Traffic calming — literature search on the
design and performance of traffic calming
measures

Prepared for Charging and Local Transport Division,
Department of the Environment, Transport and the Regions

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Executive Summary

TRL has been commissioned by the Charging and Local Transport Division of the Department of the Environment, Transport and the Regions to prepare a draft Local Transport Note providing comprehensive guidance on the design and performance of traffic calming measures.

A search of traffic calming literature has been undertaken as part of the preparation of the draft Local Transport Note. TRL is already familiar with much literature on traffic calming, including the design and implementation of traffic calming schemes both in this country and abroad. The purpose of the search was to identify relevant source reference material and to provide a summary of literature found that is likely to be particularly useful in the preparation of the Local Transport Note.

In total, 319 references were found comprising of 72 TRL reports, papers and articles and 247 other publications from the UK and around the world. This report lists all the references sorted by country and by author. A brief description of the content of each is given.
Introduction

TRL has been commissioned by the Charging and Local Transport Division of the Department of the Environment, Transport and the Regions to prepare a draft Local Transport Note providing comprehensive guidance on the design and performance of traffic calming measures.

A search of traffic calming literature has been undertaken as part of the preparation of the draft Local Transport Note. TRL is already familiar with much literature on traffic calming, including the design and implementation of traffic calming schemes both in this country and abroad. The purpose of this report is to list the relevant source reference material and to provide a summary of the literature found that is likely to be particularly useful in the preparation of the Local Transport Note.

Relevant material was identified from the TRL Library databases containing English abstracts of reports, using the following keywords: traffic calming, humps, horizontal deflections, chicanes, narrowings, buildouts and pinch points. Foreign reports with non-English abstracts will not have been identified in these searches. Some foreign reports with non-English abstracts have been considered in the literature review by following up references in English reports and translations of foreign reports.

The references are listed as follows: in Section 2, TRL reports, papers and articles; in Section 3, non-TRL reports sorted by the country in which the traffic calming measures are located; in Section 4, all references sorted by author. Sections 2 and 3 contain brief descriptions of the reference as appropriate.

This report concentrates on the design and performance of traffic calming measures and it does not necessarily contain those references which are solely concerned with public attitudes to traffic calming measures and exhaust emissions at traffic calming measures. These were the subject of recent literature reviews (Webster, 1998 and Boulter and Webster, 1997) published in TRL Report 311 and TRL Report 307 respectively.

TRL Reports

2 TRL Reports

2.1 Published TRL Reports


Measures Cushions.

Comments Results from vehicle and traffic noise surveys on roads in York. Various cushion dimensions, construction types, and locations on the roads tested.


Measures All traffic management measures.

Comments Comprehensive review of the environmental assessment of traffic management schemes.


Measures Cushions and road humps.

Comments Track trial of various designs including various cushion widths, flat-top hump and round-top profile road humps. Full details of the humps tested, the vehicles used and the results obtained are given in the report.


Measures Road humps.

Comments Trials of humps in Lytham, Winchester, Ventnor and Rotherhithe. Vehicle speeds, attitude surveys, effects on accidents, noise and vibration were all measured.


Measures Countdown signs and roundel markings.

Comments The trials describe the effectiveness of 40 mph roundels and 30 mph roundels and countdown signs.


Measures Motorway chevrons, bar markings, rumble strips, countdown signs, roundel and vehicle activated signs.

Comments The trials describe the effectiveness of various measures, particularly the effect on vehicle speeds.


Measures Humps, cushions, narrowings, gateways and roundabouts.

Comments The review describes various theoretical and empirical studies and the results obtained. The results showed that there was only limited agreement on the effects of traffic calming on vehicle emissions.


Measures Traffic management schemes.

Comments This review examines the current understanding of the dose response relationships for three important components of environmental nuisance – air pollution, noise and vibration and records how subjective responses to these components have been influenced by traffic management schemes.

Measures Flat-top humps and speed cushions.
Comments Describes a study in which the effects of two different traffic calming measures on CO emissions were investigated using a remote sensing system.


Measures In car equipment.
Comments The report describes the way that vehicles can be calmed by devices such as advisory warnings to the vehicle or the vehicle braking automatically without input from the driver.


