and produce net gains to the community (Shaw 2002).

A new growing trend in LATM is known as psychological traffic calming, including ‘naked streets’, ‘self-explaining streets’, ‘context sensitive design’ and ‘shared space’ zones. There is a need to recognise that traffic environments vary from street to street. Experiments in the Netherlands have shown that stripping-out kerbs, pedestrian barriers, traffic lights and road signs in selected areas increases uncertainty, and helps drivers to slow down to negotiate the area, to engage eye contact with each other and become more aware of their surroundings rather than simply motoring on through. Not all locations are appropriate to become ‘shared spaces’ or ‘naked streets’ and a useful starting point is to establish that the location is balanced with respect to its movement function and its sense of place. A sense of place encompasses a number of elements, most notably a streets local distinctiveness, visual quality, and propensity to encourage social activity.

As another example of this phenomena, roundabouts are now thought to be more effective than traffic lights, as drivers, pedestrians and cyclists are all forced to look around and pay more attention, instead of simply obeying a signal to stop or go.

The following additional source material is recommended for reference on this topic: Department of Transport UK (2007) and Kennedy et al. (2005).

1.9 The Future of LATM

Vehicle technologies are rapidly advancing. Driver-assist technologies such as anti-lock braking systems (ABS), electronic stability control (ESC) and adaptive cruise control (ACC) are widely integrated into the existing vehicle fleet. Additional driver-assist technologies such as lane centring and keeping, stop-start control, parking assist and full highway piloting are in the process of being introduced to the fleet over the next few years with full automation of some vehicles likely within the decade. The IEEE (2012) predicts 75% of vehicles will be fully automated by 2040.

As vehicles become more automated they will include intelligent speed controls as well as connectivity and locational awareness, and become safer to operate. While some crashes may still occur, the likelihood is that local road networks will become safer places and the objectives of LATM will change. Consequently the number, types and design applications of LATM devices will differ from those currently in common practice.

While it will take time for this change to happen, and we will have a mixed fleet at different levels of automation for many years, potentially generations, LATM practice does need to be responsive to these changing environmental factors so it remains relevant and useful to communities.

2. The LATM Planning Process

In both existing and proposed local networks, there are three broad planning aspects to LATM (as distinct from specific infrastructure aspects or details):

- local traffic as a planning rather than just an engineering issue
- the need to see neighbourhoods as systems that are part of a wider network
- the need to follow a systematic planning process when designing or especially redesigning a locality.

Often, the selection, placement, and design of LATM devices is arbitrary and responds more to local pressures and practical constraints than to orderly traffic planning. In order to clearly link proposed actions to the issues they purport to deal with, a suitable process or framework for making planning decisions about LATM first needs to be established.

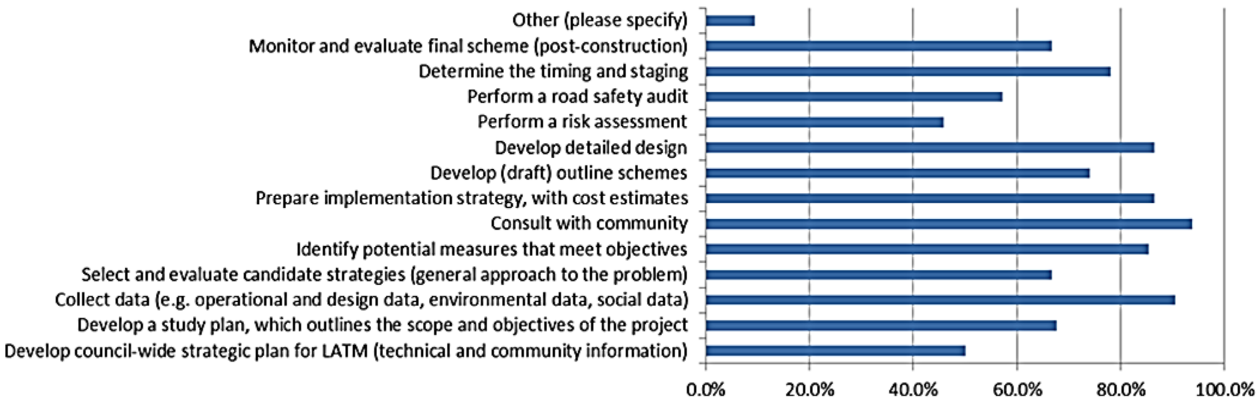
[see Commentary 7 and Commentary 8]

2.1 A Systematic and Comprehensive Approach

This Guide is based on the principle that all LATM programs, large or small, need to follow a systematic and comprehensive process **that is appropriate to the scale of the issues to be resolved**. Even small LATM schemes can be relatively expensive and have complex local consequences, requiring some form of rational process that identifies the issues to be resolved and develops physical or management responses to them. Damen and Ralston (2015) presents the frequency with which respondents use different processes within their LATM approach (Figure 2.1).

Councils and their practitioners have to judge the extent to which the various steps and methods in the LATM process, as described in the Guide, apply to a particular case. Nevertheless, the essential elements hold true, whatever the scale of the issue: a **systematic and (appropriately) comprehensive approach** is required, and a **strategic decision-making process** provides a framework for such an approach.

Figure 2.1: Different LATM processes used by local government



Source: Damen and Ralston (2015).

A useful way to ensure consistent, logical and effective planning for LATM at any level is to adopt a **strategic decision-making** approach.

In essence, the strategic decision-making approach forces attention to be focused on the desired outcomes to be achieved, and the effectiveness of the adopted actions towards that end. This is especially important in neighbourhood and road corridor traffic calming – particularly with the selection and placement of devices. Actions are grouped into strategies (broad approaches to the objectives) and measures (the specific techniques used to implement the strategies). An example is shown in simple form in Figure 2.2.

Figure 2.2: An example of the goal–objective–strategy–measure chain

GOAL ↓	Example: The improvement to living and environmental conditions in residential streets.
OBJECTIVE ↓	Example: Improve safety for road and non-road users of the street network: Specific objective – Reduce bicycle casualties in the area to zero.
STRATEGY ↓	Example: Reduce the speed differential between motor vehicles and bicycles by creating a street environment in which vehicle speeds are kept below 40 km/h.
MEASURE	Example: Install landscaped slow points at approximately 80-120 m intervals.

The strategic approach to LATM requires that the presumed causal links between action and outcome ('Why adopt action *x*? In order to achieve outcome *y*') be clearly established. For example, if there was no established connection between speed reduction and crash reduction, then the adoption of speed reduction as an objective towards crash reduction would be questionable. So **performance measurement** or anticipation of performance from practice and experience elsewhere in the case of project planning, is a vital part of planning for LATM schemes. This continuous background checking of the links between each stage in the process of project development can be called **validation**. It requires the practitioner to keep up-to-date about the performance and effects of the alternative LATM measures.

Validation in reverse turns the 'why?' question into an 'if…then' statement which assists the strategic decision-making process: '**If** you want to achieve x, **then** consider doing y (and/or z)'. If it has the technical information that validates the links between various strategies, objectives and desired outcomes, the local authority can proceed more confidently. This simple concept forms the basis of a consistent framework for selection of strategies and installation design, and allows the practitioner and decision-maker to make informed judgements about the many LATM options available to them.

The LATM process is often complex because of the many interactions that are triggered when traffic management schemes are introduced. Both direct and secondary impacts need to be considered, together with community reactions to proposals. By providing a systematic and comprehensive planning approach to this analysis, LATM allows these factors to be adequately accounted for when a decision on a particular scheme is made.

As early as the mid-1980s, it was known that shortcomings in the planning and execution of the LATM scheme could lead to disappointing outcomes (Brindle 1984b). Some rules of thumb have emerged, as a checklist for the practitioner:

- Follow a systematic planning process.
- Base the plan and subsequent actions on identified problems (existing or future).
- Recognise the underlying existing or latent traffic and network-related problems (e.g. crash potential or social response to traffic intrusion).
- See the preparation and implementation of the traffic plan as more than engineering tasks; fully utilise available planning, urban design and social investigation skills.
- Define realistic objectives that relate specifically to the identified problems or policy outcomes.

- Specify and consider alternative strategies (or general approaches) which could each satisfy the objectives; except in simple cases, have a number of workable 'solutions' for consideration.
- View the proposed treatment from the perspective of **all** road users.
- Choose effective strategies (for example, the objective of reducing speed may not be satisfied by the strategy of excluding non-local traffic).
- Choose specific measures wisely; avoid those that are likely to be ineffective or controversial, or both, if possible.
- Prepare and implement trial or demonstration programs adequately; avoid them if possible.
- Monitor outcomes and impacts, so that assessment against the objectives can be carried out.

Failure to follow a systematic process, and adequately carry through the steps in it, can result in such negative outcomes for LATM as:

- failure to meet the safety, traffic pattern, or street amenity objectives
- creation of new traffic problems
- incompatibility with other local policies and programs
- rejection by the community.

The following material and the processes in Section 3 provide details that may or may not be needed in a given case. The practitioner should make a conscious judgement about what is the appropriate level of detail required to implement the above essential steps and principles in each situation. However, the following steps and principles will always be advisable:

- identify the real problem
- quantify the problem as far as you can
- conduct the study (and, if appropriate, apply the measures) on an area-wide basis
- be careful about restricting or changing access and circulation patterns in an area
- do not rely on enforcement (corollary: use self-enforcing measures)
- facilitate, and certainly do not impede or endanger, non-motorised movement
- provide adequately for emergency and utility services
- monitor and follow-up.

The following additional source material is recommended for reference on this topic: Austroads (2009a); Brindle (1996: Chapter 14); O'Brien and Brindle (1999: pp. 265-266); RTA (2000); Transportation Association of Canada (1998: Section 1.6).

2.2 Understanding the Functions of a Local Street

Local streets serve many functions, some of which conflict. These functions can be classified into two broad groups:

- movement (access, mobility and service) functions including parking
- amenity and social functions associated with the use and enjoyment of the streetspace and the land abutting the street, often referred to as its sense of place.

For an LATM program to be successful, the practitioner must be aware of these functions, know how they are defined and measured, and how they interact, and specifically how to resolve the conflict between the movement and amenity functions.

Access, mobility and service functions relate primarily to **movement** and include:

- vehicular access to properties and distribution of traffic between properties and the major road system. Vehicular movement includes emergency vehicles, essential services and public transport services
- pedestrian and cyclist movement, which is often endangered and inconvenienced by other traffic
- parking and loading/unloading of goods.

The essential principle of LATM is that not all elements in the road network serve predominantly a transport function.

In traffic hierarchy terms, local streets serve primarily a ‘terminal’ function, allowing vehicles to reach individual places within the locality. On such streets, it is recognised that the needs of moving traffic are not more important than the needs of other users and functions in the street, and are often subservient to these other functions. Driver expectations about speed and levels of service should be modified accordingly.

Today, there is a widespread recognition of the multi-purpose nature of urban streets and the need for a holistic approach to their design and management. In fact ‘streets as multi-functional places’ has been an underpinning principle for LATM since its earliest days in Australia and New Zealand (Australian Road Research Group 1976). Local streets today are not necessarily just residential in nature and may house many different land uses including those relating to commercial, service industry and community activity, and the range of car, public transport and non-vehicular travel that they generate. Local streets may be in town and city centres and other activity zones in addition to normal suburban residential streets.

Amenity functions are related to the street as a **place** where people live, work, recreate or go about their daily business. In this context the street may function as:

- a part of the living and working environment, which may contribute to (or restrict) the pleasant use of adjacent land and buildings
- common ground for children (specifically the verge or nature strip, though play often spills over onto the street itself in quiet residential areas)
- a place for social interaction between neighbours
- a place where people work or access their work
- a place for leisure and recreational activities such as strolling or jogging or cycling
- an extension of residents’ private yards, used for parking, cleaning or working on a vehicle
- an opportunity to visually enhance the environment by streetscaping
- open space to give residents a feeling of privacy and separation.

The place function of a street can be regarded as what distinguishes it from a road, which primarily has a traffic carrying function. A ‘sense of place’ is fundamental to a richer and more fulfilling environment. It comes largely from creating a strong relationship between the street and the buildings and spaces that frame it. A sense of place encompasses aspects such as local distinctiveness, visual quality, and propensity to encourage social activity (Department for Transport 2007).

Streets also accommodate public service utilities which follow the road reserve, and usually also serve an important drainage function.

[see Commentary 9]

As international attempts to improve local street safety increased in the 1970s, it became apparent that there were very few opportunities to separate moving traffic from other road users in active urban spaces, and so it became necessary to explore ways to deal with the impacts of traffic on other activities in the street and on adjacent land uses in the typical case where the streetspace is shared (OECD 1979). The creation of an ‘environment of care’ in which pedestrian, cycle and vehicular movement in local areas can be amenably integrated, rather than segregated, was stated as being the fundamental rationale of LATM more than 30 years ago (Brindle 1979, 1984a). The nature of the degree of slowing or separation will depend on the anticipated or intended speed environment of the street.

[see Commentary 10]

Lower speed limits in neighbourhoods are now common. The creation of a general speed limit in Australia of 50 km/h in local areas more than a decade ago, and the introduction of even lower speed limits in some local precincts in both Australia and New Zealand, along with many street treatments that have been installed in parallel, have had the effect of reducing speeds in local streets, and encouraging drivers to be more speed conscious. In addition, the *Australian Road Rules* and various state Traffic Acts make provision for ‘shared zones’, in which care for non-motorised users of the street space is reflected in lower posted speed limits (usually 10 km/h) and the requirement that drivers must give way to pedestrians. Practitioners are advised to determine the extent to which the *Australian Road Rules* apply in their jurisdiction. In NZ, road rules are consistent throughout the country.

A specific outcome of actions to create a new street environment is the creation of conditions that are compatible with the introduction of lower speed limits.

The use of lower speed limits by themselves, instead of physically modifying the environment of the street to slow traffic down, frequently leads to community concerns and traffic discussions. The hope is that lower speed limits will create lower speeds. However, extensive research and experience around the world has shown that lower speed limits on their own have at best only a marginal effect on speeds. The conclusion is that, while lower speed limits provide a rationale and legitimacy for speed control devices, speed reduction measures such as common LATM devices or other treatments like streetscaping and active roadsides, are usually necessary in order to reduce the speed environment and make the lower speed limit effective. This is a basic premise of self-explaining streets. In this interplay between speed limit and street character, the speed control devices must usually first be shown to be part of the new street environment so that conditions for the lower speed limit are matched.

The specification of a general speed limit of 50 km/h in local areas has created an implicit distinction between most local streets and arterial roads, which remain at 60 km/h or higher. This presents an opportunity for practitioners to treat local streets in a different way to higher order roads that is more consistent with the role and function of a local street.

The appropriate treatment of locally-important streets (collectors and/or local distributors) should also be different to both local access streets and arterial roads. There is good justification to reduce the speed environment on these locally important streets also down below 60 km/h, noting the speed thresholds of a Safe System are lower than that. Whereas a series of 15 km/h slow points may be entirely appropriate on a local access street, where the target speed environment may be 30 km/h, it is unlikely to be safe or effective on a local distributor, where the target speed may be higher, say 50 km/h. In this case, a different treatment, such as the use of 35 km/h roundabouts, may be more consistent with the role of the street in the functional classification, and the level of service needed for the different types of users it services.

Road user behaviour is very much influenced by the physical and social nature of the street environment, as well as by the formal traffic control measures that are in place. Both the street environment and traffic control need to be in tune with each other, and compatible with the desired character of the street.

If a street looks like a traffic route on which vehicles can travel at higher speed without impediment, then that is what drivers will expect to be able to do. Speed control and other measures will be harder to explain and implement in such streets. A higher level of signs and driver guidance will usually be necessary. Conversely, LATM and street redesign treatments that are in harmony with the street environment, as is the case with self-explaining streets, should not need excessive signs for the driver to perceive them and know what to do. In fact, if done correctly, naked street and equivalent shared space schemes can be implemented without any signs and linemarking. As a rule of thumb, if it is felt necessary to apply more than minimal routine signs and warnings at a specific device, then a check should be applied to make sure that the device is consistent with the prevailing street and traffic environment (AS 1742.13 – 2009).

This is why many LATM treatments fall short of their purpose. Individual devices that aim to create a lower-speed traffic environment in a street whose physical nature is giving contrary messages to road users will be perceived by the public as being inappropriate, and the speed outcomes are likely to be disappointing.

For this reason, the LATM treatments that are chosen should be consistent with the character of the street as a whole. This can come about in one of two ways:

- Treatments *support the existing image* of the street and inhibit road user behaviour that is not compatible with that street character.
- Treatments are carefully selected, located and designed to *alter road user perception* of what is appropriate behaviour in the street, as in the philosophy of self-explaining streets.

The second of these involves changing the driver's perception of the street environment, and can occur in different ways:

- The treatment might involve substantial redesign and reconstruction of the streetspace along the full length of the street, in which traffic control features may be incorporated as an integral component.
- The individual devices (i.e. engineering treatments) are selected, located and designed so that they interact to create a desired speed profile along the street, rather than encourage severe decelerations and accelerations along the street.

The following additional source material is recommended for reference on this topic: Brindle (1996: Chapter 2); OECD (1979), RTA (2000: Sections 1.2.3–1.4.3 and 2.1.3), Department of Transport (2007) and the Chartered Institution of Highways and Transportation (2010).

2.3 Identifying the Causes of Traffic-related Problems

Identifying the root causes of traffic problems in neighbourhoods can often provide pointers to appropriate solutions. In broad terms, problems usually arise because of the quantity of traffic, its speed, or other characteristics of the network that lead directly to higher crash rates and reduced amenity. These in turn are created, at least in part, by the planning and design features of the local network.

[see Commentary 11]

In summary, inspection of the causes of traffic problems over the past 30 years or so in Australia and New Zealand has led to the following guidelines for local planning and minor street network management.

To reduce vehicle speeds:

- Shorten forward sightlines and enclose the driver's field of vision, by tree planting and other means.
- Keep street section lengths (i.e. between slow or near-stop conditions) below 200–250 m.
- Reduce the available street width and/or introduce deflections in the vehicle path, while maintaining the margin of safety.
- Ensure that there is a traffic route within 400–500 m of each local street.

To minimise traffic levels and intruding traffic in a local street:

- Maintain the level of traffic service on adjacent arterials to reduce rat-running.
- Increase the lengths (time and distance) of paths through the local street network to reduce their connectivity between points on the arterial road network.
- Direct local traffic onto those streets most able to accommodate it. Neighbourhoods with high internal connectivity (that is, grid-based systems showing network redundancy with many alternative and direct paths for trips within the local area) may actually increase the average exposure to traffic for each household.
- Provide closer spacing of traffic routes at network planning and subdivision approval stages, including the provision of supplementary traffic routes within large subdivisions. This will avoid the creation of large districts with high levels of internal traffic, and the misuse of local streets as substitutes for missing links in the traffic route network.
- Consider traffic impacts at the land-use approval stage. Traffic generators should be carefully located so that they do not create additional pressure on the local network. Changes to the local street system, LATM provisions, and the provision of other modes such as cycling and walking and other travel demand measures might be considered as conditions for planning approval.

To minimise crash risk (in addition to the above):

- Limit the number of local street intersections and junctions. Within reason, fewer intersections mean fewer crashes.
- Limit the number of cross-intersections, and include roundabouts or other passive controls where cross-intersections are unavoidable. Note that stop or give-way signs may improve cross-intersection safety but still have higher risk.
- Limit the number of major-minor road connections.
- Minimise the percentage of dwellings with their frontage to connective roads.
- Protect or manage parking on distributor roads and other connective streets.
- Minimise or manage conflict points between bicycle or pedestrian movement and motor vehicles.
- Make sure that sight lines and sight distances are adequate for likely vehicle speeds.
- Provide an adequate carriageway (width etc.) for vehicle manoeuvring.

2.4 Network Considerations

2.4.1 Road Function and Traffic Hierarchy

Although the legal classification of a road may influence the administrative and financial responsibilities that apply to it, including the processes for approvals, it is the functional classification of a road, or its place in the traffic hierarchy and in relation to local non-traffic activity, which is most important in LATM. In essence, the functional classification indicates the relative importance of the traffic mobility function and the amenity/access functions of streets and roads.

The conduct of an LATM scheme presupposes that there is a community agreement on at least one fundamental point: that the streets in which these actions are proposed are different in nature and purpose from other roads where traffic is expected to pass without such constraints. While there may be broader categorisation and consistency of approach such as used in the New Zealand ‘One Network’ classification (NZ Transport Agency 2013), LATM programs require the identification of a road hierarchy comprising of at least two basic categories, using the definitions of street environments (corridor types) adopted in *Sharing the Main Street* (RTA 2000, p. 8):

- those elements that exist to carry traffic reasonably efficiently, on which severe traffic restraint is inappropriate and frontage activities must be subordinate to the traffic function (i.e. Type I corridors or traffic routes)
- those elements on which living and environmental conditions predominate, and on which physical speed management may be considered (i.e. Type II and III corridors, such as main streets and local streets).

Road classification studies in consultation with the community and the state authorities should readily be able to allocate most roads into one category or another, in which process the functional needs of important traffic routes can be agreed. This should prove to be easier than trying to obtain accord on a more detailed and far-reaching road-hierarchy plan over a whole municipality or region. However, specific local studies will be needed to identify the types of treatments that are appropriate to a given street’s characteristics and local functions, and to deal with that difficult group of ‘intermediate’ streets which do not fall readily into the arterial or local categories.

It is important that the adopted road and street types be consistent with state road and traffic authority functional designations (e.g. a local scheme should not unilaterally designate a recognised road as a local street for the purposes of LATM), and that there be consistency in the designation of roads that cross between areas or municipalities. In New Zealand, the One Network road classification should be used to determine the function, status and level of service performance measures of a road (NZ Transport Agency 2013).

It would be expected that streets already allocated speed limits below the general urban limit would rationally be readily accepted as streets on which LATM may also be appropriate. There is mutuality between LATM and lower speed limits; lower speed limits give credibility to LATM measures, and LATM measures support lower speed limits. However, it cannot be assumed that LATM is **not** appropriate on some roads and streets with higher speed environments. For various reasons, many streets have retained higher speed limits, and these streets may require close inspection before it can be decided what, if any, LATM measures (including speed limit reductions) may be appropriate on them to ensure a Safe System. Given that these streets, which tend to be the more important local streets, usually suffer the worst safety, speed and amenity problems, they present the greatest challenge to a local road controlling authority contemplating LATM. Some streets of this type serve linear retail and other pedestrian activity centres, and can be dealt with as Type II corridors (Section 2.4.2). Others function as general urban roads, without any particular pedestrian concentrations but nevertheless may have sensitive abutting land uses with which higher speeds are not compatible. The potential for forms of traffic management that do not significantly degrade the traffic functionality of such roads became clear during the 1990s (e.g. Van den Dool & McKeown 1991), pointing the way for various types of intervention to reduce the conflict between traffic and land activity on such roads. These treatments are seen properly as sub-arterial traffic management rather than LATM.

The following additional source material is recommended for reference on this topic: Brindle (1996: Chapter 6); Main Roads WA (1990: Appendix F); Pak-Poy and Kneebone (1987: Chapter 8); RTA (2000); NZ Transport Agency (2013).

2.4.2 A Note about Type II Corridors

Traffic calming action may also be directed towards creating moderated speed conditions along traffic routes passing through various types and intensities of community activities (e.g. strip retail centres, and roads through small country towns and villages), which have been termed main streets, sub-arterials or 'Type II corridors'. Actions on these sorts of roads are covered by other parts of this Guide series, and there are also other sources of information that can be consulted for guidance (e.g. Austroads 1998a, b; RTA 2000; Austroads 2015c; NZ Transport Agency 2013).

Rather than let the road classification drive traffic management actions in these cases, and to overcome the problem artificially created by slavish adherence to hierarchical definitions, traffic planners have explored ways to reconcile traffic importance with local sensitivities and requirements. This implies using a network operations planning approach and either re-defining the relative importance of the road's traffic and non-traffic functions (i.e. change its functional classification) or accepting that sometimes traffic routes will have lower traffic speeds reinforced by some form of physical traffic control. Clearly, a conventional approach to road classification would inhibit such a proposal. Traffic calming on traffic routes thus is being introduced via two generalised strategies:

- The adoption of a road-type definition that recognises a lower-order form of traffic route on which the traffic function (particularly speed) is restrained.
- Varying the physical form of traffic routes along their length to reflect the adjacent land use and level of conflict; (for example, a road may be managed to provide a good level of service along most of its length, but through a retail precinct it may have its traffic function lowered to allow some priority to parking and pedestrian movements).

Further information on traffic calming on Type II corridors is contained in the *Guide to Traffic Management Part 5* and the *Guide to Traffic Management Part 7.*

The following additional source material is recommended for reference on this topic: Austroads (1998a, Part C-5); PIARC (1991); RTA (2000).

2.4.3 Effects of LATM on the Arterial Network

When LATM schemes are likely to involve the removal of through traffic from local streets, their external effects, especially on the adjacent arterial roads, must be assessed. The need for, and techniques of, such impact analyses are similar to those which arise when a significant traffic-generating site development is being considered.

Larger LATM schemes can have a number of effects that may affect the operation of surrounding arterial roads, such as:

- displacement of through traffic onto the arterial system
- diversion of some local journeys onto the arterial system
- removal or constraining of detours through the local network in case of emergency
- queuing and/or slowing of traffic turning from the arterial into narrowed or otherwise constrained entries.

Where traffic intrusion into local areas is relatively small, or where there is spare capacity on the arterial roads, the effects on arterial road level of service may be insignificant. Where existing traffic intrusion is high, or where there is limited spare capacity on the arterial roads, then it is usually necessary to achieve a compromise between local interests and the mobility objectives of the wider community, particularly the commercial sector. In response to this challenge, new network operations planning approaches have been devised, which allow whole of network assessments to be undertaken to understand the impact of a LATM treatment on users on other parts of the network for different modes, by day or week and by time of day (Austroads 2015b).

Likely interruptions to arterial road traffic caused by slow turns at entries to local areas can be analysed in this way by conventional traffic engineering methods. Street entries with slow-speed turns (resulting from raised crossings, narrowed entries and so on) can be assessed in a similar way to driveways. Slower-speed entries from arterials carrying traffic above 60 km/h may warrant the provision of a deceleration or turning lane, or other access management treatment (Austroads 2000).

The need for alternative emergency routes should be assessed on a case-by-case basis, remembering that convenient detour routes that bypass points of congestion on the arterial system will tend to be used regularly by through traffic.

If possible, capacity and flow improvements can be made to the arterial roads (especially their intersections) to accommodate shifts in traffic from local areas. However, insufficient arterial road space to meet the total traffic demand should not necessarily prevent the introduction of LATM schemes. It has long been an underlying principle of LATM that local streets should only be available for the terminal ends of journeys and for local circulation, and not be regarded as part of the regional urban transport network. From the beginnings of traffic calming in Australia and New Zealand, congestion on the arterial system was not seen by local government as a reason to tolerate unacceptable local traffic conditions or to oppose measures to relieve that local traffic (e.g. Loder & Bayly 1974: Section 3.11).

The following additional sources are recommended for reference on this topic: Stover and Koepke (2002); Wisdom and Henson (1996).

2.4.4 Estimating Changes in Traffic Patterns

Driver route choice in local networks is affected by (among other things) the availability of links (paths) and what might be termed their ‘impedance’ or connectivity. Connectivity is a function of the distance and time (speed/delay) of a chosen path relative to other paths, and other aspects of attractiveness to the driver such as number of stops, speed control devices, sense of movement without restraint and other factors. In networks with multiple choices of path, i.e. internally connective networks, changes in any of these characteristics will lead to some degree of traffic redistribution within the network. In addition, successful deterrence of through traffic and sometimes even the re-routing of locally generated trips will mean that traffic is displaced onto the surrounding arterial road system.

Anticipating traffic effects on the arterial network and the shifts in traffic exposure within the local network, and the various responses these may bring, both require some form of traffic analysis. It may be useful to conduct arterial road traffic management studies or network wide operations planning before or in conjunction with LATM studies.

Techniques may range from simple judgements about traffic changes, based on knowledge of the quantity of divertible traffic, through to micro-network computer modelling and simulation. Network effects, including diversion of traffic to nearby local streets and effects on arterials, should always be considered by one means or the other. The practitioner will need to judge whether or not the scale of the proposed changes, and the accuracy required by the decision makers, justify intensive analytical effort.

2.4.5 Acceptable Degrees of Change

LATM schemes can lead to increases in travel times and sometimes travel distances for locally generated trips, and may cause traffic increases on some streets. What are and what are not tolerable increases in these parameters in a particular case will emerge in consultation with land owners and residents, but some guidance is available to help scope alternative schemes as they are developed.

Travel time

Travel times within the local network may increase as a result of increased travel distances, reduced speeds and the number of delay points. The sensitivity of driver response to these changes in travel time is difficult to estimate and plan for, primarily because:

- drivers are not typically aware of what is the 'normal' travel time in the local network, and would probably not register small changes in travel time as such
- driver response is probably based more on perception of increased travel time rather than the actual increase.

Providing the area to be treated is not too large, travel time increases will rarely be significant. For example, reduction of average travel speeds on a 500 m path through a local network from 50 to 30 km/h will add less than 30 seconds to the local segment of the trip. Estimated increases in travel times should form part of the public information program so that the community can make the judgement about whether or not the gains outweigh these small increases.

At least equally important is the need to keep the length of travel under constrained-speed conditions down to a reasonable level. A rule of thumb suggests that, as travel time under lower-speed conditions increases above one minute (e.g. 500 m at an average of 30 km/h), drivers will become increasingly frustrated and may attempt to drive at unsafe or unacceptable speeds. One minute should be ample for most journeys from a residence to the nearest point on the arterial network.

The special case of the effects of increased travel times on emergency response vehicles may be more significant. This issue is not unique to areas subject to LATM treatment, being also a matter to be considered in new housing areas designed according to the low-speed principles promoted by contemporary development codes and the various policies that derive from them. If adequate consideration has been given to the needs of larger and special vehicles, increases in response and access times for emergency vehicles should be able to be kept within acceptable limits (Section 8.13.1).

Estimated increases in bus travel times should be discussed with bus operators so that schedules can be adjusted accordingly, if necessary.

Traffic volumes

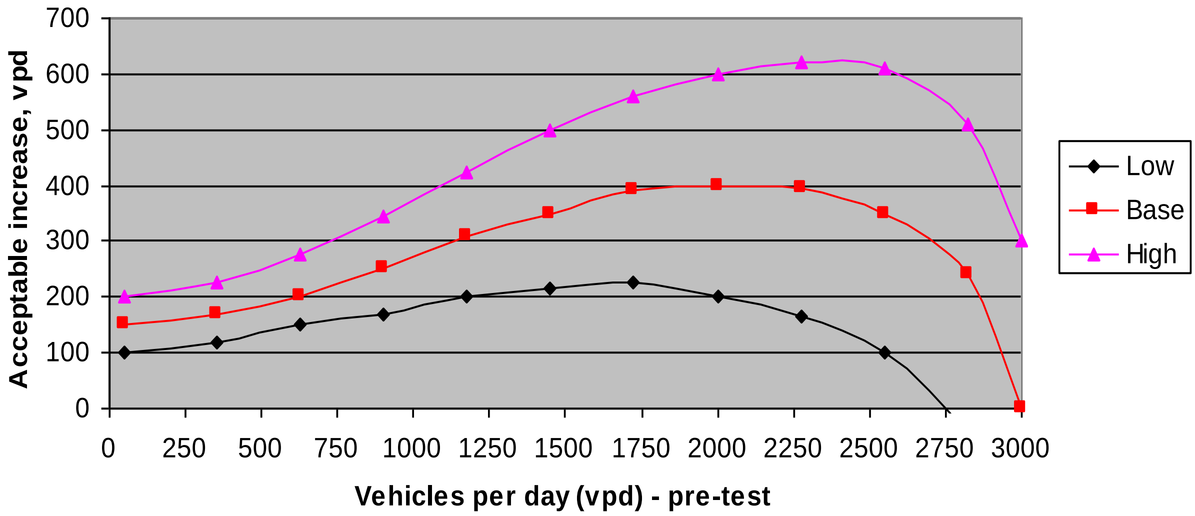
Traffic diversion may have positive or negative consequences. It would be regarded as an improvement if traffic were diverted to a higher-order road that was better able to handle it. However, it is generally regarded as unacceptable if traffic is diverted to a lower-order street or overloads neighbouring streets of similar order in the network. To complicate the task, residents may object to any appreciable increase in traffic in their street, no matter how inequitable the status quo may be for others.

The matter of tolerable increases in the traffic a street may carry as a result of LATM in the area has not been thoroughly researched, and practitioners and local authorities will have to exercise judgement about appropriate thresholds for their community.

An early rule of thumb was that increases of up to 100% on streets currently carrying fewer than 500 vpd and increases of up to 50% on streets carrying between 500 and 2000 vpd would generally not be regarded as significantly increasing traffic nuisance (Main Roads WA 1990, p. 92). Subsequent practice has suggested that the increases permitted by this rule of thumb (up to 1000 vpd) are likely to be readily perceived and unacceptable in most communities.

In Portland, Oregon, acceptable increases on non-project streets have been expressed in terms of an 'impact threshold curve' (Figure 2.3). The curve allows traffic increases of up to 150 vpd on the lowest-order streets, increasing to a maximum of 400 vpd on streets carrying about 2000 vpd. In addition, diverted traffic must not result in any street's traffic exceeding 3000 vpd (City of Portland 1992). Such thresholds are arbitrary and may be different in other communities, but the general concept is a useful model, which can be constructed to reflect policy in any community.

Figure 2.3: An example of thresholds for diverted traffic



Source: Adapted from City of Portland (1992) cited by Ewing (1999a, p. 160).

2.5 LATM can have Negative Effects

LATM has known potential negative effects, most of which can be avoided or minimised by the practices advocated in this Guide.

The negative effects of LATM could include the following (Christchurch City Council 2000):

- increased travel time for drivers and frustration for frontage owners (noise, signs, etc.)
- excessive acceleration and deceleration and associated noise
- possible discomfort for bus passengers and/or forced re-routing of buses to other streets
- effects on parking supply
- restricted access to properties adjacent to devices and perceived effects of the devices on the street appearance
- possible increased response times for emergency and service vehicles
- transfer of traffic from one street to another
- increase in delays at exits from the area
- additional cost burdens in terms of maintenance and enforcement.

LATM may arouse local passions and create disagreements, for several reasons:

- The very local nature of the issues and remedies means that LATM is visible and immediate. Local streets are usually perceived as being extensions of the home environment, and traffic problems and changes may impact on a household's perception of the quality of its living space. People may therefore be sensitive to poorly-prepared plans and badly-managed implementation programs.
- In particular, they are likely to react negatively if a council attempts to undertake changes in a street environment without involving the local community in identifying the needs and exploring options.
- There are often those who perceive that they will be worse off if an LATM proposal proceeds. These will include those whose streets may experience an increase in traffic, traders who fear a loss of trade, householders adjacent to the site of a proposed device, those who resent 'preferential' treatment given to residents of another street, and providers of delivery services.
- The treatments themselves often have environmental side-effects, some of them unavoidable, which cause dissatisfaction to those directly affected, such as noise created by vehicles negotiating the devices. While such effects can be minimised by good design, there will be times when a choice has to be made between broader gains to the local community and minor disturbances to a few households. This can cause dissension and fracture good neighbourly relations (Taylor 1992).
- There may be opposition to the concept of local traffic protection in principle. While there is much greater understanding in the community about the purposes and benefits of LATM today than there used to be, there may still be objections from some quarters (often from outside the study area, but also from disaffected locals) about speed management and deterrence of through traffic.

The key to minimising controversies and dealing with them when they arise, and to developing a sense of community ownership of the outcomes, lies in the processes put in place for community participation (Section 5). The fear of controversy should not be allowed to dissuade a council from attending to real problems in its neighbourhoods.

Local environmental and amenity effects can be real, e.g.:

- Noise at devices may occur. Vertical devices can result in audible noise from suspensions etc. (Abbott et al. 1995). Even minor noise sources such as paving lips across the line of travel or raised pavement markers and rumble strips can cause disturbance, especially in the quiet of night. Detailing and assisting drivers to approach at correct speeds can help to alleviate this problem.
- Noise from accelerations and decelerations will occur. Tyre noise as well as gear and engine noise can increase. Location of devices to discourage a widely fluctuating speed profile down the street will minimise these effects.
- Noise and threats from inappropriate driver behaviour may be an issue. Deliberate abuse of speed control devices has occasionally been experienced, more especially in the early days of LATM and when devices are new. Persistent problems of this sort may call for short-term enforcement.
- Fuel consumption will increase marginally. Speed control measures result in an increase in fuel consumption, due to the sub-optimal speeds that are induced and the patterns of (sometimes aggressive) deceleration and acceleration that are encouraged (Zito & Taylor 1996). For most trips that extend outside the local area, this will be a small proportional effect. However, the local increase in consumption is measurable and corresponds to a local increase in emissions. Conditions conducive to steady speed behaviour will help to reduce this effect.

As a result of these various factors, the community tends to tolerate rather than actively support LATM (Brindle & Morrissey 1998). Survey findings on LATM typically range from somewhat less than a half to a large majority favouring LATM programs, depending on local values and the nature of the schemes being proposed. General support in principle for LATM/traffic calming has, however, clearly increased at the professional and governmental level. Most state traffic bodies have some form of guidance and encouragement for LATM and/or local speed management programs. Once vocal opponents of LATM (see, for example, the stated position of the RACV reported in Brindle (1983, p. 11)), motoring organisations now encourage passive speed management in the form of well-designed LATM, presumably as an alternative to enforcement.

If local schemes are controversial, the problem may lie either in inadequate communication of the rationale and benefits of LATM in general, insufficient attention to good practice in device planning and design, excessive implementation periods, or the specific proposals are not properly matched to the perception of the local problem. If the problem perceived by the community does not match the real problem, a period of information and clarification may be needed.

The success or otherwise of an LATM scheme will depend largely on the accurate prediction of the likely effects of a proposed scheme, and the acceptability of those effects to the community. If sections of the community judge that the ‘solution’ is worse than the ‘problem’, they are likely to resist the proposals.

3. Steps in the LATM Process

This section takes the user through an outline of the LATM process and the key stages in that process. A checklist of tasks in each stage is outlined below (Table 3.1). The stages in Table 3.1 broadly correspond with the headings under which the material in this section of the Guide is organised.

3.1 Stage 1: Preparing for an LATM Study

3.1.1 Developing an LATM Strategic Plan for the Local Government Area

A community strategic plan

Just as traffic problems in local streets should not be dealt with in isolation from the community and network contexts in which they occur, LATM itself should properly be seen in the wider context of the things that the community seeks to maintain and achieve. The goals (or desired outcomes) of LATM should be consistent with the other goals of local land use and community planning. Council's LATM program will be facilitated if there is in place a broader strategic context which sets down visions and general processes for such things as:

- community values and goals
- amenity and environmental standards
- road safety targets
- development plans and standards
- level of service performance measures for the whole network
- integrated local transport commitments
- encouragement of walking and cycling.

These will help to set the goals for LATM and define the more broadly based assessment criteria that will help in the decision process. Conversely, LATM may well be seen as one of the instruments by which targets for such things as community road safety and integrated transport may be achieved.

A strategic plan for LATM

Councils will commonly find that there is more demand for LATM implementation than they have resources for and establishing priorities between competing precincts becomes necessary. Preparation of a forward plan for LATM investigation and implementation is one way to avoid 'knee jerk' responses to traffic management issues on a street-by-street basis. The purposes and general scope of such a plan are discussed by Hawley et al. (1993: part A7), which is recommended for guidance on this subject and is used to provide the following summary. The establishment of an LATM strategic plan for a local government area is related to the 'warrants and priorities' process in Section 4 and Commentary 16 and can use the same methods.

[see Commentary 16]

The broad purposes of a council-wide plan for LATM are to:

- establish a logical priority order for the development of LATM schemes based on the relative needs of each area and on council's budgetary constraints
- provide a vehicle and process to inform the community about LATM and the actions that council is taking in that regard.

Thus, the LATM strategic plan has two main streams of activity: technical and community information.

Table 3.1: Checklist of tasks in each stage of the LATM process

Stage 1: Initiating an LATM program (Section 3.1)
• Decide that action is needed • Define study area, precincts and functional hierarchy of roads • Develop study plan, including type of treatments and study costs • Develop consultation strategy • Council decision • Prepare brief for consultant, if required
Stage 2: Data collection and problem identification (Section 3.2)
• Define and collect required data • Identify problems • Identify potential solutions • Define and confirm objectives
Stage 3: Development of plans (Section 3.3)
• Clarify suitable strategies (including confirmation of LATM as an appropriate response) • Develop outline schemes and supporting arterial improvements • Consult on draft plans • Assess and refine alternatives • Select, present to council for adoption
Stage 4: Scheme design (Section 3.4)
• Location and design of treatments • Consult with nearby owners/occupiers • Prepare contract documents
Stage 5: Implementation (Section 3.5)
• Confirm timing and staging • Conduct additional 'before' studies as required • Community information • Construct/install • Safety audit
Stage 6: Monitoring and review (Section 3.6)
• 'After' data collection, observation and reports • Identify unanticipated impacts or outcomes • Review technical and community assessment of scheme • Revise as needed and feasible • Record and report process and outcomes

Source: Based on MRWA (1990, p. 18).

The strategic plan provides a forward planning framework for council, which can:

- give an opportunity to coordinate traffic planning and engineering works with the projected council budgets and road maintenance programs, thus minimising the additional expenditure associated with LATM
- give a logical reason for a program of works in each part of the LGA
- assist in decreasing the pressures from local residents to undertake studies in each of their areas as soon as possible.

Note that the development of a council-wide LATM strategic plan does not necessarily mean that the implementation of LATM will then strictly follow a set sequence area by area. Hawley et al. (1993, p. A39), for example, cite a case where an experienced local authority decided to abandon the concept of LATM boundaries, instead opting to rely on a city-wide approach on a technical needs basis. The boundaries of each study would be determined according to the defined problem.

3.1.2 Deciding that Action is Needed

Whether or not council has in place a strategy for sequencing LATM projects, the perceived need for action may arise in one of two ways: LATM may be proposed as either a **remedial** (reactive) or a **preventative** (proactive) measure, that is, either to deal with a problem that has become evident or to take action to avoid future deterioration in safety and amenity in a street or area.

The initiative for a remedial LATM study may come from the community, from specific staff reports or from routine monitoring of the local street system (Table 3.2). Proactive LATM is likely to arise from broader community goals concerning orderly planning and creating a quality living and working environment for the municipality, e.g. in the form of an LATM strategic plan.

Table 3.2: Sources of LATM initiatives

Reactive/remedial		Proactive/preventative
Objective	Council site investigations of 'problems' Council monitoring and assessment	Council planning action
Subjective	Community submissions, complaints	

Calls for action from the community may be based on social and environmental grounds, rather than overtly on operational and safety grounds. Complaints may only indicate the existence of a problem, but not necessarily its severity – the level of complaints in response to similar issues can vary between groups and areas in a community.

There are competing demands for limited funds, and action in all the local areas that make up a municipality will need to be sequenced. Council will therefore need to adopt, or preferably already have in place, a decision process for assessing and giving priorities to needs, whether they arise from community submissions or council's own processes.

Discussion on the use and nature of warrants and other aids for objective decision making is contained in Section 4 and Commentary 16.

The following additional source material is recommended for reference on this topic: Ewing (1999a: Chapter 8).

3.1.3 Outline of the Process

The classic stages of all planning exercises are:

- surveys: information gathering
- analysis: quantification of issues
- plan development
- implementation
- monitoring and assessment
- repetition of cycle as necessary.

Following this model, the essential stages of a comprehensive LATM planning process are shown diagrammatically in Figure 3.1, and are outlined in the form of a checklist (Table 3.1).

Figure 3.1: The basic planning process

Throughout the process, there should be continuous communication with, and input from, the community at large as well as specific interest groups, requiring the establishment of an appropriate information, consultation, and participation process (refer to Section 5).

The Austroads integrated planning publication *Cities for Tomorrow* outlines the steps by which this process can contribute to integrated planning, with a focus on improving traffic conditions so that pedestrian and local environmental needs are met (Austroads 1998a).

Various representations of the process can be constructed to help provide a checklist of the necessary activities and to accommodate different approaches to a systematic LATM process (e.g. Main Roads WA 1990, pp. 17–18; Pak-Poy & Kneebone 1987: Figure 6.1; Traffic Authority of NSW 1987: Section 7.2.4; Transportation Association of Canada 1998: Figure 1.1; VicRoads 1999a: Section 8.3). Additional source material on this topic can be found in Pak-Poy and Kneebone (1987: Part C).

The following sections provide more detail and resources for each of the steps.

From extensive practical experience, some councils have found their own ways to adapt the overall intentions of the LATM process to their own circumstances. Under typically constrained budgetary conditions, councils may find that the application of even the most stringent level of warrant or prioritising criteria more than absorbs available funds each year. This sometimes has the effect of short-cutting much of the LATM process and community participation in determining needs and assessing proposals. For example, the City of Stirling (Western Australia) has adopted a flow chart for traffic management investigations in which the 'points' system for establishing project needs provides the basis for the generation of LATM concepts, which are then offered to the public for comment (Figure 3.2).

Simplified procedures

> *Traffic managers…strive for balance between 'study it to death' and 'get it built now', and 'respond to neighbourhood wishes' and 'use your best technical judgement'. They also report that they attempt to be sufficiently process-oriented to avoid political and legal fallout, yet sufficiently output-oriented to satisfy constituents. (Ewing 1999a p. 154).*

The City of Knox (2002) reports another simplified process, which it says, has proved successful. This has these few steps:

- preliminary questionnaire to residents of the street being considered, to ascertain the demand or need for LATM
- base concept plan, showing all relevant design parameters and detail
- public meeting of those directly affected, but not those in feeder streets or nearby streets
- further consultation, usually on site, to deal with detailed concerns and questions
- pre-construction and construction period: public notification of the proposed works, and final design (with open communication between staff and residents).

Christchurch City Council (2000) developed a consultative process that had as its priority quality of living and community interaction. It is more than just redesigning physical features to slow vehicles down. The process starts with the community that must be willing to embrace new philosophies. Community participation and ownership must be nurtured from the earliest stage as traditional practices and beliefs will be challenged.

With this process there is a greater emphasis on pedestrians, public transport, bicycles, landscape planting, and other streetscape improvements. As traffic increases, traditional local area traffic control devices such as speed humps and chicanes become less popular. Instead, lower speed zones, along with improved pedestrian facilities are used to create a balance between traffic movement, access, and living.

The collaboration process can be used to develop appropriate solutions for local roads as well as along Type II corridors.

The steps in this process are:

- preliminary information gathering to gain an appreciation of the issues prior to interacting with the community and establishing a project team
- establishing the scope of the project, what must be achieved, what resources are available and the non-negotiable issues
- determining what level of public participation is appropriate to determine what needs to be achieved from the consultation process
- looking and listening to all stakeholders and ensuring that they have their say through a workshop held at a local venue
- looking and listening by professional and technical experts who will carry out an analysis that will identify strengths, issues, needs and opportunities
- identifying what the stakeholders value most and want to preserve, enhance and celebrate, identifying objectives and develop concepts
- confirming objectives and concepts through a second workshop at a local venue where preferences and further enhancements are agreed – the 'did we hear you right' process
- the analysis completed and a preferred scheme plan drawn
- the preferred scheme plan launched in the form of a presentation to stakeholders; this will provide the opportunity to explain why certain concepts were included and not others and how these decisions were made.

3.1.4 Defining the Study Area

The process by which the LATM investigation is initiated (council's own LATM strategy, problems identified by staff or community requests) will provide a first level of definition of the study area. The formal study area will usually mean the area within which the problems and countermeasures to be investigated are located. This will usually equate to a Local Traffic Area defined by natural or constructed barriers or higher-order roads, or a Local Traffic Precinct within it, as in Section 1.3. The study area for council's purposes will usually mean the area containing streets that may come under scrutiny for possible LATM treatment, and those other streets with a clear or potential traffic network relationship with them. Implicit in this process is the identification of a functional hierarchy of roads and streets (refer to Section 2.2).

However, the geographic scope of the area of investigations for the purposes of data collection, the study of network impacts, and the public participation process could extend well beyond the study area defined in this way. These two different levels of the study area are sometimes referred to as the primary and secondary study areas.

Since the boundaries of the study area are functional rather than political, a study may need to extend into a neighbouring municipality. A joint study or some other form of cooperation or consultation would then be called for.

If a project is to be implemented in stages across a study area, the impacts elsewhere in the area will need to be identified and dealt with. An unintended consequence of staging is that it sometimes changes the nature of the problem, and hence the priority for treatment, in other parts of the study area.

