LOCAL AREA TRAFFIC MANAGEMENT SCHEMES / TRAFFIC CALMING

Prepared by: Tui Patterson, Land Transport Safety Authority of New Zealand

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1. A BRIEF STATEMENT OF THE ISSUE

A major concern for street residents is the safety of their local streets, particularly the safety of vulnerable road users. However, it is difficult to control driver behaviour and reduce speeds on local streets solely through regulation and enforcement. A solution is Local Area Traffic Management (LATM) schemes (also referred to as traffic calming) whereby the physical environment of the local street is altered to ensure appropriate speed and behaviour.

2. AN ASSESSMENT OF THE ROAD SAFETY ISSUE

2.1 What is LATM/traffic calming?

The Institute of Traffic Engineers (ITE) 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”[1] (p. 22). LATM applies the same techniques as traffic calming, although it specifically refers to the planning and management of road space within a local traffic area, to improve the traffic-related safety of all road users on the local street[2]. This paper will focus on traffic calming measures within a local area using the terms “LATM” and “traffic calming” interchangeably.

There are three main categories of traffic calming measures[3]:

1. vertical – uses forces of vertical acceleration to discourage speeding (e.g. road humps, raised tables)
2. horizontal – uses forces of lateral acceleration to discourage speeding (e.g. chicanes)
3. narrowings – uses a psycho-perspective sense of enclosure to discourage speeding.

Other measures include entrance features, small corner radii and related street scaping (e.g. surface textures and colours, landscaping, trees and furniture)[1]. Table 1 explains various traffic calming measures.

Table 1: Description of various traffic calming measures.

Measure	Description
Road hump	Rounded raised area with dimensions in the order of a 4-metre radius and a 5 to 15 cm height.
Raised table	Long raised speed hump with a flat section in the middle and ramps on the ends; sometimes constructed with brick or other textured material on the flat section.
Chicane	A series of narrowings or curb extensions that alternate from one side of the street to the other forming S-shaped curves.
Roundabout	Raised circles, placed in intersections, around which traffic circulates.
Mid-block / median islands	Raised island in the road centre that narrows lanes and provides pedestrian, with a safe place to stop.
Kerb extensions / road narrowings	Kerb extensions, planters (containers of varying construction containing plants or shrubs, extending into the road way), or centreline traffic islands that narrow traffic lanes to control traffic and reduce pedestrian crossing distances. Also called “chokers”.
Threshold / perimeter treatments	Treatments placed at the entrance to an area with LATM. The treatments can take a number of forms including changed pavement and narrowing of the access.
Centre-line marking / flush kerbing	Painted markings in the centre of the road.
One- and two-lane slow points	Islands used to create an angle path for vehicles. The effect of angling the travel path slows vehicles down.
Intersection priority changes	Changes to an intersection priority, such as not allowing right turning traffic.
Channelisation	A raised island, islands or markings that force traffic in a particular direction, such as right-turn-only.
Speed cushions	A form of road hump, occupying part of the traffic lane in which it is installed, generally located in pairs.
‘Mobile’ speed humps	Temporary speed humps placed on the road at special events.
Driveway links	A partial street closure, where the street character is significantly changed with the roadway narrowed and defined with textured or coloured paving. The driver typically will not be able to see through it thus giving the appearance that the road is closed.
Left-in/left-out islands	Triangular splitter island placed at intersections to prohibit right hand turning movements.
Pavement bars / tactile surface treatments	Pavement colour (sometimes in the form of painted bars) and texture change (cobbles, bricks etc.) to create a visual and tactile warning to designate a special area.

As well as measures designed to specifically control speeding, there are LATM measures designed to restrict the volume of traffic travelling along a local road, which also serve to reduce the numbers of speeding vehicles along the route. For example, some streets may be closed at certain junctions to reduce the number of entry points. In other cases, measures to restrict turning, such as medians, are placed at street exits or along the length of streets.