Measures Humps, cushions, traffic islands, mini-roundabouts, gateways, pedestrian refuges and build-outs.
Comments This is a comprehensive report which includes measurements of vehicle speeds, traffic flows and accidents. It also includes driver behaviour and vehicle emissions, air quality, vehicle and traffic noise and residents’ attitudes to the scheme.


Measures Road narrowings.
Comments A total of 28 sites were visited and 15 were selected for video filming. Analysis of vehicle speeds and the behaviour were measured in addition to pedestrian behaviour. Cyclist interviews were also carried out and 62 Local Authorities were contacted to establish whether cyclists were considered in traffic calming design.


Measures Roundabouts.
Comments The design of continental roundabouts tends to have tighter turns which requires drivers to slow more than at typical UK designs. The likely safety implications of using the continental design in the UK are discussed and the effect on capacity is also considered.


Measures Road humps of various designs.
Comments This comprehensive report gives the noise and vibration results of a track trial using various road hump designs. A variety of vehicles were tested travelling at various speeds over the humps. A companion report TRL417 (Sayer et al, 1999) describes the passenger discomfort results for the trial.


Measures Road humps of various designs.
Comments This comprehensive report gives the driver and passenger discomfort results of a track trial using various road hump designs. Six cushion designs, a series of 4 ‘Thumps’ and two long humps (over 9 metres long) were tested. A variety of vehicles were tested travelling at various speeds over the humps. The report gives comments on each hump type and the suitability of using it on the public road.


Measures Mini-roundabouts.
Comments This accident analysis investigated various mini-roundabout types such as flush, domed and those with a central island described as ‘bumpy’. The analysis looked at geometric characteristics and it also discussed the effects on accidents to the various categories of road user, particularly two-wheeled road users. Both 3-arm and 4-arm mini-roundabouts were considered.


Measures Speed cushions.
Comments This report reviews 34 local authority speed cushion schemes installed up to 1994. It gives details of layouts, costs, maintenance, dimensions and speed relationships. Also it gives the effects on flows, accidents, passenger discomfort, driver behaviour, consultation, noise and vibration.


Measures Signs and road markings.
Comments This pilot study used the TRL driving simulator to test drivers driving through simulated villages with and without traffic calming measures. The speeds observed in the simulator were compared with those which had been measured on the real roads which the simulations were representing.

Measures Speed cameras, vehicle activated signs, flashing signs, static signs, 20 mph zones without measures.

Comments This report describes the effectiveness of the above measures. It also describes the effectiveness of six 20 mph zones which had no measures and then describes three trial sites which also had no measures.


Measures Toucan crossings.

Comments This report describes the effectiveness of Toucan crossings at 13 sites throughout the UK. Infra-red detection was used at one site which helped to minimise delays to motor vehicles when crossings were completed.


Measures Roundabouts.

Comments This report describes a study tour of continental Europe where roundabouts have been designed with cycle facilities or cycle thinking. The roundabouts were generally tighter and the report contains descriptions and photographs of the schemes visited.


Measures Measures to assist cyclists.

Comments This report describes contraflow cycling schemes in one-way streets in Continental Europe.


Measures Telematics and variable message signs.

Comments This report describes a review of the potential benefits of road telematics which include traffic calming measures such as variable message signs and speed limiting devices.


Measures Chicanes.

Comments This report gives the details of 49 chicane schemes including layouts, costs, maintenance, dimensions, speed relationships, effect on flows, accidents, passenger discomfort, driver behaviour, signing and visibility.


Measures Road humps of various designs.

Comments This report gives the driver and rider discomfort results of a track trial using various road hump designs (all 75 mm high). A variety of vehicles were tested travelling at various speeds over the humps. A companion report TRL 416 (Harris et al, 1999) describes the noise and vibration results for the trial.


Measures Road humps.

Comments Trials of humps in Oxford, Norwich, Haringey, Kensington and Glasgow. Effects on speeds and flows as well as attitude surveys, effects on accidents and noise and vibration were all measured.


Measures Toucan crossings.

Comments Attitude surveys to Toucan crossings were carried out for pedestrians and cyclists. This report contains the results of the analysis.


Measures General traffic calming measures.

Comments This report describes the use of Transport Supplementary Grant for Local Safety Schemes and assesses the effectiveness of the schemes in accident reduction terms.


Measures Mini-roundabouts.