3.1.5 Developing a Study Plan

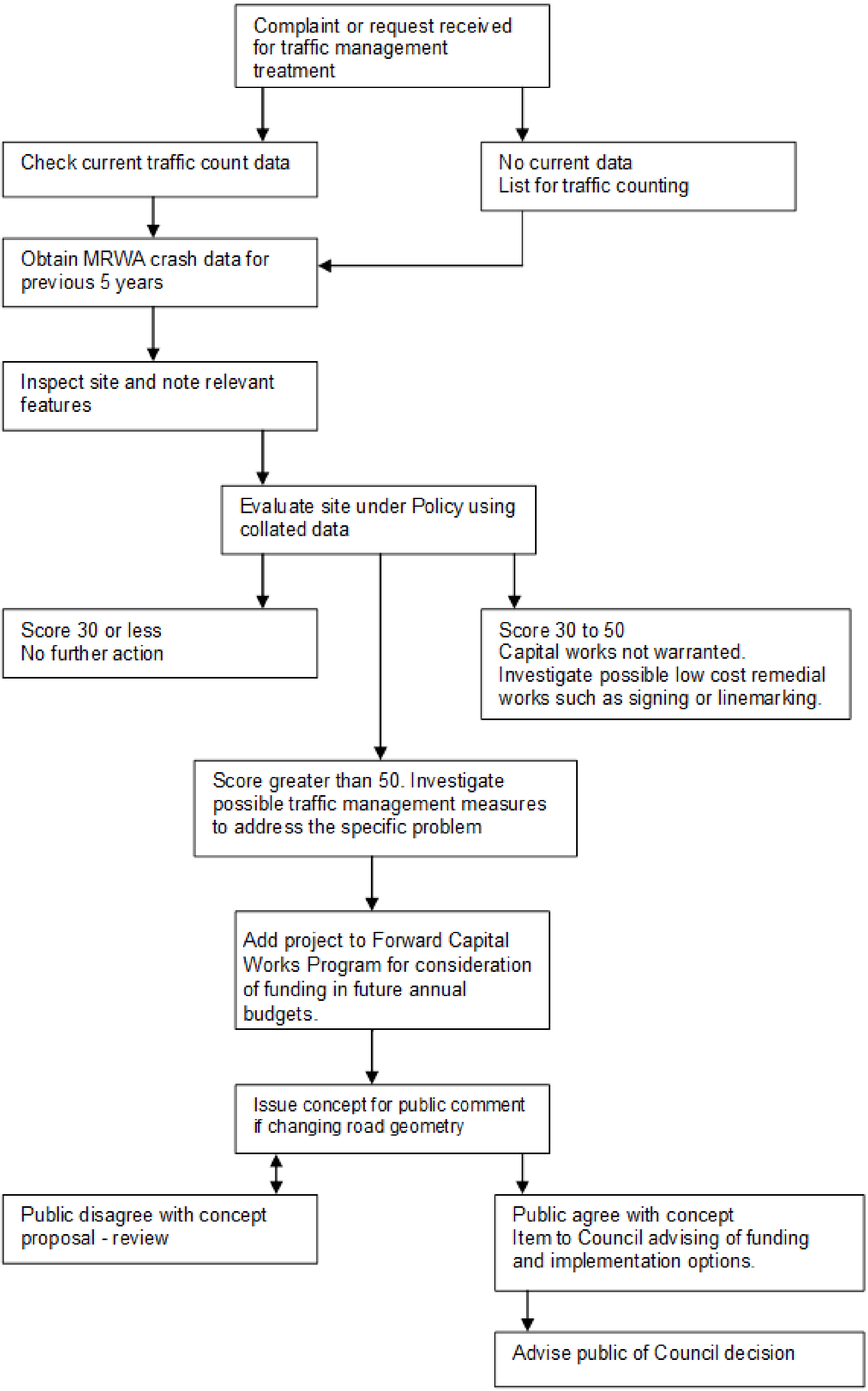
The study plan forms the investigation proposal that goes to council. It therefore should include an outline of the scope of the study, the extent to which the various steps in the process described previously are proposed to be covered, their likely timing, cost estimates, and a budget proposal.

The components of the cost estimate could include:

- data collection and surveys
- preparation of the LATM plan
- surveys of the streets where works are to be undertaken
- final design and documentation for construction
- construction and landscaping; (this will not be able to be estimated realistically before the likely works have been identified during the study)
- maintenance
- community participation and information program.

The study proposal should draw attention to any statutory requirements, including any notifications or approvals that may be required. It should also include a staff capability and availability statement, and recommendations on who should carry out the various stages of the work, especially if a consultant and/or contractor is to be considered for parts of the process.

Figure 3.2: Stirling (WA) traffic management investigations flow chart



Source: City of Stirling (2013).

3.2 Stage 2: Defining the Study Scope and Objectives

3.2.1 Defining the Objectives of the LATM Scheme

Specific objectives that seek to resolve the identified problems and deficiencies should be defined as part of the LATM process. This step ensures that the LATM scheme has a set of level of service standards by which it can be judged. The objectives adopted in a given study will depend on the identified issues to be resolved. They should be:

- clear statements of what is to be accomplished in response to the issues
- measurable and realistically attainable
- consistent with the goals and whatever policy contexts apply to the situation.

[see Commentary 12]

From the technical point of view, objectives are the measurable targets that are set to reach the desired outcomes; they are action statements (i.e. they start with a verb). They provide the principal yardsticks against which the outcomes or performance of the LATM scheme can be assessed. The objectives for LATM should properly state the changes that are intended to be achieved by the actions taken.

Objectives in the participation process

Unlike the broadly expressed goals, specific objectives may suggest contradictory actions. In addition, different parties may legitimately seek different objectives to achieve the same goal, according to their viewpoints, interests, and responsibilities. Consequently, setting the objectives is an important part of the participation process, since all interested parties have to accept the objectives. Objectives are often the focus of community participation in LATM. They help communities understand what the ultimate purpose of LATM is, by pointing towards the outcomes that follow particular objectives. The role of the technical person in this process is to educate and provide advice on which objectives are feasible in the context and are likely to contribute to the desired goals, e.g. speed management goals. Agreement on the objectives allows the technician to develop alternative specific strategies and actions that contribute to the objectives.

Public participation in the identification of problems and clarification of objectives can help to clarify the most important issues from both the technical and subjective points of view. It will also help to encourage greater ownership of the problems and a greater community commitment to seek resolution of them.

Additional source material and more detail on this topic can be found in: Brindle (1996: Chapter 2); Main Roads WA (1990: Chapter 6); Pak-Poy and Kneebone (1987: Chapter 11).

3.2.2 Data Collection

The primary uses of data in LATM are to:

- help to define and quantify the nature and extent of the problems
- provide input information for developing strategies and countermeasures
- form the basis of an assessment of alternatives and post-assessment of the implemented scheme
- develop modifications to the plan or design of elements.

Data collection is costly, so the type and extent of data collection will depend on the scale of the proposed scheme. Only data relevant to the study need be collected. Much of the information may be available from council’s existing databases, which will save time and costs if so. In some cases it may be appropriate and possible for community groups to assist in data collection.

Some data will be needed before or during the definition of problems and needs, and therefore data collation will be part of the LATM strategic plan and the setting of needs and priorities described in Section 3.1. Other data collection will continue throughout the process, for instance to provide information on changes over time.

The scope of data collection will usually extend beyond the immediate study area, to allow for the effects of and on conditions in surrounding areas to be assessed. User level of service and associated performance measures will help to identify data requirements.

Typical data to be collected

Most commonly, the data will relate to road and traffic conditions. Related physical and environmental data is often needed for planning and environmental assessment purposes. Sometimes there may be a need to have social information, for instance, to assist in anticipating difficulties and responses from specific groups of people, and to help design the participation program and materials.

The data to be collected will depend on the particular case, and will usually involve surveys before and after the implementation of a scheme. Not all of the following information will be needed or appropriate in every situation, and some of it may need to be gathered by the specialists who will use it, or advise how to apply it to their specifications.

Operational and design data	Its purpose
Traffic volumes • peak hour • 18 hr or 24 hr	To compare with adopted maxima and to calculate peaking percentage. Traffic levels may constrain the types of devices that can be considered.
Traffic composition (vehicle types)	To identify problems with specific vehicle types, e.g. commercial vehicles.
Crashes • from crash records • from local knowledge	To identify problem locations and for use in determining warrants and priorities. A major input for before and after assessments. Note that local information may indicate the extent of unreported crashes.
Predictive risk (available through expert systems such as ANRAM and AusRAP/KiwiRAP)	To proactively identify locations with potential road safety issues based on road environmental factors such as street geometry, number of intersections, etc. Can be very useful in the absence of road crash data that is recent enough or statistically significant. Can be very effective for use in determining warrants and priorities either in place of, or supplementary to, road crash data.
Road inventory and other existing infrastructure: street and carriageway widths, sight distance limitations, site access points, utility locations etc.	To provide information on existing infrastructure, road furniture, street planting, driveways, etc. on streets, to flag possible major maintenance or reconstruction works, and to provide site design information. Note that much of this data may be available from the local authority’s existing database.
Road inventory (possibly available through existing GIS-based asset management system)	To provide information on existing road infrastructure, road furniture, street planting, driveways, etc. on streets, to flag possible major maintenance or reconstruction works, and to provide site design information.
Origin/destination surveys	To identify through traffic proportions and provide input data for estimates of traffic changes resulting from the scheme.

Operational and design data	Its purpose
Traffic speeds	To identify speed problems and potential crash situations. To provide information about free speeds for use in speed-based design.
Travel times and delays	To provide information about the external connectivity of the local street system. To monitor changes in travel times for travel within, through and around the study area, and the quality of access into and out of the area.
Level of Service	To measure the capacity of the street to satisfy the needs of different road user types.
Street activity survey	To identify major activity generators as well as locations with high social interaction within the street, and those with a clear sense of place.
Bus routes (existing and potential)	To identify problems for operators and specify design requirements for treatments.
Pedestrian and cyclist desire lines and count volumes	To provide basic information on the location, number, strategic linkages, and design of devices.
Parking (resident and non-local)	To identify parking-related problems and provide design data.
Environmental data	**Its purpose**
Noise measurements and/or modelling	To assess current and changed levels of noise. Advisable to have 'before' data if noise-related objections to devices are likely.
Location and needs of environmentally-sensitive land uses	To take into consideration when assessing problems and designing treatments.
Streetscape assessment including inventories of street trees, materials and other assets; qualitative assessment of visual attributes of street	To take into consideration when considering strategies and designing treatments.
Social data	**Its purpose**
*Age distribution and household structure**	To identify likely needs and responses to traffic threats in broad terms and to plan the participation program.
*Language and ethnicity**	To help plan and target participation program and information materials.
*Proportion rental/residential mobility**	To supplement information on responses to traffic and proposed countermeasures.
Measures of geographical groupings and access patterns such as use of, and access to, local facilities (schools, medical facilities, schools, etc.)	To protect and plan routes used for local access, and identify special locational factors in designing treatments.

** Usually available only at the census-area level.*

It is helpful if there is an existing database that records the current physical character of the street networks within the study area (including right-of-way and carriageway widths), as well as traffic volume, crash and speed data. If such a database does not exist, this information should be compiled.

Additional source material and more detail on this topic can be found in: Main Roads WA (1990: Section 5); Ogden and Taylor (1996: Chapter 6); Pak-Poy and Kneebone (1987: Chapter 10) and Austroads (2014b).

3.2.3 Identifying Problems and Potential Improvements

Objective and subjective identification of problems

The issues to be resolved through LATM or other action may arise in a number of ways, e.g.:

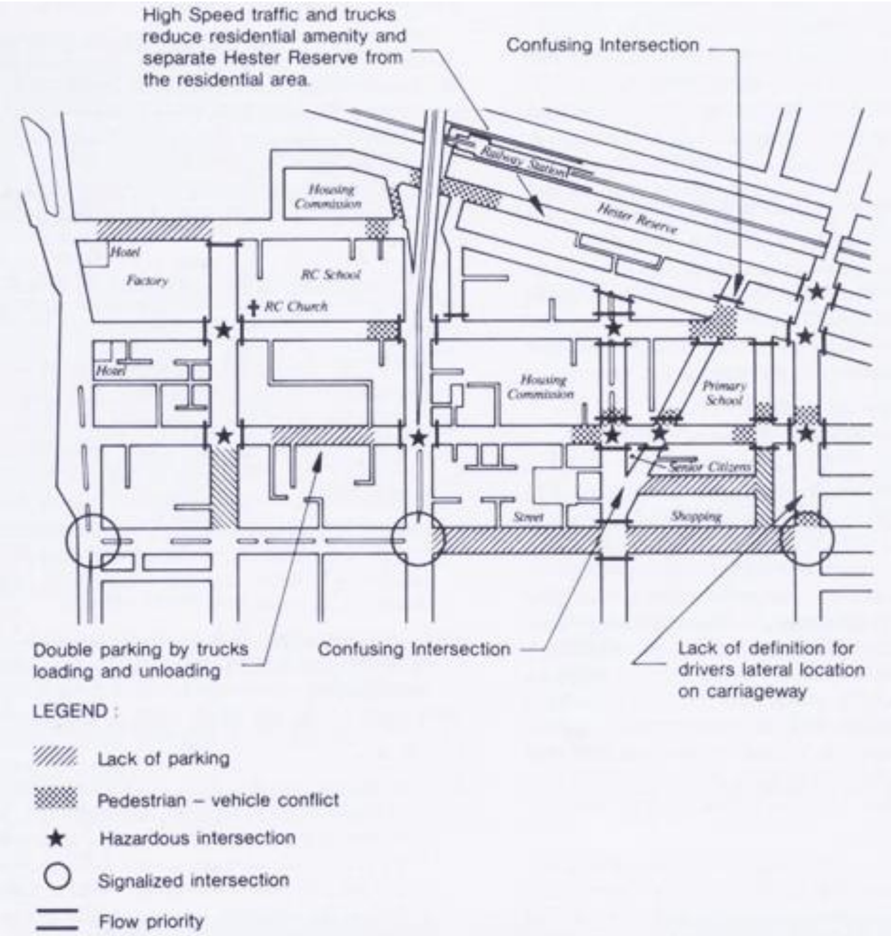
- objective assessment of street conditions compared with standards, acceptable thresholds or comparative conditions elsewhere in the locality
- as part of area improvement programs by council itself
- anticipation of changed conditions resulting from new development, or planned land use or activity changes
- complaints and suggestions from members of the community, local groups, police, etc.

The practitioner needs to be aware of both objectively and subjectively defined issues – both are ‘real’, if not always measurable. The following points are in Main Roads WA (1990, p. 177):

> - *Objective measures customarily used by traffic engineers sometimes do not measure or relate to the problem as perceived by residents. Consequently, solutions derived from objective survey data may be technically correct yet be rejected by the community.*
> - *Individual responses can also be extremely varied, often a result of the varying characteristics of the residents. Only street-specific resident surveys can uncover such unexpected facts.*
> - *Where the data indicates a safety hazard does exist, action may be necessary irrespective of the community perception of the problem. In such a case community involvement provides an opportunity to explain the hazard and discuss alternative solutions, thus facilitating acceptance of the proposed solution.*

Conditions identified as being problems on the basis of objective technical criteria can be displayed graphically (Figure 3.3). These technical criteria may need to be compared against (and synthesised with) the problems as perceived and reported by residents. Together, they help to define the study objectives.

Figure 3.3: Example of diagrammatic presentation of data – problems and opportunities



Subjective problem assessment may include:

- a review of written complaints from residents
- a questionnaire survey
- consideration of verbal comments at community events such as on-site field days
- routine assessments through existing channels such as local traffic committees and council staff's general assessments.

In trying to draw together and reconcile the technical and subjective assessments of the issues, the practitioner will probably find that initial conclusions will begin to emerge, on such matters as:

- the validity and adequacy of the data that has been used
- the extent of the problem relative to other issues before council
- the feasibility of being able to resolve the issues (technically, financially or socially)
- whether the issues are site-specific, needing early traffic engineering remedy, or area-wide, justifying inclusion in the LATM investigations
- indications of community ideas, preferences and dislikes about types of solution
- the readiness or otherwise of the community to participate in the process.

Moving towards a statement of objectives

Complaints and technical deficiencies are likely to focus on the same sorts of issues:

- excess traffic
- traffic-related intrusion
- through traffic
- traffic composition
- the amenity of the street
- recorded traffic crashes.

Other things that residents may bring up, but which are less likely to emerge from routine technical assessments, include:

- crashes: unreported crashes and near misses, concern about routes to school, and traffic security in general in the neighbourhood
- obstructions and ‘stranger parking’ in front of dwellings
- the quality of the cycling and walking environment
- problem vehicles, especially noisy and large ones
- environmental issues (noise, vibration, air quality, and street environment).

Both objective and subjective identification of problems is likely to play a part in the public debate that leads to the clarification of the LATM project objectives. During this process, demands for street works that have no genuine foundation (objective or subjective) can be identified and filtered out.

Additional source material and more detail on this topic can be found in Main Roads WA (1990: Sections 4.3, 5.6).

3.3 Stage 3: Developing Plans

Typical steps at the plan development stage of the process are:

- reaffirm that LATM is the best way forward
- select candidate strategies (general approaches to the problem)
- identify potential measures that meet objectives
- develop alternative outline schemes
- discuss with community groups and other agencies
- refine options in response to public input
- evaluate the candidate options
- prepare implementation strategy, with cost estimates
- present recommended outline scheme for public comment and council adoption.

Sections 3.3.1 to 3.3.6 provide some background to these steps.

3.3.1 Clarifying Strategies

The first step of an LATM scheme design is the selection of the ***strategies*** or general approaches that are appropriate to the objectives being sought. Among the alternative strategies, it may be appropriate to consider alternatives to LATM.

LATM is not always the best or feasible option. The focus should be on outcomes at this stage, not on specific types of measures. A combination of strategies may be required for the same set of objectives. A feasibility stage road safety audit may be explicit or implicit in this process. As part of the strategy selection stage of the process, it should be confirmed that there are not alternatives to LATM that could be considered first. These alternatives may include:

- Arterial road improvements. Particularly if the major local street problem is the amount of through traffic, measures to improve flows, reduce intersection delays and facilitate turns on the adjacent arterials may be considered as a complement to, if not a sufficient alternative to LATM.
- Land use and community design. Re-zoning to reduce the intrusion of non-resident traffic may be appropriate. Improved streetscaping, provision of play areas and careful location of more intense residential development to reduce its traffic impacts may also be considered. It will be noted that these – apart from changes to the streetscape – tend to be essentially gradual and longer-term measures.
- Vehicle trip reduction. A form of travel demand management, local trip reduction programs may be in place or under consideration. Their success in reducing local street traffic problems will, be dependent on their effectiveness in significantly reducing the number of vehicle trips generated in the local area. Changes in household composition and the ageing of the population in some areas may have a possible spontaneous influence on traffic generation. This effect has not been adequately researched and quantified so far and is not directly under council's ability to influence.
- Non-physical speed management. Proposals that have been canvassed include lower speed limits and more intense enforcement, speed cameras, electronic speed detection, education and attitudinal change programs, and intelligent transportation systems (ITS) technology (Brindle 1998a). Some of these ideas are already known to be at best only marginally effective, while with others there is so far inadequate development, experience, or research to be able to recommend their adoption. ITS offers the most promising long-term alternative to speed management using physical devices.

Additional source material and more detail on this topic can be found in: Main Roads WA (1990: Section 7.5); O'Brien and Brindle (1999: Table 9-4).

3.3.2 Device Spacing and Speed-based Design

The purpose of physical speed control devices is to lower the profile of vehicle speeds along the streets, that is, the variation of speeds plotted along the street length. The speed profile reflects those points along a street, such as small-radius bends, give-way conditions and speed control devices, where vehicles are compelled to slow down. No two drivers behave identically, and the spread of speeds at any point will form a distribution. Nevertheless, the many different speed profiles can be analysed to produce a representative profile for the given street conditions.

Arbitrary location of speed control devices that does not take account of their effects on the speed profile may lead to disappointing outcomes, for two reasons:

- the localised 'draw down' effect that the device has on the speed profile may not sufficiently change the street speed
- the changed speed profiles at each successive device interact with each other; this interaction should determine the spacing of the devices, taking into account the variability in speeds that this might lead to.

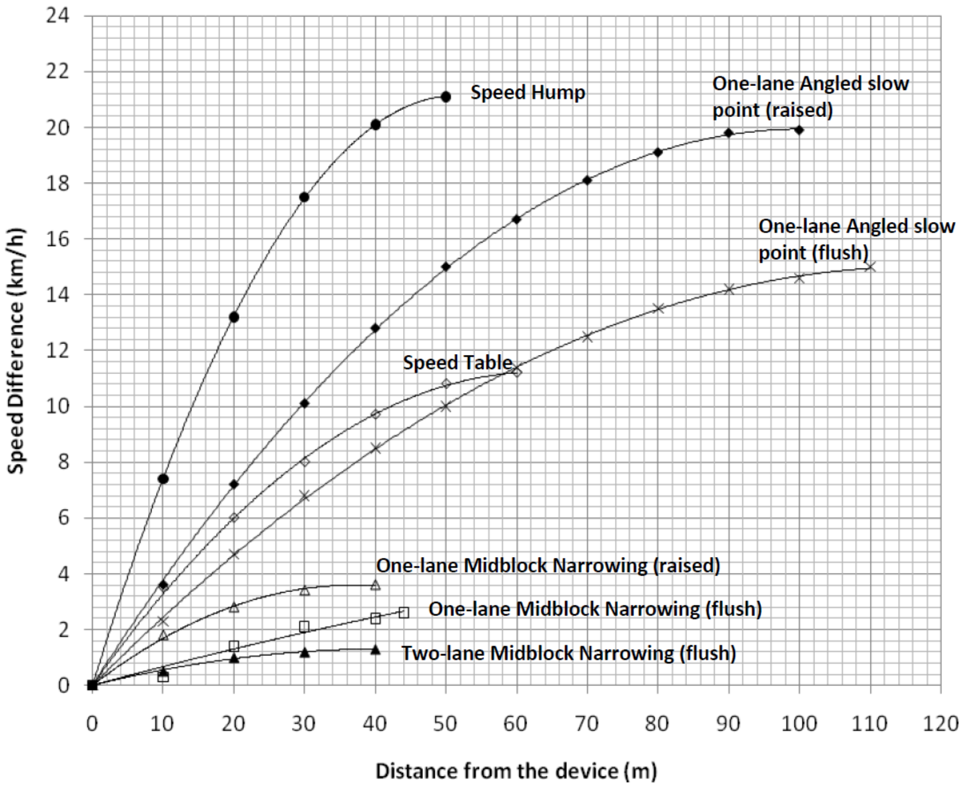
A better approach is therefore to treat the street section as a whole rather than as a series of isolated devices, and so the outline design of the whole installation is an important part of plan development.

To check that the draft proposals being considered do in fact achieve the speed objectives by checking the resultant change in the speed profile, the designer can either:

- rely on broad advice on device spacing, or
- use an empirical speed-based design technique.

Daniel, Nicholson and Koorey (2011) demonstrated that 85th percentile speeds within the influence zones of streets calmed by single devices can be estimated using the speed difference curves as shown in Figure 3.4. Each curve represents the difference in 85th percentile speeds between a point within the influence zone and the device. The beginning of the curve denotes the location of the device, while the end of the curve denotes the location where the influence zone comes into effect, i.e. the point where drivers start reducing their speeds.

Figure 3.4: Speed difference curves for traffic-calmed streets



Source: Daniel, Nicholson and Koorey (2011).

Broad advice on device spacing

[see Commentary 13]

One approach to the design of a sequence of LATM devices is to rely directly on conventional practice regarding spacing. AS 1742.13 – 2009 recommends that maximum device spacings should be in the range 80–120 m, which conforms to general experience. Other guides and research reports give some additional direction on device spacing and the effects of different kinds of device. These are examples rather than requirements:

- ‘Generally a spacing of about 100 m will reduce median speeds to between 40 and 50 km/h *depending on the type of LATM device used*.’ (Main Roads WA 1990, p. 15, italics added).
- To maintain 85th percentile operating speeds below 45 km/h, it is suggested some vertical deflection devices such as flat top road humps should not exceed 70 m spacing (Daniel, Nicholson & Koorey 2011). The device spacing will be dependent on the operating speed of the specific device design. Table 3.3 gives an example of the device spacing needed to achieve different maximum street speeds based on the research of Daniel, Nicholson and Koorey.

Table 3.3: Device spacing based on speed-spacing models

	Operating speed (km/h)	85th percentile speed			
		35	**40**	**45**	**50**
Spacing (m)	**Road humps**	≤ 50	≤ 85	≤ 125	≤ 165
	Flat top road humps	*	*	≤ 70	≤ 145

** Desired maximum street speed not attainable.*
Source: Daniel, Nicholson and Koorey (2011).

Note that the general guidance given rarely relates to the characteristic speeds for different types and designs of device. ‘Soft’ devices that have only modest effects on vehicle speeds would need to be closer and in any case could never reduce the street speed to below the typical *operating speed* of the device itself. On the other hand, aggressive devices with low operating speeds at wider spacings might result in similar street speeds, but at the cost of excessive deceleration and acceleration.

What this all points to is that the effect and required spacing of a particular device depends very much on the design of that device and its resulting device operating speed rather than its specific type. For example, two angled slow points with different horizontal deflections may have very different device operating speeds and consequently their spacing will differ to achieve the same reduction in the street speed profile.

Speed-based design

A more rigorous approach is to adopt an empirical speed-based design process such as that developed for Austroads by ARRB (Brindle 2005), the essence of which is to:

- measure (or estimate) the current free speeds
- specify the target street speed(s) (these may vary in specific locations e.g. adjacent to local centres, schools, at cycle route crossing points and similar locations), thus identifying the required speed change
- design a device or sequence of devices that achieve the target speed while complying with the speed differential limit set at each device site.

This requires knowledge of:

- the characteristic speeds of vehicles at the various devices (the **operating speeds** of the devices)
- how devices interact to produce the resultant speed profile (the between-device speed profiles, which can be approximated using known deceleration and acceleration behaviour).

In designing a scheme, the traffic planner can estimate the typical speeds of vehicles along the street, using known acceleration and deceleration rates and information about the effectiveness of various physical devices in reducing vehicle speeds. Approximations of the expected speed profile after installation of a speed control device can be obtained by superimposing these generalised speed profiles, based on the adopted device operating speeds, onto a plot of the existing street speed profile, and smoothing in the curve by eye. The estimated speed reduction and zone of influence created by the device can then be obtained.

The synthesised speed profile can be used to ensure that the speed **differential** is kept below a chosen level. The speed differential is defined as the difference between the free speed at a given location and the anticipated operating speed of a device proposed at that location; all other conditions held constant (see Figure C14 1).

The suggested upper limit to the speed differential for planning and design purposes is 20 km/h. The corollary of this requirement is that no isolated device (i.e. one which does not interact with another device in the street) should have an operating speed which is more than 20 km/h below the existing free speed at that point.

For this purpose, free speed at any point is that speed adopted by the representative vehicle at the proposed device location, as influenced by any neighbouring speed control device. The aim is to develop a new speed profile such that the speed differential is nowhere more than 20 km/h (or whatever maximum speed differential is adopted). This implies that a typical driver coming unexpectedly upon a device, having passed a previous device, will not be going more than 20 km/h faster than the speed at which that device is normally negotiated.

The installation design should desirably result in a reasonably uniform speed profile (i.e. not too much speed variation along the street).

The importance of the speed differential

The speed differential is a key criterion in speed-based design, but it also has general application as a criterion for assessing any proposed device, no matter what its location is based upon. Isolated devices or widely spaced devices that have operating speeds significantly (more than 20 km/h) below the speed limit are not recommended. If they are unavoidable for any reason, which should be documented as part of the project records, then special care must be given to their advance warning, visibility and lighting in accordance with appropriate standards. Many roundabouts and other intersection treatments fall into this category, and are validly installed if there are adequate formal and informal visual cues to the driver. As a general rule, the first device encountered in a street should be placed where it can be clearly seen and speeds are naturally low (AS 1742.13 – 2009) to limit the size of the speed differential.

Cautions about isolated or widely spaced devices

There may be a temptation (for cost reasons, for example, or to deal with complaints with minimal effort) to opt for treatments that are too far apart to be fully effective. However, spacings much above 120 m are unlikely to result in reduction of the maximum speeds reached by drivers in the street, but will instead create a sequence of accelerations and decelerations which, combined with the high speeds in between and the noise created at the devices themselves, is likely to increase public perception of traffic-related problems – with justification (AS 1742.13 – 2009, Section 2.4.1.4).

LATM devices should not generally be used as isolated treatments, but rather should ideally be installed as a consistent area-wide traffic management scheme in a local area. A typical LATM scheme includes devices placed at regular and frequent intervals, generally 80 m to 120 m apart on any one street. Isolated devices particularly raise concerns about safety. A traffic-calmed neighbourhood relies partly on the presence of constant reminders about the need to drive slowly. Under these conditions, quite severe traffic control devices and streetscaping innovations can be acceptable, but wider spacings may create isolated obstacles which drivers confront at inappropriate speeds. AS 1742.13 – 2009 states:

> *Existing street lighting, drainage pits, driveways, and services may dictate the exact location of devices. Within these controls spacing of devices 80 to 120 m apart will usually be satisfactory (C1).*

If wider spacings or an isolated device are unavoidable, careful attention should be paid to lighting, delineation, advance warnings, and to speed management by other means to ensure that approach speeds are compatible with the expected negotiating speed at each device. Isolated devices with no restraints on speeds between them are likely to rate poorly on all three counts of effectiveness, acceptability and safety.

3.3.3 Developing Outline Schemes

Selecting candidate measures

Once feasible general approaches have been identified, possible candidate measures can be identified from subjective guides such as Table 3.1 or other resources that are based on practitioner experience. The selection and preliminary assessment process is interactive and iterative.

No reliable automatic treatment selection process exists, because at this stage all the site and community factors that may affect the choices in the specific case require careful consideration. The suitability, effectiveness, and impacts of the chosen treatments must in any case be assessed as part of the plan development process.

Criteria that may be used as part of this selection process include:

- will the treatment meet the objectives?
- ease of implementation
- likely community response based on past experience
- familiarity with the treatment (by drivers and the practitioners)
- are the LATM devices self enforcing?
- preliminary cost assessment
- ability to design the treatments to meet the needs of cyclists, pedestrians and buses.

Additional information on the selection and applicability of the various LATM measures is contained in Section 7.

More important local roads

LATM choices are more limited on the more important local roads (often termed 'collectors' or 'local distributors'), but can still be effective. By definition, these roads carry higher volumes of traffic and are (or may become) bus routes. They help to break local areas into smaller land units and therefore provide the direct paths into the local area. Yet these roads also usually serve normal residential and community functions, including school access.

Suitable LATM measures for these roads typically include (Daff & Wilson 1996):

- roundabouts and/or mid-block splitter islands
- median islands, intermittent planting islands or barrier lines to restrict overtaking and provide pedestrian refuges
- carriageway narrowing or linemarking to provide one lane in each direction; this can also provide protected parking lanes and provide for cyclists.

Vertical displacement devices with low operating speeds are not usually considered to be appropriate on higher-volume streets.

Additional source material and more detail on this topic can be found in: Main Roads WA (1990: Section 7.6); O'Brien and Brindle (1999: Table 9-5); Transportation Association of Canada (1998: Table 3.2); VicRoads (1999a: Section 8.5).

Developing draft plans

Schematic layouts showing how the treatments could be located in the study area can then be prepared. These should be based on broad urban design and town planning principles as well as traffic management objectives, calling on all relevant skills at council's disposal and close liaison between the various professional disciplines.

When preparing alternative schemes, consideration needs to be given to:

- Does the scheme meet the adopted objectives and strategies?
- Is adequate circulation and access maintained for emergency services and larger vehicles that will need to operate in the area?
- Will there be any possible negative impacts in adjacent areas?
- Will the scheme, by its appearance and physical effects, induce driver behaviour that is consistent with the objectives?
- Does the street become more integrated with adjacent land uses and activities?
- Will there be a net improvement in environmental quality?
- Is a genuine range of plans, representing significantly different approaches, being prepared? If so, this will provide the opportunity for fresh insights to emerge, as well as avoid putting 'all the eggs in one basket' and risking the rejection of the whole purpose of the scheme.
- How does the scheme rate in terms of its safety, particularly for active road users such as pedestrians and cyclists?

In addition, each proposal must be feasible, internally and externally, as well as:

- functionally
- financially and economically
- socially
- politically
- legally.

Specific treatments must be identified so that those people affected understand the full implications of the options. Each suggested treatment must be justified by indicating what would be achieved in relation to the adopted objectives and strategies. Residents may accept the principles set out for an LATM scheme, but then object to the specific treatments. The nature and envisaged finish of each installation should reflect the nature of the street environment in which it is placed.

Sometimes the selection of treatments and their location is readily apparent, because of the nature of the problem. More generally, it is good practice to consider alternative plans showing a variety of devices and locations for assessment and public comment. There is rarely a single right answer, and sometimes a range of options may need to be offered to meet the same objectives.

If speed management is an objective, as it usually is in LATM, consideration should be given at this stage to the effects that the chosen treatments and their locations have on the profile of speeds in the street.

The following source provides guidance on this topic: Main Roads WA (1990: Section 7.6).

3.3.4 Consultation on Draft Plans

Intensive public consultation at this stage is not always necessary, but it is advisable to maintain close contact with residents adjacent to proposed sites for devices. This will allow the opportunity to learn about any access issues that may not otherwise be apparent, and provide an opportunity to give information about the treatment and its likely format. Communication at this stage is likely to be beneficial in the longer-term. If there is a representative community consultative committee, it may be invited to offer comments and suggestions. The plans may be displayed and public reactions and responses can be noted. The range of options in the draft plan(s) may be used to demonstrate the technical and other constraints that may affect the things that can be considered.

Consultation with other agencies and special interest groups on the draft plans is strongly advised, so that needs and likely barriers can be identified before the study progresses into too much detail.

3.3.5 Assessment of Alternative Draft Schemes

Scheme evaluation is based on two aspects of performance:

- performance against the set objectives
- assessment of other effects.

Both require the establishment of performance measures, which should be quantified wherever possible. The scheme or schemes that emerge as most feasible should be subjected to a road safety audit. In addition, the usual test of cost-effectiveness will need to be applied.

The technical assessment provides a technical appraisal of the effectiveness of treatments in achieving measurable outcomes. In addition, a community assessment of the effects of the treatment on liveability, amenity and other factors will occur. Evaluation may well consider the crash benefits of a treatment and compare it with the costs, but that may be only part of the overall evaluation as seen by the community. Some form of multi-criteria evaluation, which accommodates both objective and subjective criteria, will often be necessary.

The following additional source material is recommended for reference on this topic: Daniel, Nicholson and Koorey (2011).

Development of performance measures

The primary basis for assessment of the plans, both at this draft stage and later in the process, is the degree to which the plan meets (or is expected to meet) the objectives set for it. This assessment requires the development of specific quantifiable statements that reflect the objectives.

The adopted performance criteria will comprise both the objectives of the scheme, and the assessment criteria that will influence any decision. Measurement of performance against objectives can be expressed in terms of absolute or proportional changes in the measures adopted (mobility, safety, accessibility, amenity, etc.). Acceptable performance criteria for other impacts can be determined by reference to established guidelines or standards, where they exist (such as noise standards for residential environments). Where there are no such guidelines, or where there is a wide range of opinions, agreed measures for determining acceptable conditions should be sought. Community surveys and the participation process can be used to gain an insight into local perceptions.

[see Commentary 15]

Additional source material and more detail on this topic can be found in: Brindle (1996: Chapter 15); Hawley et al. (1993, pp. A30-31); O’Brien and Brindle (1999, pp. 286-288); Pak-Poy and Kneebone (1987: Section 13.3); Austroads (2015b).

Assessment of effectiveness of draft schemes

Most schemes are capable of being readily assessed on a before and after basis. The degree to which schemes are judged as being successful depends on the weight placed on the interacting strategies they may be seeking to implement. For example, a scheme may seek to reduce speed variability as well as reduce speeds absolutely. A device, known from experience elsewhere to result in a lower average speed but with a higher standard deviation in speeds and higher recorded maximum speed, may not be preferable to another device type with a lower standard deviation and maximum recorded speed, even if the latter device has a higher average speed. Another scheme may propose speed control devices as well as lane narrowing to create a clear path for cyclists, thus using two techniques to achieve the one strategy of creating safer local cycling routes.

Depending on the nature of the devices in the scheme, the practitioner may have to estimate changes in:

- traffic routes (i.e. increase or decrease in traffic volumes on any given street)
- traffic speeds (and hence journey times)
- road safety risk – predictions based on known road environment factors
- crashes – based on known crash changes at similar situations.

[see Commentary 20]

Assessment of other impacts of draft schemes

The impacts of the draft options from other points of view will also need to be carried out. Use can be made of the adopted measures of effectiveness for much of this task. The draft schemes can then be compared.

A purely technical solution may not be feasible in a local situation, as traffic management schemes can have a major effect on communities well beyond their immediate traffic effects. The effects can be direct, e.g. the transfer of traffic onto quiet streets, or indirect, e.g. decreasing accessibility by road closures.

It is noted in the discussion on the start of the LATM process (Section 3) that some councils will not proceed with an LATM investigation without a commitment from residents at the beginning that they are prepared to accept some change in their street environment in order to obtain the gains that the scheme intends to bring. This may not entirely avoid later hardening of attitudes, but it does at least serve to emphasise to the community that there will be some ‘collateral’ impacts in order to improve traffic conditions.

The question of displaced traffic is a key issue at this stage. The traffic displacement effects of the scheme are estimated as part of the technical effectiveness of the scheme. Perception of and responses to this change in traffic volume, particularly on non-treated streets, is discussed in Section 2.

The comparison of the impacts of the different schemes (e.g. weighing up the importance of traffic noise exposure compared with convenient access for local traders) will identify gains and losses in each case. This process is intrinsically subjective and will depend on local conditions and judgements. Often, a judgement will not be possible until a hypothetical choice turns into a real set of potential gains and losses. Again, community involvement is necessary, and estimates of impacts provided in this process should be as realistic as possible.

Costs compared with effects

The draft schemes should meet the following tests of financial feasibility:

- The scheme should be within council’s current and future budget limitations.
- It should be cost-effective.
- It should be within the physical resources of council and any other authority that is involved.
- Any staging required by cost limitations must lead to workable and acceptable intermediate stages.

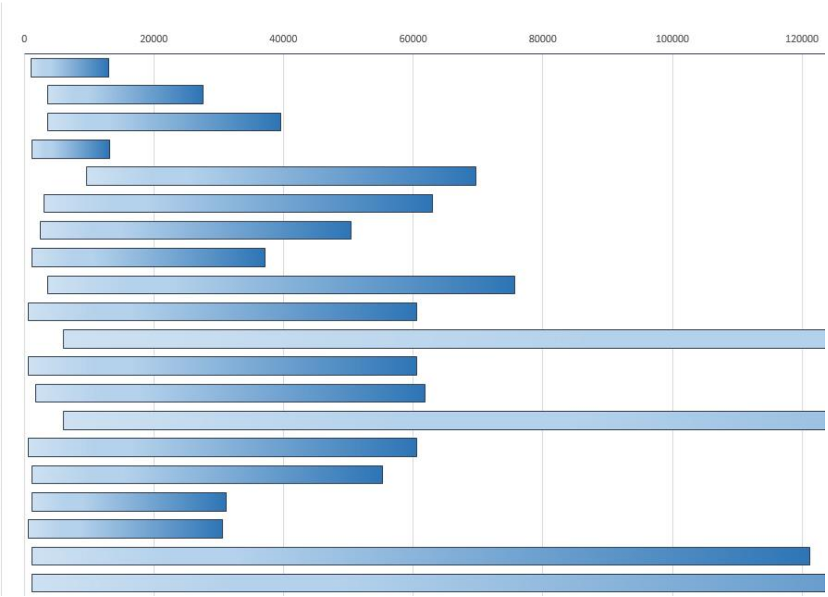
Tests of this kind require estimates of costs sufficient for preliminary budget purposes, and identification of net benefits from the analysis of effectiveness and impacts. A planning balance sheet approach may be used as a supplement or alternative to a financial benefit-cost analysis.

Costs will vary from site to site and are heavily dependent upon the materials and landscaping adopted, the size and length of the treatment as well as the extent to which existing infrastructure, particularly drainage, telecommunication pits and utility poles, has to be modified.

The more expensive treatments are likely to be landscaped roundabouts, road closures and shared zones, raised pavements, modified T-intersections, slow points and driveway links and the various forms of landscaped channelisation. Signs and road markings, road humps and cushions, kerb extensions, tactile surface treatments, simple median islands and flat top road humps will usually be among the lower-cost options. Typical costs for various treatments are cited in several sources (see suggestions at the end of this section) and can be used to estimate relative costs but would need to be updated to current dollars if they are used for budget estimation purposes. An example developed by ARRB is shown in Figure 3.5 (Damen 2007) showing the spread of actual costs reported for various treatments and the relativities between them, escalated to 2015 equivalent numbers using CPI for the construction costs.

Figure 3.5: Relative LATM device construction costs

Local Area Traffic Management Device	Construction Cost (2015 AUD$)
Road humps (round profile)	1,000 - 12,000
Flat-topped road humps	3,600 - 24,000
Wombat crossing	3,600 - 36,000
Road cushions	1,200 - 12,000
Raised intersection pavements	9,600 - 60,000
Kerbside lane narrowings / kerb extensions - per 100 m	3,000 - 60,000
Slow points (angled or straight)	2,400 - 48,000
Blister islands	1,200 - 36,000
Driveway links - per 100 m	3,600 - 72,000
Median treatments - per 100 m	600 - 60,000
Roundabouts	6,000 - 480,000
Full road closure	600 - 60,000
Half / part / diagonal road closure	1,800 - 60,000
Modified "T" intersection	6,000 - 300,000
Pedestrian crossings	600 - 60,000
Perimeter threshold treatments	1,200 - 54,000
Tactile surface treatments - per 100 m	1,200 - 30,000
Bicycle lanes / bypasses - per 100 m	600 - 30,000
bus only links / bus bypasses - per 100 m	1,200 - 120,000
Shared zones - per 100 m	1,200 - 180,000



Source: Based on Damen (2007).

The most reliable source of cost estimates is council's own experience in constructing LATM. Cost extrapolation from similar installations under similar conditions in the surrounding region can also be useful.

Treatment costs, landscaping and the construction method (staged or complete construction) are inter-related, for example:

- low maintenance cost requires higher initial cost
- improved streetscapes require permanent works and higher up-front costs
- temporary works require upgrading, usually at greater total cost.

Such relationships can be used to reduce the overall costs if needed. City of Knox (2002) estimated that 20–25% of LATM construction costs could be saved by deleting landscaping. This might be an attractive option to a council if resources are inadequate for the identified needs within a reasonable time. However, landscaping fosters greater acceptance of LATM treatments by residents and its omission could jeopardise the longer-term program, especially if the results are perceived as being excessively utilitarian. Use of modern hard materials may offer a compromise in some cases.

Also of importance in the costing of schemes is the future maintenance cost. For example, Hawley et al. (1993) stated:

- Devices constructed in concrete are considered to have the lowest on-going maintenance cost.
- Devices using bitumen or pavers have a much higher on-going maintenance cost, particularly under heavy loading situations.
- Street furniture, signs, and landscaping are all susceptible to damage and therefore contribute to the on-going maintenance cost.
- Horizontal deflection devices often require the pavement to be reinforced to allow for the side pressures exerted by vehicle tyres.
- Whilst devices such as road markings and signs are relatively cheap to install, their effectiveness relies on their up-keep to a suitable standard.

Additional source material and more detail on this topic can be found in: Amamoo (1984); Ho and Fisher (1988); Pak-Poy and Kneebone (1987: Section 12.5.21).

Community response

The final scheme (and therefore the draft schemes being tested) should be acceptable not only to the residents by whatever criterion is the prevailing local practice, but also to council, emergency authorities and the appropriate state agencies. The views of different interest groups should be taken into account, with a view to obtaining consensus, although in a majority of cases the wishes and needs of the local residents should be given the greatest importance. The adoption of a scheme by a council in the face of strong external opposition will reflect its acceptance of the greater local need. Conversely, acceptance of a scheme by reluctant residents depends on the ability of council and the supporting residents to demonstrate convincingly the need for such action.

Feedback from the community will give a guide as to the perceived merits of each of the draft schemes. These can be incorporated in the report to council on the alternative schemes.

3.3.6 Scheme Adoption

Following public and technical review of the alternatives, and receipt of comments, modifications can be made and a recommended scheme can be produced. The report to council will normally include graphic presentations of the plan(s) and the various effects and impacts in tabular form, showing how each alternative performs against the objectives and supplementary assessment criteria.

Once the plan has been finalised, it should be placed on public display, and those residents adjacent to the devices to be constructed should be personally contacted. At this stage, a more detailed plan showing the actual form, dimensions, and locations of devices relative to driveways etc. may be desirable.

3.4 Stage 4: Scheme Design

Once the draft scheme is approved, more detailed cost estimates can be prepared, priorities defined, and the timing and staging can be confirmed.

Detailed design and documentation can then be undertaken in order to:

- carry out further street surveys if necessary (kerb and property lines, driveway locations, location of above-ground and below-ground services, drainage channels and pits, tree locations and assessments, pavement surface details, etc.)
- prepare detailed drawings (see below – design of devices)
- specify landscaping plan

- prepare construction and contract documentation
- maintain close consultation with residents adjacent to device locations, services companies, and (if concerns have previously been raised) bus companies and relevant emergency services
- develop a maintenance strategy
- pursue funding (if external funding opportunities exist).

Design of devices

Detailed design advice is given in the various key reference documents that are listed in Commentary 1. Codes of practice and guides in operation in each jurisdiction should be observed.

[see Commentary 1]

Detailed design covers two stages:

- layout design, to determine the form of the device
- engineering design, as part of construction documentation.

One of the challenges to the designer at the layout stage is that, compared with standard traffic design that seeks to facilitate the safe and efficient passage of vehicles, the design of most LATM treatments seeks to impede vehicles. Doing this without adding to the level of risk is the heart of LATM design (Section 6). A detailed design stage road safety audit is an intrinsic part of this stage.

Another challenge comes from the fact that LATM devices (particularly horizontal deflection devices) induce slower speeds by employing tight geometry – yet adequate design for larger vehicles requires greater clearances and swept paths. Appropriate design templates should be adopted, but use should be made of mountable kerbs and run-over areas to help define a tighter path for general traffic. ‘The effectiveness of the device and therefore the scheme should not be compromised by over-design’ (Main Roads WA 1990, p. 118).

Comments about the design of specific devices are included in the descriptions in Section 7 and Section 8, and there is further discussion of the subject of signs, markings and other safety aspects of devices in Section 7.5.

Additional source material and more detail on this topic can be found in Australian Standard AS 1742.13 – 2009; Main Roads WA (1990: Chapter 9); Pak-Poy and Kneebone (1987: Chapter 14).

3.5 Stage 5: Implementation

3.5.1 Timing and Staging

Works may be staged, or implemented in full at one time. Staging is usually undertaken for practical or funding reasons but it may also be used as a form of trial or familiarisation. In particular, there may be uncertainty about the traffic displacement effects of a set of treatments, so the scheme may be implemented gradually and the changes monitored at each stage. Where there are identified accident black spots (usually at intersections), countermeasures may be installed in isolation in advance of the rest of the area scheme. A pre-opening stage road safety audit should be carried out before the modified street is opened to traffic.

Staging precinct by precinct is usually better than scattered sequencing of treatments. Another technique for staging is to work inwards from the boundaries of the local area, so that appropriate behaviour is ‘signalled’ to incoming traffic.

However, staging can seriously compromise the speed effects of a series of devices forming an integrated installation. The whole set of treatments is needed to obtain the desired speed effect. In addition, there are practical difficulties.

One council (City of Knox LATM Program Review, June 2002) expresses the choice in these terms:

> *The full implementation has the greatest chance of achieving the goals and objectives of an LATM scheme. With staging of a scheme, the order in which devices or countermeasures are installed, and the length of time over which they are installed can drastically affect the performance of a scheme as a whole. Risks associated with the staged approach are:*
>
> – *localised speed reduction only where devices are installed – no change elsewhere;*
> – *speed reduction at actual devices will be less than with a series of devices working together;*
> – *a few devices may do enough to reduce the priority of the balance of a scheme to a point where later stages have lower priority than the first stages of a new scheme.*

A commonly reported experience arises from a prolonged participation process or stage construction. This occurs when a new household moves into a street after agreement on a plan, but before construction, or during the time when a treatment is in its trial or interim stage. It can also occur some time after construction of the treatment when people not previously involved in the process move into the area (Damen 2003). If the new household is opposed to the device, this can undo much of the process that has already passed. It may be prudent to have some form of documented street or individual site agreement that becomes one of the routine pieces of information supplied to prospective purchasers as part of the normal property inquiry process.

The following additional source material is recommended for reference on this topic: Main Roads WA (1990: Section 8.4).

Trial installations

Temporary installations should be undertaken only very carefully and as a last resort. Full implementation has the benefit that the whole area is treated, meaning that the effect of diverted traffic can be dealt with and drivers do not have to cope with a road network that keeps changing. If all devices are placed in permanent materials, landscaping and finished materials can be used immediately to enhance the treatments; some trial installations have been so unattractive that they lead to a community backlash. Costs of temporary works are avoided if works are fully constructed at the start.

It may, however, be a useful part of the testing of the scheme to use simple marking techniques, particularly where there is still robust minority opposition to a proposed scheme. Painted outlines of roundabouts and slow points give residents and road users a ‘feel’ for what is to be built. Some local government authorities have used sandbags or modern temporary edging as forerunners of permanent devices.

Temporary installations should not be built in such a way as to reduce safety. Full signs and lighting are advisable. A road safety audit of the temporary roadworks traffic management arrangements should be carried out before opening the temporary traffic control device to traffic and then again after the temporary traffic arrangements are removed.

It is advisable to clearly notify residents (by letter and notices) of the temporary or trial status of such measures, and to ensure that the period of the temporary treatment is relatively short. The full construction should desirably follow immediately after the trial ends.

3.5.2 Risk Management

Road safety auditing and other forms of risk based predictive assessments (e.g. ANRAM and KiwiRAP) are common and recommended techniques for managing risk in the design and implementation of LATM schemes. Undertaking progressive road safety audits can also assist in meeting a road agency's legal and duty of care obligations (Section 6).

3.6 Stage 6: Monitoring and Review

Monitoring and evaluation of the final scheme and any intermediate stages is an essential part of the planning process. It is often overlooked or neglected because of time and resource pressures. The purposes and value of monitoring and evaluation include (Main Roads WA 1990, p. 128):

- to assess the scheme as a whole and the individual treatments against the adopted objectives – the primary technical measure of success
- to identify any undesirable impacts that might indicate modifications that could be made
- in stage implementation, to assess the impacts of each stage so that subsequent stages can be modified if necessary
- to provide objective information on impacts and effects for the community
- to provide information on the performance of the scheme and individual devices which may be useful in later projects or shared with other councils.

Additional source material and more detail on this topic can be found in Hawley et al. (1993: Section A6); Main Roads WA (1990: Chapter 11); Pak-Poy and Kneebone (1987: Chapter 16).

3.6.1 Monitoring

Planning of the monitoring surveys should take place early in the study so that 'before' data on the same parameters can be collected. 'After' surveys and the analysis of any changes should be carefully designed in order to ensure the efficiency and validity of the findings, calling for the assistance of people with a sound understanding of survey methods and statistical techniques. Field collection of traffic data will use standard methods, carefully focussed on the measures needed for analysis (e.g. Ogden & Taylor 1996; Pline 2008). Attitudinal surveys require the assistance of an expert in that field. If there is a community-based traffic committee or a project committee, it can provide subjective local feedback. A major indicator for council staff (and often the only indicator that is available if monitoring has not been designed into the LATM process) is the level of telephone and other complaints received.