2.2 Brief history

During the 1960’s and 1970’s in Europe, the rapid expansion of car ownership led to the expansion of the road network, with a negative impact on vulnerable road users and residents of built-up areas[4]. Footpaths were narrowed to put in additional car lanes, and parked vehicles increasingly took over the space previously devoted to pedestrians and cyclists. To overcome these problems, residential areas segregating pedestrians and motorised vehicles were built first in Sweden and then in Britain. However, this approach had its own problems, including its expense, difficulties for cyclists and public transport, and being applicable only to newly-built areas

In the late 1960's, the integration of different road user groups began, with residents of the Dutch city of Delft turning their streets into "woonerven" or "living yards"[3] (Ewing, 1999). This concept is based on the idea that, in residential areas, drivers should drive at a walking pace and give precedence to vulnerable road users in the street, particularly children. Streets were outfitted with tables, benches, sandboxes and parking bays jutting into the street. Footpaths for pedestrians were considered unnecessary and were not allowed. An evaluation of 'woonerven' in two Dutch cities found an overall 25% reduction in casualties from the 'woonerven' and surrounding traffic areas (Janssen in [4]).

Despite these positive results, the 'woonerf' approach had the disadvantage that it remained restricted to relatively small areas due to its high cost, and that the low speeds necessary to negotiate a street with a 'woonerf' design could only be sustained for short distances[3,4]. At about this time, designers became aware that the probability of serious injury for vulnerable road users was minimal if the collision speed did not exceed 30 km/h – and that for pedestrian fatalities, the critical collision speed was around 38 km/h (Proctor, 1991 in[5]). Thus, it was decided that a 30-km/h speed limit in residential streets would be acceptable, and would be able to be applied to a wider area than the 'woonerf' approach of a walking-pace speed. Since a 30-km/h speed limit sign by itself would be ineffective, and police enforcement in residential areas would be inefficient, the installation of low-cost speed-reducing engineering measures was needed. Thus, some of the concepts from the Woonerf approach were applied to residential areas. This new approach was termed "traffic calming" or "Local Area Traffic Management" (LATM).

Australia began its traffic-calming efforts with measures that changed the nature of the local street network (street closures, one-way links and so on), on the grounds that accidents were caused by excessive connectivity in the network[6]. That is, too many streets within a network were connected to other streets in the network, thereby allowing a high volume of through traffic. Excessively connected streets typically take the form of a grid network (see Figure 1 below). Traffic volumes are typically less in networks with less connectivity, such as a limited access network or an organic network (see Figure 1).

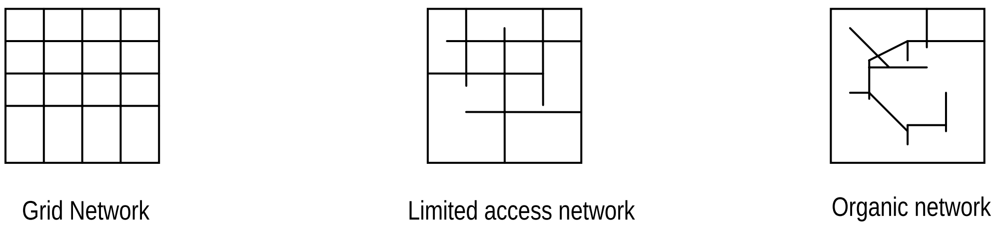

Figure 1: The three basic residential network structures[4].

The approach of changing the network was aimed at removing non-local traffic, thus affecting traffic flows in local streets. For example, by 1975 some local authorities (particularly in Melbourne and Adelaide, where grid street patterns are very common) had taken action to exclude non-local traffic[7]. These techniques had mixed success, and in many neighbourhoods the problems were found to be caused by the residents themselves, who did not drive in a safe manner along their own streets.

More recently, Australia has moved its emphasis to the European model of adapting the nature of the street space to reduce vehicle speeds and to change the appearance of the street, through measures such as roundabouts, street narrowings and some vertical speed control devices. For example, in the City of Launceston in Tasmania, LATM measures have consisted of kerb extensions/road narrowings, flush kerbing/central linemarking, and roundabouts[8]. In the City of Marion in South Australia, driveway links, threshold/perimeter treatments and speed cushions have been installed.