Comments This report describes a study which was carried out to determine the frequency and rates of accidents at mini-roundabouts.

**Measures** Road humps.

**Comments** This report describes the original track trial at TRL which investigated various hump profiles and led to the development of the round-top hump. A total of 15 different profiles were tested with discomfort and speed being measured for a range of vehicles.


**Measures** Road humps and cushions.

**Comments** This report describes a track trial at TRL which investigated ground-borne vibration alongside 5 cushion designs up to 1900 mm wide and round-top and flat-top humps from 1 metre to 8 metres in length. Various vehicles were used including a number of HGVs.


**Measures** Road humps, ‘thumps’, cushions and rumble strips.

**Comments** This report describes each measure and then gives the advantages and disadvantages of each measure. Speed spacing relationships are given for road humps and the effect on accidents and flows are also given for selected schemes.


**Measures** Rumble strips and rumble areas.

**Comments** This report describes a total of 35 sites in the UK. Each site is described and the effects on vehicle speeds, flows, accidents, driver behaviour, noise and vibration are discussed. The report contains public opinions and recommendations on suitable locations, layout of strips and the use of drainage gaps.


**Measures** Thumps and road humps.

**Comments** This report describes a total of 4 thump schemes in detail with speeds, flows and accidents. It also described a further 4 schemes which were either only just installed or were about to be installed. A total of 7 hump schemes with 50 mm high humps were also reported along with the effect on speed and accidents.


**Measures** Vehicle activated speed limit reminder signs.

**Comments** This report describes a total of 13 schemes with 10 schemes described in detail. The signs had messages usually incorporating ‘SLOW DOWN’. Speeds and accidents were the main measure of the effectiveness of the signs.


**Measures** Humps and chicanes.

**Comments** This report describes 4 schemes on distributor roads in Woking, Farnborough, Windsor and Watford which had flows of up to 12000 vehicles per day. The humps were mainly flat-top with ramps of 1:10 to 1:15. The effect on speeds, flows and accidents are given as well as reactions to the schemes from the emergency services, bus operators and residents.


**Measures** Road humps (75 mm high).

**Comments** This report describes 88 local authority schemes where 75 mm high round-top or flat-top humps had been used. It gives relationships for speed/hump separation and also the relationship between the speeds before and after installation of the humps. Traffic flows, costs, maintenance and grounding are also discussed.


**Measures** Traffic calmed 20 mph zones.

**Comments** This report reviewed the first two hundred 20 mph zones in the UK. It gives details on the overall scheme designs and comprehensive details of 6 schemes. An in-depth accident review was included together with speed/accident and speed-spacing relationships.


**Measures** Humps, cushions, chicanes, road closures and mini-roundabouts.

**Comments** This review looked at 40 UK studies of traffic calming measures. The measures were all ranked from the most acceptable to the least acceptable. The measured effect on speeds and other variables were compared to the perceived effects reported by residents and these are discussed in the report.

Measures Sinusoidal, ‘H’ and ‘S’ humps.
Comments This report describes schemes in the Netherlands, Denmark and New Zealand where sinusoidal or ‘H’ humps have been used. It then concentrates on sinusoidal humps used in Edinburgh, ‘H’ and ‘S’ humps used in Fife and an ‘S’ hump in Northampton. Speeds were measured at the sites and in addition a video analysis was carried out at Fife to determine the behaviour of drivers over the humps.


Measures Gateways, narrowings, central islands, road markings and speed limit roundels.
Comments This report reviewed the effectiveness of 10 schemes implemented in Devon and 8 schemes in Gloucestershire. The roads consisted of 5 ‘A’ class, 6 ‘B’ class and the rest were either ‘C’ class or unclassified. Detailed speed measurements were taken at the approach to the villages and also within the village so that an assessment of the overall effect of the measures on speed could be determined.


Measures Gateways, rumble strips, buildouts, narrowings, flashing signs, road markings and speed limit roundels.
Comments This report reviewed 24 schemes where speed reduction measures were used particularly on the approaches to the villages. Detailed plans, speed measurements and the effectiveness for each scheme is given together with the cost of the scheme.


Measures Cushions, pedestrian refuges, mini-roundabouts, road markings and roundels.
Comments The report describes the results from the speed, flow, noise and vibration which were carried out at the scheme at various positions along the road. It also includes a public opinion survey.