Key parameters in the monitoring program are likely to be:

- speeds
- crashes (reported and unreported)
- traffic volumes, traffic composition and time-of-day variation
- cordon origin and destination survey (especially if through traffic has previously been an issue)
- delay at exits from the area
- resident attitudes (obtained passively or actively through surveys)
- affects on, and responses of specific road users such as cyclists, commuters driving to work, commercial drivers and bus operators.

Although ‘indicator’ checks may be taken soon after installation, to alert council to any immediate problems, monitoring surveys should be carried out when the traffic network has settled down and familiarity has been achieved. As a general guide, this suggests that surveys can be carried out at the following times:

- speed surveys – two to four weeks after implementation, then periodically after
- diversion effects – three to six months
- crash analysis – one to two years
- public acceptance – six months to a year.

To be useful in other applications, key information about each treatment will need to be stated so that like items can be grouped together and their impacts pooled for comparison with different types of device (e.g. road humps compared with flat top road humps) or significant variations of the same generic device (e.g. flat-top road humps distinguished by their ramp gradients). An agreed typology for LATM treatments has not yet been established; even the terminology used to describe common techniques is not standardised (e.g. similar treatments can be termed ‘raised table’, ‘platform’, ‘plateau’ or ‘flat top hump’). The groupings used in Section 7 reflect the common types and names used in current practice in Australia and New Zealand, though there may be some local variations.

Traffic patterns

While traffic counts are probably the simplest field surveys to carry out, the detection of a significant change in volumes requires knowledge of statistical properties of traffic counts. Count only on weekdays for normal purposes. (Weekend counts may be needed for special situations such as areas near recreational facilities, for example). There can be substantial day-of-week and time-of-year variation, meaning that comparable days should be chosen for comparison, if possible. Alternatively, known temporal distributions can be used to factor the counts (e.g. a count on a Monday can be factored by the relationship between average Monday counts and average Thursday counts if the ‘before’ count was on a Thursday). As a rule of thumb, differences of at least 10% between ‘before’ and ‘after’ daily counts are required before an assumption about a real change can be made.

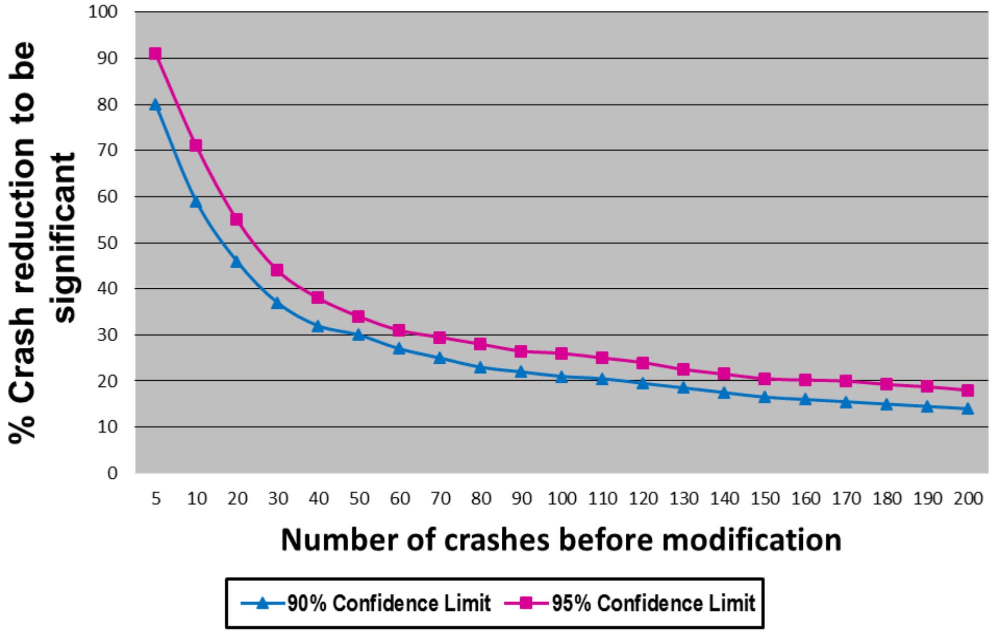
Crash data

To detect a significant change in before and after studies, considerable data is needed. This creates a problem in most local areas; while significant in total, local area crashes are usually thinly spread and random events (Fairlie & Taylor 1990). Figure 3.6 shows the percentage reduction in crashes required in an ‘after’ period to be confident in claiming that there has been a significant reduction in crashes. As the figure shows, the smaller the sample size, the larger the reduction needs to be.

Problems created by small data samples can be reduced by either combining data (e.g. analysing the LATM program over the whole municipality) or by increasing the analysis time periods. GIS-based techniques to handle crash data for this purpose are being developed (e.g. Affum & Taylor 1997). Valid analysis of crash changes at individual device sites or streets is rarely possible.

Proxy indicators for increased safety may be used in place of actual crashes under these circumstances. These may include conflict analysis techniques and behavioural measures (Brindle 1996: Chapter 15). Debris surveys are useful indicators of minor and unreported crashes, which probably rate higher in local perceptions than they do in official analyses of safety. Speed change is commonly accepted as a measure of changed crash propensity, but the numerical correspondence between speed change and changed crash risk cannot be specified.

Figure 3.6: Crash change significance test chart



Speeds

Changes in traffic speeds can be easily measured but care must be taken to ensure that the measuring itself does not affect speeds, e.g. driver response to speed guns. Speed surveys will usually yield distributions of speeds at a point. The various measures from this distribution (mean, 85th percentile, maximum, etc.) each have relevance, depending on the situation and purpose of the analysis. The statistical design of the survey and analysis will also influence the choice of speed measure that is quoted.

Community participation in monitoring and assessment

The community is a valuable source of information on unanticipated effects of the scheme, can provide local information on traffic effects that formal surveys do not pick up (such as increases in minor crashes) and provides the most important check of acceptability – if the community is not content with the perceived outcomes, then all else is secondary.

Therefore a process for community feedback and a more formal mechanism (e.g. a structured survey) to obtain community opinions and attitudes may both be required.

3.6.2 Reviewing and Revising the Scheme

The review should be professional, unbiased and ideally be independent of the implementing team. If resources permit, and the scale of the scheme warrants it, an external agent may be appointed.

Once monitoring data has been analysed, there should be a formal review of the scheme. It may be found that the scheme is successful in meeting its objectives overall, but may fall short in terms of some targets (expressed in the primary or secondary objectives) or have undesirable side effects. The review identifies amendments that could be made to the scheme to overcome these deficiencies. For example, fine-tuning could include changes to signs or channelisation or suggest that additional devices may be used.

Significant remedial action, especially if costly or impacting on the scheme's whole strategy, should not be taken too hastily after the scheme's installation – unless an urgent safety issue has become apparent. Time should otherwise be allowed for the scheme to settle down and driver behaviour to adapt to the new conditions.

3.6.3 Recording and Reporting

It is advisable to record the rationale, basis, and outcomes of the project, for the following reasons:

- for reference in later projects
- to share with other councils who may be contemplating similar actions
- as prompts and records for regular maintenance
- to record the technical basis and methods for reference in the event of liability claims.

Public reporting of the successes of the scheme provides residents with evidence of the gains from the changes to their streets and their behaviour.

It is also beneficial if practitioners can share any generally useful data or experiences with others through technical papers, presentations and other means. There is a wealth of experience with LATM in many councils' records, most of which lies unknown and unused. Only through collaborative research and testing, and the sharing of information at a local government level, will the wider community of practitioners be able to take advantage of the knowledge of both good and bad experiences so that the failures of the past are not doomed to continually recur, and the science of LATM can progress.

4. An Objective Decision Process for LATM

4.1 The Nature of Warrants

A **warrant** is a statement of those (usually objective or measurable) conditions at which intervention through countermeasures is considered to be required. It provides, by implication, a quantitative and objective basis for taking action.

Establishing when LATM action is necessary or desirable is often based on warrants or other objective measures of relative need, usually referring to traffic speeds, traffic volumes, crash rates, risk mapping, street amenity or more broadly defined levels of service. There is no best practice or standard for warrants or setting priorities for LATM, and it is important to note that there is no agreed or formally-adopted statement of conditions at which LATM must be implemented or below which it cannot be approved. A local road controlling authority must choose a decision process for LATM planning which is appropriate for its needs and circumstances taking into consideration the expectations of the community it serves. Factors to be considered, and an outline of the three broad approaches to establishing needs and priorities, are discussed in this section. Examples of decision-process systems in common practice can be found in Commentary 16.

The term ‘warrant’ is used here in a general sense rather than as an imposed rule or requirement to which all schemes must comply. Warrants provide a quantitative and objective basis for taking action. Warrants are related to level of service **standards**, which are performance targets (for example, for mobility, safety, accessibility, amenity and environmental quality) for the system in question. Standards, in turn, may be **planning** (or **policy**) standards or **deficiency** standards. Additional information on level of service standards is given in Commentary 22.

[see Commentary 22]

A planning standard is a statement of the essential levels of service criteria that define a desired outcome – a target level of performance that is desired for the system, and to which all new additions to the system should conform. These will reflect the policy intentions of the responsible body, among other things.

A deficiency standard is a statement of the essential levels of service criteria below which the system should not fall – the levels of performance that indicate that a problem exists in the system that needs early remedial action.

Failure to meet the specified criterion level may be interpreted as a warrant for some sort of action. However, as noted earlier, ***warrants for LATM can never be treated as absolute***, because judgement about what are desirable and deficient levels of operation of local streets, places and land systems are unavoidably subjective. In addition, global warrants cannot feasibly be defined because the ability of a local road controlling authority to take action is usually constrained by the availability of funding and other resources. It is therefore important to keep in mind (and to make it clear in public consultation) that warrants in themselves do not compel or justify anything. Expert discretion, and the availability of funds in the light of other demands, will always moderate the technical indicators.

Additionally, as wider traffic engineering experience has taught, the use of warrants and other level of service criteria as the sole basis for deciding to act or not can lead to misunderstandings and criticism in the community.

For these reasons, identifying the most important or beneficial among competing projects is a greater practical need, and many local road controlling authorities rely on ranking (or prioritising) systems rather than absolute warrants (Ewing 1999a; Lockwood 1997). A budget-constrained program of local works that establishes the criteria for doing one set of works before another will generally be popularly understood, if everyone understands that the budget limitations are a direct result of agreed limits on taxes and rates.

Thus, local road controlling authorities usually seek either or both of two sorts of measures of need, as reflected in the types of prioritising systems described in Section 4.3:

- thresholds of conditions (of traffic volume, speed, street amenity, level of service, etc.) at which action must be strongly considered at specific locations as a first call on available finance
- a means of ranking or establishing priorities between the needs for action in different areas and streets; these typically take the form of a 'points' system, in which the various criteria are used as constituents of a composite measure expressed in terms of a single number.

4.2 Applying Warrants in a Policy Context

There is no valid lower limit to the warrant criteria, below which LATM is always inappropriate, 'because action may be as much a function of community preferences and availability of resources as of technical criteria' (O'Brien & Brindle 1999, p. 269). In addition, LATM is often more than a reactive response to identified road crash and other mobility and accessibility traffic-related problems. As one of the tools of traffic calming and integrated local planning, it helps to moderate the effect of road traffic on the urban environment and urban lifestyles as well as contributing positively to local amenity, environment and transport objectives. This may invoke a wider range of policies and objectives beyond those specifically defined as traffic problems in order to achieve a more liveable community with the right human scale. In addition, many of the objectives of LATM (especially implicit objectives) cannot be dealt with solely by specifying technical criteria.

Thus LATM may be initiated on the basis of technical warrants or other council policies or both:

TECHNICAL WARRANTS + OTHER POLICIES

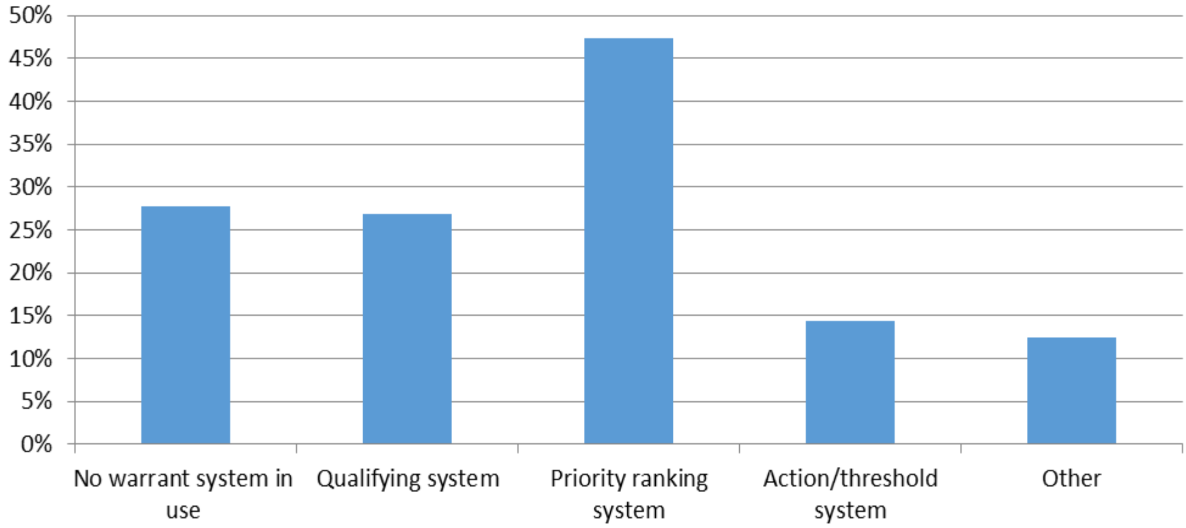
↓

LOCAL STREET ACTIONS

4.3 Warrant Systems in Use

A survey reported by O'Brien and Brindle (1999) found that practitioners in 69% of Australian local authorities that responded had some form of warrant or action criteria for LATM, and in one-third of these cases the warrants had been formally adopted by the local authority. A separate study by Damen (2007) of mostly metropolitan and regional local authorities in Australia and New Zealand revealed that approximately 80% had some form of warrant system that they use. Furthermore, 43% of those that responded always used one or more of the commonly adopted forms of warrant as summarised in this Guide, the priority ranking system being the most common type of warrant system used. A further 30% used these warrant systems less frequently, and 7% exclusively used some other form of warrant system. Later research by Damen and Ralston (2015) identified that nearly 30% of Australian and New Zealand local governments do not have an LATM warrant system currently in use, an increase of more than 10% relative to 2007, and closer to the 1999 result reported by O'Brien and Brindle. A graphical depiction of the frequency of use of each warrant system is given in Figure 4.1.

Figure 4.1: Different LATM warrant systems used by local government



Source: Damen and Ralston (2015).

Warrant systems found in practice fall into three broad groups based on the threshold or ranking approach, depending on the local need and situation:

- qualifying conditions to merit closer examination
- warrants expressed as acceptable thresholds of stated criteria
- warrants, usually expressed as points, to provide a basis for priority ranking.

A local road controlling authority may adopt any or all of these as a basis of its LATM decision making. A points system based on measures of critical variables relative to adopted threshold values is a widely used method of determining need and allocating priorities.

After noting the sorts of parameters used as warrant criteria in Section 4.3.1, the three types of warrant systems are discussed further under subsequent sub-headings.

Additional source material and more detail on this topic can be found in: Ewing (1999a: Chapter 8) for US practice; Hawley et al. (1993: A7.2, A7.3), Perone (1996), and Damen and Ralston (2015).

4.3.1 Warrant Criteria

Whatever system is used, the quantitative criteria (if not the threshold values) tend to be similar. A warrant system will typically include some or all of the following:

- traffic speed – usually in terms of 85^{th} percentile and mean speed
- traffic volume – both in terms of vehicles per day and highest hourly volume
- crashes – over the most recent period that gives useable data (say, two-to-five years), taking separate account of fatalities, serious injuries and other related crashes; it may be appropriate to include unreported crashes where information is reliable
- presence of activity generators, buildings with a high sense of place, and/or sensitive land uses – specifically in terms of likely pedestrian and bicycle generation, impact on street amenity, and the requirements for people with disabilities.

If data is available, other criteria may be included in the warrants system, such as:

- through traffic – as a proportion of total traffic
- commercial vehicles – as a proportion of total traffic
- bus routes – presence and frequency of service, both regular and school bus services
- noise – relative to adopted local standards.

Sometimes other information about the physical environment (such as road gradients, road widths and lengths, and available sight distances) as well as details about the level of social interaction in the street and the presence of local non-residential land uses is also taken into account. If level of service values are used then care needs to be taken not to double count.

Hawley et al. (1993) found from a survey of councils in four states that the need or opportunity for LATM was most commonly based on the vehicle collision record, followed by evidence of speeding, the amount of through traffic, the volume of community complaints and the level of pedestrian crashes. Representations by elected members ranked next followed by the level of truck intrusion and the concentration of pedestrian-generating land uses. The need to reconstruct the pavement was a lower-ranking criterion.

The later survey reported by O'Brien and Brindle (1999) found that speed was a criterion in 95% of the warrants used in practice, crashes in 93%, traffic volume in 93%, and consideration of land use in 68%. Just over half the jurisdictions included all four warrant criteria.

The scoring system may also be weighted by such subjective matters as (Lockwood 1997):

- local perception of the seriousness of the problem
- how long the problem has been before council
- the judgement of the staff involved about need and likely effectiveness of countermeasures
- likely costs and the funds available.

Local perception of the problem and level of community support for LATM action (percentage of residents or percentage of those responding) may be expressed in qualitative terms or as a measure such as: 'more than 50% of submissions support dealing with the issue'. Clearly, the nature and extent of the public education and consultation program that is followed will affect such a criterion.

4.3.2 Warrants Expressed as Qualifying Conditions

The simplest approaches to indicators of the need for action come in the form of a checklist or 'sieve' of conditions, some of which may be qualitative, that must apply in order for a street to qualify for closer inspection. This approach is compatible with a one-off, street-by-street approach to traffic calming but is also useable in area-wide LATM.

Such a checklist may include:

- character and function of street
- level of non-local traffic
- general speed limit
- traffic volumes and speeds
- street form and suitability for changes
- availability of lighting
- whether or not the street is important for access to an emergency facility

- presence or absence of major traffic generators or non-residential uses
- whether or not the street is part of a bus route, bicycle route or bicycle desire line
- availability of crash data and/or field assessment
- presence of an existing or proposed precinct scheme or not
- effects and likely benefits of the scheme
- degree of local support.

Some councils have adopted a two-stage process, applying an initial sieve and then subjecting the more detailed proposal to a ranking process.

4.3.3 Warrants as Thresholds (Action and Investigation Warrants)

Even when expressed as implied absolute thresholds, warrants can take on different degrees of meaning. Reflecting the difference between planning (target condition) and deficiency (minimum acceptable) standards (Section 4.1) warrants may be defined as **action warrants** or **investigation warrants** (O'Brien et al. 1997).

Action warrants – warrants or criteria that state that an identified problem needs to be dealt with to bring the system up to the deficiency standard, if funds are available.

Investigation warrants – warrants or criteria that show that the system is operating below desirable standard and needs to be investigated and/or monitored. Investigation warrants imply a technical justification for action.

Not all problems identified by the community justify LATM action being taken. There is a gap between the levels of performance criteria that reflect values or expectations of at least some in the community (what could be termed the tolerance level), and the levels of performance at which the community as a whole is prepared to pay to address such problems. O'Brien et al. (1997) suggests that the wider the gap between action and investigation warrants, the more the community pressure is likely to exist on both politicians and officers to provide funds for treatment. Consequently there are levels of problem that the adopted criteria might reflect, as in Table 4.1.

Table 4.1: Levels of problem and likely responses

Problem level	Technical criteria	Response/action
Substantial problem (a deficiency)	Above the problem warrant level or threshold, i.e. fails the deficiency standard	The problem is significant enough to be included on a funded treatment program, in order of funding priorities
Acknowledged technical problem	Satisfies the deficiency standard but fails the desirable planning standard	Acknowledged problem justifying investigation, but not sufficient to attract funding in the short-term. Alternative (non-LATM) low-cost approach may be considered
Possible technical problem	Achieves the planning standard but conditions are perceived to be above tolerance levels for some in the community	There may be a problem, but not so serious as to attract funding, even in the longer-term. Alternative (non-LATM) low-cost approach may be considered
No agreed problem	Below majority tolerance levels and thus clearly achieves the planning standard although some negative community reports may occasionally occur	Unlikely to ever lead to LATM action

It has been known since the work of Clark and Lee (1974) that there is an inter-relationship between traffic volume and speed underlying the perception of a problem in a street. Graphic combinations of speed and volume thresholds that indicate the transitions from no problem to problem to action required, based on a review of Australian practice, are suggested by O'Brien et al. (1997).

4.3.4 Warrants as Priority Ranking Systems

Given that LATM aims at improving the quality of a local street, on a number of criteria, some such as Lockwood (1997) and Kanely (1997) put a strong case for prioritising rather than relying on 'go/no go' technical warrants for LATM.

Many councils are finding that, despite having an LATM program that has run for many years, the number of candidate streets and projects is increasing. City of Knox (2002), for instance, reported that it would have taken 10 years funding at the current rate to deal with the top 10 ranking projects as at 2002. In addition, 26 candidate schemes then ranking above the notional threshold of acceptable conditions for local streets would require funding to be more than doubled if they were to be treated within 10 years.

As a result, a sieving or threshold warrant process as described above is often used to identify qualifying projects but some means of prioritising between projects is then required. On the basis of a review of warrants systems in use, O'Brien et al. (1997) concluded that:

> *The best warrants systems incorporate the following features:*
> - *a points scoring system which incorporates increments to reflect the magnitude of each criterion to determine priorities for traffic management*
> - *a higher weighting is given to the more important criteria, typically traffic speed, crashes and adjacent land use activity*
> - *different street types and classifications are scored differently for the same data*
> - *both individual streets and local traffic areas can be treated and can be prioritised*
> - *the system is readily understood and completely transparent*
> - *the system allows for potential projects to be quickly identified or rejected with a cut-off point reflecting budget funding for the candidate sites*
> - *the system incorporates flexibility to separately fund traffic management projects as part of street reconstruction, streetscape or urban renewal initiatives.*

Competing projects and areas can be ranked according to their totals of such points, and a threshold points value can be adopted to identify candidates for funding.

A council can use the points ranking system to evaluate the performance of its local street network and to reassess the level of funding it needs to make available for its LATM program if it wishes to retain the current standards it sets itself for safety and amenity in residential areas.

5. Community Participation and Information

5.1 The Role of Community Involvement in Establishing Needs

Many of the warrant criteria used to establish needs and priorities for LATM depend on inputs from the community and its representatives. Community consultation and participation therefore play a central role in establishing both needs and priorities for LATM. In Damen and Ralston (2015) it was shown that consultation with the community is the most widely used LATM process and it is used 94% of the time when considering LATM in Australia and New Zealand.

In its most passive form, community consultation can consist entirely of written and verbal complaints to council. At the other extreme, a fully participatory approach focussing on LATM within the context of the wider range of strategies for the community could be undertaken. This can be a time-consuming and expensive process and it might be more practicable to consider a broadly strategic approach using objective measures, supplemented by a community-driven identification of local problems. O'Brien and Brindle (1999, pp. 259) observed that community input in this process was more commonly directed at setting priorities rather than establishing absolute thresholds, although research into community perceptions and preferences does shed light on levels of community tolerance to various parameters.

Some councils with long and successful experience with LATM have found that it is not always essential, or even appropriate, to implement the full LATM consultation process described in this Guide. However, even when a local street treatment is installed to address a localised issue and is likely to have no traffic redistribution effects, some level of communication and explanation (at least to those whose access and movement will be affected) will usually be required.

There is a wide range of techniques and approaches to consultation and the participation process in traffic engineering and the broader responsibilities of councils. Users will need to consult the suggested sources for further and more detailed guidance.

Key sources on techniques and approaches to consultation on local traffic issues are: Main Roads WA (1990: Appendices D and E) and Noyes (1999). The broader tools and processes for consultation are discussed in Government of WA (2002).

5.2 Objectives and Benefits of Community Consultation in the LATM Process

The overall purpose of community participation is to implement an LATM scheme that meets the technical requirements while at the same time satisfying community concerns and wishes. Experience has demonstrated that where the community is consulted and involved in the development of an LATM scheme, the effectiveness of the scheme is improved, otherwise unforeseen impacts are avoided, and acceptance of the scheme by residents is far more likely.

Community consultation is required for two principal reasons. Firstly, LATM is primarily for the benefit of the local community. Therefore their concerns and preferences must be considered. Secondly, the resulting LATM scheme or specific traffic control devices can have a direct impact on residents, in some cases causing them inconvenience or possibly increasing traffic volumes on some streets. Only through on-going consultation are residents likely to understand and accept any undesirable effects and consequently accept the scheme.

Successful implementation of an LATM scheme may in fact hinge more on the process by which it is developed rather than the actual scheme that results. If residents have not been made aware of the problems the scheme is attempting to resolve, the objectives it is attempting to achieve, or the alternatives that were considered and rejected, they may focus on the more obvious inconveniences it may cause or consider the proposal as unnecessary and a waste of ratepayers' money. Their involvement in preparing the scheme can provide this awareness. Main Roads WA (1990, p. 19).

The broad objectives (and benefits) of a participation program have been listed as follows (Main Roads WA 1990, p. 179):

- To establish better community understanding of the purposes, constraints and potential effects of LATM, the issues involved and to a lesser extent the planning procedures leading to an LATM scheme (i.e. educating the community, or information dissemination). This includes acquainting conflicting groups within the community of each other's viewpoint and explaining trade-offs.
- To create greater understanding among the responsible professionals of local characteristics, needs and aspirations (educating the professionals, or information gathering). Since problems may be overlooked or perceived differently by the practitioners, community participation invariably improves the quality and range of information available for making decisions.
- To provide an opportunity for community representation in the development and evaluation of alternative solutions, thereby producing the best possible plan and gaining support and commitment to implementation of the selected plan.
- To predict and resolve potential conflict and achieve equitable solutions. Although conflict may be over a few minor points, it can easily become the focus of attention and could threaten the whole outcome.
- To allow the community to share the decision-making in local matters as a means of improving relations between council and the community.

Community participation may start even before a decision has been made to consider an LATM study. Opportunities for participation occur at all stages of the LATM planning and investigation process, as shown in Table 5.1. The stages of the process relate to the headings used in Section 3.

Throughout the process, elected representatives, appointed local committees, and council staff have various roles to fulfil.

The roles of the various participants in the consultation process may include the following:

Elected representatives – municipal

- provide historical context and continuity between projects
- identify and involve key community individuals (opinion leaders)
- identify issues of concern to council
- obtain political support for the plan
- make the final formal decisions
- obtain funding for the plan implementation.

Elected representatives – parliamentary

- assist with wider political and policy support
- assist with funding from state sources, where available
- help to promote legislative change if needed.

Local committees

- present neighbourhood concerns, help to identify problems
- provide local knowledge, perhaps facilitate supplementary data collection
- create formal and informal personal links between the community, elected representatives and staff
- provide reactions to plans to assist in scheme development.

Table 5.1: Community participation at each stage of the LATM process

Planning stage	Objectives of community participation at each stage
Stage 1: **Initiating an LATM program**	Seek input on needs and priorities. Obtain participation on wider planning policies to provide framework for LATM. Provide for community involvement in council's processes generally, including inputs from area and special interest groups.
Stage 2: **(a) Data collection and problem identification**	Inform the community that an LATM study is under way. Inform residents of scope of study and general nature of LATM. Identify community concerns and problem perceptions. Identify outstanding data requirements. Establish needs of special interest groups and users. Familiarise community with overall issues and problems. Assess and prioritise points of concern/conflict.
(b) Establishing objectives for the LATM scheme	Determine community priorities for objectives of an LATM scheme. Inform community of final objectives to be achieved. Obtain general agreement on objectives.
Stage 3: **(a) Generating alternative LATM plans/strategies**	Inform community of constraints on alternatives (technical, financial and legal). Obtain ideas and suggestions from the community. Obtain community reactions to draft alternatives. Identify and resolve points of conflict. Select set of technically-acceptable alternatives.
(b) Selecting and refining the final plan	Advise community of alternatives under consideration. Obtain the community's response to the alternatives. Draw out 'silent' residents. Determine compromises/trade-offs. Weigh up support and prioritise alternatives. Build consensus and commitment for a single plan. Inform community of selected plan.
Stage 4: **Final design**	Consult with residents adjacent to proposed traffic control devices to identify any constraints.
Stage 5: **Implementing the scheme**	Notify community of proposed works and interim impacts. Seek community cooperation during construction. Learn of unforeseen site-specific installation problems.
Stage 6: **Monitoring and evaluation**	Obtain community perceptions of built scheme. Learn of unanticipated undesirable impacts. Inform community of level of technical success of scheme.

Source: Based on MRWA (1990, Table D1).

Council staff

- facilitate the process
- provide expertise and advice regarding potential LATM solutions
- draft the study terms of reference
- assemble all previous documentation on traffic issues in the area
- provide historical, legislative and regional contexts to the local issues
- manage the consultant (if applicable)
- identify the constraints and framework set by local planning schemes and transport plans
- provide a communication link with elected representatives
- bring knowledge and experience with LATM locally and in other places
- ensure all the required statutory inputs and advisory steps take place
- ensure compatibility with neighbouring conditions and plans
- provide reports and recommendations to council for decisions
- implement and monitor the plan.

5.3 Basic Requirements for Community Participation

The form of participation will vary from community to community, depending on local expectations and the complexity of local issues. Traffic engineering literature provides pointers on what to do and what to avoid when defining and implementing a community participation process (e.g. Main Roads WA 1990, p. 181; Noyes 1999). There are basic considerations that should be common to every approach:

- The consultation process should be continuous, from the very beginnings of the study when problems are brought to attention, through to the post-installation monitoring period. The nature of the process may, however, change through the process, according to the needs of the study at each point.
- The process should be outcome-driven. If all parties are not enthusiastically supporting a given proposal, explore other ways to achieve the desired outcomes.
- Identify all relevant stakeholders at the start, and make sure they are included when appropriate.
- Participation should be embraced enthusiastically as a means to improve outcomes, not be grudgingly undertaken as an obligation.
- The information presented needs to be understandable.
- Trade-offs and impacts should be explained. Most options will involve both direct and secondary impacts, some of which may be adverse.
- Good, two-way communications, exploiting all appropriate media, must be maintained.
- Contact personnel – both council and its agents, and those representing community groups – need to be identified.
- Community participants must have the confidence that their views are being heard and given proper consideration.
- The practitioner has a key role to play in contributing judgement and information when needed.
- Council and its staff must be alert to when it is important to step back and let the community speak, and when it is time to provide responses and information.

- In particular, elected representatives may be best advised not to take a leading role in the formulation of schemes, but rather to act as facilitators of the participation process and otherwise remain separate from the process until it is time to make a decision.
- It is quite important that council technical staff provide the community and elected representatives with advice on the most appropriate technical solution taking into consideration the input received.

Additional source material and more detail on this topic can be found in: Ewing (1999a, pp. 164-8); Pak-Poy and Kneebone (1987: Chapter 5); Transportation Association of Canada (1998: Chapter 2). Additional guidance is provided in Commentary 17.

[see Commentary 17]

5.4 Potential Difficulties

There are some potential difficulties with community participation that the practitioner needs to be aware of and accommodate in the LATM process, such as the following (based on Main Roads WA (1990, p. 182)):

- Community participation demands additional time and resources. These should be budgeted for as part of the costs of the program and should result in better and more acceptable plans.
- The planning process and the decisions are exposed to public scrutiny. This means that there will be a greater demand for detailed information, and the practitioner has to explain or justify technical statements and judgements. While this may sometimes leave the practitioner feeling criticised and harassed, it could be expected to lead to a better-informed and more acceptable outcome.
- The scope for those more active and better-organised community groups to unduly influence the outcome is increased. This is less likely if the participation program encourages the more passive and unrepresented groups in the community also to provide input. Well-prepared but minority cases should not be allowed to have undue weight in the decision process.
- Some members of the community and perhaps even council may have unrealistic expectations of a community involvement program, believing that all conflict will be resolved. This may lead to disillusionment with the process in the community if disagreement remains, and a feeling among some councillors that LATM causes too much trouble. Community participation in LATM must be embarked upon with realistic and clearly stated expectations about the likelihood that some will take longer than others to come to accept the outcome.
- There is often conflicting input into the decision-making process. Decisions may be harder to make – but the end result should be more durable.
- Practitioners need to accept the validity of non-professional input, particularly on non-technical matters and the problems experienced or foreseen by residents in their living environments. Lay people may not always be able to come up with solutions, but they are generally experts on at least some aspects of the problems, and they are as familiar with the local area as are the practitioners.
- Practitioners should be particularly alert to the ‘myth of technically compelling solutions’ (Noyes 1999), which has its root in the belief that there is one superior solution to any problem. Even technically simple solutions to apparently simple problems may run into trouble with the community, and may have benefited from community input.

Despite these difficulties, the alternatives are likely to be worse: a well-conceived proposal may be rejected, or at least have difficulty in being implemented, if those affected feel they have not been adequately involved. Even a decision not to proceed with an LATM response to a traffic issue will require community involvement, because there has to be some form of agreement that the problem is either not as bad as previously thought, or can be dealt with in some other way, or simply that those affected can live with it.

5.5 Who Should be Involved?

Those who wish, or need, to be involved in an LATM study in one way or another will include:

- residents and property owners in streets that are or will be subject to changes
- residents and property owners in streets that feed into the streets to be changed
- residents of streets that may be subjected to displaced traffic
- other ratepayers who may feel disadvantaged (either in terms of equity or because they may believe that the project will reduce their mobility)
- local traders who may be affected
- local schools
- existing residents groups in the area
- local bicycle representative groups
- police, fire, and ambulance agencies
- adjacent municipalities
- bus operators in the area
- anti-traffic-control lobby groups
- state traffic and road safety agencies.

The geographic and interest spread of the participants may sometimes be a delicate matter. A judgement will need to be made as to which of the above are to be included in the participation process in a given study, and to what extent. Experience has shown that it is possible to allow a process for input from a wide range of people, some of whom may not be directly affected by the proposals, without necessarily involving them all in the development of alternatives and decisions about them.

In making this decision, consideration should be given to the relative merits of including the following types of groups in the decision-making and consultation process, and the degree to which each may be allowed to influence the outcomes:

- those affected by the present problems (e.g. residents in the problem streets, and cyclists' groups)
- those who may be disadvantaged by the proposed remedies, with little or no flexibility to avoid this disadvantage (e.g. residents in feeder or parallel streets, traders, bus operators, cyclists' groups)
- those who claim disadvantage but who can make choices to avoid it (e.g. 'rat-runners', overspill parkers)
- those with statutory responsibilities in the study area (e.g. state traffic and safety agencies)
- providers of emergency services
- other (commercial) service providers, especially large vehicle operators
- lobby and special interest groups.

LATM is not a 'democratic' matter in the sense that everyone has a right to have a vote on it, for at least two reasons. The opinions of those within the area directly under study could easily be swamped by those of people through the rest of the municipality, and their representatives on council. Furthermore, even within the study area, a truly equitable decision may mean that the needs of a small number of people who are likely to suffer most from whatever actions (or inaction) occur may outweigh the needs of the majority in the study area. Making this judgement rests ultimately with council.

Additional guidance is provided in Commentary 18.

[see Commentary 18]

6. Legal Aspects and Duty of Care

The legal responsibilities of practitioners fall into three broad categories:

- fulfilling statutory duties (where these **exist**) and statutory powers
- recognising/protecting the rights and responsibilities of road users and land owners
- fulfilling a generic (civil law) duty of care to road users.

With regard to LATM, legislation covering the powers and responsibilities varies between jurisdictions, and road agencies will need to carefully consider their obligations under any special approvals processes that may apply in their area.

In operational terms, the main legal concern relating to LATM (as in all management of the road system) has been **perceived** risk of litigation in the event of damage or injury sustained by a road user, where it is often alleged that the road agency has been negligent and failed in its duty of care.

However, the principle of LATM is well founded and the vulnerability of road agencies is often overstated. For example, it is reasonable to conclude that as a road agency looks to speed reduction measures to improve safety and reduce risk, that appropriately designed and implemented devices would improve overall safety. This conclusion is also based on the assumption that an informed driver will adopt behaviour consistent with that required or indicated by the altered road environment.

The test applied to road agency decisions and actions is one of reasonableness, i.e. if the road agency is able to demonstrate that it has reasonable systems in place when compared to peers (kindred organisations) and implements them and subsequent measures consistently, as well as making reasonable decisions based on the knowledge it has available at that time, then its potential liability (vulnerability) in a given situation is typically much reduced. It is also reassuring that a raft of changes to civil liability legislation around 2002–03 and fine tuning since have gone a long way to clarifying the obligations and liabilities of the road agencies in each jurisdiction.

Notwithstanding, it remains the case that actions brought against road agencies with respect to LATM tend to arise more from on-going maintenance issues at a specific site, rather than its design, detailing and introduction per se (although it should be noted that the consistency of introduction of a number of such treatments throughout a route or region may become of interest). Where faulty or inappropriate design is claimed, it tends to be for items such as inadequate stopping sight distances and poor sign placement, rather than the choice of the devices themselves. This emphasises the need for practitioners to apply their knowledge, skills and experience in following sound engineering design practices when inserting any treatment into a roadway.

Road agencies can improve the consistency of their performance and the outcomes achieved, and hence reduce their vulnerability to litigation by taking the following steps:

- Providing their officers with an awareness of infrastructure-related liability issues through training workshops or other knowledge transfer activities.
- Developing a policy that clearly states the support and reasons for the installation of LATM measures in principle and is widely disseminated.
- Conducting a thorough and well-documented (reasonable) **process** for each LATM scheme, including the need, objectives, alternatives considered (including the precedents set by provision at other sites), key decisions, effects anticipated, and the consultation undertaken.

- Being aware of Australian and New Zealand standards and Austroads guidelines (including generic professional standards of practice in basic traffic engineering: sight distances, delineation, signs, etc.) when designing schemes. It is important to prepare and retain documentation on the design process, stating which standards and guidelines have been used, fine-tuned or not used, and how they have been considered locally for the site of interest. It is especially important to maintain a record of where any deviation occurs from the recommendations and/or requirements of technical standards and guidelines, and why deviation has been considered necessary. This is because in legal proceedings where the road agency cannot demonstrate which standards and guidelines have been considered and applied with respect to the local site and its unique characteristics then national/good/best practice documents will be viewed as the 'default' position and therefore, be a very good indicator of what the court will consider reasonable when assessing the case.
- Considering the **responses and behaviour** of reasonable drivers exercising ordinary care, and all other users of the street (including all groups who are mobility impaired).
- Considering how the proposed improvement will contribute to a Safe System at a location.
- Undertaking progressive **road safety audits** as part of a risk management strategy (*Guide to Road Safety Part 6)* provides further detail*.*
- Clearly and consistently **signing and marking measures** according to prevailing standards and practices in each jurisdiction. The design, form, signs and delineation of each treatment should clearly indicate both the presence and nature of the device, and communicate what is required of the road user. Again, where any deviation to prevailing standard and practices of the agency occurs, the deviation and the reason for it should be documented.
- Adequately **monitoring measures** after installation to identify potential risks, and modifying them if necessary to avert the danger. Where this is not immediately possible road users should at least be warned of the hazard. It should be clearly stated and understood who is responsible for the monitoring process and how and when it will be undertaken and recorded.
- Regularly **maintaining measures** to ensure that the scheme can continue to meet its objectives and that none of their features have deteriorated or been damaged to a state where they may have become unclear or dangerous (note that the agency is likely to have intervention levels/standards as a part of its network management/maintenance regime).
- Timely and reasonable attendance to known and reasonably foreseeable risks.
- Taking reasonable care to ensure that the scheme does not create, or contribute to, a foreseeable risk of harm to road users.
- Sufficiently **documenting** the key stages in the process and the reasons for decisions reached, to help demonstrate due care and competence.

A reasonable effort should be made to anticipate the speed effects of the installation through the application of Safe System and speed-based design principles, and the likely approach speeds at each device by a reasonable driver relative to the operating speed of the device, i.e. the speed differential. Given what is known about the tendency for speeds between widely-spaced devices, and the cautions in the literature (including AS 1742.13) against widely-spaced and isolated devices, practitioners are advised to exercise great care in locating and installing obstructive devices significantly further than 120 m from any other device or other slow-speed point in the street.

In New Zealand, road agencies do not typically come under the same scrutiny for their actions as their Australian counterparts, due to differences in civil liability legislation. However, a safety management system has been introduced and the Safe System adopted to ensure that safety is considered in all network management activities. Risk management can range from simple review processes through to highly complex and formalised procedures. The responsible agency and its professional officers must decide what is the appropriate type and level of risk management to apply in each case.

Further background and detail on this topic can be found in the Austroads (2012) *Managing Asset Management Related Civil Liability Risk*.

7. Selection of LATM Devices

7.1 LATM Device Toolkit

There are a range of LATM devices that can be used for different purposes and situations.

Figure 7.1 includes a list of LATM devices in common use by local government authorities in Australia and New Zealand, ranging from the most commonly used device and descending to the least commonly used device. This information provides a good indication of the popularity and breadth of application of different LATM devices, and may be useful as a measure of the amount of experience within the industry in their design and construction. It should be highlighted that the frequency of use of particular devices should not be a major determinant in the selection of an LATM device for a specific location. Instead, each treatment should be assessed for its effectiveness and appropriateness for the situation in which it is being used, as part of a whole of street or whole of area wide implementation.

Figure 7.1: LATM devices commonly used by local governments

Most commonly used

Least commonly used

Stop or give-way sign
Standard roundabout
Speed limit sign
Lane narrowing/kerb extension
Bicycle facilities
School zone
Threshold treatment
Road cushion
Flat-topped road hump
Bus facilities
Centre blister island
Mid-block median treatment
Road hump
Left-in/left-out islands
Prohibited traffic movement sign
Marked pedestrian crossing
One-way street sign
Tactile surface treatment
Wombat crossing
Modified T-intersection
Slow points
Mini-roundabout
Shared zone/local area traffic sign
Shared zone
Dedicated cyclist crossing
Cycle/pedestrian friendly roundabout
Raised intersection platform
Mid-block raised pavement
Full road closure
Driveway link
Other
Half road closure
Diagonal road closure

Source: Damen and Ralston (2015).

Table 7.1 lists each device in the LATM toolkit and outlines their relative uses based on previous research and current Australian and New Zealand practice.

Table 7.1: Description and use of LATM devices

Measure		Reduce speeds	Reduce traffic volume	Reduce crash risk	Increase pedestrian safety	Increase bicycle safety
Vertical deflection devices (Section 7.2)	Road humps	✓	✓	✓	–	–
	Road cushions	✓	✓	✓	–	✓
	Flat-top road humps	✓	✓	✓	–	✓
	Wombat crossings	✓	✓	✓	✓	✓
	Raised pavements	✓	✓	✓	–	✓
Horizontal deflection devices (Section 7.3)	Lane narrowings/kerb extensions	✓	–	–	✓	–
	Slow points	✓	✓	–	–	–
	Centre blister islands	✓	✓	–	✓	–
	Driveway links	✓	✓	–	✓	✓
	Mid-block median treatments	✓	–	✓	✓	✓
	Roundabouts	✓	✓	✓	–	–
Diversion devices (Section 7.4)	Full road closure	–	✓	✓	✓	✓
	Half road closure	–	✓	✓	✓	✓
	Diagonal road closure	–	✓	✓	✓	✓
	Modified T-intersection	✓	✓	✓	✓	✓
	Left-in/left-out islands	–	✓	✓	✓	–
Signs, linemarking and other treatments (Section 7.5)	Speed limit signs	✓	–	✓	✓	✓
	Prohibited traffic movement signs	–	✓	✓	–	✓
	One-way (street) signs	–	✓	✓	✓	–
	Give-way signs	✓	✓	✓	✓	✓
	Stop signs	✓	✓	✓	✓	✓
	Shared zones	✓	✓	–	✓	✓
	School zones	✓	–	✓	✓	✓
	Threshold treatments	✓	✓	✓	–	✓
	Tactile surface treatments	✓	–	–	–	–
	Bicycle facilities	–	–	✓	–	✓
	Bus facilities	–	✓	–	–	–

Guidance on the advantages/disadvantages and application of each commonly used device in the LATM toolkit to address specific problems and issues is given in the following sections. Additional information on the speed and safety impacts of some of these devices is given in Commentary 21.

[see Commentary 21]

Nomenclature used to describe the different devices and their component parts varies quite considerably across Australia and New Zealand. To overcome this issue, the terminology adopted by the Australian Standard has generally been applied, but not exclusively so.

It should be noted that linemarking and signs shown in the New Zealand examples included in this section may not be consistent with Australian Standards or practice. Likewise, the Australian examples that have been used may not be consistent with New Zealand Standards or practice. In all cases the Standards and practices applicable in the relevant jurisdiction should be observed.

7.2 Vertical Deflection Devices

Vertical deflection devices force vertical changes in the ride alignment or travel path of a vehicle introduced as the result of a physical feature of a roadway. This deflection generally achieves a reduction in vehicle speeds as drivers attempt to avoid discomfort when travelling over the LATM measure. As a general rule LATM devices should not be placed at locations on roads with a longitudinal gradient of more than 10%. Refer to Section 8.6 for more information on gradients.

7.2.1 Road Humps

Description of road humps

A road hump is a speed reduction device in the form of a raised curved profile extending across the roadway. Road humps are typically 70 to 120 mm high with a total length of 3 to 4 m. On bus routes and cycle routes a hump height of 75 mm or less and a hump length of at least 3.7 m is recommended. The two main types of road hump are the sinusoidal profile hump and the Watts profile hump. The sinusoidal profile hump is more sympathetic to cyclists while the Watts profile hump has greater effect on drivers. The typical dimensions of the two different profiles are illustrated in Figure 7.3.

Careful consideration should be given to the location and design of road humps before committing to their implementation as they are the most often complained about device currently used in Australasia (Damen 2003; 2007). Vehicle speeds can be significantly reduced when they are correctly placed and designed. They should be installed at right angles to the direction of travel and should extend as close to the kerb as possible allowing sufficient opening for drainage. Road humps should be clearly visible to approaching drivers, illuminated by adequate street lighting, and enhanced by the use of signs, pavement markings, and other delineation. Road humps are a whole-of-street treatment and more than one road hump may be needed where speed reduction is required over the entire length of the street. The spacing of further road humps should be as uniform as possible allowing for side roads and vehicle crossings. Spacing of devices should not be less than 80 m and generally not more than 120 to 150 m. Consideration also needs to be given to maintaining drainage paths and providing bypasses for bicycles.

Temporary road humps can also be employed as a short-term measure during special events or to temporarily modify traffic patterns. This practice should be adopted with care because temporary treatments are often unexpected and may introduce additional safety problems (refer to Section 3).

Austroads (2009b) suggests that road humps produce an 85th percentile speed reduction of 45% at the treatment and 21% at the midpoint between treatments.

[see Commentary 19]

Application of road humps

It is appropriate to use road humps:

- where there is a need to reduce vehicle speeds
- where there is adequate street lighting to maximise visibility
- at mid-block locations
- on streets with relatively low traffic volumes
- on streets with a low speed environment (less than 60 km/h).

It is inappropriate to use road humps:

- on streets without adequate street lighting
- where property access may be significantly affected
- on bends or crests or other locations where sight distance is insufficient
- at intersections
- on bus and designated cycle routes unless an acceptable sympathetic design is used
- on streets with a high commercial traffic content (unless the aim is to divert this type of traffic)
- where access by emergency vehicles would be adversely affected.

Advantages of road humps

The advantages of road humps include:

- a significant reduction in vehicle speeds in the vicinity of the device
- a significant reduction in road crashes
- their relatively low cost to install and maintain
- they discourage through traffic
- when used in a series they regulate speeds over the entire length of the street
- they can be designed to limit discomfort to cyclists.

The effectiveness of road humps can be increased when used in combination with:

- kerb extensions/lane narrowings
- median treatments.

Disadvantages of road humps

The disadvantages of road humps include:

- traffic noise level may increase just before and after the device due to braking, acceleration and the vertical displacement of vehicles (Bendtsen & Larson 2001)
- they may divert traffic to nearby streets without LATM measures
- they are uncomfortable for vehicle passengers and cyclists
- they may adversely affect access for buses, commercial vehicles and emergency vehicles
- they can impact on passenger comfort when used on bus routes.

[see Commentary 17]

Examples of road humps

Examples of road humps are shown in Figure 7.2. Typical dimensions for sinusoidal and Watts profile humps are given in Figure 7.3.

Figure 7.2: Examples of road humps

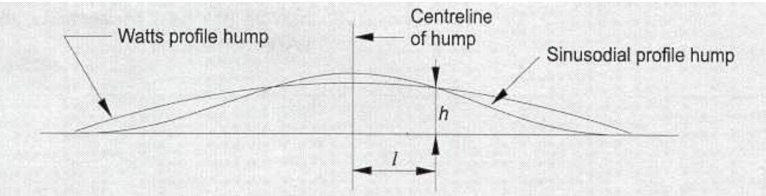
City of Bayside, Victoria

City of Christchurch, New Zealand

City of Vincent, Western Australia

City of Yarra, Victoria

Figure 7.3: Typical dimensions of the different profile road humps



l (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
h (mm)	100	100	99	97	95	93	90	86	81	76	71	65	58	51	43	34	25	16	5

(b) Watts profile hump

Note:

1. At ramps at entry points to shared zones the ramps grade is increased to between 1:2 and 1:4.

l (m)	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.7
h (mm)	120	116	104	87	66	44	24	9	1	0

(c) Sinusoidal profile hump
(Bicycle facility)

Source: VicRoads (2014).

7.2.2 Road Cushions

Description of road cushions

A road cushion is another form of road hump that occupies only a part of the roadway. It is designed to be more sympathetic to cyclists, buses, and commercial vehicles than a standard full-width road hump.

Road cushions should have minimum gaps of 750 mm between the base of the cushions and kerb and also between adjacent cushions to accommodate cyclists, etc. Cushions should generally be constructed 3.0 m long and 1.6 to 1.9 m wide with a height of 70 to 80 mm. The narrower 1.6 m wide cushions are generally more acceptable on bus routes (to allow buses to straddle the cushions) but are likely to be less effective in reducing the speed of cars than the wider versions.