2.3 Current practices in Australasian jurisdictions

Some Australian communities have had more than 20 years of experience in the use of physical treatments to create safer and more liveable local streets[6]. But Australian practice is still somewhat patchy - in some parts of the country it is a routine local government activity, in others, it is still a novelty and, in others, it is non-existent.

Recently, Damen[8] conducted a survey of practices which have been adopted by different local government authorities throughout Australia and New Zealand, with Table 1 showing the devices most and least commonly used. The survey also revealed that many local governments are using completely different practices, and some are obtaining different results with the same devices.

Table 1: Results of a survey by Damen[8] on devices installed by Local Government in Australia and New Zealand

Devices most commonly used	Devices used to a lesser extent	Devices rarely used
- Raised tables	- Intersection priority changes	- ‘Mobile’ speed humps
- Road humps	- Channelisation	- Driveway links
- Roundabouts	- Speed cushions	- Left-in/left-out islands
- Mid-block/ median islands	- One and two-lane slow points	- Pavement bars/ tactile surface treatments
- Kerb extensions/ road narrowings		
- Threshold/ perimeter treatments		
- Centre-line marking/ flush kerbing		

Uniformity of LATM devices in Australasia is encouraged through the Austroads publication, ‘Guidelines for Traffic Engineering Practice Part 10: Local Area Traffic Management’. This publication is currently being reviewed and updated[8].

3. A REVIEW OF THE RESEARCH

The effectiveness of traffic calming measures has been judged by impacts on speed, traffic volumes and/or crashes. The findings from each of these evaluation types are discussed below.

3.1. LATM and speed reduction

Evidence that traffic calming reduces vehicle speeds was shown in a study that examined the effect of LATM on four different urban distributor roads in the U.K[9]. All of the four schemes studied had flat-top humps (75-mm high flat-top humps with 1:10 to 1:15 ramp gradients) as the main speed-reducing measure. A variety of additional measures were used at the sites, including new roundabouts, kerb alignments, pedestrian islands, new road markings, humped zebra crossings and chicanes. The study found that the LATM schemes were associated with an 11-mph reduction in the 85th percentile speeds on the four distributor roads to below or near the 30-mph speed limits.

Of all the traffic-calming measures, it appears that speed humps achieve the largest speed reductions. For example, an evaluation of the effect of fifteen 30 km/h areas in the Netherlands found that, after the application of horizontal and vertical measures in residential streets, 85% of the cars had a speed of 30 km/h or less (Vis, Dijkstra & Slop, 1992 in[10]). The greatest reductions were achieved from speed humps. Similarly, an evaluation of traffic-calming schemes in three residential areas in York (England) found that the most effective measure for speed reduction was the speed hump, with an average speed reduction of nearly 24 km/h (Durkin & Pherby, 1992 in[10]).

Analyses of hundreds of before- and after-studies of traffic calming measures in the United States revealed that speed humps have the greatest impact on 85th percentile speeds, reducing them by an average of more than 7 mph or 20%[3]. Raised intersections, long speed tables, and roundabouts had the least impact.

The design of the hump is a crucial element in its effect on speed. One study found that speed humps were responsible for speed reductions of 1 km/h for every 1 cm of height of the hump (Engel and Thomsen, 1992 in[11]), although presumably there were minimum and maximum heights beyond which this was not true.

3.2 LATM and volume reduction

Evidence of the effect of LATM on volumes was demonstrated in the U.K. study of LATM on four different urban distributor roads discussed above[9]. The study found that traffic flows on the traffic calmed distributor roads were reduced by 13% to 40% at the four schemes in the study. Other evidence was demonstrated in an examination of the results of hundreds of before- and after-studies of traffic calming measures in the United States[3]. Using statistical models, it was found that volume control measures (mostly road closures, half closures, diagonal diverters) categorically reduced traffic volumes by about 39%, while speed control measures (mostly humps, tables, and circles) categorically reduced traffic volumes by 15%. The study author noted that the effectiveness of traffic calming measures on volume depends on the availability and quality of alternative routes as well as the movements restricted along a stretch of road or at an intersection[3].