Measures Pedestrian refuges, mini-roundabouts, road markings, cameras, narrowings and part time 20 mph zone.
Comments The report describes the results from the speed, flow, noise and vibration which were carried out at the scheme at various positions along the road. It also includes a public opinion survey.


Measures Flat-top road humps, narrowings.
Comments This report describes a scheme in Halifax. Traffic speeds and flows were measured as well as pedestrian activity, parking activity and illegal turning manoeuvres.


Measures 20 mph zones, cushions, narrowings, flat-top hump, gateways and vehicle activated sign.
Comments This report describes a scheme in Costessey. It gives details of speeds and flows. It also includes noise and vibration measurements and results of a public opinion survey.


Measures Narrowings and uncontrolled pedestrian crossovers.
Comments This report describes a scheme in Shrewsbury. It gives details of speeds and flows, video analysis of pedestrian and parking activity. It also describes a public opinion survey.


Measures Gateways, narrowings, cushions, pedestrian refuges, cameras, dragon teeth, chicane etc.
Comments This report gives a summary of 9 schemes and the measurements taken and the success or otherwise of the schemes. (Includes schemes described in more detail in TRL212, TRL238 and TRL364).


Measures Thresholds at entry, 20 mph zone, narrowings and buildouts.
Comments This report describes a scheme in Bury St Edmunds. It gives details of speeds and flows, results of a video analysis of pedestrian and parking activity. It also describes a public opinion survey.

*Measures:* Road humps.

*Comments:* The report describes the results from attitude surveys in Exeter, Maidstone, Bridgwater and Worcester Park.


*Measures:* Gateways, 40 mph roundels, rumble strips/cattle grids.

*Comments:* The report describes the results from attitude surveys in New Forest, Hampshire. The effectiveness of the measures and the attitudes are compared.

### 2.2 Papers and articles by TRL staff


*Measures:* Humps, cushions and village traffic calming.

*Comments:* This paper reviewed the latest research carried out by TRL into the effect of traffic calming measures on vehicle and traffic noise at urban and rural sites.


*Measures:* Pedestrian crossings.

*Comments:* Review covered 9 countries; Australia, Belgium, Denmark, Eire, Finland, Germany, The Netherlands, Norway and Sweden. Differences and similarities in design are highlighted.


*Measures:* Interactive speed limit signs.

*Comments:* This paper reviewed the use of speed limit signs in Norfolk which were activated by vehicles exceeding a pre-set speed on the approach to the sign.


*Measures:* Riblines (rumble strips).

*Comments:* This paper reviewed the use of rumble strips in Basing, Sway and Hawley in Hampshire. It discusses the effect on speed over a period ranging from one week after to 3 years after construction. The effects on noise and accidents are also discussed.


*Measures:* Flat-top humps.

*Comments:* This paper reviewed a scheme in Milton Keynes where a flat-top hump was used as a crossing point for pedestrians which was not marked as a pedestrian crossing.


*Measures:* Speed cushions.

*Comments:* This paper reviewed the work on speed cushions, particularly the effect on vehicle speeds, which had been carried out at TRL.


*Measures:* Humps, speed cushions and chicanes.

*Comments:* This paper reviewed the work on the above measures carried out at TRL. It included the design and locations of the measures, the effects on speeds and flows, public attitudes to the various measures and environmental issues (particularly noise).


*Measures:* Humps, chicanes, narrowings etc used in 30 kph (20 mph) zones.

*Comments:* This paper is a translation of the Dutch 30 kph zone design manual with comments as to the differences between Dutch and UK regulations which currently applied.


*Measures:* Humps.

*Comments:* This paper reviewed the speed/spacing relationship for 100 mm high road humps.


*Measures:* Signalised roundabouts.

*Comments:* This paper reviewed the effect that signalised roundabouts had on cycle accidents.

Measures Signs and road markings.

Comments This pilot study used the TRL driving simulator to test drivers driving through simulated villages with and without traffic calming measures. The speeds observed in the simulator were compared with those which had been measured on the real roads which the simulations were representing.


Measures General traffic calming measures.

Comments This report describes the results of analysis of the MOLASSES data base which shows the type of accident reductions which may be expected from various types of traffic calming strategies.


Measures Humps, cushions, narrowings, gateways.