Road cushions can also be employed as a short-term measure during special events or in roadworks zones. As with the application of temporary road humps, the practice of using these devices as temporary treatments should be adopted with care because their use may be unexpected and it may introduce additional safety issues (refer to Section 3).

The most common forms of road cushion are those made from moulded rubber segments but they can also be constructed from other material such as concrete or asphalt. In all cases the colour of the cushions should contrast with the adjacent street surface. Where linemarking is used for this purpose it should be consistent with relevant Australian and New Zealand standards.

Application of road cushions

It is appropriate to use road cushions:

- where there is a need to reduce vehicle speeds
- where there is adequate street lighting to maximise visibility
- at mid-block locations
- on streets with relatively low traffic volumes
- on streets with a low speed environment (less than 60 km/h).

It is inappropriate to use road cushions:

- on streets without adequate street lighting
- where property access may be significantly affected
- on bends or crests or other locations where sight distance is insufficient
- at intersections
- where access by emergency vehicles would be adversely affected.

Advantages of road cushions

The advantages of road cushions include:

- a reported 27% reduction in 85th percentile vehicle speeds in the vicinity of the device
- when used in a series they regulate speeds over the entire length of the street
- they are relatively low cost to install and maintain
- they discourage through traffic
- they do not restrict or discomfort cyclists
- they can be designed so that they do not inconvenience buses, commercial vehicles, etc.

Disadvantages of road cushions

Some disadvantages of road cushions include:

- the traffic noise level may increase just before and after the device due to braking, acceleration and the vertical displacement of vehicles and their goods
- they are less effective in slowing vehicles with a wide track
- they are less effective in slowing motorcyclists
- they can prevent cyclists using kerbside gaps on on-street parking
- drivers can reduce their effect by traversing the cushions with only two wheels.

Examples of road cushions

Examples of road cushions are illustrated in Figure 7.4.

Figure 7.4: Examples of road cushion

City of Gold Coast, Queensland

City of Banyule, Victoria

City of Banyule, Victoria

City of Marion, South Australia

7.2.3 Flat-top Road Humps

Description of flat-top road humps

A flat-top road hump or raised table is a raised surface approximately 75–100 mm high and typically with a 2 to 6 m long platform ramped up from the normal level of the street. The raised section (or platform) is flat instead of being curved as is the case with a (round profile) road hump described in Section 7.2.1. Where it is acceptable to install this device on bus routes, a minimum platform length of 6 m, a platform height of 75 mm, and a ramp gradient of 1:20 is recommended. Where the platform extends more than 6 m in length the device is likely to function as a raised pavement (see Section 7.2.5).

Devices should be clearly visible to approaching drivers, illuminated by adequate street lighting, and enhanced by the use of signs, pavement markings, and other delineation. They should be installed at right angles to the direction of travel and should extend as close to the kerb as possible allowing sufficient opening for drainage. Flat-top road humps are a whole-of-street treatment and more than one device may be needed where speed reduction is required over the entire length of the street. The spacing of further devices should be as uniform as possible allowing for side roads and vehicle crossings. Consideration also needs to be given to providing bypasses for bicycles where the situation warrants it. Flat-top road humps with ramp gradients of 1:15 to 1:20 are generally regarded as bicycle friendly.

It should be noted that the sharper the ramp gradients and the higher the platform used, the greater the speed-reducing impact of the device. Any easing of ramp gradients to be more sympathetic to bicycles and buses may need to be balanced against the extent of speed reduction that is required.

Care needs to be taken not to locate flat-top road humps in the vicinity of pedestrian thoroughfares, as pedestrians may incorrectly perceive the presence of such a device as a pedestrian crossing. Kerb ramps and pedestrian refuges should not be incorporated in the design and pedestrian footpaths should be physically separated from the device through the application of landscaping or other means. Use of special colours on the platform may also be inappropriate where priority is unclear. Where the design of flat-top road humps cannot meet these requirements, e.g. at intersections, alternative options should be considered that better cater for the pedestrian crossing function. Refer to the sections on pedestrian crossings, threshold treatments, and wombat crossings for more guidance.

Brick pavers are the most common form of material for platform construction although coloured asphalt is also often used. In either case, the surface treatment should contrast with the adjacent road-building material and be linemarked in accordance with relevant Australian and New Zealand standards to increase the visibility of the device. It is desirable that ramps are constructed from concrete to minimise shoving, scraping, and other surface deformation although asphalt is also suitable.

Austroads (2009b) suggests flat-top road humps produce an 85th percentile speed reduction of 24% at the treatment.

Application of flat-top road humps

It is appropriate to use flat-top road humps:

- where there is a need to reduce vehicle speeds
- where there is adequate street lighting to maximise visibility
- at mid-block locations
- on streets with relatively low traffic volumes
- on streets with a low speed environment (less than 60 km/h).

It is inappropriate to use flat-top road humps:

- on streets without adequate street lighting
- where property access may be significantly affected
- on bends or crests or other locations where sight distance is insufficient
- at intersections (see Section 7.2.5)
- on bus and designated cycle routes unless an acceptable sympathetic design is used
- on streets with a high commercial traffic content (unless the aim is to divert this type of traffic)
- where access by emergency vehicles would be adversely affected
- on undivided streets wider than two lanes
- where there are high volumes of pedestrians (i.e. a thoroughfare) and priority is unclear.

Advantages of flat-top road humps

The advantages of flat-top road humps include:

- a significant reduction in vehicle speeds in the vicinity of the device
- a significant reduction in road crashes
- they are relatively low cost to install and maintain
- they may discourage through traffic
- when used in a series they regulate speeds over the entire length of the street
- they can be designed to limit discomfort to cyclists.

The effectiveness of flat-top road humps can be increased when used in combination with:

- kerb extensions/lane narrowings
- median treatments.

Disadvantages of flat-top road humps

The disadvantages of flat-top road humps include:

- the traffic noise level may increase just before and after the device due to braking, acceleration and the vertical displacement of vehicles and their goods
- they may divert traffic to nearby streets without LATM measures
- they are uncomfortable for vehicle passengers and cyclists
- they may adversely affect access for buses, commercial vehicles and emergency vehicles.

Examples of flat-top road humps

Examples of flat-top road humps are illustrated in Figure 7.5. Typical dimensioned details are given in Figure 7.6.

Figure 7.5: Examples of flat-top road humps

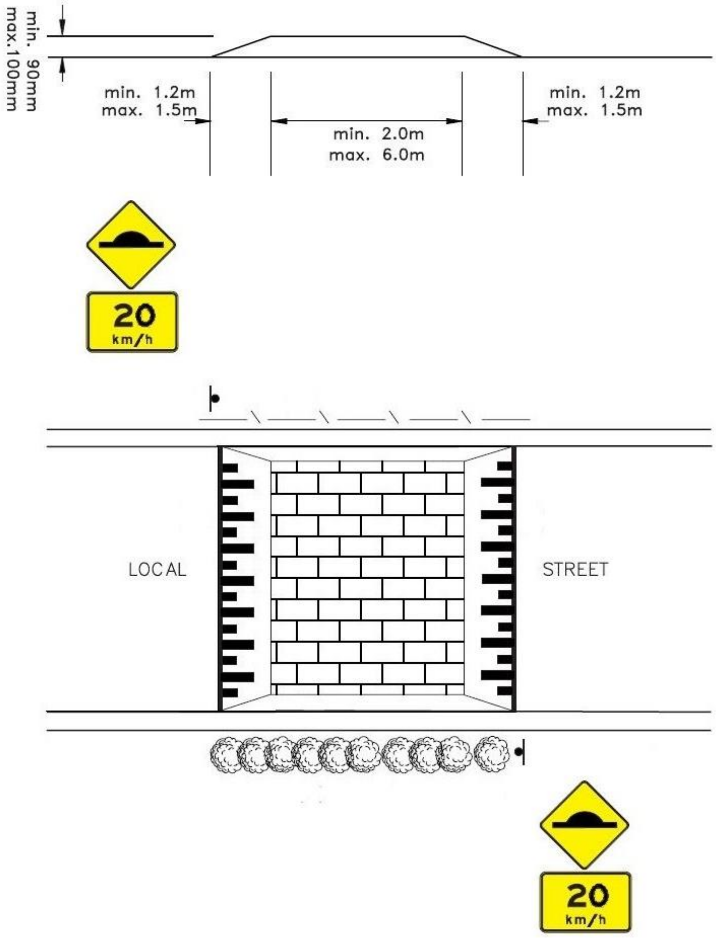
City of Christchurch, New Zealand

City of Gold Coast, Queensland

City of Hobart, Tasmania

City of Brisbane, Queensland

Figure 7.6: Indicative dimensions of a flat-top road hump



Source: Based on AS 1742.13 – 2009 and RTA (2011).

7.2.4 Wombat Crossings

Description of wombat crossings

Wombat crossings are generally of the form of flat-top road humps with a pedestrian crossing on the raised flat surface and in some jurisdictions flashing amber lights. Although similar to a flat-top road hump, wombat crossings give priority to pedestrians while flat-top road humps do not. While wombat crossings may be installed at locations where there is a need to give pedestrians priority to safely cross the road, in the context of LATM, they should always be installed as part of a whole of street treatment.

The minimum length of the device **including ramps** is 6 m (platform = 3.6 m long) and the desirable height of the platform is 100 mm. Where it is acceptable to install this device on bus routes, a minimum 9 m long device (platform = 6 m long), a 75 mm high platform, and ramps with a gradient of 1:20 are recommended. Where buses do not regularly use a street, and it is acceptable to bus operators, a higher (e.g. 100 mm) and a shorter platform may be justified (e.g. 4.5 m long). Wombat crossings with ramp gradients of 1:15 to 1:20 are generally regarded as bicycle friendly.

It should be noted that the sharper the ramp gradients and the higher the platform used with the device the greater the speed-reducing impact. Any easing of ramp gradients to be more sympathetic to bicycles and buses may need to be balanced against the extent of speed reduction that is required.

Kerb extensions and/or mid-block islands should be considered where lane widths are in excess of 4 m to increase pedestrian visibility and decrease exposure time. Devices should be clearly visible to approaching drivers, illuminated by adequate street lighting, and enhanced by the use of signs, pavement markings, and other delineation. Both side ramps should be delineated with piano markings in Australia whereas in New Zealand white triangles are used. Care needs to be taken to ensure that the height of the platform is consistent with the height of the adjacent footpath and is flush for the full width so that tripping and swerving hazards are not introduced. Consideration also needs to be given to maintaining drainage paths and providing bypasses for bicycles where the situation warrants it.

A variation to the standard form of device is where an at-grade pedestrian crossing is installed (or retained) with two flat-top road humps placed at a set distance either side of the marked crossing. This variation creates a physical entry and exit treatment to the speed zone. It is predominantly used where sight distances to the marked crossing are poor and it is necessary to reduce the approach speeds of vehicles before they reach it. It is stressed that this form of treatment is not generally desirable and if other options exist that have the potential to address the problem (e.g. relocate the crossing or increase the sight distance) then they should be adopted in preference.

An important factor is the choice of materials. Brick pavers are a common platform construction material but it has been found that they do not provide sufficient contrast after a period of use for the crossing markings to be clearly seen. This is largely due to the movement of the pavers causing the accelerated deterioration of the markings. Consequently, black or coloured asphalt is a more effective contrasting material to the white paint used for the pedestrian crossing.

Application of wombat crossings

It is appropriate to use wombat crossings:

- where pedestrian crossings are needed
- where there is a need to reduce vehicle speeds at a pedestrian crossing
- on one-lane (one-way) and two-lane streets
- at mid-block locations, especially at or near schools
- on streets with low speed (less than 60 km/h) and traffic volume environments
- where there is adequate street lighting to maximise visibility.

It is inappropriate to use wombat crossings:

- on streets without adequate street lighting
- where property access may be significantly affected
- on bends or crests or other locations where sight distance is insufficient
- on bus and designated cycle routes unless an acceptable sympathetic design is used
- where access by emergency vehicles would be adversely affected
- on undivided streets wider than two lanes.

The effectiveness of wombat crossings as an LATM device can be increased when used in combination with kerb extensions/lane narrowings, median treatments, flashing amber lights, and other whole of street treatments.

Pedestrian crossing linemarking is essential requirements to legally define a wombat crossing. Refer to Australian Standard AS 1742 – Set: 2014 for specific guidance on the appropriate use of signs and linemarking for wombat crossings.

Advantages of wombat crossings

The advantages of wombat crossings include:

- a significant reduction in vehicle speeds and crashes
- a relatively low cost to install and maintain
- a possible reduction in traffic volumes due to lower speeds and longer travel times
- they may discourage through traffic
- they reduce vehicle-pedestrian conflicts
- they provide a designated crossing place for pedestrians.

Disadvantages of wombat crossings

The disadvantages of wombat crossings include:

- the traffic noise level may increase just before and after the device due to braking, acceleration and the vertical displacement of vehicles and their goods
- they may divert traffic to nearby streets without LATM measures
- they are uncomfortable for vehicle passengers and cyclists
- they may adversely affect access for buses, commercial vehicles and emergency vehicles
- they require more attention to road drainage.

Examples of wombat crossings

Examples of wombat crossings are shown in Figure 7.7. Typical dimensioned details are given in Figure 7.8.

Figure 7.7: Examples of wombat crossings

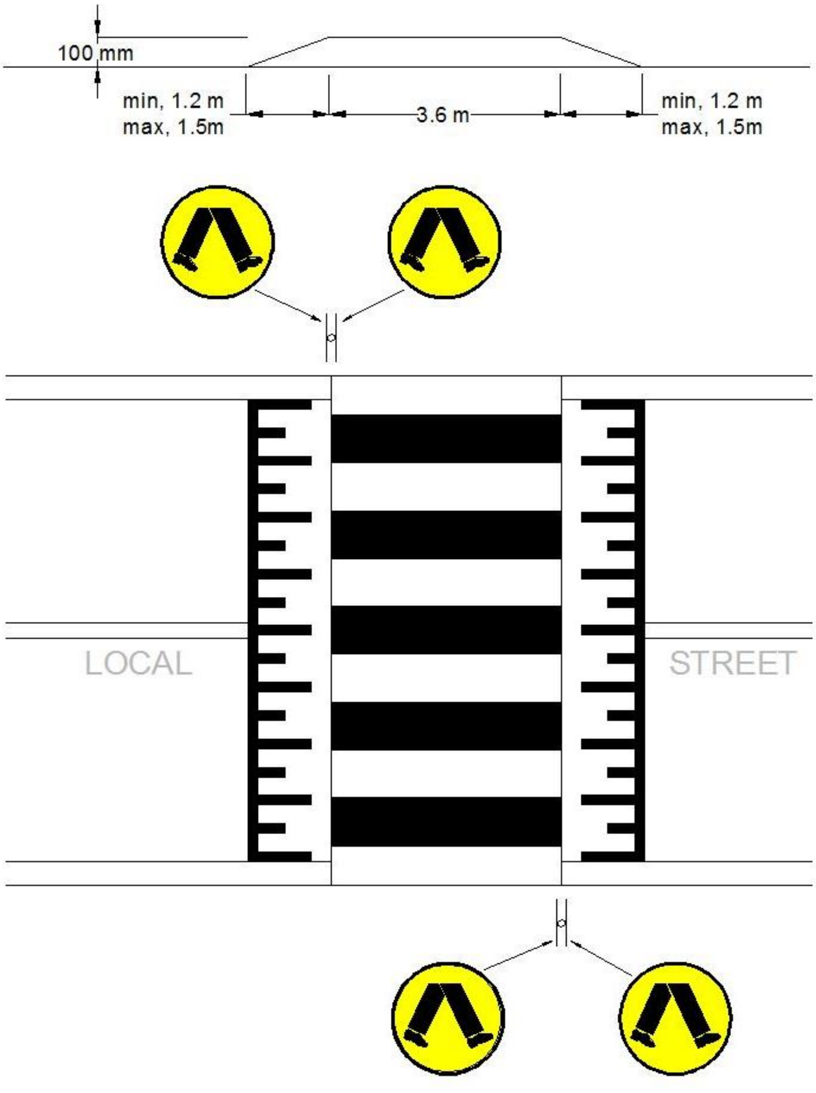
City of Knox, Victoria

City of Leichardt, New South Wales

City of Glenorchy, Tasmania

Brisbane Airport, Queensland

Figure 7.8: Indicative dimensions of a wombat crossing



Source: Based on AS 1742.13 – 2009 and RTA (2011).

7.2.5 Raised Pavements

Description of raised pavements

A raised pavement is a raised section of roadway approximately 90 to 100 mm high ramped up from the normal level of the street with a platform extending over more than a standard car length (at least 6 m but typically more). It can be located either mid-block or cover the entire intersection.

It differs from a flat-top road hump both in terms of dimension and functionality. The raised pavement is longer than a flat-top road hump and is different in that it allows a vehicle to bring both sets of wheels up onto the platform at the same time. Flat-top road humps have more of a pitching action as one set of wheels comes up onto the platform and the other set goes down; this does not occur with raised pavements. Instead, the vertical deflection is generally less severe. Consequently, speed reduction may not be as substantial as with flat-top road humps although the zone of influence may extend over a longer street section.

The extent of speed reduction that can be derived from this device is determined by the gradient and height of the ramp sections. A gradient of 1:12 is most commonly adopted in Australia and New Zealand. Steeper ramp gradients, which provide greater speed reducing benefits, can be employed. However, care should be taken to ensure that the ramp transition is not so severe that it will cause vehicles to bottom out. Raised pavements with ramp gradients of no more than 1:15 are generally regarded as bicycle friendly and 1:20 as bus friendly.

Similarly to flat-top road humps, raised pavements should be clearly visible to approaching drivers, illuminated by adequate street lighting, and enhanced by the use of signs, pavement markings, and other delineation. Consideration should be given to drainage paths but in doing so care should be taken that devices do not create a hazard for cyclists.

Where raised pavements are located at intersections, they should not extend into or beyond the throat of the intersection or across any other area where pedestrians would normally cross as they may incorrectly perceive the raised and/or coloured features of the device as giving them priority over vehicles. Kerb ramps and pedestrian refuges should be set back from the edge of this device a minimum of 1 m for the same reason.

The study by Webster and Layfield (1996) showed that there was little difference in the speed reduction effectiveness between 75 and 100 mm high raised pavements. Platform length was noted to have a small influence on speed, with speed being higher with a longer platform.

Application of raised pavements

It is appropriate to use raised pavements on streets:

- where there is a need to reduce vehicle speeds
- where there is adequate street lighting to maximise visibility
- on streets with a low speed environment (less than 60 km/h).

It is inappropriate to use raised pavements:

- on streets without adequate street lighting
- where property access may be significantly affected
- on bends or crests or other locations where sight distance is insufficient
- on bus and designated cycle routes unless an acceptable sympathetic design is used
- where access by emergency vehicles would be adversely affected
- on undivided streets wider than two lanes
- where there are high volumes of pedestrians (i.e. a thoroughfare) and priority is unclear.

Advantages of raised pavements

The advantages of raised pavements include:

- a significant reduction in vehicle speeds in the vicinity of the device
- they may discourage through traffic
- they can be used as a form of threshold treatment
- they can highlight the presence of an intersection
- when used in a series they will regulate speeds over the entire length of the street.

Disadvantages of raised pavements

The disadvantages of raised pavements include:

- the traffic noise level may increase just before and after the device due to braking, acceleration and the vertical displacement of vehicles and their goods
- they may divert traffic to nearby streets without LATM measures
- they are uncomfortable for vehicle passengers
- they may adversely affect access for buses, commercial vehicles and emergency vehicles
- they require care that ramp markings are not confused with intersection control markings when located at an intersection.

Examples of raised pavements

Examples of raised pavements are illustrated in Figure 7.9.

The following additional source material is recommended for reference on this topic: Austroads (2009b), Brindle et al. (1997), Smith et al. (2002) and Webster and Layfield (1996).

Figure 7.9: Examples of raised pavements

City of Subiaco, Western Australia *City of Gold Coast, Queensland*

City of Christchurch, New Zealand

City of Charles Sturt, South Australia

7.3 Horizontal Deflection Devices

Horizontal deflection devices are designed to change the horizontal course or path of a vehicle as the result of a physical feature of a roadway. This deflection generally discourages short-cutting or through traffic to a varying extent and may achieve a significant reduction in traffic volume, speed and conflicts.

Horizontal deflection devices should be clearly visible to approaching drivers, illuminated by adequate street lighting and enhanced by the use of signs and other linemarking if necessary. The manoeuvring of large vehicles should be determined by using relevant turning templates. Consideration needs to be given to maintaining drainage paths and where possible, providing bypasses for bicycles.

7.3.1 Lane Narrowings/Kerb Extensions

Description of lane narrowings/kerb extensions

Lane narrowings involve the narrowing of the trafficable carriageway to reduce speeds, improve delineation and to minimise pedestrian crossing distances (and therefore exposure to conflict). It is generally done by extending the kerbs inwards or via other forms of kerb modifications but it can also be achieved through the introduction of on-street parking. When designing these devices, careful consideration should be given to the need for bicycles to pass clear of the extension either adjacent to the traffic lane or via other means, taking into account the likely risks to cyclists, the demand for cycling at the treatment location, and issues relating to site constraints. Kerb extensions should be clearly visible by approaching drivers, illuminated by adequate street lighting and enhanced by the use of signs and road marking. Careful consideration should be given to maintaining drainage paths without creating a potential hazard to cyclists and pedestrians.

Application of lane narrowings/kerb extensions

It is appropriate to use lane narrowings/kerb extensions in:

- commercial areas
- low-speed residential environments.

It is inappropriate to use lane narrowings/kerb extensions:

- where the kerbside lane is required for traffic
- in locations with limited sight distance
- in streets without adequate street lighting
- where the narrowing is such that it will pose a difficulty to buses and cyclists on fixed routes.

The effectiveness of lane narrowings/kerb extensions can be increased when used in combination with:

- median treatments including splitter islands
- flat-top road humps/wombat crossings/raised pavements
- road humps/cushions
- roundabouts.

Advantages of lane narrowings/kerb extensions

The advantages of lane narrowings/kerb extensions include:

- a shorter crossing distance for pedestrians
- they may improve the visibility of pedestrians and vehicles
- a reduction in vehicle speeds, particularly on curvilinear alignments
- relatively low cost
- to delineate and protect parking spaces
- providing an opportunity for landscaping
- they have relatively little effect on emergency vehicles
- significantly less disruptive to local traffic than some other forms of LATM devices that are more severe in their design.

Disadvantages of lane narrowings/kerb extensions

The disadvantages of lane narrowings/kerb extensions include:

- they may reduce the amount of available kerbside parking
- bicycle lanes may be difficult to accommodate
- drivers may mistake an empty kerbside parking lane for a traffic lane
- they may introduce squeeze points and increase the conflict between motor vehicles and cyclists
- they are less effective than many other horizontal displacement devices in reducing speeds
- parking manoeuvres may be difficult on heavily trafficked streets
- they may increase congestion.

Examples of lane narrowings/kerb extensions

Examples of lane narrowings/kerb extensions are illustrated in Figure 7.10.

Figure 7.10: Examples of lane narrowings/kerb extensions

City of Yarra, Victoria

Town of East Fremantle, Western Australia

City of Glenorchy, Tasmania

City of Mitcham, South Australia

7.3.2 Slow Points

Description of slow points

A slow point is a series of kerb extensions on alternating or opposite sides of a roadway, which narrow and/or angle the roadway. Slow points are intended to reduce vehicle speeds. Slow points can be either one or two lanes wide and can be angled. In a two-lane slow point, a median island is generally very effective in separating opposing traffic. This will also provide a greater visual restriction and it can be used as a pedestrian refuge if designed appropriately.

Application of slow points

It is appropriate to use slow points on local streets where:

- vehicle speeds are considered excessive
- there is a high proportion of through traffic
- the resulting traffic volume will be low (not more than 1000 vehicles per day) otherwise congestion and crash risk may increase.

It is inappropriate to use slow points:

- on bus routes
- at locations where the resulting sight distance to the device will be inadequate
- on streets with a high connective role in the local street network
- on streets where on-street parking is in short supply and its removal will significantly impact on adjacent properties (e.g. where they do not have access to off-street parking)
- routes leading to emergency facilities, e.g. a hospital
- streets where there is a high number of commercial vehicles (unless the aim is to divert this type of traffic).

When designing slow points the following should be considered:

- design for a maximum speed through the device of 10–20 km/h
- a lane width between 2.8 and 3.0 m should be maintained through the device
- deflection angles may be varied in the range of 10° to 30° depending on the level of control required
- raised kerb returns should be provided to redirect vehicles away from parked cars, pedestrian paths, bicycle bypasses, and adjacent properties
- on-street parking should be considered in the design to ensure the device remains clear at all times at the entry and exit of the device
- adjacent driveways should be taken into account
- an appropriately designed bicycle bypass may be provided, based on an assessment of relative risk and demand for cycling, so long as it does not compromise the speed reduction benefits of the design
- the device should be lit and signed to the appropriate standard.

The effectiveness of slow points can be increased when used in combination with lane narrowings, median treatments, centre blister islands and threshold treatments.

Austroads (2009b) suggests slow points produce an 85^{th} percentile speed reduction of up to 34% at the treatment.

Advantages of slow points

The advantages of slow points include:

- a reduction in vehicle speeds in the vicinity of the device and when used in a series, speeds are reduced over the length of the street
- a significant reduction in road crashes
- they may provide pedestrians with a shorter distance to cross the street
- they discourage through traffic
- they impose minimal inconvenience on local residents
- they can provide a landscaping opportunity.

Disadvantages of slow points

The disadvantages of slow points include:

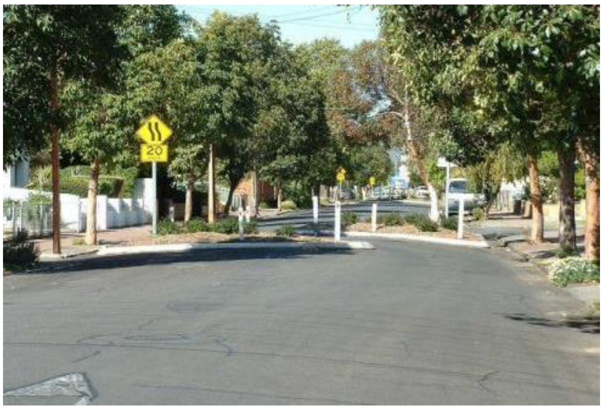
- they may restrict emergency vehicles and buses
- possible increase in traffic noise
- they will require the removal of on-street parking
- with one-lane devices, confrontations between opposing drivers may occur when arriving simultaneously and it may be unclear who should give way
- they can be hazardous for cyclists if they are not catered for in the design
- landscaping needs to be maintained so as not to reduce visibility.

Two-lane slow points are usually less effective than one-lane slow points in controlling speeds and providing an adequate visual obstruction.

Examples of slow points

Examples of one-lane slow points are illustrated in Figure 7.11 and two-lane slow points in Figure 7.12. A diagrammatic illustration of the two types of angled slow point is provided in Figure 7.13.

Figure 7.11: Examples of one-lane slow points



City of Prospect, South Australia

City of Christchurch, New Zealand

City of South Perth, Western Australia

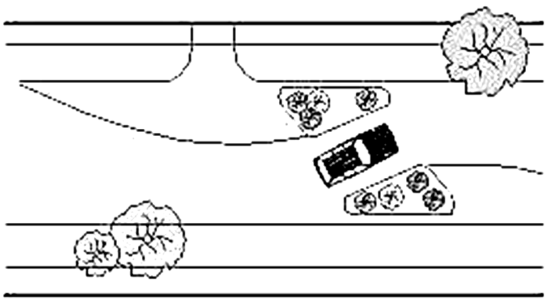
City of Prospect, South Australia

Figure 7.12: Examples of two-lane slow points

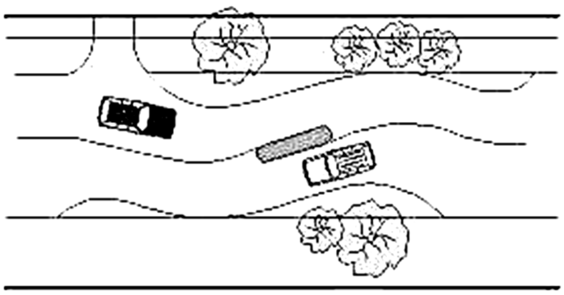
City of South Perth, Western Australia

City of Stirling, Western Australia

Figure 7.13: Two main types of angled slow point



Single laned angled slow point



Two lane angled slow point

7.3.3 Centre Blister Islands

Description of centre blister islands

A centre blister is a concrete island positioned at the centreline (median) of a street that has a wide oval plan shape that narrows the lanes, diverts the angle of traffic flow into and out of the device, and can be used to provide pedestrians with a refuge. They are a variation of a slow point. Often they incorporate kerb extensions particularly if the carriageway is wide. Where they are used as a pedestrian and cyclist refuge, they should be completely free of landscaping or other sight obstructions, and kerb ramps should be incorporated to facilitate safe and easy access. They should be clearly visible to approaching drivers, illuminated by adequate street lighting and enhanced by the use of signs, road marking and other delineation. The design of the islands should ensure that the width and length are not less than 2 and 3 m respectively. Consideration should be given to provide for a bicycle bypass where justified, either on or off-road. Selective use of barrier kerbs should be considered when using centre blisters as refuges, otherwise semi-mountable kerbing should be used.

Application of centre blister islands

It is appropriate to use centre blisters:

- where vehicle speeds on a street are less than 60 km/h
- where there is a need to break long, straight lines of sight
- on bus routes where raised devices and other forms of slow point are not acceptable
- where the street will continue to be used by a reasonable number of commercial vehicles
- on wide streets
- where there is a need to provide an intermediate pedestrian refuge.

It is inappropriate to use centre blisters on:

- narrow roadways where islands of sufficient width and length cannot be fitted
- where property access will be severely restricted resulting in drivers performing U-turn manoeuvres.

The effectiveness of centre blisters can be increased when used in series or placed together with lane narrowings, threshold treatments, roundabouts or other forms of slow point.

Advantages of centre blister islands

The advantages of centre blisters include:

- they reduce vehicle speeds
- they prevent drivers from overtaking others
- they can provide a refuge for pedestrians and cyclists crossing the street
- their flexibility in design allows buses and commercial traffic to be accommodated
- they may visually enhance the street through landscaping and reduce the ‘gun barrel’ effect on long straight roads.

Disadvantages of centre blister islands

The disadvantages of centre blisters include:

- they prohibit or limit access and movement from driveways
- they reduce on-street parking adjacent to the islands
- they may create a squeeze point for cyclists if not appropriately catered for in the design
- they may require kerb and footpath realignment in narrow streets
- they are not particularly effective at reducing through traffic
- they are relatively expensive to install and maintain.

Examples of centre blister islands

Examples of centre blisters are shown in Figure 7.14. A diagrammatic illustration of the two types of centre blister arrangement is provided in Figure 7.15.

Figure 7.14: Examples of centre blister treatments

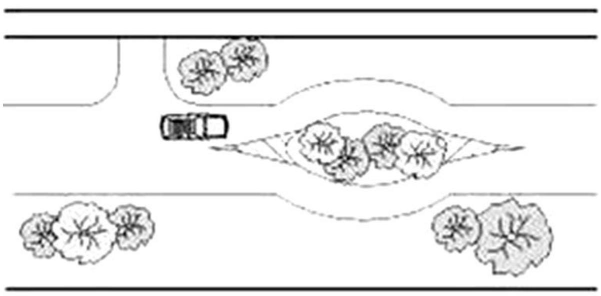
Moreton Bay Region, Queensland

City of Stirling, Western Australia

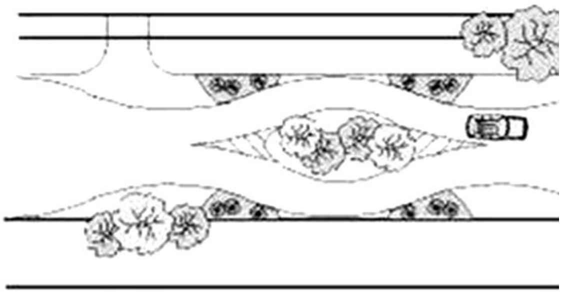
City of Tea Tree Gully, South Australia

City of Manningham, Victoria

Figure 7.15: Examples of the two main types of centre blister arrangement



Blister islands on narrow carriageways may require widening



Blister islands on wide carriageways may require kerb extensions

7.3.4 Driveway Links

Description of driveway links

Driveway links take the form of a single-lane two-way meandering road extending over the length of two or more property frontages. They are an extended form of a slow point that generally provides a greater visual and physical impact on the street and the amount of traffic using it. Passing points may be required along the link if it is either very long or it is curved such that approaching drivers cannot see to the far end. Driveway links are particularly effective in reducing through traffic. Consideration needs to be given to maintaining drainage paths and providing bypasses for bicycles where possible.

Driveway links often incorporate extensive landscaping and care needs to be taken that sufficient sight distance is retained. Paving materials should contrast with the adjacent street surface.

Application of driveway links

It is appropriate to use driveway links where:

- there is a high proportion of through traffic
- full or partial road closures are not appropriate
- vehicle speeds on a street are less than 50 km/h
- the resulting traffic volume will be low (not more than 1000 vehicles per day) otherwise congestion and crash risk may increase
- there is a need to break long, straight lines of sight.

It is inappropriate to use driveway links on:

- bus routes
- streets with a high connective role in the local street network
- streets where on-street parking is in short supply, it cannot be replaced in the design, and its removal will significantly impact on adjacent properties (e.g. where they do not have access to off-street parking)
- where access to properties by service vehicles will be prevented
- routes leading to emergency facilities, e.g. a hospital.

Driveway links are an effective treatment if installed in isolation but can also be quite successful if implemented in series. Two or more driveway links should not be installed in the same section of a street (i.e. between intersections) as this may prevent access to properties by service vehicles.

Advantages of driveway links

The advantages of driveway links include:

- a reduction in vehicle speeds
- discouragement of through traffic
- an increase in pedestrian safety
- the provision of greater visual and physical impact than slow points
- they visually enhance the street through landscaping and reduce the ‘gun barrel’ effect on long straight roads.

Disadvantages of driveway links

The disadvantages of driveway links include:

- they may restrict emergency vehicles and commercial vehicles and are not suitable for buses
- they will reduce the amount of on-street parking
- they can be hazardous for cyclists if they are not catered for in the design
- confrontations between opposing drivers may occur and it may be unclear who should give way
- landscaping needs to be maintained so as not to reduce visibility
- they are an expensive device.

Examples of driveway links

Examples of driveway links are shown in Figure 7.16 and Figure 7.17 illustrates a typical layout.

Figure 7.16: Examples of driveway links

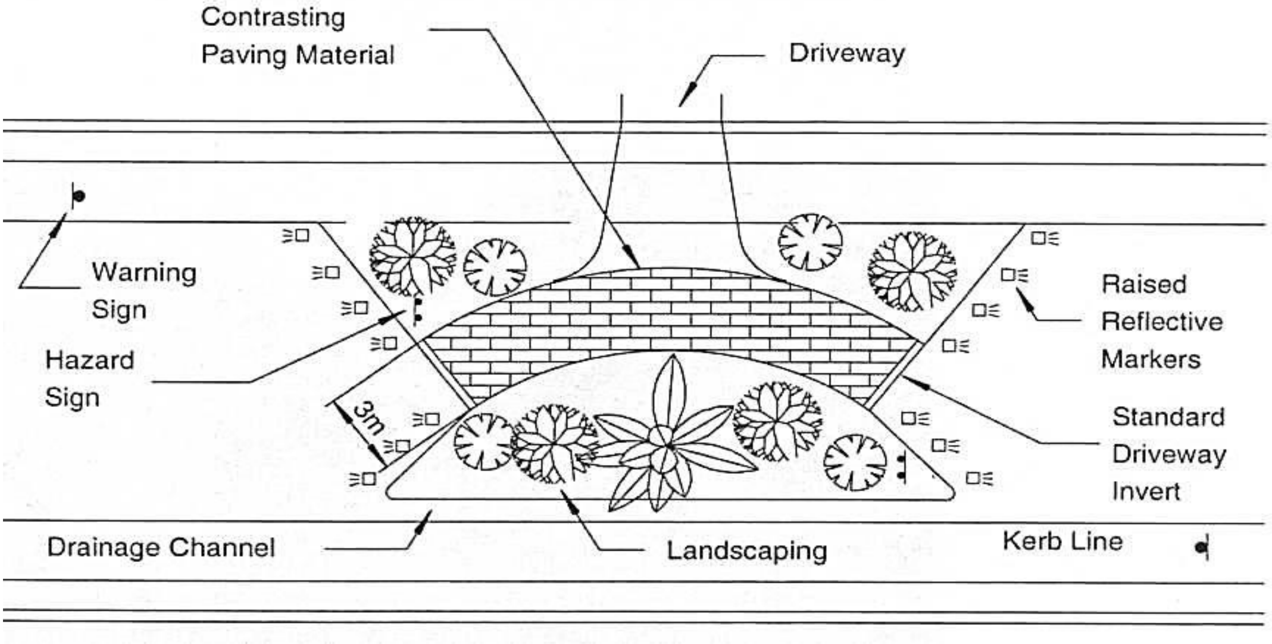
City of Prospect, South Australia

City of Stirling, Western Australia

City of Port Adelaide, South Australia

City of Subiaco, Western Australia

Figure 7.17: A typical driveway link treatment



7.3.5 Median Treatments

Description of median island treatments

A median island treatment is a raised or flush island positioned at the intersection or the centreline of a street that narrows lanes and can provide pedestrians with a refuge. They can be an effective form of road narrowing and at intersections they can provide drivers with a clear indication they are entering a local street. Median treatments should be clearly visible to approaching drivers, illuminated by adequate street lighting and enhanced by the use of signs, pavement markings and other delineation.

Flush medians are defined by flush kerbing or painted lines laid down the centre of the street and often supplemented with a coloured or textured pavement surface infill. Flush median treatments have the benefit that they separate opposing traffic flows while not obstructing turning movements in and out of driveways, intersections, etc. Note that the *Australian Road Rules* prevent turning movements across some forms of painted or flush median treatments.

Raised medians or splitter islands are kerbed concrete or paved islands typically 90 to 100 mm high incorporating kerb ramps or cut throughs to facilitate safe and easy pedestrian access when used as a pedestrian and cyclist refuge. The benefit of the raised physical island is that it provides additional protection for pedestrians and cyclists not provided by flush kerbed or painted medians. When median islands are intended to be used as a refuge for pedestrians and cyclists they should be completely free of landscaping or other sight obstructions and should have adequate width. When placed at intersections the setback of the island should be adequate to provide for turning movements of all traffic commonly using the intersection. It is worth noting that there has been success experienced with the use of partially raised fully mountable mid-block median treatments where the treatment is constructed one surface layer thickness (i.e. 20 mm) higher than the trafficable carriageway.

Application of median treatments

It is appropriate to use median treatments in:

- wide streets where the pavement width permits
- areas with pedestrian movements not necessarily concentrated at any particular location and there is a need to provide an intermediate pedestrian refuge
- intersections to control turning traffic and prevent corner cutting
- areas where there is a need to reduce entry speed of vehicles to a residential street
- local distributor or higher classification roads.

It is inappropriate to use median treatments:

- on narrow two-lane streets where median islands of sufficient width and length cannot be fitted
- where property access will be severely restricted resulting in large numbers of drivers performing U-turn manoeuvres
- in locations with high numbers of pedestrians crossing the street
- where there is insufficient sight distance.

Parking restrictions for mid-block islands usually only apply on the approach side of the island to protect sight lines. Where this approach is taken, it may create a squeeze point for cyclists on the departure side if cars are parked immediately after the island. The imposition of parking restrictions on both the approach and departure sides of the island provides greater protection to cyclists.

Advantages of median treatments

The advantages of median treatments include:

- provision of a refuge for pedestrians and cyclists crossing the street
- separation of vehicles in opposing traffic lanes thereby reducing the probability of head-on collisions
- prevention of drivers from overtaking others
- flexibility in design allows buses and commercial traffic to be accommodated
- they may visually enhance the street through landscaping
- they can be relatively low cost to install
- they can improve intersection definition
- they may discourage through traffic by reducing intersection capacity
- enforcement of no right turns, when placed across an intersection on the through road
- reduction of vehicle speeds when used at mid-block locations, and reduction of entry speeds at intersections
- accommodation of centrally displayed traffic control devices
- flush treatments do not generally restrict vehicle movements, particularly right-turning vehicle movements from driveways.

Disadvantages of median treatments

The disadvantages of median treatments include:

- they may require significant amounts of parking to be removed
- they may create a squeeze point for cyclists if not appropriately catered for in the design
- they have limited speed and traffic reduction benefits
- if raised treatments are used they may prohibit or limit access and movement from driveways and may be restrictive for emergency and service vehicles.

Examples of mid-block median treatments

Examples of mid-block median treatments are shown in Figure 7.18.

Figure 7.18: Examples of mid-block median treatments

City of Wanneroo, Western Australia

City of Auckland, New Zealand

City of Subiaco, Western Australia

City of South Perth, Western Australia

7.3.6 Roundabouts

Description of roundabouts

A roundabout (or mini-roundabout) is a form of channelisation that incorporates a circular central island. Roundabouts can be either single-lane or multi-lane depending on the class of roads on which they are to be constructed, and the traffic volume moving through the intersection. A roundabout is an effective form of intersection control that can be installed on both four-leg and three-leg intersections. Roundabouts reduce the relative speeds of conflicting vehicles by providing impedance to all vehicles entering the roundabout. A form of roundabout that is mountable or traversable is often called a 'humpabout'.

Austroads research indicates (Austroads 2009b) an 85th percentile speed reduction of 46% at the treatment and 15% at the midpoint between treatments.

For a more detailed description, including design guidance, see the *Guide to Road Design Part 4: Intersections and Crossings* and *Part 4B: Interchanges*, and the *Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings*.

Application of roundabouts

It is appropriate to use roundabouts:

- at any intersection where traffic flow from all approaches is approximately equal
- at intersections with a high crash rate, especially where the crashes have predominantly been of a right-angle or right-turn-through type
- on local streets in residential areas that have a high volume of unnecessary through traffic.

It is inappropriate to use roundabouts:

- at locations other than intersections
- at the intersection of two roads of significantly different traffic function (e.g. minor street and arterial)
- where marked uneven flows of traffic occur
- where satisfactory geometry cannot be provided due to insufficient space or other constraints
- on any intersection that is not sealed
- where large combination vehicles or over-dimensional vehicles frequently use the intersection
- in a temporary form or when a temporary device is needed.

When designing a roundabout, consideration should be given to:

- the functional classification of the intersecting roads
- the vehicle types expected to use the intersection
- the speed profile on the approach to, and through, the device
- the distribution of turning traffic
- safety for pedestrians and cyclists crossing the intersection, and the potential for off-road path connections
- appropriate landscaping that does not present a hazard (e.g. affect sight lines for drivers)
- access requirements of emergency and service vehicles and buses.

It is stressed that there are significant potential dangers for cyclists and pedestrians at roundabouts if they are not appropriately designed. There is no single preferred treatment for safely accommodating cyclists and pedestrians at roundabouts and each case requires careful consideration before committing to a course of action.

The effectiveness of roundabouts can be increased if used in conjunction with:

- intersection channelisation and slow points (City of Stirling example in Figure 7.19)
- median treatments
- kerb extensions/lane narrowings
- centre blister islands.

Advantages of roundabouts

The advantages of roundabouts include:

- reduction of vehicle conflict points and road crashes at intersections
- reduction of vehicle speeds on the approach to, and through, the intersection
- control of traffic movement and provision of orderly and largely uninterrupted flow of traffic
- an increase in the visibility of the intersection
- clarification of the priority of traffic movements
- enhancement in the appearance of the street when landscaped.

Disadvantages of roundabouts

The disadvantages of roundabouts include:

- they restrict larger service and emergency vehicles and buses unless the roundabout is mountable
- they are relatively expensive especially if land needs to be acquired
- traffic noise may possibly increase due to braking and acceleration
- they reduce the availability of on-street parking
- they can be difficult for cyclists and pedestrians to negotiate.

The following additional source material is recommended for reference on this topic: Austroads (2009b), Corkle et al. (2001), Jurewicz (2008), Parham and Fitzpatrick (1998), Petruccelli (2000), Fehr and Peers (2015), Tucker (2006) and Zito and Taylor (1996).

Examples of roundabouts

Several examples of roundabouts are illustrated in Figure 7.19.

Figure 7.19: Examples of roundabouts

City of Stirling, Western Australia

City of Stirling, Western Australia

City of Marion, South Australia

City of Marion, South Australia

City of Stirling, Western Australia

Shire of Yarrawonga, Victoria

7.4 Diversion Devices

Diversion devices are used to redirect traffic, typically through the use of physical obstructions in the roadway supplemented by regulatory signs. These measures obstruct specific vehicle movements typically at intersections or mid-block locations to discourage short cutting or through traffic, which may reduce conflicts and vehicle speeds.

7.4.1 Full Road Closure

Description of full road closures

A full road closure is the closure of a street to two-way traffic. It serves as a means of eliminating through traffic from a street or simplifying an intersection layout to reduce the possible number of conflict points and the consequent crash risk. The closure can be located at either an intersection or placed mid-block.

Application of full road closures

It is appropriate to use a full road closure:

- where the use of other less restrictive traffic controls would be ineffective
- to discourage traffic bypassing busy distributor roads and using local streets
- to eliminate right-turning traffic from busy distributor roads where right-turn lanes are not available and turning traffic impacts on the following through traffic
- at intersections where crash history indicates a high number of right-angle and right-turn-through crashes
- at intersections where sight distances are substandard and turning movements are potentially dangerous.

It is inappropriate to use a full closure:

- where high or unacceptable levels of traffic transference into adjacent streets is expected
- where there is no reasonable alternative route that affected traffic can use
- on a bus route unless a bus bypass is provided
- routes leading to emergency facilities, e.g. a hospital
- over a crest, or in other situations where insufficient stopping sight distance is available.

When designing a full closure the following should be considered:

- the selection of the location of road closures should be carefully chosen so that unacceptable volumes of traffic are not redirected to unsuitable routes
- all anticipated turning movements should be facilitated
- sufficient manoeuvring space should be provided for drivers to turn their vehicles around at the closure
- ‘no through road’ signs should be installed at the last entry to the closed section of the street
- generally the closure should not create a cul-de-sac longer than 200 m in length
- the location of the closure should be well lit
- cycle and pedestrian access should be provided
- bus and emergency vehicle access should be considered.

Advantages of full road closures

The advantages of full road closures include:

- reduction in traffic volumes
- reduction in conflict points when used at an intersection
- an increase in pedestrian safety
- elimination of non-local traffic
- they can accommodate pedestrian, cyclist and/or bus access
- they provide landscaping opportunities.

Disadvantages of full road closures

The disadvantages of full road closures include:

- they may restrict or reduce accessibility for local residents
- traffic may be diverted to other adjacent local streets without closures, resulting in increased traffic volumes in those streets
- they may restrict access by emergency services
- they will increase travel times for some road users
- they may reduce the availability of on-street parking.

Examples of full road closures

Examples of full road closures are illustrated in Figure 7.20.

Figure 7.20: Examples of full road closures

City of Melbourne, Victoria

City of Charles Sturt, South Australia

7.4.2 Half Road Closure

Description of half road closures

Half road closures restrict entry or exit to local areas by kerb arrangement and regulatory control to one direction only. Half road closures are used where traffic control without full restriction to traffic movements is required. Half road closures rely on closing one lane to traffic and may be located either at intersections or mid-block. Their effectiveness relies on drivers obeying regulatory signs prohibiting access through the device.

Application of half road closures

It is appropriate to use a half road closure where:

- a restriction on through traffic is required but a full closure is too restrictive
- entry from an adjoining street needs to be restricted.

It is inappropriate to use a half road closure:

- on bus routes unless a bus bypass is provided
- on routes leading to emergency facilities
- where road user compliance may be a problem resulting in wrong-way movements.

Half road closures should be designed so that:

- there is physical difficulty in completing prohibited manoeuvres
- appropriate advance warning signs are provided
- cyclists and pedestrians are accommodated
- turning facilities are provided adjacent to the half closure
- the treatment is well lit
- unacceptable volumes of traffic are not redirected into adjacent streets.

Advantages of half road closures

The advantages of half road closures include:

- reduction in traffic volumes
- reduction in conflict points when used at an intersection
- reduction in through traffic
- an increase in pedestrian safety if used at an intersection
- provision of landscaping opportunities.

Disadvantages of half road closures

Some disadvantages of half road closures include:

- restriction of access by emergency vehicles (unless they disregard controls)
- reduction of accessibility for local residents
- diversion of some traffic to other local streets without closures
- an increase in travel times for some road users
- they may reduce the availability of on-street parking
- there is the potential that the restrictions will be violated.

Examples of half road closures

Examples of a half road closure are illustrated in Figure 7.21.

Figure 7.21: Examples of half road closures

City of Stirling, Western Australia

City of Subiaco, Western Australia

City of Hurstville, New South Wales

City of Stirling, Western Australia

7.4.3 Diagonal Road Closure

Description of diagonal road closures

Diagonal road closure is a kerb extension or vertical barrier extending to approximately the centreline of a roadway that effectively obstructs or prohibits one or more directions of traffic. Diagonal road closures are generally used to redirect traffic by modifying a four-leg intersection into two discrete 90° bends. Diagonal closures can effectively reduce through traffic while improving road safety at an intersection by removing conflict points.

Application of diagonal road closures

It is appropriate to use a diagonal road closure when:

- a restriction on through traffic is required but a full closure is inappropriate
- entry from an adjoining street needs to be restricted.

It is inappropriate to use a diagonal road closure:

- on bus routes unless a bus bypass is provided
- on routes leading to emergency facilities
- where road user compliance may be a problem (e.g. on one-way streets).

Diagonal closures should be designed so that:

- they are located where there is sufficient sight distance
- physical difficulty is presented to drivers attempting to cross the diagonal dividing strip
- pathways are constructed through the closure to accommodate cyclists and pedestrians
- appropriate parking prohibitions are provided to maintain two-way movement through the bend
- appropriate warning signs and road markings are provided in advance
- the area in the vicinity of the treatment is well lit
- the minimum width of the roadway around each bend allows for the largest vehicle regularly using the street.