3.3. LATM and crash reduction

A number of studies have examined the effect of LATM on crashes. Elvik[12] conducted a meta-analysis of 33 studies that evaluated the safety effects of area-wide traffic-calming measures in urban residential areas. The studies came from eight countries (seven European countries and Australia) over the period 1971 to 1994. The traffic calming consisted of measures designed to discourage non-local traffic from using residential streets, and reducing the speed of the remaining traffic. From the studies Elvik[12] found that, on average, traffic calming reduced the number of injury accidents by about 15% in the whole area affected by a measure. The accident reduction was greater on local roads (about 25%) than on main roads (about 10%).

In the examination of hundreds of before-and-after studies of traffic calming measures in the United States, discussed above, Ewing[3] found that, for sites where volume data was available, collisions decreased by over 25%. When adjusting for the reduction in traffic volumes, collisions declined by 4%. However, it is important to note that the study quality (in terms of experimental design) was not taken into account in the evaluation.

A summary of 43 studies outside the United States also found traffic calming was associated with a reduction in collision frequency, ranging from 8 to 100% (Geddes et al, 1996 in[3]). The study found roundabouts and chicanes had the most favourable impact on safety, reducing collision frequency by an average of 82%. Humps were associated with an average 75% reduction in collisions.

Although many evaluations show that LATM reduces crashes, the effect on pedestrians and cyclists has not been quantified. For example, in a review of studies Brindle (1986; cited in[13]) found extensive evidence that LATM treatments, both individual devices and area-wide schemes, are effective in reducing crashes. However, Brindle did not identify any studies that separated out crash reductions for pedestrians or cyclists. This is likely to be due to the small number of crashes involving pedestrians or cyclists when conducting an evaluation of a local area. Despite the lack of evaluations, Brindle concluded that there is good reason to expect that LATM would be effective in reducing pedestrian and cyclist crashes in residential areas, due to either the reduction in through traffic (thus reducing pedestrian and cyclist exposure to conflict with motor vehicles), or to the reduction in vehicle speeds.

3.4. Explaining Crash Reductions

The studies discussed above show that LATM is associated with a reduction in vehicle speeds and a reduction in traffic volumes. The effect on speeds and volumes depends on the measures implemented. Some measures may be more likely to affect volumes than speeds, while for others the converse is true.

The ultimate effect of a reduction in speeds or volumes is a reduction in collisions, as shown in a number of studies. In some situations, it may be the traffic volume reduction that influences the reduction in collisions. In other situations, it may be the speed reduction that led to the crash reduction. Also because of lower speeds, when collisions do occur, they are less serious. Furthermore, it may often be a combination of the volume and speed reduction that reduces collisions.

4. POLITICAL, SOCIAL AND OTHER FACTORS

4.1 Public acceptance/resistance

There is a need for consultation with stakeholders at all project stages. Although the idea of installing traffic-calming devices is often supported by society, the reality of their installation is often not supported[14]. For example, there is some evidence of residents asking for a particular device to be installed, and then the same residents asking for the device to be removed due to concerns about noise, loss of parking, lack of accessibility and the effectiveness of the treatment[3,15]. In Australasia, complaints - mainly from local residents - are, in many cases, received during construction and for up to two months after installation[6]. However, after this initial two-month period, people often get used to the devices and complaints generally cease.

Sometimes the reason for complaints is poor selection and design of the treatments[7]. The most effective devices are those that do not overly inconvenience local residents, are highly visible, and provide sufficient horizontal and vertical deflection or diversion so that they produce much lower speeds. It is important that LATM schemes treat a well-defined problem with underlying causes and that they are not installed needlessly in response to complaints from a minority of the local community.

4.2 Pedestrians and Cyclists

The safety of vulnerable user groups is an essential consideration. Although traffic-calming devices are intended to reduce speeds, and hence make walking and cycling safer, they can have some negative aspects for pedestrians and cyclists[10]. For example, pedestrians sometimes complain about poles or obstructions alongside the pavement blocking their free passage and cyclists sometimes complain about vertical measures that affect their comfort and safety[10], but these can be designed so that there is a space at the side to allow cyclists to avoid the traffic-calming device.