Comments This paper describes the Safer City project in Gloucester which is being funded by the Department of Transport and is being monitored by TRL.


Measures Gateways and road markings.

Comments This paper describes the early attempts at reducing vehicle speeds at rural villages which formed part of the VISP study.


Measures Flat-top road humps, narrowings.

Comments This article describes a scheme in Halifax. Traffic speeds and flows were measured as well as pedestrian activity, parking activity and illegal turning manoeuvres.


Measures Flat-top hump, narrowing, block paved road surface and bollards.

Comments This paper describes a TRL study carried out in Lincoln historic core zone, Newport Arch. A public attitude study was carried out including pedestrians and cyclists.


Measures Gateways, narrowings, cushions, pedestrian refuges, cameras, dragon teeth, chicanes etc.

Comments This paper gives a summary of each of 9 schemes, the measurements taken and the success or otherwise of the schemes.


Measures Road humps.

Comments This paper gives the ground clearances of various vehicles and also suggests what can be done to minimise the problem of grounding at road humps.


Measures Gateways, rumble strips, buildouts, narrowings, flashing signs, road markings and speed limit roundels.

Comments This paper describes TRL studies carried out in Devon, Gloucestershire and the 24 VISP sites.


Measures Rumble strips, buildouts, narrowings, flashing signs, road markings and speed roundels.

Comments This report reviewed 24 schemes where speed reduction measures were used particularly on the approaches to the villages. The effectiveness of each scheme is given together with the cost of the scheme.

3 Non-TRL literature sorted by country (Country refers to location of traffic calming scheme)

3.1 United Kingdom

Non-TRL reports from UK


Measures 20 zones.

Comments DETR project looking at activity in 20 mph zones.


Measures Humps, chicanes, narrowings.

Comments Report on 10 traffic calming schemes. Accidents were analysed for the traffic calmed areas and the surrounding roads.

**Measures**
- Round-top humps, flat-top hump at school, gateways, chicanes, planting and 20 mph zone.

**Comments**
- Consultation and measurements investigated whether rat-running was a problem and also whether accidents were caused by drivers not giving way at junctions, disobeying signals or pedestrians crossing heedless of the traffic.


**Measures**
- Variable speed limits.

**Comments**
- General discussion.


**Measures**
- Road humps.

**Comments**
- Two injuries to bus passengers after passing over humps are described. The authors believed these accidents to be the first due to crossing humps.


**Measures**
- Humps and chicanes.

**Comments**
- Describes consultation in Edinburgh traffic calming schemes and gives results of the popularity of the various measure.


**Measures**
- 20 mph zones.

**Comments**
- A questionnaire was sent to all Highway authorities in 1995 and updated in 1997-98. It was used to assess how consultation had altered over the period.


**Measures**
- Includes humps and chicanes.

**Comments**
- Comprehensive assessment method for traffic calming schemes.


**Measures**
- Chicanes.

**Comments**
- Objections to humps from bus operators and fire service led to a chicane scheme in Wakefield. Results for ‘free flow’ and non ‘free flow’ speeds are given.

Bulpitt M (1995). *Traffic calming - have we given everyone the hump, or is it just a load of chicanery?* Highways and Transportation December 1995.

**Measures**
- Humps, gateways, refugees, chicanes and narrowings.

**Comments**
- This report gives the experience of Kent with various traffic calming measures and describes the effect on response time for emergency vehicles, problems for bus companies such as repair costs on exhausts and grounding. The effect of gateways, refugees, chicanes and narrowings on congestion is also discussed.

**Measures** Road humps.

**Comments** The report describes the braking behaviour of drivers on the approach to road humps.


**Measures** Limiting top speeds to the speed limit and imposing lower speeds when road conditions demanded.

**Comments** Simulator trials and real road trials are to be carried out in phases 2 and 3.


**Measures** Gateways, slogan messages, 40 mph carriageway markings, police enforcement, width restrictions.

**Comments** This report describes the New Forest traffic calming scheme and gives results of the effect on vehicle speeds and accidents. Accidents which involved animals are also discussed.


**Measures** Humps.

**Comments** Describes development of Traffic Action Plan through to construction of road humps. Accident and speed reductions achieved are discussed. The cost of the scheme is given.