Advantages of diagonal road closures

The advantages of diagonal road closures include:

- reduction in through traffic and hence vehicle conflict points
- an increase in pedestrian safety
- elimination of selected turning movements
- provision of landscaping opportunities
- they are self-enforcing and as such, violation is minimal.

Disadvantages of diagonal road closures

The disadvantages of diagonal road closures include:

- reduction in accessibility of local residents
- increase in travel times and lengths
- diversion of some traffic to other local streets without closures
- restriction of access by emergency vehicles
- they may reduce on-street parking opportunities.

Examples of diagonal road closures

Examples of diagonal road closures are illustrated in Figure 7.22.

Figure 7.22: Examples of diagonal road closures

Town of Cambridge, Western Australia

Town of Vincent, Western Australia

7.4.4 Modified T-intersection

Description of modified T-intersections

Modified T-Intersections are used to affect a change in the vehicle travel path thereby slowing traffic via deflection of traffic movements and/or reassignment of priority. They act in a similar manner to slow points in moderating traffic speeds but at a three-way intersection. When used in series they can provide effective speed control down the length of a street. When used to change priority, the terminating leg of the intersection is connected to one 90° intersection leg to become the new priority carriageway (refer to Figure 7.23).

Application of modified T-intersections

It is appropriate to use a modified T-intersection where:

- there is a need to regulate traffic movements
- there is a need to moderate speeds without displacing traffic
- crash numbers and incidents are high
- to change priority on T-intersection legs.

It is inappropriate to use a modified T-intersection on:

- crests where sight distance is limited
- streets where the width is insufficient to accommodate standard size splitter islands (i.e. less than 7 m)
- where the priority is not changed and the visibility from the relocated give-way line would be less than the safe intersection sight distance.

Modified T-intersections should be designed so that:

- service vehicles are able to negotiate the intersection
- appropriate parking prohibitions are provided
- appropriate regulatory and warning signs and road markings are provided in advance
- the area in the vicinity of the treatment is well lit
- all kerbing has a semi-mountable profile
- landscaping will not obstruct sight lines
- drainage paths are maintained
- cyclists and pedestrians are adequately catered for and no squeeze points are introduced
- where the priority of the intersection is to be changed, consideration should be given to the installation of a threshold treatment on the newly defined terminating leg of the intersection. It should be enhanced by the use of signs and linemarking.

Advantages of modified T-intersections

The advantages of modified T-intersections include:

- controlling of traffic movement and improvement in traffic flow
- a reduction in vehicle speeds at the treatment
- facilitation of safe pedestrian crossing
- reduction in vehicle conflict points
- when placed in series can lower vehicle speeds along the length of the street
- accommodation of buses.

Disadvantages of modified T-intersections

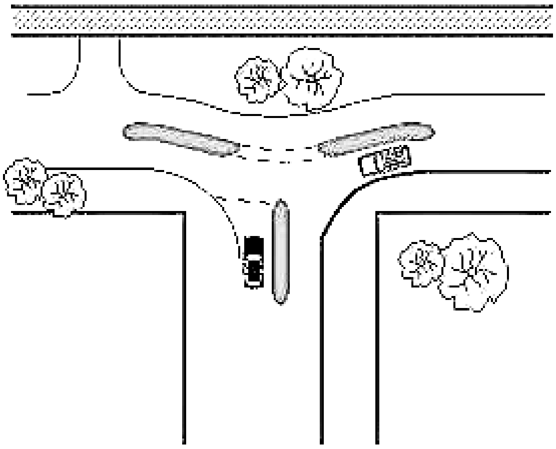
Some disadvantages of modified T-intersections include:

- they are relatively expensive devices
- creation of squeeze points for cyclists if not appropriately catered for in the design
- reduction in the availability of on-street parking opportunities.

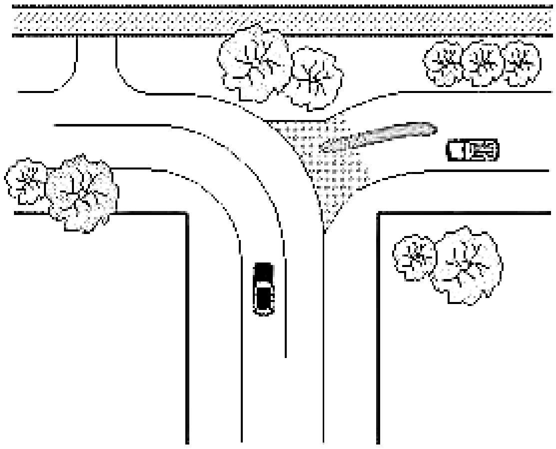
Examples of modified T-intersections

Figure 7.23 illustrates the two main types of modified T-treatment: to change priority and to act as a traffic calming device. Examples of a modified T-intersection channelisation are shown in Figure 7.24.

Figure 7.23: Two main types of modified T-intersections



Modified 'T' Junction as a calming device



Modified 'T' Junction to change priority

Figure 7.24: Examples of modified T-intersection channelisation

City of Monash, Victoria

Moreton Bay Region, Queensland

7.4.5 Left-in/left-out Islands

Description of left-in/left-out islands

A left-in/left-out island is a raised triangular island at an intersection, which aims to obstruct right turns, and through movements to and from the intersection, street or driveway. This device is a form of partial road closure similar in its effect to a half road closure. The device is more effective if a median island is incorporated in the design to prevent non-complying traffic movements.

Application of left-in/left-out islands

It is appropriate to use left-in/left-out islands when:

- the safety of traffic movements turning right and going through an intersection is an issue
- a restriction on through traffic is required but a full closure is too restrictive
- entry from an adjoining street needs to be restricted.

It is inappropriate to use left-in/left-out islands on:

- wide divided cross-intersections as drivers can easily avoid the island
- streets used by large trucks and buses, as any reduction in the island size to cater for them will reduce the effectiveness of the device for smaller vehicles.

Advantages of left-in/left-out islands

The advantages of left-in/left-out islands include:

- reduction in the traffic volume
- reduction in the number of conflict points
- provision of a refuge for pedestrians and cyclists
- their inclusion reinforces the need for drivers crossing the dividing line to give way
- they may enhance the appearance of the street when landscaped.

Disadvantages of left-in/left-out islands

The disadvantages of left-in/left-out islands include:

- restriction of access
- they may create a squeeze point for cyclists
- diversion of some traffic to other local streets without the same restriction
- compliance may be an issue if a median island is not incorporated.

Examples of left-in/left-out islands

Examples of left-in/left-out islands are illustrated in Figure 7.25.

Figure 7.25: Examples of left-in/left-out islands

City of Bayswater, Western Australia

City of Cockburn, Western Australia

7.5 Signs, Linemarking and Other Treatments

Signs and linemarking can be used to regulate traffic movements or calm traffic. It may discourage speeding, prevent vehicle conflicts, and prevent through traffic from short-cutting along a street. The primary aims of signs and linemarking are to aid in the safe and orderly movement of traffic. They may contain instructions that the road user is required to obey or they may be used to impart information. Signs are typically categorised into one of the following categories:

- regulatory – to indicate legal requirements
- guide – to inform and advise road users of directions, distances and destinations
- warning – to warn road users of unusual or unexpected conditions
- temporary – to control, warn and guide road users safely through, around or past roadworks or other temporary features.

Other treatments include those on-road and off-road facilities for road users such as pedestrians, cyclists, public transport and emergency vehicles. These treatments are often dedicated or shared facilities that assign special priority and give consideration to a particular road user group or groups while in many instances acting to calm the general flow of traffic.

7.5.1 Speed Limit Signs and Indication Devices

Description of speed limit signs and indication devices

The purpose of a speed limit sign or indication device is to indicate to drivers the maximum legal vehicle speed permitted under normal driving conditions on the street section or in the area where the sign is installed.

Application of speed limit signs and indication devices

It is appropriate to use a speed limit sign or indication device where:

- vehicle speeds in a street or area need to be reduced
- the proposed speed limit is compatible with the street speed environment.

It should be noted that it is far more effective if the speed environment of a street is designed to match the posted speed limit rather than using a speed limit as a constraint in itself. Speed signs and indication devices should be used in combination with the physical features of a street to reinforce the intended speed environment.

Advantages of speed limit signs and indication devices

The advantages of speed limit signs and indication devices include:

- reduction in the speed of traffic along a street
- minimal installation and maintenance cost
- potential to lower the incidence of extreme speeding
- provision of benefits for all road users.

Disadvantages of speed limit signs and indication devices

A disadvantage of speed limit signs and indication devices is that they require regular police enforcement to achieve compliance unless accompanied by effective physical speed-reducing measures.

Examples of speed limit signs and indication devices

Examples of speed limit signs and indication devices are given in AS 1742.1 – 2014.

7.5.2 Prohibited Traffic Movement Signs

Description of prohibited traffic movement signs

Prohibited traffic movement signs indicate to drivers that they are not permitted to undertake a particular turn or other traffic movement. The signs are used to prevent short-cutting or undesirable turning movements into and from residential streets. The signs can also be used to prohibit access by specific road user types, e.g. trucks, cyclists, buses, pedestrians.

The effectiveness of prohibited traffic movement signs can be increased when used in combination with:

- kerb extensions/lane narrowings
- mid-block median treatments and intersection channelisation
- partial road closures.

Application of prohibited traffic movement signs

It is appropriate to use prohibited traffic movement signs to:

- prevent through traffic from short-cutting along a street
- prohibit access by specific road user types
- reduce the incidence of particular types of crashes.

Advantages of prohibited traffic movement signs

The advantages of prohibited traffic movement signs include:

- traffic volumes may reduce from restricting the traffic movements
- safety may increase from the removal of conflicting movements
- prohibition may be applied part-time or to specific road user types
- there are minimal installation/maintenance costs.

Disadvantages of prohibited traffic movement signs

Some disadvantages of prohibited traffic movement signs include:

- acceptance depends on the user and will be less effective if they seem illogical or where convenient alternatives are not available
- restriction of accessibility of residents
- they may require increased police enforcement to achieve compliance
- turns at less safe places or manoeuvres such as U-turns may occur as a result of restricted movements.

Examples of prohibited traffic movement signs

Australian examples of prohibited traffic movement signs are illustrated in Figure 7.26. A full listing of all such signs is contained in Australian Standard AS 1742.1 – 2014.

A full listing of all prohibition signs in New Zealand is contained in the Land Transport TCD Rule and MOTSAM (NZ Transport Agency 2010).

Figure 7.26: Australian examples of signs to prohibit designated traffic movements

No left turn | No trucks | No entry | No U-turn

7.5.3 One-way Street Signs

Description of one-way street signs

One-way street signs indicate to drivers that traffic is allowed to travel only in the direction of the arrow in the section of the street applying. Careful planning and sign positioning is required to ensure a reasonable amount of access is maintained so that problems are not transferred to another street in the area. Where warranted, bicycle contra-flow lanes should be considered to improve permeability for cyclists and to narrow the vehicle carriageway.

Application of one-way street signs

It is appropriate to use one-way streets to:

- reduce traffic volumes
- reduce pedestrian crossing distances (if road narrowing ensues)
- direct traffic to or away from a particular street
- enhance the streetscape and pedestrian environment.

The effectiveness of a one-way street can be enhanced when used in combination with:

- kerb extensions/lane narrowings
- flat-top road humps/wombat crossings/raised pavements
- prohibited turn signs
- partial road closures
- bicycle lanes, bypasses and other facilities
- bus only lanes/links/bypasses.

Advantages of one-way street signs

The advantages of one-way streets include:

- are generally accepted by the public
- increase the opportunity for on-street parking
- increase the opportunities for dedicated facilities for pedestrians, cyclists and public transport
- may reduce traffic volumes on the street
- increase safety for pedestrians and cyclists
- decrease vehicle conflicts due to the lack of opposing traffic conflict.

Disadvantages of one-way street signs

The disadvantages of one-way streets include:

- the one-way system may be ignored if the street is only lightly trafficked and the potential conflict from opposing traffic appears low
- speeds may increase due to the removal of conflict from oncoming vehicles
- reduction in accessibility for local residents
- diversion in traffic to other streets
- increase in travel time and length
- emergency vehicles may have to travel the wrong way in emergencies, which may create a hazard
- refuse collection points and bus stops may need to be relocated to the one side of the street.

7.5.4 Give-way Signs

Description of give-way signs

The purpose of a give-way sign is to assign and indicate priority at intersections. In the context of LATM, give-way signs that are used to reassign priority should be reinforced through the use of other physical measures as part of an area wide or whole of street LATM treatment.

Application of give-way signs

It is appropriate to use a give-way sign at:

- intersections not controlled by traffic signals, a roundabout or the T-intersection rule.
- If sight distance is poor, a stop-sign is warranted. This includes all four-leg intersections and any three-leg intersection where priority would otherwise be unclear such as Y-intersections.

Advantages of give-way signs

The advantages of a give-way sign include:

- loss of priority may be a discouragement to through traffic using a street and this may lead to a reduction in traffic volumes
- safety may be improved with the better definition of priorities
- minimal installation/maintenance cost
- speed reduction may occur within the intersection.

Disadvantages of give-way signs

The disadvantages of a give-way sign include:

- reassignment of priority might not perform safely if placed contrary to driver expectation, and is therefore of limited value as a stand-alone LATM treatment.

7.5.5 Stop Signs

Description of stop signs

Stop signs are regulatory signs used to assign priority and facilitate the safe passage of vehicles through an intersection. They require all drivers and cyclists to come to a complete halt before proceeding. Stop signs are generally placed on the minor road approach to an intersection, thereby assigning priority to the major road. In this situation they are used where the sight distance from the minor leg of the intersection is insufficient and it would be unsafe to proceed without stopping. Stop signs can be placed on the major road approaches to an intersection as a means to discourage traffic use and speeding (only appropriate in this instance if used in conjunction with other devices and providing that care is taken to ensure it is obvious to the driver).

Application of stop signs

Australian Standard AS 1742.13 – 2009 *Manual of uniform traffic control devices – Part 13: Local area traffic management* and Australian Standard AS 1742.2 – 2009 *Manual of uniform traffic control devices – Part 2: Traffic control devices for general use* provide details on the sight distance requirements for the installation of a stop sign in lieu of give-way conditions. A Stop sign is warranted only where sight distance falls below a speed-related distance on the major road (e.g. 30 m on a 50 km/h road) observed from 3 m back along the minor road.

Advantages of stop signs

The advantages of stop signs include:

- reassignment of priority may be a discouragement to through traffic using a street and this may lead to a reduction in traffic volumes
- safety may be improved with the better definition of priorities
- minimal installation/maintenance cost
- speed reduction may occur within the intersection
- advising drivers to stop at appropriate points increases safety, as applied according to warrants.

Disadvantages of stop signs

A disadvantage of stop signs is:

- reassignment of priority might not perform safely if placed contrary to driver expectation, and is therefore of limited value as a stand-alone LATM treatment.

7.5.6 Shared Zones

Description of shared zones

A shared zone is an area utilised by both pedestrians and vehicular traffic in which drivers must give way to pedestrians at all times, and where the street environment has been adapted for very low-speed vehicles. Shared zones should aim to change the image and character of a street so that drivers are made aware that they are entering a street environment with driving conditions that are quite different to other more common situations. This can be achieved by the use of different coloured and/or textured pavement surfaces, by the use of full width flush paving between property lines and through landscaping. Shared zones must be designed in such a way that the low speed environment is reinforced through the physical layout and treatment. A speed limit of 10 km/h is considered appropriate in shared zones to compliment these speed environment changes.

Shared zones are often constructed on residential streets with mixed vehicle and pedestrian traffic or in areas where a form of control is required that allows complete pedestrian mobility and safety. Due to the high cost involved, shared zones are normally used in areas of high commercial activity, medium to high-density residential areas or recreational areas.

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 the demarcation of separate vehicular and non-vehicular 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 (Department for Transport 2011) and further comment on this approach is given in the *Guide to Traffic Management Part 7*.

Figure 7.27: Examples of shared zone signs

Shared zone sign (Australia)

Shared zone sign (NZ)

Source: AS 1742.1 – 2014 and MOTSAM (NZTA 2010).

Application of shared zones

It is appropriate to use shared zones:

- at boundaries between different classifications of streets
- at boundaries between different land uses
- where there are large numbers of pedestrians using the space
- where there is need to provide pedestrian priority over a relatively long section of street
- where one or more isolated pedestrian crossings would be ineffective.

It is inappropriate to use shared zones:

- at the junction of two minor local streets
- on local distributor roads with a high-speed problem
- on streets with a high vehicle-to-pedestrian ratio.

Advantages of shared zones

The advantages of shared zones include:

- increase in the safety of pedestrians and cyclists
- reduction in the speed environment of the street
- they provide for flexibility of parking layouts
- they alert drivers that they are entering a different driving environment
- they can improve amenity without affecting access.

Disadvantages of shared zones

The disadvantages of shared zones include:

- they are relatively expensive
- drivers may not observe the speed restrictions when pedestrian use is low
- they require education and enforcement to encourage understanding and compliance
- pedestrian safety possibly being compromised by non-complying drivers.

Examples of shared zones

Examples of shared zones are shown in Figure 7.28.

Figure 7.28: Examples of shared zones

City of Perth, Western Australia

Canberra, Australian Capital Territory

City of Sydney, New South Wales

City of Sydney, New South Wales

7.5.7 School Zones

Description of school zones

A school zone is a sign-posted section of road adjacent to or in the vicinity of a school in which a reduced speed limit applies during the specified times or conditions indicated on signs in accordance with relevant regulations – typically 40 km/h or less in urban areas and 60 km/h or less in rural areas.

School zones aim to control street speeds immediately before, after and during school hours (or part thereof) so that a more child-friendly street environment is provided and safety is improved. They are most effective when supported by other physical treatments that modify the speed profile of a street. School zones may incorporate devices such as pedestrian crossings, wombat crossings, threshold treatments, raised pavements, median islands and the like in an integrated fashion.

Application of school zones

It is appropriate to use school zones:

- in the immediate vicinity of a school or similar facility.

Advantages of school zones

The advantages of school zones include:

- safety of pedestrians and cyclists is increased, particularly school-age children
- can be applied only during specified periods of the day when activity around a school is at its greatest, e.g. in the period before and after school
- they heighten the awareness of drivers by alerting them to the presence of a school
- they reduce the travel speeds of vehicles within a street
- they can be relatively inexpensive.

Disadvantages of school zones

The disadvantages of school zones include:

- drivers may not observe the speed restrictions when pedestrian usage is low, particularly outside school hours
- they require education and enforcement to encourage understanding and compliance
- pedestrian safety may be compromised by non-complying vehicles.

7.5.8 Threshold Treatments

Description of threshold treatments

Threshold treatments or entry statements are coloured and/or textured road surface treatments that contrast with the adjacent roadway. Threshold treatments aim to alert drivers that they are entering a driving environment that is different from the one they have just left by the use of visual and/or tactile clues. They may incorporate either raised or flush median treatments. When installed at intersections they may extend to cover the entire intersection area.

Threshold treatments are commonly used at the interface with the arterial road network and at the boundaries of differing land uses, such as at the interface of residential and commercial properties or on either side of a school. To maximise the visibility of the device, the surface treatment should contrast with the adjacent road-building material and the device should be well lit.

Application of threshold treatments

It is appropriate to use threshold treatments at:

- boundaries between different land uses
- the interface with the arterial road network
- the interface between one speed zone and another
- changes in street or area character.

It is inappropriate to use threshold treatments on:

- streets with a high traffic volume (greater than 4000 vpd)
- streets with a speed environment greater than 60 km/h
- wide carriageways unless road narrowing is provided.

When designing perimeter threshold treatments the following should be considered:

- If median islands are used, lane widths should provide for the turning movements of commercial vehicles and buses.
- Parking restrictions should apply near the device to safeguard approaches and departures.
- The device should be designed to be entirely flush with the street (refer to the sections on flat-top road humps and raised pavements for information on raised flat-topped devices).
- Must not be constructed from the same coloured material as the adjacent footpath or shared path/bicycle path as it may be confused for a formal pedestrian crossing facility.
- Tactile surface treatments should be used if there is no difference in level where the footpath meets the street to differentiate the edge of the roadway, particularly to alert people with sight impairment.
- The minimum length of the threshold treatment should be 5 m to provide adequate visual impact (a longer length is desirable) and to lessen any ambiguity that may exist in relation to vehicles having priority over pedestrians (particularly if constructed from a different colour material to the street).
- If devices are located mid-block, their locations should be selected to maintain property access wherever possible.

The effectiveness of threshold treatments can be increased when used in combination with local area and speed limit signs, median treatments, kerb extensions/lane narrowings and many other LATM devices.

Advantages of threshold treatments

The advantages of threshold treatments include:

- reduction in approach speeds to an intersection
- they highlight the presence of an intersection
- provision of separation between residential areas from areas of non-residential use
- they alert the driver that they are entering a local area.

Disadvantages of threshold treatments

The disadvantages of threshold treatments include:

- they increase maintenance requirements
- texturing may create stability problems for cyclists and motorcyclists
- turning traffic from and into the low speed local area may be more likely to affect traffic flow on the connecting arterial roads
- vehicle priority may be unclear to pedestrians in some circumstances
- effectiveness is limited unless complemented by other devices in the street.

Examples of threshold treatments

Examples of threshold treatments are illustrated in Figure 7.29.

Figure 7.29: Examples of threshold treatments

City of Vincent, Western Australia

City of Auckland, New Zealand

7.5.9 Tactile Surface Treatments

Description of tactile surface treatments

Tactile surface treatments are low bumps, buttons, bars, grooves or strips closely spaced across or immediately adjacent to streets or paths that draw attention to a feature or hazard, and can have a vibratory and audible effect when travelled over. They can be constructed across traffic lanes or parallel to traffic lanes normally in the form of edge lines.

These devices aim to alert drivers to take greater care when approaching a hazard such as a bend or junction, or warn drivers to undesirable lateral movements and unusual conditions. They are also effective in alerting pedestrians with vision impairment to the presence of pedestrian crossings and to provide additional direction guidance. It is generally inappropriate to use devices such as pavement bars or strips within the normal bicycle operating space as they may create a safety hazard for cyclists.

Application of tactile surface treatments

It is appropriate to use tactile surface treatments:

- to alert drivers, cyclists and pedestrians in advance of a hazard or unusual feature
- as a supplementary device when warning or regulatory signs have been ineffective.

Advantages of tactile surface treatments

The advantages of tactile surface treatments include:

- they are relatively low cost to install
- they can be useful where sight distance to signs is limited
- they are effective in alerting drivers, cyclists and pedestrians to hazards.

Disadvantages of tactile surface treatments

The disadvantages of tactile surface treatments include:

- they cause a change in the intensity of traffic noise
- stability problems may occur for motorcyclists and cyclists if placed on small radii curves due to differential skid resistance
- the buttons and bars may damage and involve high maintenance
- they are not as effective in reducing speeds as some other devices such as road humps
- they may impact on channel drainage.

Examples of tactile surface treatments

Examples of tactile surface treatments are illustrated in Figure 7.30.

Figure 7.30: Examples of tactile surface treatments

City of Perth, Western Australia

City of Monash, Victoria

City of Yarra, Victoria

City of Perth, Western Australia

7.5.10 Bicycle Facilities

Description of bicycle facilities

Bicycle lanes (Figure 7.31) are not often needed in local areas where the speed environment is low and the mixture of bicycle and vehicle traffic works well together.

Advisory treatments are provided to indicate or advise road users of the potential presence of cyclists and of the location where cyclists may be expected to ride on the street. They consist of pavement markings and warning and guide signs, and as such have no regulatory function. As with bicycle/car parking lanes, collisions between cyclists and opening doors of parked cars are a significant concern to cyclists.

Bicycle bypasses provide a safe and comfortable mechanism for cyclists to bypass devices. They are desirable where there is a need to separate cyclists from other traffic to make routes more attractive for travel, or to avoid squeeze points, adverse surface conditions, and other obstacles. The design of bicycle bypasses should be done in such a way that they take the cyclist past the device to a separated space or they allow safe reintegration with motorised traffic.

Figure 7.31: Bicycle lane example

Other bicycle facilities that may be appropriate in a local area include contra-flow bicycle lanes, wide kerbside lanes, bus/bicycle lanes, and supplementary street treatments.

Further information on the provision and design of bicycle lanes, advisory treatments, bypasses and other facilities is provided in the *Cycling Aspects of Austroads Guides* and various parts of the Austroads *Guide to Traffic Management* and *Guide to Road Design*.

Application of bicycle facilities

It is appropriate to use bicycle lanes, advisory treatments, and bypasses:

- where there is a significant difference in the speed of vehicular and bicycle traffic (i.e. > 20 km/h)
- where it is desirable to separate cyclists from other traffic (e.g. for reasons of safety)
- anywhere cycling needs to be encouraged, e.g. along major routes near town or city centres.

It is inappropriate to use bicycle lanes, treatments and bypasses where it will restrict the movement of buses or significantly reduce the safety of other road users.

Advantages of bicycle facilities

The advantages of bicycle lanes, advisory treatments and bypasses include:

- increase in cyclist safety
- improvement in accessibility and connectivity of the bicycle network
- they can be used to narrow the width of traffic lanes
- they promote the use of alternative modes of transport.

Disadvantages of bicycle facilities

The disadvantages of bicycle lanes, advisory treatments and bypasses include:

- separate facilities may be expensive
- facilities may be incompatible with other LATM devices.

Examples of bicycle facilities

An example of a bicycle lane is illustrated in Figure 7.31. Examples of bicycle bypasses are illustrated in Figure 7.32.

Figure 7.32: Examples of bicycle bypasses

City of Gold Coast, Queensland *City of Unley, South Australia*

7.5.11 Bus Facilities

Description of bus facilities

Bus-only links or lanes, bus-modified traffic control devices or bus bypasses of treatments are designed to accommodate buses and provide a special priority to bus services. Measures to facilitate bus travel should involve the removal or reduction of unnecessary impediments to a safe, comfortable, and undelayed bus journey, while ensuring that road safety is not reduced. Measures and treatments may include the modification of traffic control devices, no-turning exemptions for buses, bus-only streets, queue jumps, or facilities allowing buses to bypass LATM devices.

Application of bus facilities

When designing LATM devices on bus routes the following should be considered:

- As noted in Section 8.13.2, local guidelines and legislation should be conformed to.
- Devices on bus routes should be safe and comfortable for passengers and should not cause damage or turning problems for buses.
- The location of devices should be coordinated with bus stops to minimise delays.
- Where road humps are introduced on bus routes, consideration should be given to the use of cushions or flat-top road humps rather than round profile road humps.
- It is important to restrict kerb-side parking near road cushions to allow buses to straddle the device.
- The carriageway should be more than 7.4 m wide at intersections to allow bus turning movements.
- Roundabouts on major bus routes can be designed with mountable aprons.
- Where general traffic is restricted from turning or travelling into a street, the provision of an exemption for buses will ensure bus service continuity without delays.
- Where numerous LATM devices are installed on a bus route, facilities such as bus entry or turning exemptions, alternative route/lane arrangements can provide significant comfort and travel time improvements for buses.

Advantages of bus facilities

The advantages of bus-only links/bus-modified traffic control devices/bus bypasses of treatments include:

- facilitation of the comfortable passage of buses
- reduction in discomfort for bus passengers
- provision of priority to buses relative to other traffic
- minimisation of delays and travel time for buses
- minimisation or elimination of damage to bus sumps or gearboxes from travelling over raised devices.

Disadvantages of bus facilities

The disadvantages of bus-only links/bus-modified traffic control devices/bus bypasses of treatments include:

- they are relatively expensive
- they may increase delays for other traffic
- non-compliance can be an issue where bus use is low
- they may impede the movement of other road users.

Examples of bus facilities

Examples of a bus-only link and a bus lane are shown in Figure 7.33 and Figure 7.34 respectively.

Figure 7.33: Example of a bus-only link

City of Stirling, Western Australia

Figure 7.34: Example of a bus lane

City of Sydney, New South Wales

7.6 Alternative Treatments

Physical LATM devices are not always the best or most feasible option available in terms of managing traffic in local streets. The LATM strategy development process should check to see if there are alternatives that could be considered first.

Education and community advertising as well as context sensitive urban design and landscaping practices are commonly employed. New psychological approaches such as ‘naked streets’ and ‘self-explaining streets’, and also community reward programs have become popular in some areas. The City of Stirling in Western Australia for example reports (2013) using a variety of programs, such as bin stickers and the council’s ‘safe speed promise’ program.

Reinforcing a low speed environment by giving the street back to families and thereby carefully using the presence and activities of people in the street to encourage good driving behaviour can be very effective. This is particularly so where streets have mixed land uses that support a very active environment for large parts of the day.

Other alternative treatments include:

- arterial road improvements to enhance capacity or to manage turns more effectively
- change the image or place function of the street
- encouraging more active roadsides
- careful location of intensive traffic generators
- use of variable message signs
- smart travel programs
- vehicle trip reduction
- police presence/speed enforcement/speed cameras
- use of neighbourhood pace cars
- intelligent transport systems including in-car speed limiting technology
- speed overrides.

8. Design Considerations for LATM Schemes

When it is desired to change the local street environment to be more sympathetic to the needs of local residents, a carefully thought out approach is required. Wide, long carriageways and high design speed environments encourage high vehicle speeds and present a greater potential for conflict, which are incompatible with the multipurpose function of residential streets. An objective of local area traffic management should be to create a street layout arrangement that is self-regulating in terms of traffic behaviour.

The success of a traffic management scheme can be greatly affected by the appropriateness of specific design considerations. It will also depend on the detailed design of the various devices being correct both individually and in combination. Figure 8.1 illustrates one example of the type of design conditions that must be considered when implementing LATM in Australia and New Zealand.

Figure 8.1: Slow point in Christchurch, New Zealand after a snow fall

The design of LATM devices would not normally proceed until after a particular scheme has been formally adopted by council. Nonetheless, there are a number of general considerations that apply to the selection and design of LATM devices that must be kept in mind. These include:

- design speed and design vehicle
- minimum and maximum grades
- location and spacing of devices
- appropriateness of the gradient
- allowance for cyclists and pedestrians (including people with disabilities)
- allowance for other road users such as public transport, commercial and emergency vehicle users
- lane and carriageway widths
- surface drainage requirements
- provision for underground utilities
- maintenance provisions
- construction materials
- climatic conditions
- visibility requirements
- critical dimensions
- suitability of the type of device
- signs and linemarking requirements
- the need for temporary installations
- provision of landscaping.

The design of treatments should meet the general requirements of function, appearance and safety. In addition, the selection, placement and design of treatments should have regard to the needs of all road users including users of buses and emergency vehicles, people with disabilities and mobility impairment, and other pedestrians and cyclists.

Many devices introduce additional complexities for cyclist/pedestrian/driver interaction and separation in the vicinity of treatments may be desirable. Some devices can be quite problematic for cyclist and pedestrian safety particularly where speeds are even moderately high or when speeds or volumes on intersecting roads are significantly different to each other. A basic premise of the design should be that all new or modified traffic control devices should enhance the amenity of the area and should aim to make the street safe and accessible for everyone irrespective of their level of ability or mode of transport.

Australian Standard AS 1742.13 – 2009 *Manual of Uniform Traffic Control Devices – Part 13: Local Area Traffic Management* provides specific details on the design of individual LATM devices. Additional details on the form, construction and location of devices to maximise their inherent safety are provided in the sections that follow and in the Austroads *Guide to Road Design*.

8.1 Placement and Nature of Devices

The following principles should generally be followed when determining the placement and nature of devices:

- The location of a treatment in the street should ensure that no device is encountered unexpectedly or in an environment in which drivers are likely to be travelling above a safe speed at which to negotiate the device.
- Devices should be chosen to be consistent with the target speed environment at that location. LATM devices are consistent with a 50 km/h or lower speed limit.
- The first device encountered in a street should be placed where it can be clearly seen and speeds are naturally low (AS 1742.13 – 2009).
- LATM has been advanced largely by innovation and experimentation. Every type of treatment, no matter how familiar elsewhere, is 'new' the first time it is tried in a locality. Unconventional or unfamiliar treatments need to be carefully designed and implemented.
- The design aim should be that the type of treatment and the required action is clearly apparent to approaching drivers.
- The potential for deliberate and accidental violations, leading to risky behaviour, should be considered.

8.2 Forgiving Design

There are a number of principles for forgiving design consistent with a Safe System:

- All physical devices should be designed in such a way as to minimise damage to vehicles that fail to negotiate them in the correct manner.
- Semi-mountable kerbs, frangible signs, hazard markers and other similar forgiving treatments should be used. Semi-mountable kerbs should be used in preference to barrier kerb except where pedestrian safety at a device requires a barrier kerb.
- Electricity supply poles and other road furniture that are located close to the kerb, especially on the departure side of LATM devices, should be relocated or protected.
- Landscaping materials and features, such as walls, rocks and other solid items, should be carefully located so as not to be hazards. The safety needs of drivers accidentally deviating from their proper path and the need to control drivers' deliberate abuse of devices (e.g. by drivers manoeuvring the wrong way around them) should be carefully balanced.

8.3 Spacing of Devices

In Section 3.3.2, providing guidance on device spacing, it was noted that LATM devices should not be spaced too far apart if they are to exert an influence on speeds along the whole street. AS 1742.13 recommends that device spacings should be in the range of 80–120 m. Refer to Section 3 and Commentaries 13 and 14 for more information on speed-based scheme design.

8.4 Device Deflection

Devices should be designed in terms of their location and form such that the horizontal or vertical deflection caused by the device reduces the 85th percentile speed at the device below 40 km/h in all cases. Many devices like driveway links and angled slow points should preferably be designed such that the angle of deflection through the device will safely reduce vehicle operating speeds at the device down to between 10 and 20 km/h. However, if this is done, care needs to be taken to ensure that the speed differential on the approach to the device is not greater than 20 km/h. Additional information on speed-based design is given in Section 3 and Commentaries 13 and 14.

8.5 Design Vehicles and Checking Vehicles

Devices are required to be designed using the appropriate design vehicle and checking vehicle (Austroads 2013a) for the function of the road or street. In a local access street generally this will be some form of rigid truck, e.g. a garbage or furniture removals truck. When considering a collector street or a bus route, a different design vehicle and checking vehicle may be required than for an access street. In all cases the design vehicle must be able to negotiate the entirety of the scheme without mounting kerbs or encroaching into dedicated pedestrian spaces. The checking vehicle can be allowed to mount kerbs and go on the wrong side of islands if needed. However, where possible, an easily identifiable and accessible alternative route to each property should be used. It should be noted that when the appropriate design vehicle is applied together with 'device deflection' and spacing requirements, some devices will not be suitable on bus routes or collector roads. For example, it may not be possible to design a roundabout with enough deflection for it to operate safely and with adequate speed reduction, while still accommodating a design bus, especially if the bus is executing a right turn. In that case, other devices will have to be considered and they may need to be located at different positions along the road. Refer to Sections 2.4.1 and 8.12 for more information.

8.6 Gradients

Grades at intersections are generally more critical than at mid-block locations because drivers may need to come to a complete stop after traversing an LATM device on the approach to an intersection.

LATM devices should not generally be installed on roads with a longitudinal grade greater than 3%. Where there is no reasonable alternative available, a maximum of 10% longitudinal road grade may be acceptable providing that any devices are not installed in isolation, all risks have been identified and appropriately addressed, and the treatment can be justified.

Installation of LATM devices on grades steeper than those indicated above is not generally considered acceptable but may be justified in extreme circumstances where safety would otherwise be compromised providing that a comprehensive risk management assessment process is conducted and all necessary requirements are appropriately addressed. Factors to be taken into consideration are road type and width, horizontal and vertical alignment, speed environment, vehicle types using the road, terrain, etc. In these cases before and after studies should be conducted (including road safety audits and speed monitoring) to verify the safety and effectiveness of the treatment.

8.7 Colours and Textures of Materials

Materials should be sympathetic to the desired streetscape and environment. To clearly distinguish between facilities for different road user types the following road pavement colours should generally be adopted in Australia:

- Red: bus lanes, bypasses and other on-road bus facilities
- Green: cycle lanes, bypasses and other on-road cycling facilities
- White: linemarking and dedicated on-road pedestrian facilities.

In New Zealand a road controlling authority may provide a contrasting colour or texture to that of adjacent lanes to discourage use of special vehicle lanes by other drivers. While no specific colours are prescribed, there is general consensus that if a contrasting surface treatment is to be used for on-road bus and bicycle facilities that it be green (Figure 8.2).

Figure 8.2: Example of the green coloured bus facilities used in New Zealand

The texture of pavement materials used in LATM treatments should have good skid resistance properties and should contrast with the adjacent roadway so as to complement the visual impact of the device. Where there is an interaction of pedestrians and vehicles such as the case with pedestrians crossing at intersections, the colour and texture of the road surface treatment must not be the same as the adjacent footpath, especially if the treatment incorporates a flat-top road hump or a raised pavement, as it may be confused for a formal pedestrian crossing facility. Care also needs to be taken to ensure that flush surface treatments (e.g. threshold treatments) do not create confusion in relation to road user priority.

Tactile surface treatments should be used if there is no level difference where the pedestrian footpath meets the road to differentiate the edge of the roadway, particularly for people with sight impairment.

8.8 Lane Widths

Care needs to be taken that the introduction of LATM treatments that narrow the road carriageway width do not create safety problems for cyclists.

Practice should be that lane widths are either designed to be wide enough in all instances to allow the safe passage of a cyclist and a vehicle side by side (3.7 m or more) or narrow enough to permit the passage of a vehicle or bicycle only (3.0 m or less). Widths in between these two extremes create squeeze points and result in conflicts.

Local streets with speed environments of 50 km/h or more should be 4.2 m or wider in order to be satisfactory for cyclists. In higher-speed environments, lane dimensions should be 4.3–5.0 m (see the *Guide to Road Design Part 3: Geometric Design*).

In local streets where the speed is 30 km/h or less it is generally preferable to adopt lane widths of 3.0 m or less. In these cases there is no side by side travel and instead the cyclist will occupy the whole lane. However, narrow lane widths (3.0 m or less) should not be promoted where significant numbers of child or inexperienced cyclists are likely to occur, as it would be inappropriate from a safety perspective. In these instances off-street bicycle paths should be considered to physically separate cyclists from vehicles.

Where the demand warrants it and it can be accommodated, separate facilities for cyclists such as bicycle lanes may be provided. It should be noted that the sharing of lanes cannot be legally performed in all states.

Wider lane widths (acceptable 3.7 m, desirable 4.2 m or more) should generally be used on roads with bus routes or that carry a reasonably high proportion of commercial vehicles. Kerbside lane widths in excess of 4.2 m should be avoided where kerbside parking demand is high to limit the possibility of moving and parked vehicles sharing the same lane.

8.9 Sight Lines

Devices should be designed so that drivers can recognise and react to them appropriately in terms of both the approach speed and alignment. Issues to be considered to ensure visibility is high include:

- Roundabouts: There should be a clear view of the approach splitter island, the central island and the circulating roadway from a distance of 40–70 m, depending on the road function and entry speed, to ensure that there is sufficient stopping distance. At the give-way line, the driver should have a clear sight of traffic approaching on the right. There is some evidence to suggest that the safety of roundabouts can be improved by restricting the sight distance on the approach to the roundabout (but still ensuring adequate sight distance close to the give-way line) as this tends to encourage slower approach speeds (see the *Guide to Traffic Management Part 6*: *Intersections, Interchanges and Crossings*).
- On other treatments, adequate sight lines should be maintained for oncoming traffic (particularly at single-lane devices) while keeping in mind the form and landscaping of these treatments can be used to reduce the apparent scale and length of the street to induce lower speeds.
- Adequate sight lines for pedestrian and cyclist safety must be ensured (see the *Guide to Traffic Management Part 7: Traffic Management in Activity Areas* and the *Guide to Traffic Management Part 13: Road Environment Safety).*
- Landscaping should be maintained so that it does not impact upon visibility particularly for pedestrians.
- Devices should only be installed where there is adequate street lighting. In addition, all street features and road furniture should be delineated for night-time operation (see AS/NZS 1158 – Set: 2010, *Lighting for roads and public spaces* and the *Guide to Traffic Management Part 13: Road Environment Safety*).

Provision for sight distance should generally be consistent with the requirements of Austroads *Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings* for an urban environment. This would normally mean that up to 60 m stopping sight distance needs to be provided on the approach to LATM devices.

8.10 Conspicuity: Signs, Marking and Lighting

The conspicuity and legibility of treatments is critical to their safety and functionality. Night-time visibility under poor weather conditions should be the basis of the scheme design. When designing LATM devices, consideration must be given to providing adequate road marking, signing and lighting to support the device's purpose.

Signs

Signs and delineation should conform to AS 1742.13 and any requirements current in each jurisdiction. Appropriate signs should be used at entry points to a local area.

Signs should be kept to the minimum necessary. If a device is part of an area-wide scheme, certain signs and markings may be omitted (AS 1742.13: Section 3.2). These, and the conditions under which they may be omitted, are described in AS 1742.13. If a device is found to require substantial signs to guide drivers, 'thought should be given to simplifying the device' (AS 1742.13: Section 3.2).

Other aspects that should be considered include:

- Signs must be reflectorised or illuminated.
- Adequate vertical clearance to signs should be maintained over pedestrian spaces (2.3 m).
- Existing street furniture may be used for the mounting of signs.

All legal requirements regarding procedures and approvals for signs in the jurisdiction should be observed.

Delineation and marking

Raised reflective pavement markers and/or linemarking should be used to delineate vehicle paths but should not be used within the bicycle operating space. The noise created by vehicles running over pavement markers may also need to be considered.

Bollards with reflectors will help to highlight the presence and shape of an LATM device.

Differential kerb materials help to highlight the edges of an LATM device. Darker materials such as bluestone or coloured concrete require extra attention with reflective markers.

Lighting

The intensity of lighting in the area surrounding an LATM device should be provided to at least AS/NZS 1158 – Set: 2010 standard. Adequate shielding should be provided to minimise disturbance to adjacent occupiers.

Within the limits set by spacing requirements, LATM devices may be placed at existing light positions to minimise the need for additional street lighting. However, locations of existing lighting poles should not be allowed to adversely affect the functionality of the devices. In this respect, care should be taken not to increase the road safety risk by installing lighting poles adjacent to the kerb on the departure side of horizontal deflection devices.

8.11 Landscaping and Planting of Treatments

The landscaping component of an LATM scheme will play an important role in the acceptability, performance and safety of the scheme. Suggested safety objectives of landscaping of LATM treatments are:

- Landscaping should reinforce the idea to drivers that the street is ‘special’ and different to a traffic route.
- Landscaping should be used to improve safety by reinforcing the need for drivers to change direction in the case of slow points, closure of the street image, or providing a contrasting background to a sign.
- Landscaping should create visual continuity, reinforce the local nature of the area and the local function of the street.
- Landscaping should increase safety by reinforcing vehicle and pedestrian paths, but must not obscure visibility.
- Plants should be chosen in terms of their eventual size and form in relation to these safety considerations, as well as aesthetics, durability, maintenance and watering needs.

The additional costs of landscaping of treatments are stated in Section 3.3.5. However, it should be noted that omission of landscaping, as well as possibly threatening the acceptability of the scheme, might not necessarily increase the safety of the installation, e.g. if approach speeds are increased as a result.

8.12 Catering for Cyclists and Pedestrians

The safety and convenience of cyclists and pedestrians in the general traffic system is usually achieved through various ways of segregation from motor traffic, in time or space: separate lanes and paths, signalised crossing points and other treatments (*Guide to Traffic Management Parts 5* and *6*). However, the free and ubiquitous nature of pedestrian and cyclist movement at the local level means that their total segregation from other traffic is neither desirable nor possible in most cases. Local streets should be attractive and feasible for most pedestrian and cyclist movement, and it is not necessary to provide separation for pedestrians and cyclists in local streets to an excessive manner. Conditions in local streets should therefore cater for the expectation that these different road users may need to share the street space (McClintock 2002). Note, however, that experience has shown that, even in shared streets, there should be a defined footway where vehicles cannot intrude.

An underlying principle of LATM is that conditions should be made better for pedestrians and cyclists, by virtue of the intentions of LATM (particularly speed reduction) (Yeates 2000a, b). The consequences of poorly designed LATM schemes are more likely to impact on cyclists than pedestrians. Although experience in countries such as the Netherlands and Denmark demonstrates the compatibility of traffic calming measures with high bicycle use (Cleary 1991), similar treatments are often criticised in Australia and New Zealand for increasing rather than decreasing risks to cyclists.

The ideal described by Cleary is rarely achieved. Commonly, this is because potential conflicts between bicycles and vehicles are increased but vehicle speeds have not been sufficiently reduced. Close attention should be given to **how** things are done as much as **what** is done.

Whether or not separation of bicycles and other vehicles is required depends on considering all conditions and objectives. Unless speeds are quite low (say < 30–40 km/h) some form of separation for cyclists may be desirable (at least on the designated bicycle network). Separation is more critical at intersections and at devices that deflect the travel path (e.g. slow points) than at uncontrolled mid-block locations. Where mid-block bicycle lanes are provided, they should be carried through these more critical locations. In local areas, especially where there is direct access to abutting development and frequent need to cross roads and streets, on-road lanes are more preferred over off-road paths for cyclists, as cyclists entering or crossing roads, especially the young, are at increased risk.

Bicycle and pedestrian safety considerations should also be included in safety audits of LATM schemes and treatments, at all stages. The needs of mobility impaired pedestrians and people with disabilities should also be carefully considered. The *Guide to Road Design Part 6A: Pedestrian and Cyclist Paths* provides guidance on alignment, width and geometric requirements, and information on the design of treatments necessary for a designer to prepare detailed geometric design drawings.

Additional source material and more detail on this topic can be found in: Bicycle Federation of Australia (1996); Cleary (1991, 1992); CROW (1988); Hawley et al. (1993); ITE (2002); Maher (1990, 1994); Maher and Stallard (1994); McClintock H (ed) +(1996, pp. 20–41); McClintock (2002: Chapter. 5); Main Roads WA (2014); Ove Arup and Partners (1997); Road Data Laboratory (1993); VicRoads (2008); Department of Infrastructure, Planning and Natural Resources (2004); Taverner Research (2009) and many of the jurisdictional guidelines listed in Commentary 1.

8.12.1 Providing for Bicycles in LATM

The main goal of bicycle planning is to provide safe and attractive facilities for riders of all ages and abilities that encourage cycling as a desirable alternative to motor vehicle travel including providing programs that provide for safe and convenient travel by bicycle. The purpose of a bicycle network is to provide the facility for cyclists of a wide range of abilities and experience to move safely and conveniently to chosen destinations via suitable routes.

Consideration of cyclist needs should be an integral part of the LATM planning and design process rather than treated as a supplementary or post-design check. Cyclists' needs can be expressed in terms of four requirements (Maher & Stallard 1994):

- *Enhanced cycling access* – by linking safe cycling streets to form continuous through-routes for cyclists, and by improving crossing points across main roads.
- *Enhanced safety of cycling* – by restricting the speed, volume and movement of motor vehicles, without introducing additional hazards for cyclists.
- *Enhanced convenience of cycling* – by providing new, safe cycling opportunities and short cuts to destinations.
- *Maintenance of continuity of bicycle routes* – by ensuring uninterrupted bicycle passage through local streets, and by ensuring bicycle access through full or partial road closures.

Clearly, the needs of cyclists (and pedestrians) should be considered in the planning of LATM schemes and in the detailed design of treatments. The most credible approach for assessing on-road bicycle facilities is based largely on a consideration of kerb lane width and traffic speed, taking into account other factors such as number of commercial driveways, number or heavy vehicles, parking turnover and the quality of the road surface.

The sources noted at the end of this section offer guidance on the planning and design of LATM schemes in ways that acknowledge bicycle requirements.

The design guidance given in the following sections should be kept in mind in the treatment, selection and design process (see also the *Guide to Road Design Part 3: Geometric Design of Roads* and the *Guide to Road Design Part 6A: Pedestrian and Cyclist Paths*).

When considering the type of bicycle facility, such as bicycle lanes or shared use paths, the two guiding principles are separating cyclists from motor vehicles and providing a high level of priority for cyclists across driveways and through intersections (see the *Guide to Traffic Management Part 4: Network Management*).

Separation of cyclists from motor vehicles is not always required on local and collector roads that have traffic volumes less than 5000 vpd and speeds less than 40 km/h. In these circumstances, it is considered appropriate that adult cyclists may share the road with motor vehicles and younger cyclists may use the footpath where this is supported by appropriate road rules. However, where space permits, it is still important to consider the provision of a separated bicycle facility such as a bicycle lane or shared use path.

Design considerations

There are three design issues that the treatment selection and design of LATM should take into account:

- bicycle/vehicle conflict
- bicycle/pedestrian conflict
- bicycle service and comfort.

When adapting the traffic environment, keep in mind:

- the dynamic characteristics of the bicycle and rider, which may vary widely according to age, bike type, experience, skill, etc.
- the seven broad categories of cyclists and their very specific needs; the categories include:
  - primary school children
  - secondary school children
  - recreational cyclists
  - commuter cyclists
  - utility cyclists
  - touring cyclists
  - sports cyclists in training
  - (Refer to the *Guide to Traffic Management Part 13: Road Environment Safety*)
- it will often be necessary to provide separate facilities for different groups of cyclists
- the sometimes aggressive, and often inconsiderate, attitude of drivers towards cyclists
- the youth and inexperience of many local street cyclists, who are nevertheless a legitimate part of the traffic system.

General requirements

The following aspects of good LATM design and maintenance are especially important for cyclists:

- Avoid placing speed control devices in isolation.
- Position devices sufficiently closely together to deter unnecessary acceleration and braking.
- Provide bicycle bypasses of devices
  - where closely spaced devices could detract from the attractiveness of the route for cyclists
  - where there is a significant difference in the speed of vehicular and bicycle traffic
  - where it is desirable to separate cyclists from other traffic
  - anywhere cycling needs to be encouraged.
- Provide clear signs and visibility.
- Provide adequate street lighting.
- Aim for a speed environment that is sympathetic to cyclists as well as other road users.