On the positive side, European studies suggest that lower speeds and volumes, after traffic calming, encourage walking, bicycling, and street life[3], as long as the change in vehicle volume is not too extreme.

4.3 Emergency Services

There is concern that LATM measures may restrict the mobility and ease of access of emergency services, such as ambulances. Although a traffic-calming device tends to delay traffic for less than 10 seconds, this can soon add up if several devices are strung along an emergency response route. Furthermore, vertical devices, such as speed humps, can be associated with damage to emergency vehicles and injuries to patients.

The best solution is to keep the traffic-calming measures off emergency response routes[3]. However, where this is not possible, consideration should be given to measures that accommodate emergency response vehicles. For example, extended plateaux or humps on main roads allow large vehicles, such as emergency services to pass faster and more comfortably, while smaller vehicles are still affected[10].

In the Netherlands, a trial has started of 'intelligent' humps[10]. These rise automatically from the ground when cars approach too fast. However, emergency vehicles have a special device to switch the 'intelligent' hump off when passing in an emergency situation.

4.4 Public transport

Traffic-calming devices may result in a loss of comfort for bus passengers and an increase in travel time[10]. There are, however, possibilities for minimising these disadvantages, for example, plateaux longer than 10 metres or raised areas are more comfortable for bus passengers than humps.

4.5 Noise Levels

Residents are often concerned that vertical measures – humps, tables, and especially textured surfaces – will raise noise levels in the community[3]. However, a survey of communities in the United States indicated that the lower speeds resulting from the proper design and application of traffic calming measures tend to lower noise levels. European studies have reached similar conclusions, for example, a study of British traffic-calming schemes in villages (Taylor & Wheeler, 1998 in[10]) found that, alongside the speed reduction, there was a reduction in noise of around 10%. However, it is important to note that noise impacts are less favourable where commercial traffic is heavy, and where slow points are so far apart that traffic fully accelerates between them.

4.6 Environmental Effects

There is some concern that acceleration and deceleration caused by traffic calming devices will increase emissions. However, it appears that the overall effect on emissions is positive. For example, a study of traffic calming schemes in two Dutch cities found that, at some locations, there were negative effects in terms of exhaust gases, but that overall the effects were positive, mainly because the traffic calming measures reduced car volumes in residential areas (Kraay, 1985 in[10]). A traffic-calming project conducted in Buxtehude in Germany reported reductions in carbon dioxide, hydrocarbon and nitrogen oxide levels of 20%, 10% and 33%, respectively (Harvey, 1992 in[16]).

4.7 Traffic migration

LATM measures are designed to cause traffic migration to safer streets. Evidence of traffic migration was demonstrated in a study of LATM devices installed in 15 areas in the Netherlands (Vis et al., 1990 in[11]). The study found a 5 to 30% reduction in traffic volumes before and after the devices were installed. There is some concern that traffic migration may create a crash problem on the streets to which the traffic has moved. However, in a good LATM design, the traffic should migrate from less safe to safer streets, thus leading to an overall reduction in crashes.

4.8 Extreme Reduction of Traffic Volume

In some cases, LATM may cause an extreme reduction in traffic on the treated streets. This in turn may lead to closure of local shops along the street due to lack of business from passing vehicles. Furthermore the reduction in vehicles in the neighbourhood may cause pedestrians and cyclists to use the street less due to concerns about personal safety. LATM should be designed to ensure such extreme reductions in traffic do not occur, particularly on streets where local businesses depend on passing vehicles.

4.9 Evaluation

As mentioned earlier LATM schemes should only be used where a well-defined problem can be alleviated. The effectiveness of such schemes should be judged by the extent to which the problem for which the scheme was introduced has been dealt with. The means for doing this are well known but outside the scope of this paper.

5. CONCLUSIONS

Installation of appropriately designed LATM/traffic calming devices can be an effective method for reducing speeds and crashes on local streets, thus reducing the need for enforcement.

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