**Measures** Narrowing, surface changes.

**Comments** Shirley Street is an ‘A’ road and therefore humps were not appropriate.


**Measures** Humps, chicanes, narrowings, 20 mph zones and gateways.

**Comments** Design guide based on Design Bulletin 32 (DB32) and Policy Planning Guidance 13 (PPG13).


**Measures** Cushions, humps.

**Comments** Design and implementation, changes in speeds and accidents. Noise/vibration from HGVs. Costs given.


**Measures** Traffic calming, Woonerf style.

**Comments** Very low speeds of 10 mph or less. Drivers must give way to pedestrians and cyclists and are responsible for any injuries. 10 mph speeds emphasise change of status through signing, calming, seating and rearranged parking. Residents need to be in favour and involved in the design.


**Measures** Humps, horizontal deflections.

**Comments** An early scheme in Devon. Description and implementation of scheme showing accident plot and reductions in speeds and flows. Costs given.


**Measures** Humps, cushions, narrowings, chicanes, gateways.

**Comments** Important early book with scheme examples from Europe and Great Britain.


**Measures** Humps, narrowings and mini-roundabouts.

**Comments** Describes the effectiveness, particularly speed, of a scheme in Worcester Park.


**Measures** Speed limiter in the vehicle.

**Comments** Simulated urban environment combined with automatic speed control. Safer and riskier driving observed. Gap acceptance at junctions and accidents at junctions in urban areas were discussed.


**Measures** Most traffic calming features.

**Comments** 85 case studies. Important book with scheme assessments.

**Measures**

- Measures to assist cyclists.

**Comments**

- Comprehensive book produced by The Bicycle Association, Cyclists Touring Club, Institute of Highways and Transportation and the Department of Transport, covering all aspects of catering for cyclists.


**Measures**

- Gateways, build-outs, changed surfacing, traffic islands, narrowings, red skid resistant surfaces and humps.

**Comments**

- Measures have been designed in consultation with the schools to improve road safety around schools. ‘Dinosaur footprints’ mark the safe routes to schools in Luton. No results given.


**Measures**

- Humps and narrowings.

**Comments**

- Layouts for new roads which include traffic calming measures. Gives spacing and speed estimates for typical measures.


**Measures**

- Measures for cyclists, pedestrians, public transport, parking and traffic management.

**Comments**

- Important for Local Authorities. Revision to document currently at consultation stage.


**Measures**

- All traffic calming measures.

**Comments**

- This should be read with DB32.


**Measures**

- Wide range including humps, cushions, chicanes, gateways, narrowings, 20 mph zones, pedestrian and cyclist measures.

**Comments**

- Very comprehensive study of traffic calming measures in 6 bypassed towns with many results. Vehicle speed, vehicle flow, journey times, noise, air quality and public attitudes.


**Measures**

- Narrowings and humped pedestrian crossings.

**Comments**

- Design standard for crossings.


**Measures**

- Pedestrian crossings including refuge islands.

**Comments**

- Covers, zebra, pelican, puffin and toucan crossing general requirements including installation, timings, lighting, signing and catering for pedestrians with disabilities.


**Measures**

- Road humps, bus lanes, pedestrianised streets, bus gates, Mova, Scoot, Bus Transyt.

**Comments**

- Outlines measures which can be used to assist buses to keep to their timetables.


**Measures**

- 20 mph zone, junction speed tables, narrow road widths and a false ford.

**Comments**

- Green field residential development in Daventry which follows the DOE DB32 principles and is supported by the emergency services.


**Measures**

- Humps, cushions and speed cameras.

**Comments**

- Kinston-Upon-Hull has installed its 50th 20 mph zone and this article describes the accident reductions recorded.


**Measures**

- Transport telematics.

**Comments**

- Electronic messages, variable speed limits considered.


**Measures**

- Humps, speed cameras.

**Comments**

- Accident reductions at all hump schemes given for pedestrians, cyclists, motorcyclists and others using police database. Costs given. Speed reductions reviewed.

**Measures**
- Hard shoulders, central reserves, junction treatment, centre line, lateral strips and coloured lanes.

**Comments**
This report describes the effect that colour has on accidents and improving operation. The use of red buff and green are discussed.