Route continuity

LATM can be used actively to improve bicycle route connectivity and continuity. It certainly should not hinder cyclist or pedestrian movement. Provision should be made for cyclists through street closures and other treatments that block some or all motorised traffic. Where bicycle routes cross traffic routes, islands and refuges should be wide enough to shelter bicycles safely.

Vehicle speeds

Most of the concern about risks and impediments to cyclists arises from the excessive speed of motor vehicles when they come in close proximity with bicycles. If motor vehicles are not travelling faster than bicycles then spatial separation is less critical and therefore integration of bicycles within the traffic stream is appropriate.

Therefore, the most important contribution to pedestrian and cyclist safety and amenity in local streets comes from effective reduction in vehicle speeds, requiring concerted application of all the relevant advice in this Guide. This means aiming at speeds below 40 km/h rather than above 50 km/h, for all vehicles, if a compatible speed environment is genuinely sought. See, for example, Bicycle Federation of Australia (1996), which argues for maximum speeds of 30 km/h in a cycling environment unless other measures are provided.

Isolated treatments encourage fluctuating speeds, which in turn expose cyclists to greater risk. LATM treatments should aim to encourage lower and more consistent speeds along the street (Section 2).

Sometimes the speed of cyclists may be a problem. While cyclists need to be able to maintain momentum, they should not expect to ride at high speed through traffic-calmed areas (especially shared zones) where the intention is to create a low-speed environment.

Surfaces

Cyclists need smooth and sufficiently wide surfaces. Treatments should avoid creating:

- leading edges (to humps and changes in materials) that stand proud of the road surface
- longitudinal ruts, grooves, grates or edges that may trap a bicycle wheel, especially when cyclists are directed to travel near the kerb
- any surface that might destabilise a bicycle or provide poor skid resistance
- surfaces that may cause severe grazing in the event of a fall.

Areas for cyclists that are likely to accumulate debris should be regularly swept. Inaccessible spaces that cannot be easily maintained should be avoided.

Squeeze points and roundabouts

Squeeze points and locations where drivers may attempt to negotiate severe deflections at excessive speeds, exposing cyclists to vehicles at higher speeds, should not be created. The number of squeeze points in general should be minimised, and their visibility maximised.

Wherever possible, LATM schemes should be designed so that the speed of motor vehicles in a street will not be appreciably higher than that of bicycles, and cyclists can use the road space safely and comfortably on equal terms. Particularly under low traffic volumes and speeds, it is appropriate that the lane width be designed such that it is narrow enough to only allow the movement of a motor vehicle or a bicycle but not both side by side (i.e. less than 3 m). The placement of a bicycle pavement symbol in the middle of the travelled way helps to alert drivers to the fact that a cyclist may expect to use the lane.

Where possible, especially on streets with moderate to higher traffic flows and/or speeds or where the above conditions cannot be met, cyclists should be provided with a means to bypass squeeze points such as angled slow points. It is preferable for bypass treatments to remain on the road surface to avoid creating additional give-way issues. Where bypasses are incorporated into the design:

- there should be adequate clearance to obstacles
- they must not lead cyclists into hazardous situations
- they should join smoothly with the road surface
- they should be designed in a way that will enable them to be kept clean
- parking will need to be banned in the vicinity of the device to permit easy access through it, or the bypass will need to be angled back towards the road so that it emerges beside on-street parking rather than at the kerbside and reliant on parking compliance.

Roundabouts are a common, and often problematic, form of squeeze point in local streets. They improve safety for drivers but may decrease safety for pedestrians and cyclists (Cleary 1991, Robinson 1998), and designers should strive to design roundabouts to provide an acceptable level of safety for cyclists. While these concerns are a practical consideration mainly on more frequently-trafficked streets (where there is a realistic probability of a cyclist meeting motor vehicles at a roundabout and having to share the circulating roadway with them) there is a high level of concern among cyclists about smaller roundabouts (Cleary 1991, pp. 9). The same principles for all squeeze points apply: either separate cyclists from drivers, or scale down the roadway so that sharing of the lane is not possible, and the cyclist occupies the lane. This will require careful attention to approach speeds and geometry, and speeds through the roundabout. A cyclist is able to negotiate most roundabouts in tight intersections at a higher speed than motor vehicles, but is more exposed where the geometry is eased to allow for buses and other larger vehicles.

Failure of drivers to perceive and give way to cyclists in roundabouts is commonly reported, and is a symptom of a wider problem for cyclists in the traffic network. LATM programs should include education and physical prompts to remind drivers of their obligations to other road users in local streets.

Information on the selection and design of roundabouts and related issues on cycling is contained in Cycling aspects of Austroads guides, the *Guide to Road Design Part 4: Intersections, Interchanges and Crossings*, Section 5.3 of the *Guide to Road Design Part 4B: Roundabouts* and the *Guide to Traffic Management Part 12: Traffic Impacts of Developments*.

Path Design Criteria

Information on the path design criteria for bicycles is contained in the *Guide to Road Design Part 6A: Pedestrian and Cyclists Paths*.

Interaction with parking

Where there is a high demand for parking, and the street is wide enough and it can be done safely, space should be allocated to accommodate parked vehicles, an operating space for cyclists, and adequate clearance to accommodate the opened door of parked vehicles.

With parallel and angle parking, bicycle lanes should be constructed in accordance with the layout details shown in the *Guide to Road Design Part 3: Geometric Design.*

Vertical devices

While there is some debate about this among cycling advocates, there is generally a preference for vertical speed control devices with smooth and gradual surface transitions rather than horizontal devices that create squeeze points. Flat-top road humps with ramps of 1:15 to 1:20 relative to the gradient of the road are generally regarded as bicycle friendly. Side slopes across the line of travel should not be severe. Transitioned ramps (such as sinusoidal humps) are recommended (Webster & Layfield 1998). Greater downhill speeds should be anticipated when considering humps on grades.

Factors to be considered with respect to horizontal and vertical alignment, gradients, cross-section and clearances are provided in Section 4.8 of the *Guide to Road Design Part 3: Geometric Design*.

Additional source material and more detail on this topic can be found in: Austroads (2014a) and RTA (2005).

8.12.2 Providing for Pedestrians in LATM

Many of the network planning considerations for cyclists (Section 8.12.1) also apply to pedestrian networks. The design of LATM treatments and street changes should, as much as possible, aim to improve pedestrian amenity, convenience, and safety. In addition, LATM may be considered as part of a pedestrian plan, or conversely pedestrian policies may guide the selection, location, and design of LATM treatments (RTA 2002). In general, measures that reduce vehicle speeds will improve conditions for pedestrians. Other principles are:

- Integrate LATM into pedestrian networks and plans, e.g. safe routes to school.
- Reduce roadway widths at points where pedestrians may cross, and other places where pedestrians are exposed to traffic.
- Provide clear sight lines between drivers and pedestrians.
- Avoid confusion and make clear who has priority and what behaviour is expected of both pedestrians and drivers at points of conflict (e.g. where to cross and where not to cross, etc.).
- Create conditions such that drivers choose appropriate speeds at points of conflict.
- Pedestrian paths along and across streets (including refuges) should be of adequate width and surface quality.
- Pedestrian considerations should be a key part of safety audits at all stages of the process.
- The speed difference between cyclists and pedestrians can be quite high, and collisions between pedestrians and cyclists can be serious for both parties. The design should provide adequately for both groups of road users.
- Care needs to be taken not to locate flat-top road humps in the vicinity of pedestrian thoroughfares, as pedestrians may incorrectly perceive the presence of such a device as giving them priority over vehicles. Kerb ramps and pedestrian refuges should not be incorporated in the design and pedestrian footpaths should be physically separated from the device through the application of landscaping or other means. Use of special textures/colours on the raised pavement may also be inappropriate where vehicle priority is unclear.
- Although speeds are expected to be low in shared zones and other streets where pedestrians and vehicles share the same space, experience has shown that encouraging drivers to use the centre part of the street to leave room for pedestrians is generally desirable for the young and the elderly.

Other design aspects related to specific LATM treatments are mentioned in Section 7.

Information on the design criteria for pedestrian paths is contained in Section 6 of the *Guide to Road Design Part 6A: Pedestrian and Cyclists Paths*.

Additional source material and more detail on this topic can be found in: AS 1742 – Set: 2014, AS 1428 – Set: 2010 and in the jurisdictional guidelines listed in Commentary 1.

8.13 Catering for Emergency Vehicles, Buses and Trucks

Designs that allow for larger vehicles will not be as effective in controlling car speeds. Catering for legitimate large vehicles without compromising the speed-control objectives will require skilful planning and design, and some degree of trade-off.

Plans do not always have to allow for the largest conceivable vehicles. Deliverers and service providers may have to be alerted to the need to use smaller vehicles (e.g. for furniture removal and garbage collection). There may be operating cost implications that need to be taken into account in evaluation.

Advance warning signs should be provided in order to discourage large vehicles from entering areas where devices are difficult to negotiate.

Design templates and guides should be used to ensure that design vehicles, including modern low-floor buses, can pass through or across devices.

Consultation with bus and emergency services agencies is a necessary part of the planning and design process.

Road cross-sections and parking control at and near LATM devices should take account of the needs of emergency vehicles (especially fire trucks), buses and commercial vehicles.

The following sources contain additional material on this topic: Ewing (1999a: Chapter 7), Hawley et al. (1993), VicRoads (1999b).

8.13.1 Providing for Emergency Services Vehicles in LATM

Emergency services commonly express concerns about the impacts of speed control devices on turn-out times. Reported research (e.g. Ewing 1999a) shows that the delay per slow point or road hump is generally well below 10 seconds. The delay at each road hump is reported to be between 3 and 5 seconds for fire trucks and up to 10 seconds for an ambulance with patient (ITE n.d.). It should be possible to calculate the increase in response times for a given proposal, and compare this with the current response time and with the target times. The issue is not whether the slow points add to the turn-out time, but whether the required turn-out time targets are met to all parts of the service area while improving general traffic safety and amenity for the neighbourhood. Other studies have shown that road humps caused less severe impacts.

Recommended elements of a process to address emergency services concerns are:

- Consult with the responsible agencies, particularly at the early stages of investigation and planning.
- Focus on the actual rather than claimed effects of speed control devices (i.e. have the factual evidence before you).
- Recognise designated response routes and minimise restrictive devices on those routes where possible.
- Ensure (by design template checks and so on) that essential vehicles can gain access to all properties at reasonable speed. This may involve wrong-way movements at roundabouts and displacement of signs and bollards in emergencies.
- If possible, implement treatments in stages so that the impacts can be observed and modified if needed.
- Select treatment types and designs, including innovative treatments such as road cushions that help to meet emergency services concerns.
- Re-design treatments where possible in response to realistic emergency services submissions.
- Create informed public opinion about the benefits that offset any marginal increases in turn-out times.

Emergency response routes are likely to be potential or actual bus routes, be feeder routes to schools and other local facilities, and also are likely to be the more important traffic collector streets in the neighbourhood. They will therefore generally be among the streets with the greatest problems and challenges. While restrictive devices are generally inadvisable on streets with high emergency vehicle volumes such as an access to a fire station, doing nothing on these streets may not be an acceptable option. It may be appropriate to consider these streets for non-physical speed enforcement measures such as speed cameras (manned or unmanned), lane reduction and speed advisory devices.

The effect of vertical displacements on patients is the main concern for ambulance operators. While vertical accelerations will be generally no greater than those encountered in normal operation on the road system if ambulances traverse devices at an appropriate speed, it is advisable not to place vertical displacement devices on streets frequently used by patient transport vehicles.

The following source contains additional material on this topic: VicRoads (1999a: Chapters 1, 8 and 10).

8.13.2 Providing for Buses in LATM

Buses present LATM design issues such as manoeuvrability and occupant comfort. In addition, speed control along portions of bus routes may affect schedules and fleet management.

As a general rule buses must be able to negotiate all LATM devices situated on bus routes and access routes to schools. Bus operators should be consulted prior to the design stage and their written agreement obtained to the proposed devices. On bus routes, from a bus service perspective, horizontal deflections are generally preferred over vertical deflections as they provide less discomfort to bus passengers.

Some jurisdictions have rules governing the use of single-lane devices on bus routes and angled devices that require buses to occupy the full width of a roadway. Bus-only links are generally regarded as desirable and have been the subject of technological development (refer to Section 7).

State regulations and guides should be consulted to determine local requirements. Some of these are noted in the following discussion of roundabouts and humps on bus routes.

Roundabouts on bus routes

Roundabouts appear to be generally acceptable to bus operators, with the literature focussing on the need for careful design and consultation. However, they are not universally favoured in all jurisdictions.

The *Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings* is the primary reference document for the design of roundabouts in local streets. All roundabouts should be designed in accordance with the principles outlined in that Guide.

Additional information on the selection and design of roundabouts is provided in Section 7.

Road humps on bus routes

Prevailing state regulations or operator requirements may prohibit some or all forms of vertical speed control devices. Where road humps are permitted on bus routes, they should in general conform to the research-based indicators except where jurisdictional requirements differ:

- Round profile (Watts profile) road humps should have a maximum height of 75 mm.
- Flat-top devices on bus routes will generally need to have flatter ramps than the 1:12 to 1:15 ramps required to bring car crossing speeds down to a required level. This will mean a degree of compromise. In these cases, a platform length of 6 m or more, a platform height of 75 mm, and a ramp gradient of 1:20 are recommended essentially preventing the use of flat-top road humps and requiring the use of raised pavements.
- Note that a slightly higher platform of greater length may also work. ARRB research (Jarvis 1992) suggests that a 2 m long ramp on a 100 mm high; 8 m long platform (i.e. 1:20) would provide satisfactory conditions for buses at low speeds, while producing car crossing speeds only some 4 km/h higher than over 1:15 ramps. Note that ramps flatter than 1:15 are also generally regarded as being ‘bicycle friendly’.
- Wombat crossings on bus routes should be treated similarly to flat-top road humps. As such, a minimum platform length of 6 m, a platform height of 75 mm, and ramps with a gradient of 1:20 are recommended. Where buses do not regularly use a street the platform length may be able to be reduced and the platform height increased if acceptable to bus operators.
- Road cushions should be considered on bus routes where other forms of road hump are unacceptable.
- Design variations of both round profile and flat-top humps to create gentle transitions at the points of grade change, such as the sinusoidal hump, may make vertical devices more acceptable in terms of occupant comfort.

Figure 8.3: Combination road hump (Copenhagen)

Combination road humps such as the example in Figure 8.3 have flatter ramps for buses straddling more severe plateau ramps for general traffic (Kjemtrup 1988). Note also provision for cyclists to bypass the narrowed section.

Additional methods to reduce the impact of LATM schemes on bus operations are discussed in *A Guide for Traffic Engineers: Road Based Public Transport and High Occupancy Vehicles*.

The following sources contain additional material on this topic: Brindle and Morrissey (1998), Department of Transport (1992), O'Brien and Brindle (1999), VicRoads (1998, 1999a, b).

8.13.3 Providing for Trucks and Other Larger Vehicles in LATM

Many of the considerations outlined in the previous sections also apply to accommodating large private and commercial vehicles. The needs of service vehicles, especially garbage collection vehicles, will influence the selection and design of devices. Householders will have expectations concerning access for caravans, removalists, deliveries by larger vehicles and others. The selection of a design vehicle should take these expectations into account, recognising that a local street network designed for speed restraint cannot reasonably be expected to allow the passage of all large vehicles that may be in the road system.

The key factors when considering the design needs of larger vehicles are:

- select an appropriate design vehicle
- keep in mind that the larger the design vehicle, the less speed reduction will be achieved
- use warnings signs at the thresholds to the local area to advise drivers of larger vehicles not to enter
- use appropriate design templates, or conduct field trials to establish swept paths, etc.
- consider the use of removable street furniture (bollards, etc.) for occasional large vehicle access
- be careful of poles etc. close to the left edge of the roadway, especially where the cross-fall is significant.

References

Abbott, PG, Tyler, JW & Layfield, RE 1995, *Traffic calming vehicle noise emissions alongside speed control cushions and road humps*, TRL report 180, Transport Research Laboratory, Crowthorne, UK.

Affum, JK & Taylor, MAP 1997, SELATM – a GIS based program for evaluating the safety benefits of local area traffic management schemes, *Transportation Planning and Technology,* vol. 21, no. 1, pp. 93-119.

Amamoo, S 1984, ‘Cost effectiveness of local area traffic management’, *Australian Institute of Traffic Planning and Management forum, Sydney, 25 May 1984*, AIPTM, Sydney, NSW.

AMCORD 1992, *AMCORD urban guidelines for urban housing*, 1st edn, Australian Government Publishing Service, Canberra, ACT.

Andreassen, DC & Hoque, MM 1986, ‘LATM and road safety: accidents in road classes in Melbourne’, *Australian Road Research Board conference, 13th, 1986, Adelaide*, Australian Road Research Board, Vermont South, Vic, vol. 13, no. 9, pp. 17-24.

Australian Road Research Group 1976, ‘Streets not roads: local government symposium proceedings’, *Australian Road Research Board conference, 8th, 1976, Perth,* ARRB, Vermont South, Vic, vol. 8, part 2.

Ashton, NR 1981, ‘Traffic management schemes: local areas’, in KW Ogden & DW Bennett (eds), *Traffic engineering practice,* 2nd edn, *s*ection 5.3, Department of Civil Engineering, Monash University, Clayton, Vic.

Assar, RA & Aburahma, A 1998, ‘Traffic calming in the USA: a critical state-of-the-art review’, *Institution of Transportation Engineers annual meeting*, *68th, Toronto*, *Canada,* ITE, Washington, DC, USA.

Australian Transport Council 2011, *National road safety strategy 2011-2020*, ATC, Melbourne, Vic.

Austroads 1998a, *Cities for tomorrow: integrating land use, transport and the environment: better practice guide*, AP-57-98, Austroads, Sydney, NSW.

Austroads 1998b, *Cities for tomorrow: integrating land use, transport and the environment: resource document,* AP-58-98, Austroads, Sydney, NSW.

Austroads 2000, *Pedestrian and cyclist safety: recent developments*, AP-R155-00, Austroads, Sydney, NSW.

Austroads 2007, *A framework for appraisal and evaluation of travel demand management measures*, AP-R306-07, Austroads, Sydney, NSW.

Austroads 2009a, *Guide to road transport planning*, AGRTP-09, Austroads, Sydney, NSW.

Austroads 2009b, *Impact of LATM treatments on speed and safety*, AP-T123-09, Austroads, Sydney, NSW.

Austroads 2010, *Guidelines for selecting techniques for the modelling of network operations*, AP-R350-10, Austroads, Sydney, NSW.

Austroads 2012, *Managing asset management related civil liability risk*, AP-R412-12, Austroads, Sydney, NSW.

Austroads 2013a, *Austroads design vehicles and turning path templates guide,* 3rd edn, AP-G34-13, Austroads, Sydney, NSW.

Austroads 2013b, *Improving the performance of safe system infrastructure: stage 1 interim report,* AP-T256-13, Austroads, Sydney, NSW.

Austroads 2014a, *Cycling aspects of Austroads guides*, AP-G88-14, Austroads, Sydney, NSW.

Austroads 2014b, *Australian National Risk Assessment Model*, AP-R451-14, Austroads, Sydney, NSW.

Austroads 2015a, *Improving the performance of safe system infrastructure: final report*, AP-R498-15, Austroads, Sydney, NSW.

Austroads 2015b, *Development of the accessibility-based network operations planning framework,* AP-R499-15, Austroads, Sydney, NSW.

Austroads 2015c, *Level of service metrics (for network operations planning),* AP-R475-15, Austroads, Sydney, NSW.

Bendtsen, H & Larson, L 2001, *Noise by humps on roads*, Denmark Transport, Forskning, Lyngby, Denmark.

Bennett, GT & Marland, J 1978, *Road accidents in traditionally designed residential estates*, supplementary report 394, Transport Research Laboratory, Crowthorne, UK.

Bicycle Federation of Australia 1996, *Towards a safe urban speed limit*, BFA, Adelaide, SA.

Brindle, RE 1979, 'Local street planning and management', *Australian Road Research Board (ARRB) regional symposium, 17th, 1979, Perth,* Australian Road Research Board, Vermont South, Vic, pp. 87-116.

Brindle, RE 1983, 'Local street traffic and safety: a perspective', in RE Brindle & KG Sharp (eds), *Workshop on local street traffic and safety, 1980, Sydney, Australia*, research report ARR 129, pp. 1-8, Australian Road Research Board, Vermont South, Vic.

Brindle, RE 1984a, *Town planning and road safety,* Office of Road Safety report CR 33, Australian Road Research Board special report SR 28, Australian Road Research Board, Vermont South, Vic.

Brindle, RE 1984b, 'Traffic and local streets: what are we learning?' *Australian Road Research Board conference, 12th, 1984, Hobart,* Australian Road Research Board, Vermont South, Vic, vol. 12, no. 5, pp. 167-77.

Brindle, RE 1991, 'Traffic calming in Australia: a definition and commentary', *Australian Road Research*, vol. 21, no. 2, pp. 37-54.

Brindle, RE 1992, 'Local street speed management in Australia: is it traffic calming?' *Accident Analysis & Prevention,* vol. 24, no. 1, pp. 29-38.

Brindle, RE 1996, *Living with traffic: twenty-seven contributions to the art and science of traffic calming 1979-1992*, special report SR 53, ARRB Transport Research, Vermont South, Vic.

Brindle, RE 1998a, 'Managing the impacts of traffic on local communities', *National road safety summit, 1998, Canberra, ACT, Australia*, Federal Office of Road Safety, Canberra, ACT, pp. 321-30.

Brindle, RE 1998b, 'Towards guidelines for LATM in different speed environments', contract report CR RC6047-3, ARRB Transport Research, Vermont South, Vic.

Brindle, RE 1999, 'Towards guidelines for LATM in different speed environments', *Road and Transport Research,* vol. 8, no. 1, pp. 92-5.

Brindle, RE 2005, 'Speed-based design of traffic calming schemes', *Institute of Transportation Engineers (ITE) annual meeting, 2005, Melbourne, Victoria, Australia*, ITE, Washington, DC, USA.

Brindle, RE, & Andreassen, DC 1984, 'Where do reported bicycle accidents occur?' *Australian Road Research Board conference, 12th, 1984, Hobart,* Australian Road Research Board, Vermont South, Vic, vol.12, no. 7, pp. 96-109.

Brindle, RE, Cusack, SG, Dods, J, Taylor, MAP & Zito, R 1997, 'Speed control device evaluation: flat-topped raised pavings', contract report CROC6517, ARRB Transport Research, Vermont South, Vic.

Brindle, RE & Lydon, M 1998, 'Speed control device evaluation: summary report and suggested generalised speed profiles', contract report CR OC6517-3 for Austroads project NRS 9531B, ARRB Transport Research, Vermont South, Vic.

Brindle, RE & Morrissey, Z 1998, 'Local area traffic management: review and survey of effectiveness, contract report CR RC6047-1, ARRB Transport Research, Vermont South, Vic.

Buchanan, CD (chair) 1963, *Traffic in towns: a study of the long term problems of traffic in urban areas*, report of the Working Party appointed by the Minister of Transport, HMSO, London, UK.

Bulpitt, M 1995, 'Traffic calming: have we given everyone the hump, or is it just a load of chicanery?' *Highways and Transportation*, vol. 42, no. 12, pp. 8-10.

Cairney, PT & Catchpole, J 1991, *Road user behaviours which contribute to accidents at urban arterial/local intersections*, research report ARR 197, Australian Road Research Board, Vermont South, Vic.

Chartered Institution of Highways and Transportation 2010, *Manual for streets 2*, CIHT, London, UK, viewed 20 December 2015, <www.ciht.org.uk/en/document-summary/index.cfm/docid/055693F6-8DB0-4BBE-AA9FF1B5BC5E9412>.

Christchurch City Council 2000, 'Draft: local area traffic management policy and guidelines', City Streets Unit, Christchurch City Council, New Zealand.

Chua, CS & Fisher, AJ 1991, 'Performance measurements of local area traffic management: a case study', *Australian Road Research*, vol. 21, no. 2, pp. 16-36.

City of Knox 2002, 'Knox City Council LATM program review', City of Knox, Melbourne, Vic.

City of Portland 1992, *Neighbourhood traffic management for local service streets*, Bureau of Traffic Management, City of Portland, Oregon, USA.

City of Stirling 2013, *Traffic management warrants policy*, City of Stirling, Stirling, Western Australia.

Clark, NF & Lee, JA 1974, 'The environmental design of residential street systems', *Australian Road Research Board conference, 7th, 1974, Adelaide,* Australian Road Research Board, Vermont South, Vic, vol. 7, no. 2, pp. 147-69.

Cleary, J 1991, *Cyclists and traffic calming*, CTC technical note, Cyclists Touring Club, Surrey, UK.

Cleary, J 1992, 'Traffic calming & cyclists: a European perspective', *AUSBIKE 92: national bicycle conference, 1992, Melbourne, Victoria, Australia*, Bicycle Federation of Australia, Melbourne, Vic, pp. 273-6.

Colman, J 1978, *Streets for living*, special report SR17, Australian Road Research Board, Vermont South, Vic.

Corkle, J, Giese, JL & Marti, MM 2001, *Investigating the effectiveness of traffic calming strategies on driver behaviour, traffic flow and speed*, report, MN/RC-2002-02, Minnesota Department of Transportation, St Paul, MN, USA.

CROW 1988, *Recommendations for urban traffic facilities*, 3rd edn, CROW Centre for Legislation and Research in Geotechnical, Civil and Traffic Engineering, Ede, Netherlands.

Daff, M & Wilson, C 1996, 'Local area traffic management', part 3.5, in K Ogden & SY Taylor (eds), *Traffic engineering and management*, Department of Civil Engineering, Monash University, Clayton, Vic.

Dalby, E 1979, 'The use of area-wide measures in urban road safety', *'TRAFFEX 79' conference on traffic engineering and road safety,* Printerhall Ltd, London, UK.

Damen, P 2003, 'Recent experiences, successes and failures with local area traffic management in Australasia', *ARRB Transport Research conference, 21st, 2003, Cairns, Queensland, Australia & Road Engineering Association of Asia and Australasia (REAAA) conference, 11th, 2003, Cairns, Queensland, Australia*, ARRB Transport Research, Vermont South, Vic, 6 pp.

Damen, P 2007, 'The whole box'n'dice of traffic calming experiences in local government', *Cairns International Public Works conference, (IPWEA), 2007, Cairns, Queensland*, Cairns Media Corporate Productions, Qld, 10 pp.

Damen, P & Ralston, K 2015, 'The latest on local area traffic management practice in Australia and New Zealand: an update and comparison for local government', *International Public Works conference, (IPWEA), 2015, Rotorua, New Zealand.*

Daniel, B, Nicholson, A & Koorey, G 2011, 'Investigating speed patterns and estimating speed on traffic-calmed streets', *Institution of Professional Engineers New Zealand (IPENZ) transportation conference, 2011, Auckland, New Zealand*, Harding Consultants, Christchurch, NZ, 14 pp.

Department of Infrastructure, Planning and Natural Resources 2004, *Planning guidelines for walking and cycling,* DIPNR, Sydney, NSW.

Department of Transport 1992, *Guidelines for the use of speed control devices on bus routes*, NSW Department of Transport, Sydney, NSW.

Department for Transport 2007, *Manual for streets*, Thomas Telford Publishing, London, UK, viewed 20 December 2015, <https://www.gov.uk/government/publications/manual-for-streets>.

Department for Transport 2011, *Shared space*, Local Transport Note 1/11, DfT, London, UK, viewed 20 December 2015, <www.gov.uk/government/uploads/system/uploads/attachment_data/file/3873/ltn-1-11.pdf>.

Department of Transport and Main Roads 2013, *Traffic and road use management manual (TRUM)*, TMR, Brisbane, Qld.

Engel, U & Thomsen, LK 1992, Safety effects of speed reducing measures in Danish residential areas, *Accident Analysis & Prevention*, vol. 24, no. 1, pp. 17-28.

Ewing, R 1999a, *Traffic calming: state of practice*, Department of Transportation, Federal Highway Administration and Institute of Transportation Engineers, Washington, DC, USA.

Ewing, R 1999b, 'Traffic calming in new developments: avoiding the need for future fixes', *Transportation Research Record,* no. 1685, pp. 209-20.

Fairlie, RB & Taylor, MAP 1990, 'Evaluating the safety benefits of local area traffic management', *Australian Road Research Board conference, 15th, 1990, Darwin, Northern Territory,* vol. 15, no. 7, pp. 141-66.

Fehr & Peers 2015, *Roundabout from Virginia*, Fehr & Peers, viewed 8 September 2015, <trafficcalming.org>.

Gattis, JL & Watts, A 1999, 'Urban street speed related to width and functional class, *Journal of Transportation Engineering,* vol. 125, no. 3, pp. 193-200.

Geddes, E, Zein, SR, Hemsing, S & Johnson, M 1997, 'Safety benefits of traffic calming', *Transportation Research Record*, no. 1578, pp. 3-10.

Godfrey, JA 1979, 'Traffic management schemes: local areas', in KW Ogden & DW Bennett, (eds), *Traffic engineering practice,* 2nd edn, Department of Civil Engineering, Monash University, Clayton, Vic.

Government of Western Australia 2002, *Consulting citizens: a resource guide*, Department of Premier and Cabinet, Perth, WA.

Harper, BCS 1970, 'Design of the local street system', '*Proceedings Tewksbury symposium: analysis of urban development'*, special report no. 5, Transport Section, Department of Civil Engineering, University of Melbourne, Parkville, Vic.

Hass-Klau, C, Nold, I, Boecker, G & Crampton, G 1992, *Civilised streets: a guide to traffic calming*, Environmental and Transport Planning, Brighton, UK.

Hawley, L & Gennaoui, F 1984, 'Evaluating residential street management schemes: guidelines and criteria', report to the Director General of Transport, Adelaide, SA.

Hawley, L, Henson, C, Hulse, A & Brindle, R 1993, *Towards traffic calming: a practitioner's manual of implemented local area traffic management and blackspot device,* CR 126, Federal Office of Road Safety, Canberra, ACT.

Ho, LK & Fisher, AJ 1988, 'Cost implications of local area traffic management', *Australian Road Research Board conference, 14th, 1988, Canberra,* Australian Road Research Board, Vermont South, Vic, vol. 14, no. 2, pp. 186-98.

IEEE 2012, 'Look ma, no hands!', IEEE *News Releases*, Institute of Electrical and Electronics Engineers, New York, NY, viewed 3 June 2015, <https://www.ieee.org/about/news/2012/5september_2_2012.html>.

IMEAQ 1993, 'Queensland streets: design guidelines for subdivisional streetworks', prepared for the Institute of Municipal Engineering Queensland Division by Weathered Howe Pty Ltd, IMEAQ, Fortitude Valley, Qld.

ITE 2002, *Innovative bicycle treatments*, IR-114, Institute of Transportation Engineers, Washington, DC, USA.

ITE n.d., *Traffic calming measures: speed hump,* webpage*,* Institute of Transportation Engineers, Washington, DC, USA, viewed 3 June 2015, <http://www.ite.org/traffic/hump.asp>.

Jarvis, JR 1980, 'The off-road testing of road humps for use under Australian conditions', *Australian Road Research Board conference, 10th, 1980, Sydney,* Australian Road Research Board, Vermont South, Vic, vol. 10, no. 4, pp.293-305.

Jarvis, JR 1992, *An investigation of road humps for use on bus routes*, ARR 222, Australian Road Research Board, Vermont South, Vic.

Jurewicz, C 2008, 'Impact of LATM treatments on speed and safety: overview of recent research', *ARRB conference, 23rd, 2008, Adelaide, South Australia,* ARRB Group, Vermont South, Vic, 14 pp.

Kanely, BD 1997, 'Neighbourhood traffic calming: do we need warrants?' *Institution of Transportation Engineers annual meeting*, *67th, Boston, USA,* ITE, Washington, DC, USA.

Kennedy, JV, Gorell, R, Crinson, L, Wheeler, A & Elliott, M 2005, '*Psychological' traffic calming*, TRL report 641, TRL, Wokingham, UK, viewed 20 December 2015, <http://www.trl.co.uk/online_store/reports_publications/trl_reports/cat_traffic_and_the_environment/report_psychological_traffic_calming.htm>.

Kjemtrup, K 1988, 'Speed reducing measures', *Australian Road Research Board conference, 14th, 1988, Canberra*, Australian Road Research Board, Vermont South, Vic, vol. 14, no. 2, pp. 125-32.

Klyne, M 1988, 'Geometric design of local street roundabouts and S-bend slow points for speed regulation', *Australian Road Research Board conference, 14th, 1988, Canberra*, vol. 14, no. 2, pp. 56-67.

Land Commission of NSW 1984, *The streets where we live; a manual for the design of safer residential estates*, Land Commission of NSW, Sydney, NSW.

Land Transport Safety Authority 2002, *Guidelines for urban rural speed thresholds,* RTS 15, LTSA, Wellington, NZ.

Litman, T 2002, *Traffic calming: benefits, costs and equity impacts*, Victoria Transport Policy Institute, Victoria, BC, Canada.

Lockwood, IM 1997, 'Do we need traffic calming warrants?' *ITE international conference, 1997, Tampa, Florida,* Institute of Transportation Engineers, Washington, DC, pp. 55-9.

Loder and Bayly 1974, 'City of Fitzroy traffic plan: plan for east and west wards and report on existing situation', report to City of Fitzroy, Loder and Bayly, Consultants, Hawthorn, Vic.

Loder and Bayly 1980, *Safer roads for new urban areas,* Road Safety and Traffic Authority, Hawthorn, Vic.

Loder and Bayly 1981, 'Geelong streetscapes: a feasibility study on the application of shared space principles and design to local area traffic management', report to the Geelong BikePlan, Loder and Bayly, Hawthorn, Vic.

Loder and Bayly 1990, 'Planning for safer subdivisions, working paper no. 1: safety on residential streets; working paper no. 2: addressing institutional constraints to achieving safer roads; working paper no. 3: design ideas for safer and more livable streets', reports to VicRoads and Department of Planning and Urban Growth, Hawthorn, Vic.

Mackie, AM, Ward, HA, & Walker, RT 1990, *Urban safety project 3: overall evaluation of area-wide schemes*, RR263, Transport Research Laboratory, Crowthorne, UK.

Maher, M 1990, 'The needs of cyclists in local area traffic management', *Local Government Engineers Association of Western Australia conference, 7th*, *Perth*, Local Government Engineers Association of Western Australia, Perth, WA.

Maher, M 1994, 'Better LATM: sharing the road with cyclists', *State municipal engineering conference, 11th*, *Perth*, Institute of Municipal Engineering Australia, Western Australian Division, Perth, WA.

Maher, M & Stallard, R 1994, 'Local area traffic management: the effect upon cycling', *Australian pedestrian and bicyclist safety and travel workshop, 1994, Melbourne,* ARRB Transport Research, Vermont South, Vic, pp. 267-73.

Main Roads Western Australia 1990, *Guidelines for local area traffic management*, Pak-Poy & Kneebone and Main Roads, Perth, WA.

Main Roads Western Australia 2013, *Guidelines for local area traffic management*, document no. D08-102211, MRWA, Perth, WA.

Main Roads Western Australia 2014, *Pedestrian cyclist facilities*, document no. D11-317418, MRWA, Perth, WA.

McClintock, H 2002, *Planning for cycling*, Woodhead Publishing, Cambridge, UK.

McClintock, H (ed) 1996, *Cycle-friendly infrastructure: guidelines for planning and design,* Cyclists' Touring Club, Godalming, UK.

Morrison, DS, Thomson, H & Petticrew, M 2004, ‘Evaluation of the health effects of a neighbourhood traffic calming scheme’, *Journal of Epidemiology and Community Health,* vol. 58, no. 10, pp. 837-40.

NZ Transport Agency 2010, *Manual of traffic signs and markings (MOTSAM): part 1: traffic signs,* NZTA, Wellington, New Zealand.

NZ Transport Agency 2013, *Applying the one network road classification guidelines*, NZTA, Wellington, New Zealand, <www.nzta.govt.nz/assets/Road-Efficiency-Group-2/docs/onrc-guidelines.pdf>.

Noyes, PB 1999, ‘Effective public involvement’, in J Pline (ed) *Traffic engineering handbook,* 5th edn, Institute of Transportation Engineers, Washington, DC, USA.

O'Brien, A 1996, ‘Design of new urban networks’, in K Ogden & SY Taylor (eds), *Traffic Engineering and Management*, Department of Civil Engineering, Monash University, Clayton, Vic.

O'Brien, AP & Brindle, RE 1999, ‘Traffic calming applications’, J Pline (ed) *Traffic engineering handbook,* 5th edn, Institute of Transportation Engineers, Washington, DC, USA

O'Brien, A, Brindle, R & Fairlie, R 1997, ‘Some Australian experiences with warrants’, *Institution of Transportation Engineers annual meeting, 67th, Boston, USA, ITE, Washington, DC, USA.*

OECD 1979, *Traffic safety in residential areas*, final report of research group TS2, Organisation for Economic Cooperation and Development, Paris, France.

Ogden, KW & Taylor, SY 1996, *Traffic engineering and management*, Department of Civil Engineering, Monash University, Clayton, Vic.

Ove Arup and Partners 1997, *The national cycle network: guidelines and practical details*, issue 2, Sustrans, Bristol, UK.

Pak-Poy & Kneebone 1987, *Residential street management*, Director-General of Transport, Adelaide, SA.

Parham, AH & Fitzpatrick, K 1998, *Handbook of speed management techniques*, research report 1770-2, Texas Transportation Institute, College Station, TX, USA.

Parliamentary Travelsafe Committee Queensland 1994, *Report on local area traffic management,* Parliamentary Travelsafe Committee report no. 12, Legislative Assembly of Queensland, Brisbane, Qld.

Perone, J 1996, ‘Developing and implementing traffic calming warrants’, *Institution of Transportation Engineers annual meeting, 66th, Minneapolis, USA,* ITE, Washington, DC, USA.

Petruccelli, U 2000, ‘Traffic calming: a review of techniques and their effectiveness’, *Traffic Engineering and Control*, vol. 41, no. 11, pp. 458-64.

PIARC 1991, ‘Through traffic in small towns: safety and environmental aspects’, *Routes Roads,* special issue, July, PIARC (World Road Association), Paris, France.

Pitcher, IK 1990, *Speed profiles of isolated vehicles in residential streets*, research report ARR 166, Australian Road Research Board, Vermont South, Vic.

Pline, J (ed) 2008, *Traffic engineering handbook,* 6th edn, Institute of Transportation Engineers, Washington, DC, USA.

Retting, RA, Ferguson, SA & McCartt, AT 2003, ‘A review of evidence-based traffic engineering measures designed to reduce pedestrian–motor vehicle crashes’, *American Journal Public Health*, vol. 93, no. 9, pp. 456–63.

Road Data Laboratory 1993, *An improved traffic environment: a catalogue of ideas,* report 106, Danish Road Directorate, Road Data Laboratory, Road Standards Division, Herlev, Denmark.

Robinson, DL 1998, 'Accidents at roundabouts in New South Wales' *Road and Transport Research*, vol. 7, no. 1, pp. 3-12.

Royal Dutch Touring Club 1980, *Woonerf*, Royal Dutch Touring Club, ANWB, Hague, Netherlands.

RTA 2000, *Sharing the main street,* 2nd edn, Roads and Traffic Authority, Sydney, NSW.

RTA 2002, *How to prepare a pedestrian access mobility plan (PAMP),* Roads and Traffic Authority, Sydney, NSW.

RTA 2005, *Planning guidelines for walking and cycling,* technical direction 2005/01, Roads and Traffic Authority, Sydney, NSW.

RTA 2011, *Use of traffic calming devices as pedestrian crossings*, technical direction TDT 2001/04a, Roads and Traffic Authority, Sydney, NSW.

Shaw, T 2002, 'Effects of LATMs and street narrowing on traffic speed and crashes', Institute of Public Works Engineering Australia Foundation research project, draft', May 2002, IPWEA Foundation, Subiaco, WA.

Silcock, DT & Walker, RT 1982, 'The potential for area-wide application for accident countermeasures in residential areas', *Seminar on short-term and area-wide evaluation of road safety measures*, SWOV, Amsterdam, Netherlands.

Smith, DJ, Knapp, K & Hallmark, S 2002, 'Speed impacts of temporary speed humps in small Iowa cities', *Institute of Transportation Engineers (ITE) annual meeting, 72nd, 2002, Philadelphia, Pennsylvania, USA,* Institute of Transportation Engineers (ITE), Washington, DC, USA.

Stover, VG & Koepke, FJ 2002, *Transportation and land development,* 2nd edn, Institute of Transportation Engineers, Washington, DC, USA.

Taverner Research 2009, *Study of bicyclist and pedestrian safety on shared paths*, report for the Roads and Traffic Authority, Sydney, NSW.

Taylor, MAP 1992, 'LATM: successes and failures', *Australian Institute of Traffic Planning and Management (AITPM) national conference, 5th, 1992, Sydney, Australia,* AITPM, Thornleigh, NSW.

Taylor, MAP & Rutherford, LM 1986, 'Speed profiles at slow points on residential streets' Australian Road Research Board conference*, and Australia Road Engineering Association of Asia and Australasia (REAAA) conference, 5th, 1986, Adelaide, Australia,* Australian Road Research Board, Vermont South, Vic., vol. 13, no. 9, pp. 65-77.

Taylor, MAP 2000, 'Experience with the use of the TrafikPlan road traffic network model in urban areas in developing countries', in Dhingra & Krishna Rao (eds), *Proceedings 4th international workshop on transportation planning and implementation methodologies for developing countries: transport infrastructure,* Department of Civil Engineering, Indian Institute of Technology, Mumbai, India.

Traffic Authority of NSW 1985a, 'Local streets are for living', brochure, Traffic Authority of NSW, Sydney, NSW.

Traffic Authority of NSW 1985b, *Safer neighbourhood streets in existing areas,* brochure, Traffic Authority of NSW, Sydney, NSW.

Traffic Authority of NSW 1985c, 'Safer neighbourhood streets in new areas', brochure, Traffic Authority of NSW, Sydney, NSW.

Traffic Authority of NSW 1985d, '*Policies, guidelines and procedures for traffic generating developments: part F: guidelines on the traffic and safety aspects of subdivisional design',* Traffic Authority of NSW, Sydney, NSW.

Traffic Authority of NSW 1987, 'Guidelines for traffic facilities: part 7.2: local area traffic management', Traffic Authority of NSW, Sydney, NSW.

Transportation Association of Canada 1998, *Canadian guide to neighbourhood traffic calming*, TAC, Ottawa, Ontario, Canada.

Tucker, JN 2006, 'Evaluation of the Queensland Streets Concept in residential streets in Logan City', BEng. thesis, University of Southern Queensland.

Van den Dool, D & McKeown, H 1991, 'Sub-arterial traffic calming', NRMA Traffic Engineering, Sydney, NSW.

VicRoads 1998, *Design for trucks, buses and emergency vehicles on local roads*, brochure, VicRoads, Kew, Vic.

VicRoads 1999a, *Traffic engineering manual: volume 1: traffic management*, VicRoads, Kew, Vic.

VicRoads 1999b, *Designing local roads for ultra low floor buses,* brochure, VicRoads, Kew, Vic.

VicRoads 2008, *Traffic engineering manual: volume 1: chapter 4: pedestrian facilities,* VicRoads, Kew, Vic.

VicRoads 2014, *Traffic engineering manual: volume 1: traffic management: chapter 8: local area traffic management,* 5th edn, VicRoads, Kew, Vic.

Vreugdenhil, JJ 1976, 'Traffic management schemes for existing residential street layouts on the grid system', *Australian Road Research Board conference, 8th, 1976, Perth,* vol. 8, no. 2, pp. 1-19, 41-2.

Walsh, D & Smith, M 1999, 'Effective speed management: the next step forward: saving lives by decreasing speeds in local streets', *Road safety research, policing, education conference, 2nd, 1999, Canberra, ACT,* Australian Transport Safety Bureau (ATSB), Canberra, ACT, pp. 685-94.

Webster, D 1993, *Road humps for controlling vehicle speeds*, TRL project report 18, Transport Research Laboratory, Crowthorne, UK.

Webster, DC & Layfield, RE 1996, *Traffic calming: road hump schemes using 75 mm high humps*, TRL report 186, Transport Research Laboratory, Crowthorne, UK.

Webster, DC & Layfield, RE 1998, *Traffic calming: sinusoidal, 'H' and 'S' humps*, TRL report 377, Transport Research Laboratory, Crowthorne, UK.

Webster, DC & Mackie, AM 1996, *Review of traffic calming schemes in 20 mph zones*, TRL report 215, Transport Research Laboratory, Crowthorne, UK.

Western Australian Planning Commission 2000, *Liveable neighbourhoods: street layout, design and traffic management guidelines,* Western Australian Planning Commission, Perth, WA.

Wisdom, AS & Henson, CC 1996, 'Traffic impact analysis', in K Ogden & S Taylor (eds), *Traffic engineering and management*, Monash University, Clayton, Vic.

Yeates, M 2000a, 'Road safety: for all road users?'*, Safe Cycling, Conference, 2000, Brisbane, Queensland,* Department of Transport, Brisbane Qld, pp. 79-86.

Yeates, M 2000b, 'Making space for cyclists by sharing the road: Brisbane City Council's 'Bicycle Friendly Zone', *Safe Cycling, Conference, 2000, Brisbane, Queensland,* Department of Transport, Brisbane Qld, 8 pp.

Zaidel, D, Hakkert, AS & Pistiner, AH 1992, 'The use of road humps for moderating speeds on urban streets', *Accident Analysis & Prevention*, vol. 24, no. 1, pp. 45-56.

Zein, SR, Geddes, E, Hemsing, S & Johnson, M 1997, 'Safety benefits of traffic calming', *Transportation Research Record*, no. 1578, pp. 3-10.

Zito, R & Taylor, M 1996, 'Speed profiles and vehicle fuel consumption at LATM devices' *Combined 18th ARRB Transport Research conference and Transit New Zealand land transport symposium, 1996, Christchurch, New Zealand,* vol. 18, no. 7, pp. 391-406.

Australian Standards

AS 1348 – 2002, *Glossary of terms: road and traffic engineering*.

AS 1428 – Set: 2010, *Design for access and mobility*.

AS 1742.1 – 2014, *Manual of uniform traffic control devices: part 1: general introduction and index of signs*.

AS 1742.2 – 2009, *Manual of uniform traffic control devices: part 2: traffic control devices for general use*.

AS 1742.9 – 2000, *Manual of uniform traffic control devices: part 9: bicycle facilities.*

AS 1742.10 – 2009, *Manual of uniform traffic control devices: part 10: pedestrian control and protection.*

AS 1742.13 – 2009, *Manual of uniform traffic control devices: part 13: local area traffic management.*

AS 1742 – Set: 2014, *Manual of uniform traffic control devices.*

AS/NZS 1158 – Set: 2010, *Lighting for roads and public spaces*.

Commentary 1 Further Reading

Practitioners should be aware of, and comply with, advice and requirements that apply in their jurisdictions. Practitioners are responsible for ensuring that they have access to all relevant codes and guides that apply to their specific situation. Documentation current at the time this Guide was prepared follows.

Austroads/National Transport Commission

- Austroads 2009, *Guide to road transport planning*, AGRTP-09, Austroads, Sydney, NSW.
- Austroads 2013, *Guide to road design: set,* Austroads, Sydney, NSW.
- Austroads 2015, *Guide to traffic management: set,* Austroads, Sydney, NSW.
- National Transport Commission 2012, *Australian road rules*, NTC, Melbourne, Vic, viewed 12 June 2015, <http://www.ntc.gov.au/Media/Reports/(F1D63B25-98A0-8E5A-EBD4-BA6FC69ABF7D).pdf>.

Standards Australia

- AS 1348 – 2002, Glossary of terms: road and traffic engineering.
- AS 1428 – Set: 2010, Design for access and mobility.
- AS 1742.1 – 2014, Manual of uniform traffic control devices: part 1: general introduction and index of signs.
- AS 1742.2 – 2009, Manual of uniform traffic control devices: part 2: traffic control devices for general use.
- AS 1742.9 – 2000, Manual of uniform traffic control devices: part 9: bicycle facilities.
- AS 1742.13 – 2009, Manual of uniform traffic control devices: part 13: local area traffic management.
- AS 1742 – Set: 2014, Manual of uniform traffic control devices.
- AS/NZS 1158 – Set: 2010, Lighting for roads and public spaces.

New South Wales

- RMS 2013, RMS Austroads guide supplements: Austroads guide to traffic management: part 8: local area traffic management, Roads and Maritime Services, Sydney, NSW.
- RTA 1989, *Road design guide*, Roads and Traffic Authority, Sydney, NSW.
- RTA 2005, *Planning guidelines for walking and cycling,* technical direction 2005/01, Roads and Traffic Authority, Sydney, NSW.
- RTA 2011, *Use of traffic calming devices as pedestrian crossings*, technical direction TDT 2011/04a, Roads and Traffic Authority, Sydney, NSW.
- Department of Transport 1992, *Guidelines for the use of speed control devices on bus routes*, NSW Department of Transport, Sydney, NSW.
- Traffic Authority of New South Wales 1980, *Functional classification of roads*, Traffic Authority of NSW, Sydney, NSW.

Victoria

- VicRoads 1998, Design for trucks, buses and emergency vehicles on local roads, brochure, VicRoads, Kew, Vic.
- VicRoads 1999, Designing local roads for ultra-low floor buses, brochure, VicRoads, Kew, Vic.
- VicRoads 2014, Traffic engineering manual: volume 1: traffic management: chapter 8: local area traffic management, 5th edn, VicRoads, Kew, Vic.
- VicRoads 2014, Traffic engineering manual: volume 1: chapter 10: trucks, buses and emergency vehicles, 5th edn, VicRoads, Kew, Vic.

The installation of major traffic control items listed under the Road Safety (Road Rules) Regulations 2009, such as speed limit signs and road humps, require the approval of VicRoads. Consent to install these items is delegated to councils on certain roads. In order to install a road hump on a scheduled bus route, written agreement of the Public Transport Corporation or the bus company operating the route is required.

Queensland

- Department of Transport and Main Roads 2013, *Traffic and road use management manual (TRUM)*, TMR, Brisbane, Qld.
- Queensland Office of the Queensland Parliamentary Counsel 2005, *Transport planning and coordination regulation 2005*, no. 178.
- Transport and Main Roads 2013, *Road planning and design manual*, 2nd edn, TMR, Brisbane, Qld.
- Transport and Main Roads 2014, Manual of uniform traffic control devices: part 4: speed controls, TMR, Brisbane, Qld.
- Transport and Main Roads 2014, Manual of uniform traffic control devices: part 13: local area traffic management, TMR, Brisbane, Qld.

The *Transport Planning and Coordination Regulation 2005 Act* gives Translink, as the part of the Department of Transport and Main Roads responsible for public transport planning/operations, the power to require that all bus routes are designed and constructed to allow for efficient bus travel. Design plans for local area traffic management devices must be forwarded to Translink for approval prior to construction.

The amendments to AS 1742 Part 13 for use in Queensland include prescriptive advice on actions that should be taken in order to demonstrate a duty of care.

Western Australia

- Department of Transport 2012, *Planning and designing for pedestrians: guidelines*, Department of Transport, Perth, WA.
- Main Roads WA 1992, Design guidelines for channelisation pavement markings and regulatory signing, MRWA, Perth, WA.
- Main Roads WA 2006, Guidelines for assessing level of service: pedestrian, MRWA, Perth, WA.
- Main Roads WA 2013*, Local area traffic management*, document no. D08-102211, MRWA, Perth, WA.
- Public Transit Authority 2003, *Bus route planning and transit streets*, PTA, Perth, Western Australia, (under review).
- Public Transit Authority 2003, *Traffic management and control devices (bus routes),* PTA, Perth, Western Australia, (under review).
- Public Transit Authority 2004, *Bus priority measures: principles and design*, PTA, Perth, Western Australia, (under review).

- Public Transit Authority 2011, *A practitioner's guide to bus movement and priority*, PTA, Perth, Western Australia.

The installation of signs, road marking and delineation must have Main Roads Western Australia approval. Consent to install is delegated to those councils that have obtained Main Roads Western Australia authorisation.

Note that the term 'Local Traffic Area' has a specific meaning in Western Australia; it is related to the imposition of a 40 km/h speed limit.

South Australia

- Department of Planning, Transport and Infrastructure 2012, Manual of legal responsibilities and technical requirements for traffic control devices: part 2: code of technical requirements, DPTI, Adelaide, SA.
- Pak-Poy & Kneebone Pty Ltd 1987, *Residential street management: manual*, Department of Transport, Adelaide, SA.

Councils have been granted approval from the Minister for Transport and Infrastructure to install standard traffic control devices on their roads, except for those listed in Appendix A of the Code of Technical Requirements, which require approval of the Department of Planning, Transport and Infrastructure (DPTI). Installation of LATM devices on bus routes require consultation with DPTI's Public Transport and Operations section and bus operators.

New Zealand

- Ministry of Transport 1987, *Guidelines for the use and construction of speed control humps,* Ministry of Transport, Wellington, New Zealand.
- Land Transport Safety Authority 2003, *Land transport rule: setting of speed limits: rule 54001*, as amended 2005 rule 54001/1 and 2007 rule 54001/2, LTSA, Wellington, New Zealand, <http://www.ltsa.govt.nz/rules/>.
- Land Transport Safety Authority 2004, *Land transport rule: traffic control devices: rule 54002*, as amended 2005 rule 54002/1, 2006 rule 54002/2 and 2007 rule 54002/3, LTSA, Wellington, New Zealand, <http://www.ltsa.govt.nz/rules>.
- NZ Transport Agency 2008, *Traffic control devices manual*, NZTA, Wellington, New Zealand, <www.nzta.govt.nz/resources/traffic-control-devices-manual/index.html>.
- NZ Transport Agency 2004, *Traffic note 2: platforms as crossing points: guidelines*, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2004, Traffic note 29: school crossing points ('kea crossings'): information, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2004, Traffic note 43: speed limits less than 50 km/h: guidelines, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2011, *Traffic note 1: pedestrian crossings: requirements*, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2011, Traffic note 37: 40 km/h variable speed limits in school zones, NZTA, Wellington, New Zealand.
- NZ Transport Agency 2011, *Traffic note 50: marking and signing of roundabouts,* NZTA, Wellington, New Zealand.

[Back to body text]

Commentary 2 LATM and Traffic Calming

LATM is only one of the possible applications of traffic calming but it is by far the most common and, for most practical purposes, the two terms are synonymous. This is reflected in modern dictionary definitions, which state that traffic calming involves 'the deliberate slowing of road traffic, especially through residential areas, by narrowing or obstructing roads' (Shorter Oxford English Dictionary). Similarly, the Transportation Association of Canada (1998) defines traffic calming as:

> *…the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behaviour and improve conditions for non-motorised street users.*

This precisely defines modern LATM. Thus, local traffic calming policies will, in practice, almost always require practitioners to investigate LATM possibilities. This Guide concerns only LATM in the form of traffic calming at the local level.

Traffic calming has become a broad and imprecise term. It was coined in Germany originally to describe measures used to support the introduction of 30 km/h zones, but now carries much broader connotations. Some concepts of traffic calming shift the focus from changing **driver** behaviour to inducing more fundamental social and attitudinal changes that would be reflected in **travel** behaviour, thus becoming more to do with travel demand management than traffic management. The *AMCORD Urban Guidelines for Urban Housing* (AMCORD 1992) defined traffic calming to include measures related to street design and construction as well as traffic management. Austroads (1998a) observes that 'traffic calming then becomes more than the application of devices; it provides an integrated approach to traffic precincts'. Thus, traffic calming is understood to embrace physical, educational and management approaches to reducing the impacts of vehicles on urban areas. It also has application beyond local streets. By some interpretations at least, 'travel smart' programs, bicycle preference policies and other local transport actions may be seen as being part of 'traffic calming'.

The following additional source material is recommended for reference on this topic: Brindle (1992: pp. 29–38); Austroads (1998a: part L-11).

[Back to body text]

Commentary 3 Local Area and Local Precinct

A local area may include one or more connective roads (connectors, collectors or local distributors, depending on the recognised local terminology) which carry some acceptable through (non-local) traffic (Figure C3 1). Note that some local and state policies specifically exclude roads serving a significant collector or distributor function from the scope of local area traffic management. In general, LATM may apply on streets for which a speed limit of 50 km/h or lower is considered appropriate. The processes and techniques in this Guide cannot be assumed to be suitable for roads to which a higher speed limit has been applied, although there may be many 60 km/h roads that are deemed to be more properly treated as lower-speed streets as part of an LATM scheme. The identification of such roads is part of the LATM planning process.

A local traffic area may comprise one or more local (traffic) precincts which contain only local access streets and no legitimate through traffic. In the earlier literature (particularly that before 1980), these terms were often used interchangeably and were synonymous with the concept of environmental areas introduced in the Buchanan Report (Buchanan 1963). However, while a local traffic area may sometimes fit the description of a precinct, it is useful to allow for sub-areas within the local traffic area. This implies that some roads carrying non-local traffic may fall within the local traffic area and be included in the study.

C3.1 Example Definitions

Local traffic area

A local area is defined as an urban area containing local and collector roads and bounded by arterial and sub-arterial roads or other limiting features.

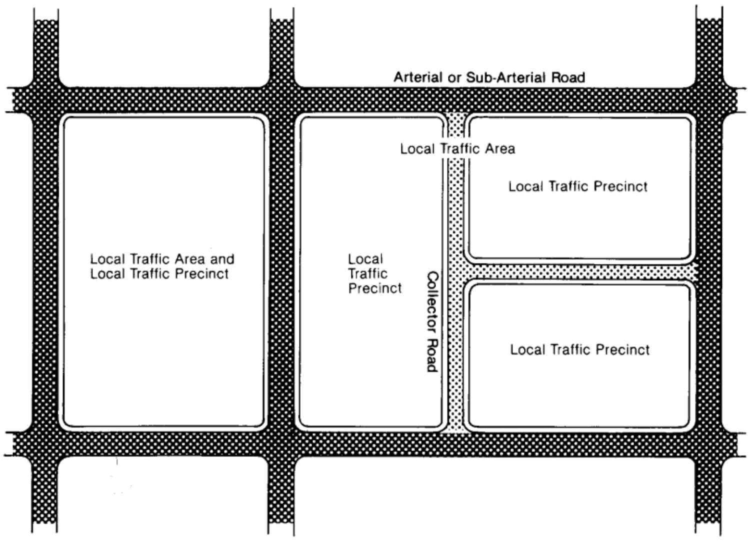
Local precinct

Local precincts are areas within a local area where specific local problems exist related to the speed of traffic and/or pedestrian crossing difficulties.

The key criterion in defining the extent of the local area is to establish which parts of the street network can logically be treated as lower-speed links, on which the needs of other road users and abutting properties have clear equality to, or priority over, passing traffic. Note that a local area for traffic planning purposes may not coincide with areas that may be defined in terms of social groupings, catchments (to schools, shops etc.), or other socio-demographic criteria. However, an LATM study is greatly assisted if its scope embraces or coincides with areas that have cohesion that the residents or users can identify with.

LATM is commonly applied in residential areas, but the same planning and engineering approaches can be applied to other land uses and mixed-use areas.

Figure C3 1: Local traffic area and local traffic precinct



[Back to body text]

Commentary 4 Origins of LATM in Australia and New Zealand

The first tentative modern programs of local traffic restraint were established in the UK and elsewhere in Europe in the late 1960s and early 1970s. The principal aim was to alter grid street networks (using street closures, one-way links and so on) to make the streets less connective for through traffic, and to create (or reinforce) a road hierarchy. Councils in Melbourne, Sydney and Adelaide, in particular, adopted similar approaches through the 1970s. At the same time, a more holistic approach to the design and management of local streets was emerging (Australian Road Research Group 1976 and Colman 1978).

There was mixed success with these techniques of network modification. Network changes had the inevitable effect of changing local access patterns, leading to opposition by some residents and traders. In addition, it became clear that in many neighbourhoods the removal of non-local traffic did not remove the core problems. This caused some reconsideration in Australia in the late 1970s, following the pioneer contribution of Vreugdenhil (1976) in Woodville (SA). About the same time, concern was growing about the large number of casualty crashes that were occurring in local streets (typically between a quarter and a third of all reported casualties in urban areas), which had up to then not received much road safety attention. The emphasis shifted from changes in the nature of the local street network to the modification of the behaviour of drivers of all vehicles that used the street. A radically new model had been offered by the emergence of the 'woonerf' in Delft (The Netherlands), which required a different understanding of the mutual relationship between vehicles and other road users. Following the sponsored distribution of an innovative brochure (Royal Dutch Touring Club 1980) by the (then) Office of Road Safety, there was widespread Australian interest in the principles and practice of the woonerf. Tools were sought that influenced a reduction of vehicle speeds, and the creation of opportunities for streetscaping to change the character of the street (e.g. Loder & Bayly 1981), parallel to (and largely unaware of) the various forms of 30 km/h zone that were appearing in Europe.

Thus, by the end of the 1970s, various techniques for both network modification and speed management had gained widespread use in Europe and Australia, and were being promoted in the US (Assar & Aburahma 1998). The term 'local area traffic management' was already being used in Australia to describe these actions. Small roundabouts at local street intersections were already numerous in Australia and set an example that other countries were later to follow. One hundred mm high, 3.6 m long round-profile (Watts) road humps became the subject of careful research in the UK during the 1970s and subsequently in Australia into the 1980s (Jarvis 1980). This research encouraged rapid expansion of humps in local streets in Australia, while their use became less common in the UK as a result of perceived legal and administrative constraints.

LATM is now widely practised; three-quarters or more of urban local government authorities in Australia and New Zealand now appear to have had experience with some form of LATM or traffic calming treatments in their streets, and the body of experience and knowledge has increased considerably (Damen & Ralston 2015). For many councils, it has become a routine part of street improvement and traffic management programs. Interest in LATM has increased, as it has become clear that it can play an important local role in supporting integrated land use-transport outcomes and also is an essential part of sustainable neighbourhood planning.

The following additional source material is recommended for reference on this topic: Brindle (1996: Chapter 23), Ewing (1999a: Chapter 2), Hass-Klau et al. (1992: Chapter 1), Pak-Poy and Kneebone (1987: Chapter 4, Appendix C).

[Back to body text]

Commentary 5 Goals of LATM

Goals of LATM, when applied to residential areas, are often expressed as follows:

- to improve the safety for all users of residential streets, and in particular children and other more vulnerable groups. This can be achieved by more effectively controlling conflict points (specifically intersections), reducing through traffic movement, and lowering speeds
- to improve the physical environment by lowering traffic noise, vibration and vehicle-generated air pollution, and upgrading the visual appearance of the streets. As far as possible the street environment should have a peaceful and quiet ambience that is consistent with its living function.

These types of goals have been adopted in most of the guidelines and source documents in use in Australia and New Zealand over the past 15–20 years, and can be taken to hold true in contemporary LATM. They reflect visions of the long-range outcomes of a broad range of urban policies, which typically imply (if not state) such things as:

- a safer city
- reduced impacts of vehicles on urban life
- improved amenity and liveability of localities
- a more efficient city
- sustainability – and so on.

It is expected that goals are mutually supporting or at least not in conflict with each other.

Both safety and amenity are also influenced by measures other than LATM, such as the intrinsic character of the street and the network of which it is a part. LATM may create small adjustments to street character and to the local network, but is only one component of the full range of planning, design and management techniques that can contribute to improved street environments. Desirably, these should combine to avoid traffic-related problems arising in the first place.

Many objectives sought by community, including the predominant targets of reduced crashes or improved amenity, are in fact **outcomes** or goals in terms of the planning process. The achievement of the outcome of improved amenity commonly depends on achieving **objectives** such as reduced traffic noise and improved local air quality, for example. This point becomes important when specifying the scheme’s objectives, which express its more specific local targets.

Since LATM involves intervention in a functioning neighbourhood, it will usually have implications for those who are part of that neighbourhood. Established patterns of travel and driving behaviour may be affected. There may be changes in how people perceive traffic volumes and the disturbance it brings. Not all of these changes will be perceived as being positive. The local community must therefore be clear about the issues and problems, and thus the expected gains from the LATM proposals. The gains are expressed in terms of the broad **goals** and the more specific **objective***s* of the proposals. The goals express the desired outcomes for the major issues.

The following additional source material is recommended for reference: Pak-Poy and Kneebone (1987: pp.15–21); Transportation Association of Canada (1998: part 1.4).

[Back to body text]

Commentary 6 Economic Benefits of LATM

The safety and amenity improvements sought from LATM translate into economic benefits for society and individuals. The economic cost of a single fatal or serious casualty crash far exceeds the cost of most LATM installations, reflecting a potentially high ratio of benefits to costs. The availability of database software to calculate crash reduction benefits against costs (as in Western Australia, for example) allows councils to focus at least on crash savings as a basis for a benefit-cost analysis.

Indirect health benefits will follow from reduced traffic noise if speeds and traffic volumes are lowered, but, to offset this, account must be taken of increased noise and other traffic-related stresses that are often perceived by residents adjacent to devices.

Ho and Fisher (1988) estimated that an increase in safety would bring about 60% of the benefits of LATM, and increased amenity would account for about 40%. Assuming a (modest) life of 10 years for each project, they calculate a preliminary benefit-cost ratio of 3.8 overall for LATM, which compares more than favourably with many major road projects. This figure is even more promising when it is realised that, by definition, LATM benefits do not include time savings.

Studies have also shown that well-executed LATM schemes can lead to increased property values, due to improved local amenity. Since property value increases do not flow to the municipality, this is a benefit to the individual rather than to the community. Care should be taken with parking and street network changes if they are likely to affect levels of activity at commercial sites within or on the edge of the study area, especially if this is likely to harm the viability of these ventures.

The amounts budgeted for LATM vary widely, but are often substantial. Ho and Fisher (1988) estimated that the cost of LATM fully implemented over one square kilometre would be about $0.5m (1988 dollars – equivalent to more than $1m in 2015). This, they estimated, is equal to 10% of the original cost of the streets and about 0.25% of the property value in a local area. They concluded that the relative cost of upgrading an area to overcome the intrusion of the motor vehicle is small. Note that a nominal 50-year reconstruction cycle means a commitment of at least 2% of roadworks infrastructure value each year. If reconstruction is combined with street reconfiguration, the LATM budget would be even less.

The following additional source material is recommended for reference on this topic: Amamoo (1984), Ho and Fisher (1988), Litman (2002), Pak-Poy and Kneebone (1987: Section 9.4).

[Back to body text]

Commentary 7 LATM as a Planning Issue

LATM is more complex than simply providing a technical solution to a specific traffic problem, i.e. it is more than just a traffic-engineering task. LATM is traffic planning where the needs of the local community take high priority. It therefore must consider the interaction between the many elements that make up a residential area – transport, land uses and the needs and preferences of the community. Consequently, an LATM scheme may have to satisfy a range of objectives, and should not be seen as traffic management solely for the safe and efficient movement of vehicles (Main Roads WA 1990).

Traffic problems in neighbourhoods may arise from the inherent characteristics of the local land use/network pattern, from changes in the nature of intruding traffic, from sudden changes in the nature of traffic demand affecting the area (such as traffic generated by a new commercial centre nearby), or combinations of these. Yet planning decisions are often made without regard for the local traffic consequences, on the implicit assumption that LATM will fix any problems that may arise. The very success of many physical traffic control measures in neighbourhoods thus helps to divert attention away from the land use/traffic system as the underlying cause. Many of the situations that LATM tries to resolve could be avoided by proper land development and planning decisions in the first place.

LATM may also be employed within the planning process to pre-empt potential problems and to support community programs such as integrated local transport plans, trip reduction strategies, bicycle plans, and so on. Thus, LATM, and traffic calming as a whole, is not, at its root, solely an engineering matter. Rather, LATM can be seen as the use of engineering tools in either a remedial or proactive planning process.

The following additional source material is recommended for reference on this topic: Austroads (1998a: Section 9.3.3).

[Back to body text]

Commentary 8 Neighbourhoods as Systems

LATM may be implemented on a street-by-street basis or by areas. Whichever is adopted, however, it is important to see the causes and effect of the changes on an area-wide basis.

An LATM plan should be more than a catalogue of works; the effective area-wide plan is truly greater than the sum of its component treatments. There are two reasons for this:

- streets are part of networks
- movement networks are only one part of the urban system.

C8.1 Streets within Networks

The adaptability of networks is well known to traffic engineers, and there is a risk that a restricted focus on one site or street may shift the problem traffic to another street or intersection. Soundly-based LATM schemes will therefore have regard for the effects of the proposals on travel decisions and driver route choice, and hence on traffic displacement and reduction. Even small schemes and isolated devices may have effects across the local network.

There is sometimes an unduly optimistic expectation of the extent to which LATM will reduce total travel, but the effects of street changes on travel and route choice are well established. If the diversion of traffic to other routes is not anticipated and carefully analysed, there may be adverse community response. In Australia, the term for local street traffic calming – local area traffic management – was coined specifically to emphasise the need for such an area-wide approach.

C8.2 Networks in the Urban System

The place of LATM within the urban system is more elusive. One way to approach this is to consider what the root cause of the problem is and if in fact physical traffic management treatments are the only way to resolve it. Without a clear definition of problems, appropriate solutions are difficult to select and there are inadequate criteria by which to measure their performance. The devices become the focus of attention, from concept to implementation and public debate, and often become ends in themselves.

At the very least, an attempt should be made to see problems and solutions in the context of the locality (neighbourhood or ‘main street’, for example) as a functioning unit, not just as a site-specific traffic problem. The solution to traffic problems in a residential precinct, for example, could lie in finding ways to modify the form or operation of a nearby employment node. Conversely, future traffic problems likely to lead to pressure for LATM should be acknowledged when land development proposals are being considered; sometimes the ‘solution’ to a future problem is to avoid the problem in the first place.

The following additional source material is recommended for reference on this topic: Austroads (1998b: pp.231-2).

[Back to body text]

Commentary 9 The Issue of Amenity

Amenity is a measure of the pleasantness and liveability of an area, in its public and private spaces. Liveability, in turn, has in many places become a primary focus of government policy for neighbourhoods and other places in which a community may gather. It is a component of policies on urban sustainability. Modern urban communities place high value on local amenity and expect to be protected from adverse impacts on their amenity from traffic and other causes. Being an overt and everyday experience, the quality of local amenity may be more likely than the background level of traffic risk to lead to pressure for LATM action.

Amenity can be expressed in terms of such things as:

- local environmental quality
- sense of security
- degree of relaxation about children, pets, possessions being unsupervised outside the property
- freedom to use the streetspace for a range of purposes
- privacy
- lack of constraints on what one chooses to do in and around the home
- sense of community and local identity
- property value
- compatibility for pedestrian and bicycle movement.

These (mostly qualitative) measures of amenity can be adversely affected by many (mostly quantifiable) aspects of traffic, such as:

- noise and vibration caused by vehicles
- air quality
- quantity of traffic
- percentage of commercial vehicles, motorcycles etc.
- vehicle speed
- intrusion by strangers
- over-spill parking from nearby shops or stations
- lack of care for other road users.

Most of these are a function of the quantity and nature of the vehicles, and the behaviour of the drivers.

The earliest Australian actions to control traffic flows and speeds in local streets were justified on the basis of protecting local amenity and integrity (Vreugdenhil 1976). Despite the adverse reaction to early attempts to exclude non-local traffic, the desire to reduce the impacts of traffic on local amenity was still strong. Actions began to focus directly on the vehicles, no matter where they were from. The impetus for that came from a growing realisation that crashes in local areas were far from a trivial issue.

[Back to body text]

Commentary 10 The Issue of Safety

Early descriptions of LATM in Australia did not place great emphasis on safety as a motive (e.g. Ashton 1981, Godfrey 1979). Yet data had already emerged that suggested that the crash rate per unit travel was about 50% greater on local streets than on arterials (Harper 1970), and information being issued by ARRB (Brindle 1983) was suggesting that up to one-third of urban casualty crashes were occurring on local streets. Neighbourhoods began to attract the attention of traffic engineers and road safety specialists (e.g. the NSW Neighbourhood Road Safety campaign (Traffic Authority of NSW 1985a, b, c).

Since the mid-1980s, LATM and other actions have increasingly been implemented in local areas as part of road safety programs. Improved safety has typically been an explicit motivation and goal for LATM schemes, especially as awareness increased of the risks to other road users in areas where the community generally expects a greater degree of protection for young pedestrians, cyclists and other active road users. Melbourne data for 1981, for example, had shown that more than a third of reported bicycle crashes had occurred on collector and local access streets and that more than 80% of cyclists in these local crashes were under 18 (Brindle & Andreassen 1984). It was noted that, due to under-reporting, this might even underestimate the extent of crashes involving bicycles in neighbourhoods.

However, apart from a few identifiable black spots and typical crash locations, these crashes are generally scattered across a large local network (around 80% of total urban road length). The scattered occurrence and low frequency of local area crashes should not be taken to indicate the absence of a road safety issue. This low density of crashes reflects an area-wide rather than a localised safety issue. Area-wide rather than spot treatments are therefore usually appropriate (Dalby 1979; Silcock & Walker 1982).

The principal strategy directed at improving local street safety (and secondarily, improving amenity) has been to reduce speeds overall in local areas. The basis for this is well established in experience and research (Brindle 1996: Chapter 16; Walsh & Smith 1999).

The following additional source material is recommended for reference on this topic: Andreassen and Hoque (1986); Mackie, Ward and Walker (1990); Main Roads WA (1990); OECD (1979); Transportation Association of Canada (1998: part 1.5).

[Back to body text]

Commentary 11 The Origins of Traffic Problems in Local Areas and Their Countermeasures

Understanding the inbuilt problems in local networks can suggest management remedies as well as point towards better planning and design practices for new development. It is better to avoid likely future problems than to try to fix them when they become an issue (Ewing 1999b).

C11.1 Common Contributors to Vehicle Speed

The speed that drivers adopt in local areas is a function of many behavioural factors, which are not yet fully understood. Prevailing speed limits and their enforcement, and the driver's general attitude to the law and safety of others, will clearly be major factors. In addition, drivers respond (consciously or not) to the physical environment and the 'signals' it sends about what is or is not appropriate behaviour. In summary, the major physical contributors to increased speed in streets, other things being equal, are described below.

Street length

It has been shown that crash rates in local streets increase with increases in street length (Bennett & Marland 1978). It has also been argued (Loder & Bayly 1980) that it is not the street length directly but the increase in driver expectations, traffic volumes, and speeds permitted by increased street lengths that are the underlying factors. Generally the use of short street lengths is the most effective means of reducing speeds on the residential street network. Most existing street networks can be modified using this philosophy to improve safety (refer to *Guide to Road Design Part 3: Geometric Design of Roads*).

There are two aspects to street length: forward visibility ('visual length') and the physical length of the street section.

Streets with long sight lines, even when the carriageway is curving or interrupted, draw the driver towards the distance. Streets with shorter and terminated vistas (such as in curvilinear and heavily planted streets, or in neighbourhoods with short streets terminating in T-intersections), on the other hand, do not encourage increased speeds. In streets with continuous carriageways but shorter sight lines, drivers familiar with the street may still drive beyond the available sight distance, so the form of the carriageway should be compatible with the sight distance that is available.

Indicated countermeasures – Those directed at shortening forward sight lines.

In streets, or street sections, that are physically shorter, most drivers will not attempt to reach higher speeds. Research and experience suggests that in order to keep most vehicles below 40 km/h, street sections should not be longer than 200–250 m (Loder & Bayly 1990, Pitcher 1990).

Indicated countermeasures – Those that create physically shorter street sections between near-stopped conditions.

Street width

If the street section is long enough, a wider street is likely to experience higher speeds. Drivers appear to be more constrained by restrictions in lateral sight distance than in forward sight distance, and a wider street may also signal to the driver that it is a higher-order (and therefore a higher-speed) street. However, speeds may still be relatively high on long continuous streets even if they have limited visual or physical cross-sections. Kerbside parking is not a reliable traffic calming tool and is often a factor in local street crashes, for instance. In such cases, drivers are likely to be exceeding the safe stopping speed in the event of crossing or entering traffic, or dart-outs by pedestrians or cyclists.

Indicated countermeasures – Those that reduce the available street width and/or introduce deflections in the vehicle path, without reducing the margin of safety.

Enclosure of forward line of sight

The visual length and width of the street are components of the ‘enclosure’ of the driver’s field of vision. Apart from the form of the road and adjacent property, the major influence on the forward field of vision is the density and nature of roadside vegetation, including that in adjacent gardens. Larger trees may tend to form a canopy over the road, adding to the subtle restraint on drivers.

Indicated countermeasures – Those that create a more enclosed visual environment.

Distance from the nearest traffic route

Drivers are more likely to maintain more appropriate lower speeds if the distance they have to travel to reach a traffic route is not unreasonable. Large areas served only by subdivisional roads are likely to experience pressure towards higher speeds. Areas in which drivers have to travel more than about 400–500 m to reach a traffic route will probably experience some sort of speed-related pressure.

Indicated countermeasures – Closer spacing of connective traffic routes at the network-planning stage.

The following additional source material is recommended for reference on this topic: Brindle (1996: Chapter 11), Gattis and Watts (1999), Land Commission of NSW (1984), Loder and Bayly (1990), O’Brien (1996), Traffic Authority of NSW (1985d), Western Australian Planning Commission (2000).

C11.2 Common Contributors to Higher Traffic Volumes and Intruding Traffic

Arterial road congestion

Related to the adequacy of the road network and transport policy in general, arterial road congestion and delay create the ‘stick’ that drives external traffic into local areas. In areas with grid local street systems, this congestion does not have to be severe for the alternative paths through the local area to become attractive in terms of travel time and avoidance of delay. Local streets intersecting with arterials near traffic signals are especially vulnerable to through traffic.

Indicated countermeasures – Increase in intersection capacity and signal timing adjustments, prevention of turns into local streets and removal of parking from the arterial traffic lanes. Some measures introduced to protect efficient flows on arterial roads, such as medians and turn bans, will also constrain turns into and out of local streets, making them less attractive and available to through traffic.

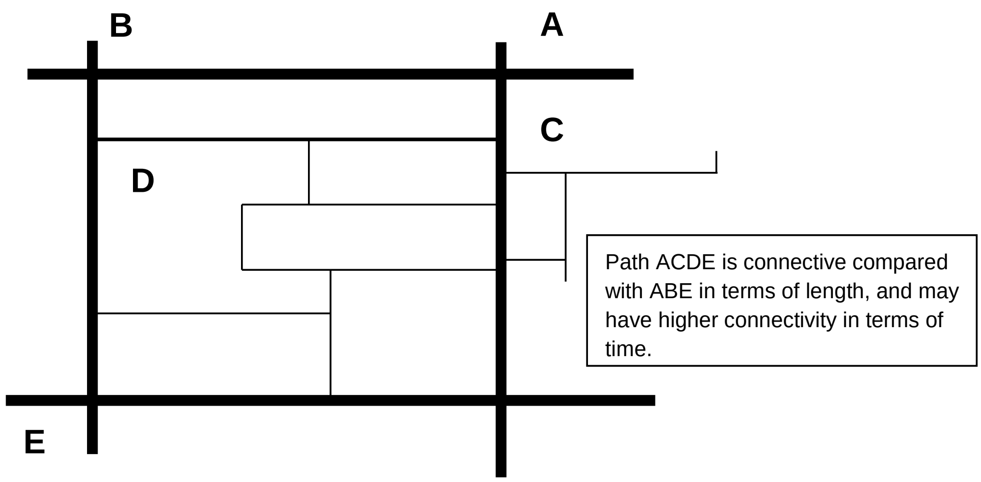
External connectivity

Connectivity describes the extent to which a path through a network provides an attractive connection between any given points, compared with alternative paths (Taylor 2000). When paths through the local street network have equal or higher connectivity than the alternative routes using the major road system, they will attract through (non-local) traffic. These paths through a connective local street system may be attractive to through traffic because they are shorter or faster than the alternative arterial routes, or they may simply be preferred because they involve fewer stops (‘dodging the lights’) or provide opportunities to ‘jump the queue’ at congestion points on the major road system (Figure C11 1).

In recent decades, local street systems have been planned deliberately to create low connectivity paths that are not attractive to through traffic. More recent planning philosophies have sought to create permeable local networks which, if not designed and managed carefully, may introduce connective paths through new local street systems. Such problems should preferably be anticipated and dealt with at the network planning stage rather than left to be dealt with by LATM. Networks that are permeable for pedestrian and cycle movement, and which provide adequately for local traffic circulation, bus routes and emergency vehicle access, do not have to have high external connectivity for motor traffic.

Indicated countermeasures – Those that increase the lengths (time and distance) of paths through the local street network.

Figure C11 1: A connective street in the local network

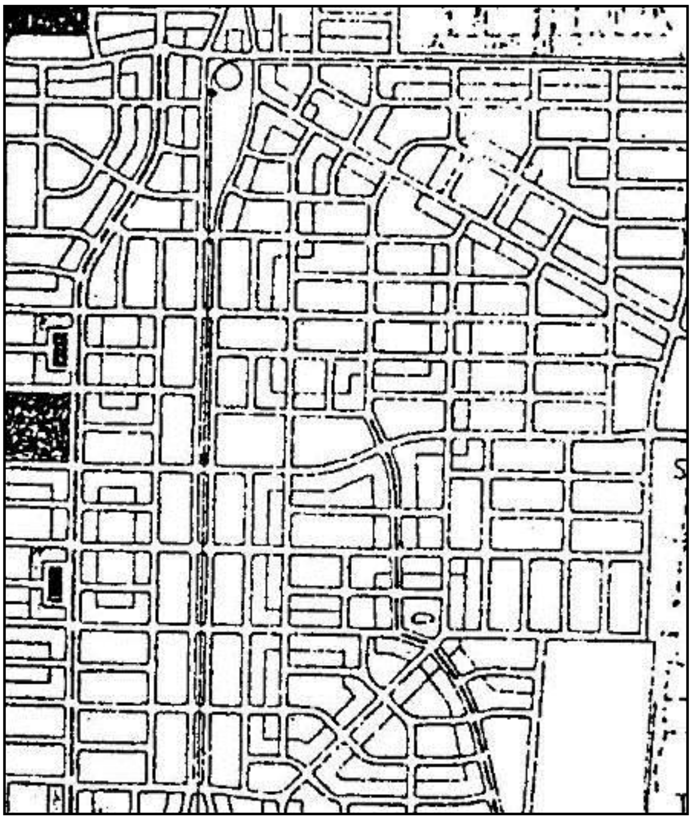


Internal connectivity

In neighbourhoods with high internal connectivity that is, network redundancy with many alternative and direct paths for trips within the local area, such as so-called permeable networks (Figure C11 2), traffic will be dispersed through the network rather than being concentrated on some streets as in tributary networks. While this may tend to avoid concentrations of traffic on some streets, it may actually increase the average exposure to traffic for each household. Under these circumstances, there may be a higher rather than lower local perception of traffic problems.

Indicated countermeasures – Those that direct traffic onto those local streets most able to accommodate it.

Figure C11 2: A permeable local network



Under-provision of traffic routes

Especially in outer suburban areas, problems may arise from the incompleteness and wide separation of the through traffic network, which inevitably means that the major road system has lower connectivity for many desired trips. Lack of major roads at adequate spacing leads to:

- larger development cells, which generate higher internal levels of traffic (Figure C11 3)
- the use of subdivisional roads as substitutes for missing links in the major road network (Figure C11 4).

These factors may combine to create quite high levels of traffic on local streets, even when there is relatively little through traffic.

Indicated countermeasures – Closer spacing of traffic routes at network planning and subdivision approval stages; provision of supplementary traffic routes within large subdivisions.

Figure C11 3: Local streets take on the character of sub-arterials in excessively large cells

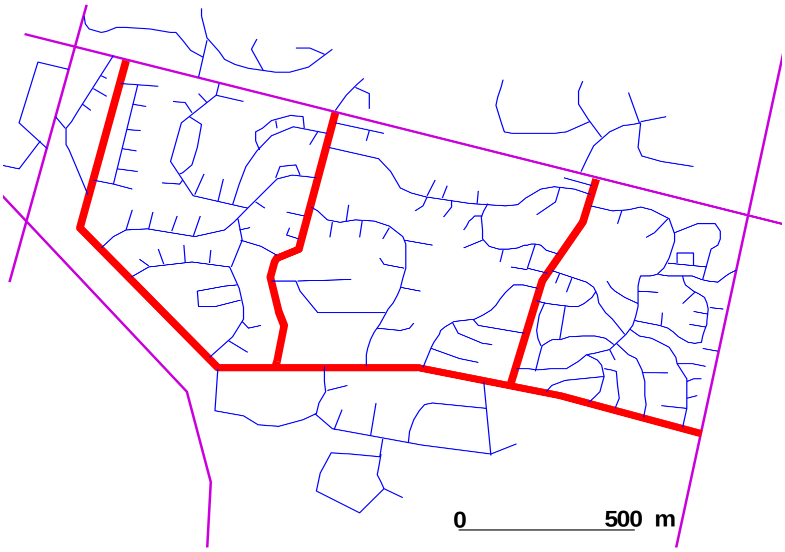
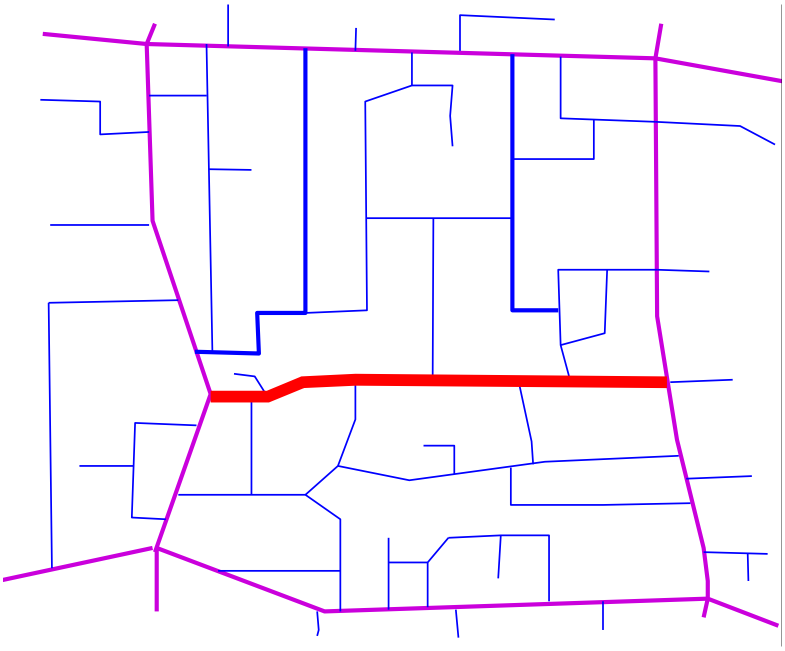


Figure C11 4: A subdivision road supplementing the arterial traffic network



For a given area, the greater the density of traffic generation, the higher the levels of traffic on the street system. Replacement of a single-household detached dwelling by several units, for example, usually leads to an increase in site traffic generation. Although traffic generation rates per dwelling unit are generally lower for medium-density development than for detached houses, this is usually more than offset by the increase in dwellings per unit area. A single traffic-generating activity such as a place of employment or a medical practice will similarly lead to higher levels of traffic on the approaching streets than would occur if the area were purely residential. Given that higher site densities and the provision of traffic-generating mixed land uses in local communities are often desirable planning objectives, the task of the traffic planner is to anticipate any traffic concentrations that may cause later problems, and to provide advice on either the location of these land uses or the design of the local street system to accommodate them. Once implemented, land use changes are hard to reverse and LATM becomes one of the few available countermeasures to deal with the consequences of the generated traffic.

Indicated countermeasures – Consideration of traffic impacts at land use approval stage; changes to the local street system, LATM provisions, and the provision of other modes such as cycling and walking and other travel demand measures as conditions on the planning approval.

The following additional source material is recommended for reference on this topic: Loder and Bayly (1990), Pak-Poy and Kneebone (1987: pp. 21–25).

C11.3 Common Contributors to Local Street Crashes

In addition to the quantity and speed of traffic, the causes of which are discussed in the preceding sections, crashes are related to several other characteristics of the local street system (Andreassen & Hoque 1986).

Intersections

About half of crashes on local distributor (or major collector) roads, and about 40% of crashes on other local streets, occur at (local) intersections. Intersections of two local distributor roads are particularly hazardous.

Parked vehicles

The largest single category of non-intersection local street crashes involves parked vehicles.

Roadside objects

Vehicles leaving the carriageway form a little over 10% of non-intersection crashes.

Bennett and Marland (1978) identified the nature of the local network itself as a fundamental contributor to a neighbourhood’s crash character, finding significantly lower crash rates in areas based on culs-de-sac and other low-connectivity streets than in areas with more connective streets.

From such observations, it can be suggested that the physical characteristics likely to contribute most to local street crashes (other than those already noted as inducing higher speeds and volumes), and therefore meriting close scrutiny, are:

- numbers of intersections: within reason, fewer intersections mean fewer crashes
- cross-intersections offer more opportunities for crashes, especially between connective streets. Local areas can have adequate pedestrian and cyclist permeability without recourse to frequent cross-intersections for motor traffic. Any new cross-intersection should be controlled by a roundabout
- major-minor connections: crashes at major-minor intersections constitute a high percentage of urban collisions (Cairney & Catchpole 1991)
- numbers and percentages of dwellings (and consequent pedestrian and manoeuvring activity) on connective roads
- unprotected parked vehicles on carriageways of locally-important roads and other connective streets
- conflict points between bicycle or pedestrian movement and motor vehicles
- sight lines not matching vehicle speeds and carriageway characteristics
- inadequate carriageway (width etc.) for vehicle manoeuvring.

By implication, countermeasure programs could focus on remedying these contributing factors.

The following additional source material is recommended for reference on this topic: Andreassen and Hoque (1986), Bennett and Marland (1978), Brindle (1996: Chapters 3, 14), Loder and Bayly (1990).

[Back to body text]

Commentary 12 Defining Objectives

C12.1 A Hierarchy of Objectives

There are different types of objectives. Consider the following statements:

1. to increase the safety of routes to school
2. to reduce vehicle speeds
3. to improve the amenity of the street
4. to maintain bus level of service quality.

These are essentially different in how they relate to the problems and how LATM measures can achieve them. Points 1, 2 and 3 are examples of **primary objectives** – things that the scheme is actually trying to achieve. Point 4 is a **secondary objective** – not the direct purpose of the LATM scheme, but an essential assessment criterion by which proposed schemes will be tested.

In addition, Points 1, 2 and 3 are intrinsically different. The first and third are outcomes that are sought, but are not directly and conveniently measured or interpreted in terms of how it might be achieved, whereas Point 2 is a **specific objective** – a more direct technical target that is known to contribute to the desired outcomes and is the direct and measurable effect that the LATM treatments try to achieve.

Thus:

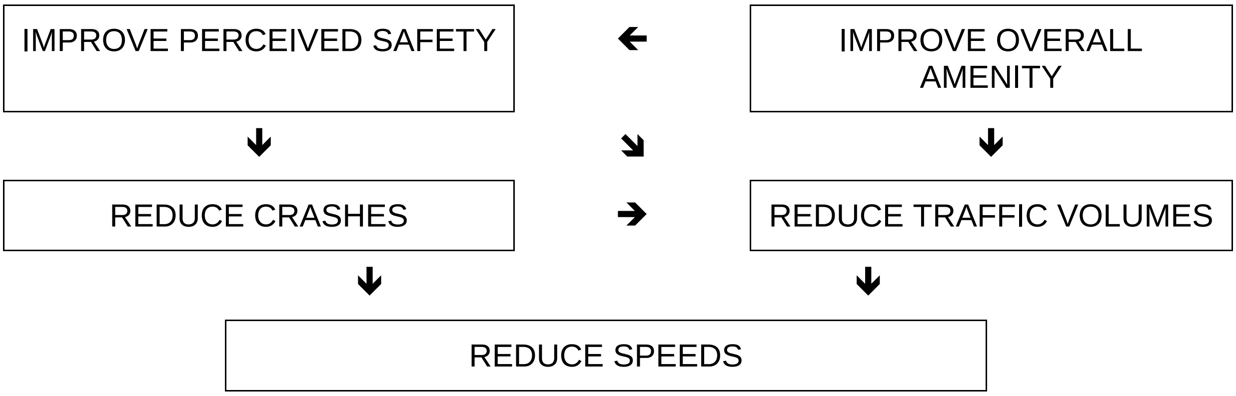
- *Primary objectives* state what is the intent of the LATM scheme?
- *Specific objectives* state what is the desired purpose and effect of the chosen strategy, and thus of the specific treatments, in order to achieve the intent of the scheme?
- *Secondary objectives* state what other things are to be monitored and protected as the scheme is being developed and implemented? They are not, however, the purpose of the LATM program.

Most objective statements may fall into any one of these categories, depending on the situation. In particular, the specific objectives of the treatments are the primary objective of the scheme in many cases (e.g. reducing speed in a street may well be adopted as an outcome in itself, not as a means to an end such as decreasing noise). It is helpful to maintain these distinctions, so that the selection of LATM measures can remain focussed on the specific objectives that are to be achieved.

C12.2 Primary and Specific Objectives

Primary objectives tend to be either complementary with each other, or dependent on one another. Figure C12 1 shows a hypothetical set of inter-related objectives, illustrating how (in this theoretical case) reducing speeds can be a valid specific objective to achieve the other objectives. The arrows indicate the 'how' relationship between objectives; e.g. How to improve perceived safety? By reducing traffic volumes. How to reduce traffic volumes? By reducing speeds.

Figure C12 1: An illustration of a possible relationship between objectives



Specific objectives are in effect statements of the means to achieve other objectives, e.g.:

- to reduce vehicle-related ground vibration – by reducing heavy-vehicle through traffic
- to reduce mid-block crashes – by decreasing traffic speeds
- to improve street quality for residents – by reducing traffic volume and speed.

Thus, reduction in commercial vehicles, reduced vehicle speeds and reduced traffic volume become objectives in their own right. They are the specific objectives that the LATM scheme would adopt. Speed change, for example, becomes a proxy (and more readily assessable) target in place of reduced crashes, and is a legitimate proactive objective when the actual crash experience on any one street is low.

It is important to be clear about these sequential relationships between objectives when setting down the purposes of a given LATM project because if, for instance, the safety benefits of a treatment rely on it achieving its speed reduction purpose and it does not in reality greatly reduce speeds, the safety outcome may not be achieved either. It might in fact be compromised if the treatment increases the driving task without reducing speeds.

Primary objectives typically include some of the following measurable indicators of the desired outcomes (primarily, increased safety and amenity):

- reduce vehicle-related collisions
- increase safety of the walk or cycle to school
- reduce traffic intrusion of residential areas
- reduce crash hazards and blackspots
- maximise the use of traffic routes for the primary links of journeys
- improve residents' perceived safety
- increase the sense of social space; increased use of streets for interaction and play
- increase driver sensitivity to the local environment
- encourage traffic movement in conformity with the road hierarchy.

These may be translated into such specific objectives as:

- reduce speeds
- displace through traffic movement to more appropriate routes
- improve public transport access/movement
- reduce non-resident on-street parking

- reduce parking-related visual blight
- improve streetscape
- reduce or simplify vehicle-vehicle conflict points
- reduce conflict points and hazards for pedestrians and cyclists
- improve pedestrian and cycle route continuity
- reduce the amount of streetspace given to traffic movement.

The practitioner will often have to translate the council's statements of intent (the primary objectives, or 'what we are wanting to do') into specific objectives (how in practice that can be achieved).

Wherever possible, objectives should be specified in terms of measurable targets, perhaps within a specified timescale, as part of their performance requirement, e.g.:

1. To reduce traffic casualties and collisions within the local area to a predetermined level, such as a municipal target rate per area, unit of population or unit of travel
2. To reduce traffic-related complaints to the council by X% in the next 12 months.

C12.3 Secondary Objectives: Supplementary Assessment Criteria

At the same time as helping to achieve their specified objectives, LATM schemes have to meet a wide range of community expectations which may constrain what can be done, or affect the community's response to a scheme. These expectations include the values and measures of quality of life that the community uses to gauge its satisfaction with the environment around it, and the wider implicit or explicit policy objectives that governments and the community might hold. They also include the background technical requirements that the scheme must satisfy, while meeting its primary objectives.

These secondary objectives or **supplementary assessment criteria** should not be confused with the primary objectives of an LATM scheme. They may be outside the strategic decision-making process but exert a separate influence on the plan development and the final decision, often through the political process or as part of the final technical judgement. They are nonetheless important and cannot be ignored. They typically include:

- effect on local accessibility and circulation
- effect on adjacent arterials
- effect on public transport access/service/comfort
- effect on emergency vehicle access
- degree to which the problem is shifted
- maintenance of property values
- equity among ratepayers: who bears costs and benefits?
- involvement of all stakeholders equitably (adequacy of the participation process)
- affordability (total capital cost)
- cost-effectiveness (economic justification)
- political considerations
- effect on driving task – considering the entire spectrum of drivers and vehicles
- consistency with local bicycle programs
- integrated design and traffic management

- total safety audit
- noise effects
- effects on parking supply and convenience
- effects on local trade
- degree of self-enforcement/required level of enforcement
- maintenance implications (downstream direct costs)
- effect on property turnover
- effects on the capacity and safety of the traffic (major road) system.

Remember that assessment criteria are not the objectives of an LATM scheme, but may exert a similar influence on the final decision. They should be explicitly stated, if possible, to minimise unexpected negative responses to an otherwise technically successful scheme.

[Back to body text]

Commentary 13 Guidance on the Effects of Device Spacing on Spot Speeds

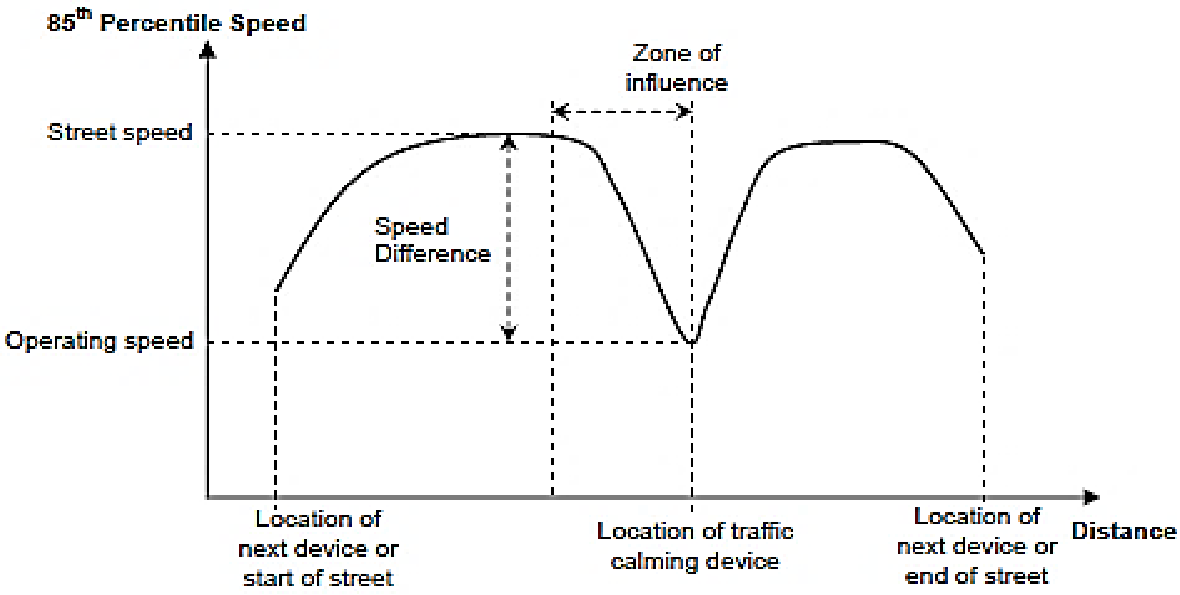
Each device has a 'zone of influence' over which it exerts a speed-reducing effect (e.g. Taylor & Rutherford 1986 found that it was about 80 m in total). This means that the devices should not be too far apart if they are to exert an influence on speeds along the whole street.

In addition to the general guidance noted in the main text, the following can be noted:

- US data on speeds between road humps on 58 streets presented by Ewing (1999a, pp.105) indicated that the 85^{th} percentile speeds increased linearly from 45 km/h at 60 m spacing, approximately 1 km/h for every 30 m of separation up to 300 m. These data suggest a device crossing speed over 30 km/h. Note that the 'before' 85^{th} percentile speeds in these streets averaged about 60 km/h.
- International data presented by Ewing (1999a, pp. 64) reflected somewhat lower intermediate speeds and a greater effect of spacing of unspecified slow points. Eighty-fifth percentile intermediate speeds averaged 25 km/h at 45 m spacing and 40 km/h at 120 m, tapering off to 50 km/h (expected to be close to the free speed in Europe) over 200 m spacing.
- Observations in Europe in the mid-1980s showed that devices were at 50 m maximum spacing in 15 km/h streets, with maximum spacings up to 90 m in 30 km/h zones (Brindle 1996, Chapter 17).

85^{th} percentile speed and mean speed profiles were measured by Daniel, Nicholson and Koorey (2011) to compare the speed-reducing effect for each type of traffic calming device. A typical speed profile using 85^{th} percentile speeds at varying distances of a traffic-calmed street is shown in Figure C13 1.

Figure C13 1: Typical speed profile of a traffic-calmed street



Source: Daniel, Nicholson and Koorey (2011).

[Back to body text]

Commentary 14 Speed-Based Design

Limiting speed by designing or altering the street geometry is essentially a matter of limiting the length of unconstrained street sections so that the target speed is not exceeded at any point. As pointed out in *Queensland Streets* (IMEAQ 1993), this may be achieved by:

- limiting total street length
- limiting the lengths of straight (by introducing low-speed bends in the design)
- creating a horizontal alignment which induces continuous lower speeds
- introducing slow or stop conditions along the street length to simulate shorter street section lengths or lower-speed alignments.

Speed management using LATM focuses on the last of these options. Traffic calming may also be achieved by street reconstruction to create a continuously slower street environment. Such major works normally fall outside the ambit of LATM, although an installation comprising alternating kerb extensions and parking protectors to create a continuous 'axial shift' has that effect.

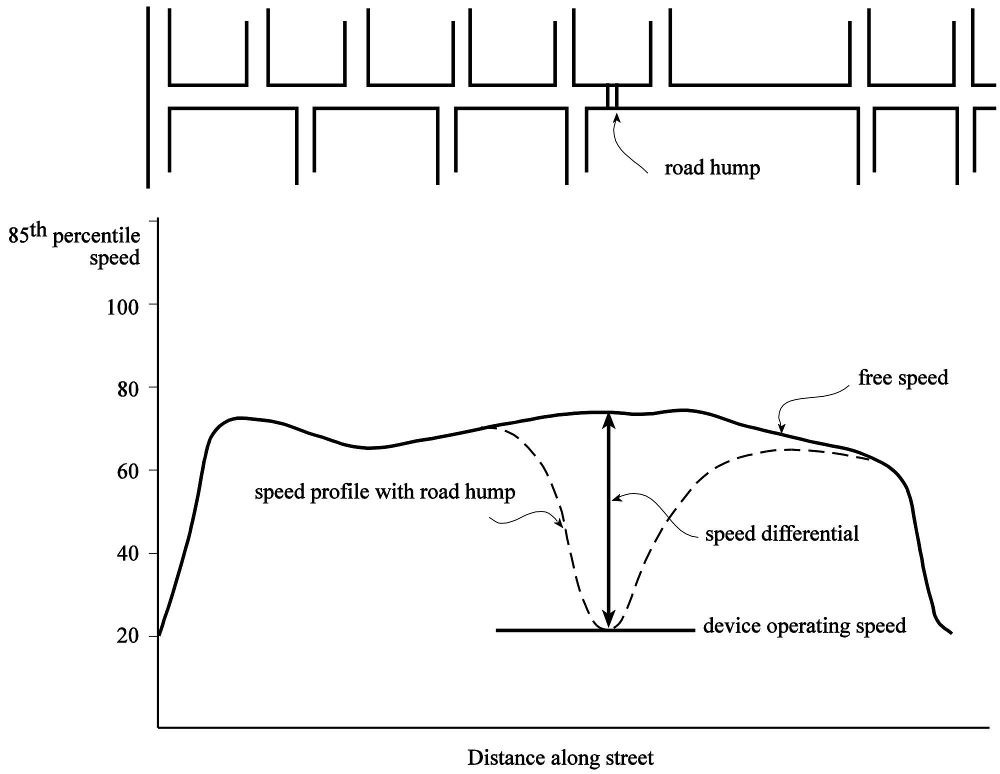
C14.1 Definitions of Speed

The objective of speed management techniques in LATM is to attain target street speeds within acceptable speed differential limits. These, and related terms used in this Guide, have the following specific meanings:

- The street speed is defined as the highest mean, 85th or any other percentile speed actually observed along the street (or street section). The 85th percentile street speed is taken as the design speed.
- The target speed is the mean, 85th percentile or any other percentile speed aimed at in (or adopted as the upper limit for) the design.

- The operating speed of a device is defined as the point mean or 85th percentile speed typically found at a particular device and layout.
- The crossing speed is the speed at which a given vehicle actually crosses or passes through a device or other treatment. (Thus, analysis of many crossing speeds at a device will allow the device operating speed to be estimated.)
- The free speed is the speed pertaining to the existing street or street section, unhindered by other traffic, parked vehicles or other transient impediments, but under the prevailing traffic control conditions (existing speed limits, speed control devices, levels of enforcement, etc.) – simply, the speed without the proposed device(s) but with everything else. The speed profile shows the variation of free speeds along the street.
- The speed differential is defined as the difference between the free speed at a given location and the anticipated operating speed of a device proposed at that location, all other conditions held constant (Figure C14 1).

Figure C14 1: Definition of speed differential



C14.2 Device Crossing and Operating Speeds

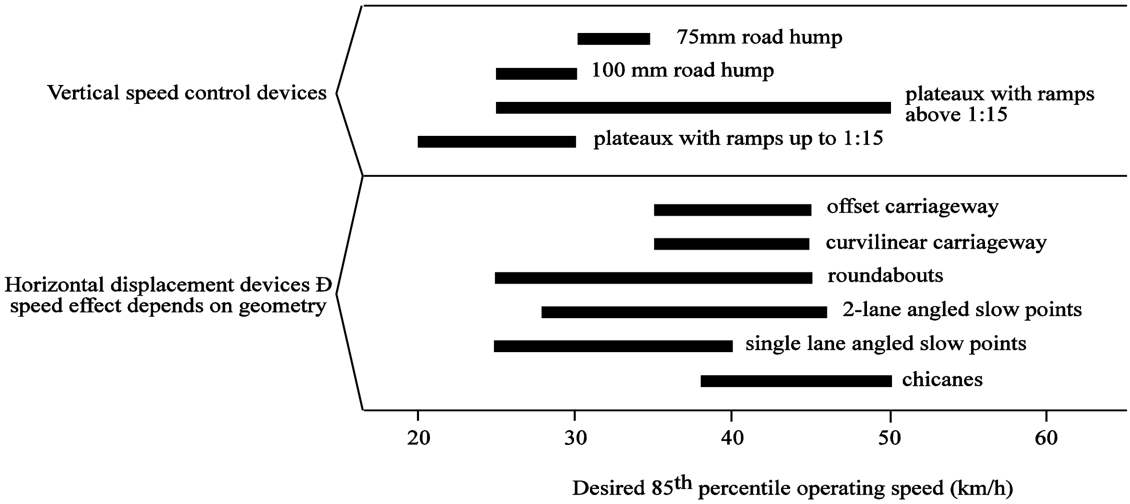
The practitioner needs to know what effect an LATM scheme will have on speeds in a street. The first step in that knowledge is the effect of a single device.

Estimates of likely operating speeds for future installations can be derived from observed or reported crossing speeds for similar devices already installed or (for horizontal deflection devices such as angled slow points or roundabouts) from first principles based on device geometry. Given the likely influence on speed behaviour of the ambient driving culture as well as the style of device, observations in the same area are likely to be the most reliable estimators of operating speed for that device in that place.

There is very little systematic information available on device crossing speeds; there is even less reliable information on whether or not operating speeds can be specified for a given type of device (see definitions in Section C14.1).

Sample indicative data on crossing speeds is illustrated in Figure C14 2.

Figure C14 2: Reported operating speed ranges for selected device types



Source: Brindle (1999).

Other guidance can be obtained from published information, such as the following:

- Taylor and Rutherford (1986) report mean crossing speeds at a sample of four angled slow points were in the range 25–30 km/h.
- ARRB undertook research for Austroads that found that the mean of crossing speeds at four angled slow points was 36 km/h. The 85th percentile was 44 km/h (Brindle & Lydon 1998).
- In the same study, the mean crossing speed over four flat-topped humps was 33 km/h and the 85th percentile was 44 km/h.
- Daniel, Nicholson and Koorey (2011) reported that the speed hump was the most effective device, reducing speed by 21.1 km/h. Overall mid-block narrowing showed the smallest changes in speeds. The raised angled slow point was the most effective horizontal deflection device reducing speed by 19.9 km/h.

The spread of these reported speeds reflects to some extent the variations in geometry that are found within device types. However, it also shows that assumptions that there are characteristic speeds for specific device designs are unlikely to be valid (i.e. that the operating speed of a given device is universal and can be confidently predicted).

The operating speed serves as an indicator of the effectiveness of traffic calming devices. An effective device will have an operating speed close to or less than the target speed.

Table C14 1 shows the device operating speed for different devices used by Daniel, Nicholson and Koorey (2011). Of all devices represented in the table, the road hump was most effective, reducing speed by 21.1 km/h. The least effective device was the two-lane mid-block narrowing, which registered a speed difference of 1.3 km/h. One-lane angle slow points performed better than mid-block narrowing in terms of lowering speeds.

Table C14 1: Operating speeds, street speeds and zone of influence for single traffic calming devices

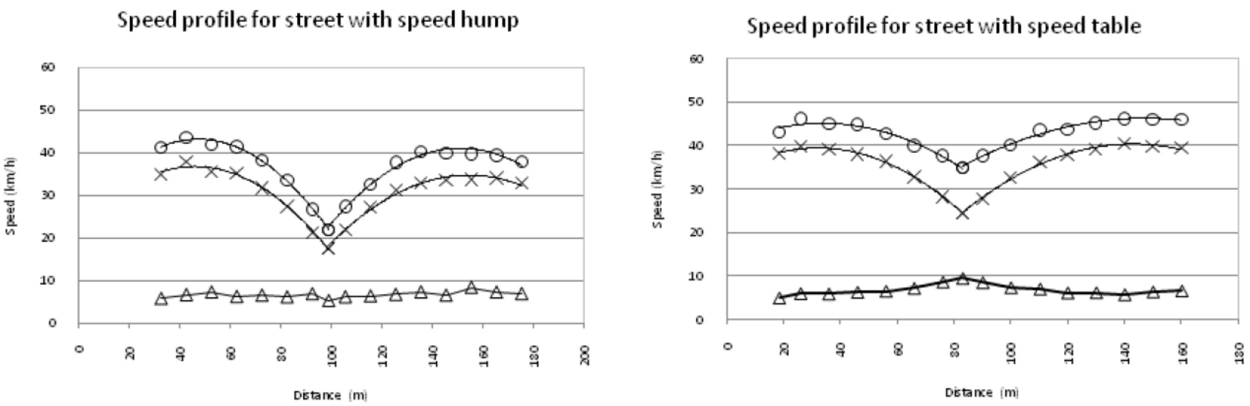
Device	Operating speed (km/h)	Street speed (km/h)	Speed difference (km/h)	Zone of influence (m)
Road hump 100 mm (H), 3.7 m (L), 5.8 m (W)	21.9	43.0	21.1	50
Flat-top road hump 120 mm (H), 5.8 m (L), 8.3 m (W) 1:8 ramp gradient	35.0	46.1	11.1	55
Angled slow point One-lane, flush 3.0 m (W), 5.1 m (L)	39.5	54.5	15.0	110
Angled slow point One-lane, raised 3.2 m (W), 16 m (L), 50 mm (H) 1:20 ramp gradient	30.0	49.9	19.9	110
Mid-block narrowing One-lane, flush 3.6 m (W), 11.6 m (L)	50.8	53.4	2.6	44
Mid-block narrowing One-lane, raised 4.6 m (W), 3 m (L), 50 mm (H) 1:40 ramp gradient	44.7	48.2	3.5	40
Mid-block narrowing Two-lane, flush 5.6 m (W), 6 m (L)	50.8	52.1	1.3	40

The following additional source material is recommended for reference on this topic: Daniel, Nicholson and Koorey (2011), Jurewicz (2008) and Klyne (1988).

C14.3 Estimating Speed Profiles Between Devices

Daniel, Nicholson and Koorey (2011) developed the speed profiles in Figure C14 3 for round profile and flat-topped road humps. Another study by ARRB (Brindle 1998b, Brindle & Lydon 1998) developed the speed profiles in Figure C14 4 for angled slow points and flat-topped road humps.

Figure C14 3: Speed profiles of speed humps and speed tables



Legend: -O-: 85th Percentile speed. -X-: Mean speed. -Δ-: Standard deviation.

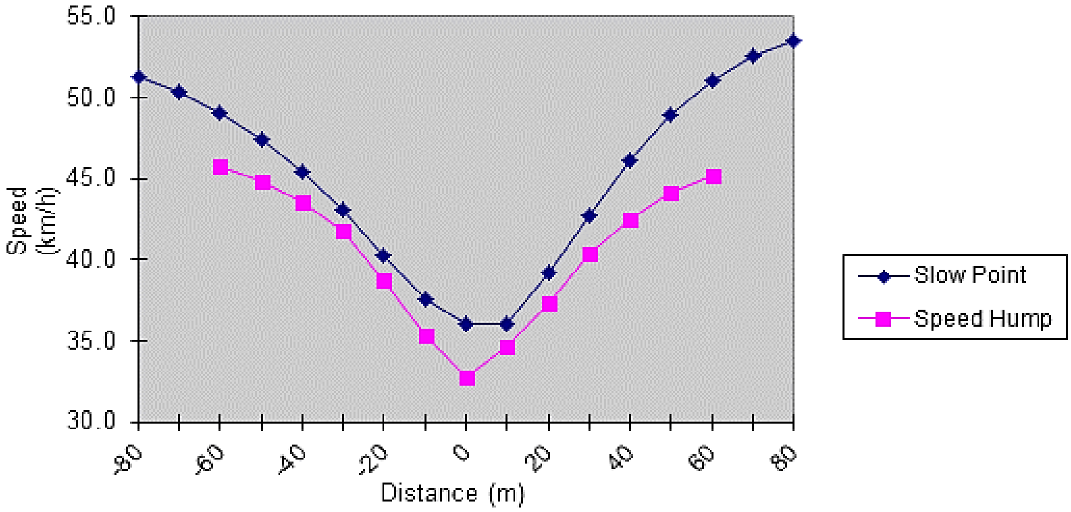
Source: Daniel, Nicholson and Koorey (2011).

For practical purposes, the factors in Table C14 2 can be used to roughly estimate speeds at a given distance before and after an isolated flat-top road hump or slow point (other values may be interpolated):

Table C14 2: Speeds as a ratio of speeds at the device

Distance	Ratio of mean speeds	
	Angled slow point	Flat-top road hump
60 m before	1.4	1.4
40 m before	1.3	1.3
20 m before	1.1	1.15
At device (the device operating speed)	1.0	1.0
20 m after	1.1	1.2
50 m after	1.3	1.4
70 m after	1.4	

Figure C14 4: Consolidated mean speed profiles for two speed control device types



Note: vehicle moving right to left.

Source: Brindle and Lydon (1998).

In Brindle and Lydon (1998), a 30% reduction in mean speed was observed at both devices, compared to the mean speed 60 m before the device. Speeds had recovered to that level 50 m after the humps and 70 m after the angled slow points.

Approximations of the expected mean speed profile after installation of a speed control device can be obtained by superimposing these generalised speed profiles, based on the adopted device operating speeds, onto a plot of the existing street speed profile, and smoothing in the curve by eye. The estimated speed reduction and zone of influence created by the device can then be obtained.

Figure C14 5 and Figure C14 6 show a typical speed-distance profile representative of the range of typical local road roundabouts and centre blister islands. The zone of influence of the roundabout on the free speed is 60–80 m on the approach and 100–120 m on the departure. Conversely, the centre blister does not have a major effect on speeds. Trial data analysis done by Jurewicz (2008) found that the 85th percentile speed reduction from centre blisters was only 8 km/h, or 14%. Data in Tucker (2006) suggested that centre blisters can be effective in speed reduction if the radius of the maximum travel path is reduced to between 20 m and 60 m.

Figure C14 5: Typical speed profiles for local road roundabouts

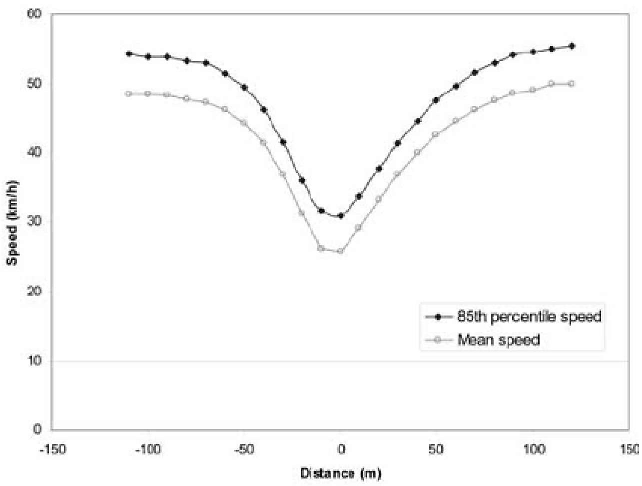
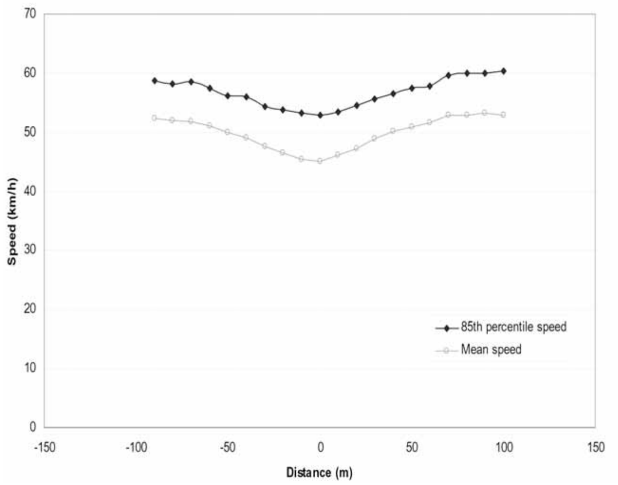


Figure C14 6: Typical speed profiles for centre blister islands



A linear relationship was developed (Austroads 2009b) for the minimum 85th percentile speed at a roundabout (V_{85min}) as a function of its outer radius of the maximum travel path (Rmtp) as shown in the Equation C1 and Equation C2. The range of these radii found in the roundabout was 24 to 63 m.

$$V_{85min} = 0.16R_{mtp} + 23.6 \quad \text{C1}$$

where

V_{85min} = is the minimum 85th percentile speed at a roundabout in km/h

R_{mtp} = is the radius of maximum travel path in m

A multi-linear regression was performed to determine the relationship between the V_{85min}, the 85th percentile speed at the treatment, $V_{85\ app}$, the 85th percentile approach speed, and R_{mtp} the external radius of maximum travel path (Equation C2):

$$V_{85min} = 1.1V_{85\ app} + 0.1R_{mtp} - 22.3 \quad \text{C2}$$

Webster and Layfield (1996) produced a relationship for mean speed between the Watts profile humps of 75 mm or 100 mm height, as follows (after conversion to metric units) (Equation C3):

$$Vmbet = 10.6 + 0.093\ S + 0.31\ Vmbef \quad \text{C3}$$

where

Vmbet = the mean speed (km/h) between 100 mm or 75 mm high Watts profile humps

S = separation between the humps, m

Vmbef = mean before speed, km/h

The standard errors of the coefficients were: 0.011 for S and 0.05 for Vm_{bef}.

The following additional source material is recommended for reference on this topic: Austroads (2009b).

C14.4 Interpreting the Speed Differential

A high speed differential (defined above) implies dramatic speed reductions within an otherwise unchanged street environment. This will result in excessive accelerations and decelerations, with accompanying noise impacts and inconsistent driver behaviour.

A high speed differential also implies a perception of incongruity about the device. In urban design terms, this means that the device will appear out of place in the visual environment of the street and thus will create greater demands for conspicuity, delineation, signs, lighting, etc.

Primarily, however, a high speed differential is undesirable because of its safety implications. It suggests that the street's general visual and physical environment is indicating a higher appropriate speed than the physical conditions at a given device location will actually accommodate safely and comfortably.

The suggested upper limit to the speed differential for planning and design purposes is 20 km/h. The corollary of this requirement is that no isolated device (i.e. one which does not interact with another device in the street) should have an operating speed which is more than 20 km/h below the existing free speed at that point as influenced by existing conditions and any proposed adjacent traffic control devices.

This, in effect, means that a driver unaware of a device's presence will not be expected to encounter the device at a speed more than 20 km/h faster than that at which drivers normally negotiate that device.

C14.5 Sketching the Revised Speed Profile

For the case of isolated devices (which implies that free speeds are already below the target street speed over much of the street length, and the device is needed only where the free speed is above the target speed) the process is to:

1. identify locations where the current free speed is above the target speed
2. select a device type and design that satisfies the requirement: (free speed – operating speed) < 20 km/h
3. if (free speed – operating speed) > 20 km/h, consider supplementary treatments to reduce approach speeds.

For a sequence of devices, where the existing free speed is above the target speed over much of the street length, the process is to:

1. plot current speed profile
2. superimpose target street speed(s)
3. select combination(s) of devices that together bring the estimated speed profile below the target speed(s)
4. select and locate each device in turn taking account of the operating speed and location of the previous device in the sequence.

In practice, locations for most treatments are severely constrained by driveways and other features, resident requirements and so on. Compromises to accommodate such constraints should always be checked to ensure that an effective outcome can still be achieved, and that excessive speed differentials have not been produced.

There appears to be a spacing of treatments below which drivers tend to adopt a more or less constant low speed rather than accelerate and decelerate between devices. At this point, the theoretical oscillating speed profile based on known decelerations and accelerations ceases to apply. Few installations in Australia or New Zealand meet this description, and so far there is no empirical information to guide the practitioner. It would be expected that maximum spacings would need to be more of the order of 50–60 m to have such an effect, implying a more comprehensive change to the street's form than simply inserting occasional treatments.

C14.6 Treatments for Given Speed Environments

This approach suggests a way by which treatments can be selected and designed for a range of speed environments. Designs appropriate for local streets with a target street speed of (say) 30 km/h will not be appropriate for 50 km/h collector streets or mixed-function roads. Clearly, if the maximum speed differential is selected as 20 km/h, a device with an operating speed of (say) 30 km/h will be inappropriate at a point in a 50+ km/h speed environment because the implied speed differential would be more than 20 km/h.

The implication for streets in which widely spaced (i.e. isolated) treatments are to be installed is that only treatments with operating speeds no more than 20 km/h below the current free speed can be considered. For example, devices such as road humps or flat-top road humps with ramps steeper than 1:15, may be inappropriate as isolated installations in streets with 85th percentile free speeds in excess of 55 km/h because their 85th percentile operating speeds are typically below 35 km/h.

Adopting a maximum speed differential as a design parameter does not prevent speed control devices being used in those streets where real speeding problems exist. Note that:

- As previously indicated, **isolated** severe devices are inappropriate in streets experiencing higher speeds.
- Devices in combination change the free speed profile. A device placed near the start of a street changes the free speed profile from there on down the street. The speed differential at the site of the next device is based on the typical acceleration profile from the first device, not the original free speed with no treatments at all. In this way, successive treatments along the street can be used to pull down the speed profile and allow the target speed to be achieved.
- Streets with an excessive speeding problem should be examined to identify the factors (network, social or street form) that encourage such speeds. LATM devices cannot change a street's character totally; the response to a serious speeding problem may lie at least partly in more broadly based action.

Other cues such as signs which have the effect of reducing traffic speed over a section of street will also reduce the speed differential between the device speed and the speed without the device (but with everything else in place). Signs which do not have that effect but which merely legalise the isolated device, do not meet this requirement and the whole installation should be seriously questioned.

The objective should be to reach a situation where the street treatments do not need individual signs to obtain the desired speed behaviour and level of driver awareness of the treatments. The speed differential approach offers a way to do that.

[Back to body text]

Commentary 15 Measures of Effectiveness

Measures of effectiveness (MoEs) are examples of a framework for qualitative or quantitative assessment of the level of achievement of scheme objectives as well as more broadly defined criteria that may affect a community and technical assessment of the plan. An example set of MoEs is listed in Table C15 1. Such measures of effectiveness are defined in terms of their target objectives, and can all be expressed by a measure, either qualitative or quantitative, using a percentage, index, relationship, or rating. For example, for the objective 'restrict through traffic', the MoE is 'percentage of through traffic'.

Table C15 1: Measures of effectiveness of local traffic plans

1	Percentage of through traffic
2	Traffic volumes by vehicle types
3	Percentage heavy vehicle through traffic
4	Spot speed by category of vehicles
5	Total no. of crashes by category
6	Number of crashes by category per million vehicle kilometres
7	Travel time to/from and within local areas
8	Delay time at intersections
9	Level of parking utilisation (%)
10	Intersection capacity
11	Capacity of arterial road
12	Travel time along arterial road system and through local area
13	Noise levels
14	% of residents subjected to noise level exceeding specified limits
15	Concentration of vehicle emittants at different points
16	Area wide air pollutant concentration index
17	% of residents subjected to vibration levels exceeding specified tolerance levels
18	Scale and geometry of street
19	Degree of visual intrusion of utilities and parked cars
20	Trends in property values
21	Degree of capital upgrading of properties
22	% turnover of properties
23	Average no. of neighbour contacts (per week)
24	Proportion of small children going to school unaccompanied
25	Numbers of children playing on street
26	Types/durations of activities undertaken in local street
27	Numbers of cyclists by category
28	Proportion of local trips undertaken by foot
29	Number of residents participating in RSM scheme
30	% resident satisfaction

Source: Based on Hawley and Gennaoui (1984).

[Back to body text]

Commentary 16 Examples of LATM Warrant Systems

C16.1 Qualifying Warrants – Checklists of Required Characteristics

Qualifying warrants are typically structured in the form of a series of mandatory and other conditions. An example from the Christchurch City Council follows:

Christchurch City Council (NZ)

Seven key questions are to be addressed prior to the processing of a local area traffic management request. These are:

1. Is there an accident history in the street?
2. Is the installation of an LATM device or scheme an appropriate solution?
3. Is the proposed solution supported by the local residents and other affected parties such as the police, emergency services, public transport operators and utility service providers?
4. Is the scheme technically feasible?

5. Does the scheme stack up against other similar schemes vying for limited budgets?
6. Will the establishment of features or devices implemented result in an acceptable level of service for both traffic and residents and be consistent with the road hierarchy?
7. Is the road due for reconstruction or kerb and channel replacement anyway?

C16.2 Priority Ranking Systems (Using a Points System or Threshold Values)

The following examples of priority ranking systems are just that – examples. They should not be taken as being appropriate to any area other than that for which they were originally developed. The examples illustrate the types of criteria that are likely to be useful and the approach to be adopted. Note that the relative weightings are area specific and consequently they should be developed specific to a local government area in consultation with key stakeholders.

Example 1: Stirling City Council (WA)

This is a points-ranking system linked to action/investigation warrant criteria (Table C16 1).

Table C16 1: Stirling City Council Priority Ranking System

Category	Parameter	Range/item	Point scores for each parameter	
			Local road	Local distributor
Speed	85^{th} percentile Speed in 50 km/h zone (measured in kilometres per hour)	Under 50 km/h	0	0
		50–53 km/h	2	2
		54–57 km/h	5	5
		58–61 km/h	10	10
		62–65 km/h	15	15
		66–68 km/h	25	25
		69–72 km/h	40	40
		73–76 km/h	65	65
Traffic volumes	Average weekday traffic volume (measured in vehicles per day)	0–1000 vpd	0	0
		1000–1499 vpd	4	0
		1500–1999 vpd	7	0
		2000–2499 vpd	10	0
		2500–2999 vpd	14	0
		3000–3999 vpd	18	4
		4000–4999 vpd	24	7
		5000–5999 vpd	30	12
		Over 6000 vpd	39 + 9 per 1000	18 + 7 per 1000

Category	Parameter	Range/item	Point scores for each parameter	
			Local road	Local distributor
Crash data	Fatal crashes (refer to Table 2)	1 crash	4	4
		2 crashes	20	20
		3 crashes	45	45
		Over 3 crashes	45 + 25 per crash	45 + 25 per crash
	Injury crashes (refer to Table 2)	1 crash	3	3
		2 crashes	12	12
		3 crashes	27	27
		Over 3 crashes	27 + 15 per crash	27 + 15 per crash
	Non-injury crashes (refer to Table 2)	1 crash	2	2
		2 crashes	6	6
		3 crashes	11	11
		Over 3 crashes	11 + 5 per crash	11 + 5 per crash
Road design and topography	Restricted sight crest curve	Under 50 km/h	2	2
		50–60 km/h	6	6
		Over 60 km/h	18	18
	Restricted sight horizontal curve	Under 50 km/h	2	2
		50–60 km/h	6	6
		Over 60 km/h	18	18
Road design and topography (continued)	Bends with unrestricted sight distance	Under 50 km/h	0	0
		50–60 km/h	2	2
		Over 60 km/h	6	6
	Steep hill	Under 50 km/h	1	1
		50–60 km/h	4	4
		Over 60 km/h	10	10
Vulnerable road users	Major bicycle or pedestrian crossing point	Under 1000 vpd	1	1
		1000–1999 vpd	2	2
		2000–2999 vpd	4	4
		3000–3999 vpd	6	6
		4000–4999 vpd	8	8
		Over 5000 vpd	10	10
	Important bicycle route	Under 1000 vpd	0	0
		1000–1999 vpd	1	1
		2000–2999 vpd	2	2
		3000–3999 vpd	3	3
		4000–4999 vpd	4	4
		Over 5000 vpd	5	5

Category	Parameter	Range/item	Point scores for each parameter	
			Local road	Local distributor
Activity generators	College	Under 30 km/h	0	0
		30–40 km/h	0	0
		40–50 km/h	4	4
		50–60 km/h	10	10
		Over 60 km/h	12	12
	School	Under 30 km/h	0	0
		30–40 km/h	2	2
		40–50 km/h	4	4
		50–60 km/h	8	8
		Over 60 km/h	10	10
	Retail	Under 30 km/h	0	0
		30–40 km/h	0	0
		40–50 km/h	2	2
		50–60 km/h	4	4
		Over 60 km/h	8	8
Amenity factors	Trucks	Under 1%	0	0
		1–2%	2	0
		2–3%	4	1
		3–4%	7	3
		4–5%	10	6
		Over 5%	12	8
	Rat-running through traffic	Under 10%	0	0
		10–20%	5	3
		20–40%	15	10
		Over 40%	20	15

Traffic volume	Crash reduction factor
0–1000 vpd	1.0
1000–1999 vpd	0.9
2000–2999 vpd	0.8
3000–3999 vpd	0.7
4000–4999 vpd	0.6
Over 5000 vpd	0.5

Source: Adapted from City of Stirling (2013).

Example 2: Canberra (ACT)

This is a standardised points ranking system that takes the additional step of linking the resultant score to a unit length of road. It makes the ranking of candidate projects much more comparative.

Table C16 2: Canberra Points Ranking System

Traffic parameter	Value	Points for a street or road		
		Local access	**Minor collector**	**Major collector**
Traffic speed (km/h)	> 50	3	0	0
85th percentile speed	> 55	9	3	0
	> 60	15	9	0
	> 65	24	18	6
	> 70	33	27	18
	> 75	45	40	27
	> 80	55	45	40
Traffic volume (vpd)	> 1000	4	2	0
24 hour volume	> 1500	7	4	0
	> 2000	10	7	0
	> 2500	14	10	0
	> 3000	18	13	6
	> 4000	24	18	9
	> 5000	30	24	12
	6000+	39+9 per 1000	33+9 per 1000	21+9 per 1000
Traffic volume (vpd)	> 150	1	0	0
Highest hourly volume (HHV)	> 200	2	1	0
	> 300	3	2	1
	> 400	4	3	2
	> 600	6	5	4
	700+	8+2 per 100	8+2 per 100	8+2 per 100
Crash Data *(5 year period)*	Points per crash			
Per fatal crash		2.0	2.0	2.0
Per injury crash		0.8	0.8	0.8
Per non-injury crash		0.4	0.4	0.4
Heavy vehicles (%)	1	0	0	0
Per cent of total traffic	2	0	0	0
	3	0	0	0
	4	1	1	1
	5+	2+1 per %	2+1 per %	2+1 per %
Activity generators	Residential	1	1	1
	Medium residential	2	2	2
	Primary school	6	8	12
	Secondary school	6	8	10
	Small retail centre	6	8	10
	Large retail centre	8	10	12
	Bike/pedestrian crossings	3	5	7
	Major bike/ped path crossings	4	6	8
Verge width (m)	> 6	0.07	0.07	0.07
	> 10	0.15	0.15	0.15
	> 15	0.25	0.25	0.25
Weightings for each traffic parameter	Speed	25.0	25.0	25.0
	Volume	25.0	25.0	25.0
	HHV	0	0	0
	Crashes	20.0	20.0	20.0
	Heavy vehicles	5.0	5.0	5.0
	Activity generators	25.0	25.0	25.0

C16.3 Action and Investigation Warrant Criteria

There are two types of conceptual warrants:

- action warrants – the warrants which state that an identified problem is of such magnitude that it will be treated with the limited funds available
- investigation warrants – the warrants or criteria which show that there is an agreed identified problem (which if funds were available, is of such magnitude that it would justifiably be treated).

Example 1: Typical example of a multi-criteria action-investigation warrant system

In the following example (Figure C16 1) only one of the three warrant criteria thresholds (i.e. 85th %ile speed, traffic volume or points) needs to be exceeded to achieve the warrant cut-off. Equally, a council might decide that it is appropriate for one or more criteria to be mandatory (e.g. point score).

Figure C16 1: Example of warrant criteria thresholds

85th%speed	Traffic volume	Total points	Problem?	Recommended action
↑ 60+	↑ **6000+**	↑ 50+	Substantial problem	Problem which is great enough to be included IN a funded treatment program
ACTION (FUNDING) WARRANT CUT-OFFS				
60 ↑ 55+	**6000** ↑ **4000+**	50 ↑ 40+	Acknowledged technical problem	Acknowledged problem justifying investigation or monitoring, but not of sufficient degree to attract funding in the short-term
AGREED PROBLEM' WARRANT CUT-OFFS				
55 ↑ 50+	**4000** ↑ **2000+**	40 ↑ 30+	Possible technical problem	There may be a problem, but not so serious as to attract funding even in the longer term
50 ↑	**2000** ↑	30 ↑		The problem is not of such an extent that it is ever likely to be funded for treatment

Example 2: City of Stirling (WA)

The following example (Table C16 3) links a point score, as determined using the priority ranking system, with an action response.

Table C16 3: Example of warrant system action responses

Total point score	Decision	Typical response
More than 50 points	Denoted as Technical Problem Site (High Priority)	Considered to be a site that has problems. Suitable solutions to be considered for funding and implementation.
30 to 50 points	Denoted as Minor Technical Problem Site (Medium Priority)	Consider low cost non-capital works solutions (e.g. signing and line marking) if appropriate. Review again after 2 years.
Under 30 points	Denoted as Site with Low Safety and Amenity Concerns (Low Priority)	No further action required.

Source: City of Stirling (2013).

[Back to body text]

Commentary 17 Choosing Public Participation Techniques

The following factors need to be taken into account when choosing techniques for public participation:

- The chosen techniques must contribute to outcomes that the public, council and its practitioners, and other agencies can all accept with confidence (in other words, will they trust that process?).
- Are there, or have there been, provisions in place for public involvement in other planning and community development processes overseen by council? Are there representative groups or ward committees already in place for interaction between council and the community?
- What is the level of real public interest in the traffic problems being considered? If that level of interest is low, then outreach or information programs to reach a broad base of the community are necessary. On the other hand, if local interest is high, more direct participatory programs such as workshops, focus groups and community advisory committees may be necessary.
- Are there already established attitudes and opinions towards traffic matters in the area? If so, and particularly if conflicting views are already evident, more sophisticated techniques are required.
- What are the community's expectations of its role in the planning process? If there is a history of consultation on matters of community concern, the machinery of consultation will be already partly in place but expectations will be higher.
- What is the community's past experience of consultation? If that experience is somewhat negative, greater effort will be needed to launch a successful consultation program and more gradual processes may be justified.
- What is the level of education and English language skills in the community? This will affect the type of materials to be prepared, as well as affect the nature of responses that are to be encouraged. Many of the techniques of consultation require competence in spoken and written English. If this competence is not general, the chosen techniques will have to provide other means of input.
- What resources and skills are available to council and its staff? Resources, skill and commitment have to be sufficient to sustain the chosen techniques through the study period, which may be longer than originally planned.

Techniques for participation and information dissemination are wide-ranging. The following list outlines the most common techniques, which can be combined to suit the requirements of a particular study.

Public opinions and responses

- questionnaire/attitudinal surveys
- written submissions
- enquiries and submissions hot line
- study area shop front or open house
- project caravan.

Representative committees

- use of existing representative committees and organisations
- appointment of street or area committee(s)
- ward (or local) traffic committees
- advisory committee (to represent wider interests, in larger studies).

Community events

- walkabouts (small group guided tour of the area and its problems)
- community-assisted data collection
- workshops, focus groups, or intense planning sessions such as design charettes.

Public meetings

- town meetings, debates
- formal public hearings
- public presentations (see below under Education and outreach).

Education and outreach

- public presentations
- news releases
- project newsletters
- leaflets
- internet: web sites etc.
- community radio and television
- exhibitions in council premises
- displays and videos in shopping centres, libraries etc.
- schools program
- media events, field days etc.

Councils with long experience in LATM report that much of the effort that once had to be put into community education and participation is usually not required, as the community's understanding of the form and intent of traffic control in local areas has increased. Many now adopt an abbreviated process which involves a much more localised and small-scale community contact program.

A typical process in an experienced municipality:

> *When a street is being considered for treatment, all residents are usually contacted by letter with a diagram of the proposal, including alternatives. An opportunity is provided to comment on the proposal, either through a response form or by telephone. The results of this consultation are then collated and a decision is made whether to proceed and, if so, the works that are to be undertaken. Following detailed design, residents who live directly adjacent to the devices are further contacted with a final copy of the plans and given another opportunity to comment. It has generally been found that this method of consultation is more useful than public meetings and works quite well, provided all residents within the street or precinct are informed of the works and are given opportunity to comment. (A suburban council in Melbourne.)*

Large-scale public meetings are often unproductive, being easily diverted from the objective of two-way communication, and are now usually undertaken only reluctantly, if at all, in LATM studies. Smaller meetings, including on-site meetings, are found to be more constructive for all parties.

[Back to body text]

Commentary 18 Roles and Responsibilities in Consultation

Consultation with the various statutory bodies and others with responsibility for services and utilities is essential throughout the study, and may be mandatory in legislation applying in any given jurisdiction.

Establishing these obligations should be among the first steps in the study process.

Consultation with such bodies will usually be on a direct basis rather than through the local committees. After the initial contact to establish requirements and give notification of intentions, it will most likely be on an as-needed basis. These bodies should, however, be kept informed of progress with the study, even during periods when they are not involved.

Examples of such bodies and their relevance to the study follow.

State road/traffic authority

The traffic management branch of the state road agency may need to be consulted about matters concerning:

- road hierarchy designation
- traffic data
- traffic modelling
- analysis of impacts on the arterial system
- signs and other major traffic control devices
- road safety audits.

Note that some or all LATM devices are classified as major traffic control devices in some jurisdictions, and need the approval of the state road/traffic body.

State transit agency/local bus operators

LATM treatments on bus routes can affect passenger and driver comfort and bus operations (routing and scheduling). Consultation with the state transit agency and/or reference to its codes may be mandatory, and in any case close cooperation with the operators of local bus services is essential.

Emergency services

It is essential that the operational requirements of fire and ambulance services be obtained and allowed for in the development of proposals. All emergency services require up-to-date information about hindrances and road closures, and adequate advisory routes for quick access to and through local areas. Their requirements may also influence the selection and design of treatments.

Bicycle representative bodies

Some jurisdictions have a statutory requirement that bicycle bodies be consulted about cycle routes and facilities and are included in the technical aspects of device selection and design. Bicycle groups can provide informed input into the selection, location and design of treatments, and should be included in the participation process.

Utilities agencies

It may be necessary to consult with authorities and companies responsible for utility services such as telephone, electricity, water, sewerage and gas. The relocation of poles and underground services can be expensive. Information about costs and scheduling of alterations to suit the construction timetable will be needed.

Adjacent municipalities

If there is potential for traffic or other impacts to spill over into an adjacent municipality, especially where the study area is on or near the boundary of two municipalities, the neighbouring municipality should be consulted to minimise undesirable impacts, to coordinate road hierarchy designations, and to obtain a degree of consistency in treatments for traffic moving from one area to the other.

State planning agency or redevelopment authority

It may be necessary to consult the planning agency if the LATM scheme is part of an area redevelopment, or if it has possibly significant land use implications.

[Back to body text]

Commentary 19 Negative Impacts of Humps

Zaidel et al. (1992) investigated claimed negative impacts of humps on emergency vehicles, and concluded that:

- Humps cause no damage to emergency vehicles if crossed at the recommended speeds.
- Humps are no worse than the off-road, driveway and on-kerb manoeuvring done in the normal course of emergency vehicle operation.
- Emergency response times are primarily determined by the adequacy of main roads, not the short approach stretches in neighbourhoods.
- The requirements of rare events should not be allowed to completely overshadow everyday safety and amenity needs.
- Speed control devices, by reducing the risks of injury in local streets, help to reduce the number of calls for emergency services.

[Back to body text]

Commentary 20 Assessment of Traffic Pattern Changes

LATM measures may aim to redirect through traffic onto the appropriate higher-order roads. At the same time, the practitioner must be careful not to create unacceptably high increases in traffic on other local streets in the neighbourhood.

This means that some attempt must be made to anticipate the changes in traffic on links and at intersections within and on the boundaries of the study area that would result from each of the schemes being assessed.

In terms of the elements of travel analysis, the process involves at least the allocation (assignment) of vehicle trips to the local street and surrounding arterial network, with the proposed changes to the network reflected as speed or other penalties on local street links and intersections. Turn bans and other route changes can also be incorporated. More complex and ambitious schemes may lead to assessments about changes in the trip table itself (reductions in trips and/or redistribution of trips between origins and destinations).

There are two general approaches:

1. manual estimation
2. use of a traffic network model.

C20.1 Manual Assessment

Experienced traffic planners who are familiar with traffic behaviour in networks and with the locality under study may be able to make a reasonable approximation of the likely changes in local traffic patterns related to the scheme. This may take the form of assumption testing, in which various proportions of the non-essential traffic in a given street are assumed to take different routes, and that traffic is then allocated by judgement to the remaining network. In tributary (closed) networks with few alternative paths, there is usually little non-essential traffic in a given street, and the process of reassignment is relatively simple. Most problems in such networks usually occur on the collector roads, and reassignment can be done on the basis of changes in relative travel times and delays. In grid (open) networks, the likelihood of intruding traffic is higher and the number of alternative paths for reassignment is greater.

The results should always be quoted in ranges of values, not precise traffic estimates. The range of increase in traffic on any street under the various assumptions can then be assessed, and the combinations of assumptions that create unacceptable outcomes can be identified. The realism of those assumptions can be examined, and estimation made of the probability of an unacceptable outcome.

C20.2 Use of Computer Models

Computer-based models are not necessarily more accurate than these manual methods, depending on their input data and internal logic. However, a local area traffic model may be appropriate if there is expected to be significant diversion of traffic to the surrounding arterial network, and it is clearly preferred that indications of the variations between options are wanted. Modelling is also appropriate if congestion levels in the study area or on the surrounding roads are such that traffic diversions could result from changes in those levels.

As the complexity of the traffic assessment task increases, the more useful is the assistance of a computer model. Models also allow objective assessment of a number of alternative plans on a common basis. Likely circumstances under which a model might be considered include:

- Non-local traffic forms a medium to high percentage of total traffic in the local network.
- The arterial road network near the local area is congested.
- The likely traffic displacement effects will be widespread.
- A number of traffic management strategies or plans are to be considered.

Due to the data-hungry nature of these computer modelling tools and the effort required to construct and run them, their use is unlikely to be justified for a single LATM study. They would be more appropriately used over a larger area to justify the total cost involved. The choice of a computer modelling approach is helped if there is already in place an area-wide model for the municipality or part of it, or at least if the network and its characteristics are already geo-coded.

C20.3 Available Models

There are several techniques to model the impact of network operations, each with its own advantages and disadvantages. The suitability of each technique therefore, depends on the context of the project. Austroads (2010) reviewed the suitability of the different modelling techniques. To model traffic diversion impacts, the modelling technique needs to have network assignment capability (i.e. user equilibrium assignment) and the capability to adequately model the impact of treatment options to be tested. For most LATM measures, they involve restriction of movements or speed limitations. Network assignment software would be a practical option, given that it is simple to set-up and run. EMME, CUBE and VISUM are specific network assignment software that can be used. More complicated treatments may require microsimulation or macrosimulation software to properly model impacts of traffic diversion. For example bus priority signals are dynamic measures that could not be readily modelled without simulation. It should be noted that microsimulation and macrosimulation models tend to be time and resource-hungry (especially microsimulation) but do allow unique areas of investigation and variation. The realistic graphical output is an advantage for consultation. VISSIM, AIMSUN and PARAMICS are specific microsimulation software and SATURN is an example of a macrosimulation software.

[Back to body text]

Commentary 21 Impact of LATM Devices on Speed and Safety

Table C21 1 represents the percentage reduction in the 85th percentile speeds and crashes of each commonly used LATM treatment. These speed reductions were provided for speeds at treatment sites and across entire LATM schemes (scheme-wide) measured at various points within the treated area.

Table C21 1: Speed and safety benefits of different LATM devices

Treatment type	Studies	Change in 85th percentile speeds		Crash reduction, scheme-wide
		At treatment	Scheme-wide	
Raised tables (best defined as flat-top road humps)	Brindle et al. (1997), Smith et al. (2002), Webster and Layfield (1996)	–24%	–	71%
Road humps	Evans (1994), Corkle et al. (2001), Huffine (2005), Petruccelli (2000), Ponnaluri and Groce (2005), Smith et al.(2002), Webster (1993), Webster and Layfield (1996), Zito and Taylor (1996)	–45%	–21%	71%
Road cushions	Layfield and Parry (1998), Wheeler et al. (1996, 1998)	–27%	–	60%
Kerb extensions	Corkle et al. (2001), Parham and Fitzpatrick (1998), Fehr and Peers (2015), WSROC (1993)	–7%	–	–
Slow points – two-lane	Cusack et al. (1998), Sayer et al. (1998), Tucker (2006)	–27%	–15%	51%
Slow points – one-lane	Corkle et al. (2001), Sayer et al. (1998)	–34%	–32%	61%

Treatment type	Studies	Change in 85th percentile speeds		Crash reduction, scheme-wide
		At treatment	Scheme-wide	
Centre blisters	Cusack et al. (1998), Tucker (2006), WSROC (1993)	–24%	–	–
Midblock median treatments	Parham and Fitzpatrick (1998), Fehr and Peers (2015), WSROC (1993), Austroads (2007)	15%	–	15 – 20% for painted 45% for constructed
Roundabouts (local road)	Corkle et al. (2001), Parham and Fitzpatrick (1998), Petruccelli (2000), Fehr and Peers (2015), Tucker (2006), Zito and Taylor (1996)	–46%	–15%	55%
Modified T-intersections	Tucker (2006)	–56%	–	–
Tactile surface treatments	Watts et al. (2002)	–2.5%	–1.5%	60%

Source: Austroads (2009b).

[Back to body text]

Commentary 22 Level of Service Approach

Essential to the consideration of the management of any street system is having an understanding of the current and future level-of-service (LOS) from the perspective of the users of that system.

LOS provides a qualitative performance measure of a particular facility or service. Service levels can relate to aspects such as quality, reliability, useability, responsiveness, acceptability, cost, and so on. It is often used as a trigger to warrant improving facilities or services and is not only applicable to motorists but also applies to any user of the street system including pedestrians, cyclists, public transport riders, and those using emergency services.

Austroads (2015a) provides guidance on level of service metrics for road network optimisation in Australia and New Zealand. These metrics can be applied to all elements in the road network whether they be a path, local street, public space or public service. Suggested metrics of a particular feature or facility include mobility, safety, accessibility and amenity.

The LOS of a facility is usually categorised using a six level system extending from A to F with ‘A’ considered the best or highest level of service and ‘F’ considered the worst. Generally, a value of C or D is considered acceptable but that very much depends on the service level expectations of the local community. By using a level of service approach, the gaps in the performance of the local network can be identified and improvements can be proposed to address those gaps. Certain LATM treatments will provide different LOS outcomes for different transport modes at different times of the day or even different days of the week and this approach can be a very effective input into the development of a jurisdictional wide approach to traffic management.

By adopting a level of service approach it can:

- help to identify if action is warranted, to what extent, and in what form
- assist in the identification of data requirements
- be used as a means of assessing the success of a LATM scheme based on pre-defined performance measures.

Councils in consultation with their communities must determine the level of service and quality and cost standards that are acceptable for different services and facilities within their portfolio. Each user group will have different expectations and needs. It is important to remember that the focus should be given to the needs of the users of the street rather than to the needs of vehicles. In cases where not all the requirements can be met it is necessary to have trade-offs between user groups. At all stages, the safety of all road users should be given the top priority. In the context of local order streets, amenity and accessibility is generally considered more important than mobility.

Additional source material providing more detail on this topic can be found in: Austroads (2015b) and Austroads (2015c).

[Back to body text]

Austroads' *Guide to Traffic Management Part 8: Local Area Traffic Management* is concerned with the planning and management of road space usage 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 provides guidance for planners and engineers associated with the design, development and management of residential precincts.

Guide to Traffic Management Part 8

8

Austroads

Austroads is the association of Australasian road and transport agencies.

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