**Measures**
- Speed camera and VMS sign in 40 mph zone.

**Comments**
Describes the effect on vehicle speeds.

**Gilmour J (1993).** *Traffic calming with a gentler touch.* Urban street environment. 1993-04/05.

**Measures**
- Humps, cushions and ‘H’ Humps.

**Comments**
Based partly on a survey by Environmental and Transport Planning of bus operators. Describes consideration required before installing humps, cushions or ‘H’ Hump particularly the effect on buses, public service and emergency vehicles.


**Measures**
- Includes humps and chicanes.

**Comments**
Examines the efforts being made by councils using traffic calming measures and includes guidelines (based on DB32) from Wiltshire, Suffolk and Strathclyde.


**Measures**
1. Humps, central islands, non skid surfacing.
2. Road closures.
4. Remotely controlled bollards.

**Comments**
Four sites considered.
2. Toxteth area (Liverpool) ‘Red light area’.
3. City of London ‘Terrorism’.
4. South Shields pedestrian area ‘Ram raiding’.


**Measures**
- Flat-top humps, bollards with design integrated in an historic design.

**Comments**
Article by an architect showing the need for integrated designs where highway engineers and architects work together particularly in conservation areas where natural materials can be used.


**Measures**
- Narrowings and shared road space.

**Comments**
Reviews schemes in Wolverhampton in 1970 – 1980s. Environmental schemes where roads were generally short and block paved throughout. The cost of the scheme is given.


**Measures**
- Includes humps and chicanes.

**Comments**
Considers various alternatives and gives the preferred option.

**Hampshire County Council (1996).** *Calming success.* Highways December 1996.

**Measures**
- Humps, chicanes, narrowings, cushions, buildouts

**Comments**
Review by Hampshire County Council. Emergency vehicles and bus operators claim that road humps cause unnecessary discomfort and damage to vehicles.


**Measures**
- Humps, chicanes, narrowings, cushions, buildouts

**Comments**
Report describes 25 hump and 9 horizontal deflection safety schemes. It also describes 14 hump and 10 horizontal deflection environmental schemes. The description of the schemes include speeds, flows and accident reductions where available.


**Measures**
- Humps, cushions, pinch points.

**Comments**
Surveys in Leeds using multi-criteria approach. Views of residential road residents different to mixed priority street residents in terms of traffic volumes and effect on buses.

**Harrison I B (1992).** *Development of traffic calming in Devon.* 20th PTRC annual meeting, 1992.

**Measures**
- Humps, narrowings, horizontal deflections.

**Comments**
Background, key event flow chart and 3 case study results of speeds, flows, accidents and costs.

Measures  Humps, chicanes, cushions, narrowings, ‘H’ hump, rumble strips.

Comments  Important early book with scheme examples and assessments from Europe and 37 British case studies with results and comments.


Measures  Horizontal deflections.

Comments  Important book which provides an overview of horizontal measures including accidents, speeds, flows and costs at 38 case study sites.


Measures  Road humps.

Comments  Article based on Kent experience at road hump schemes with buses, hearse and emergency vehicles.


Measures  Humps, cushions, 20 mph zones, road markings and signals.

Comments  Discusses the use of cushions and humps of various heights. Gives the Web Address of the Northern Regional Casualty Reduction Group which includes 120 local safety schemes that the councils have carried out including before/after accident assessments. The Web Address is: http://www.s-tyneside-mbc.gov.uk


Measures  Humps (100 mm round-top, 85 mm round and flat-top, 60 mm flat-top), rumble strips, gateways, chicanes, and speed cameras.

Comments  Speeds and accidents discussed. Effect on speeds given for 3 sites.


Measures  Traffic light and speed cameras.

Comments  Report gives speed and accident reductions at speed camera sites and traffic light camera sites. The cost of the cameras and the running costs are given.


Measures  Long flat-top humps.

Comments  Describes Hertfordshire’s approach to traffic calming, including long humps to assist buses and pedestrians.


Measures  Various traffic calming measures.

Comments  Discusses the use of lighting at measures, particularly at pinch points.


Measures  All traffic calming measures.

Comments  A very comprehensive updated reference book from IHT which has Traffic calming and speed control as Chapter 20. Contains a number of references with many from DOT and TRL. This is an important reference book for local authorities.


Measures  30 mph speed limits.

Comments  Speed limits introduced on previous 60 mph (24 schemes) and 40 mph (20 schemes). Interim results for vehicle speeds are discussed. The costs for the schemes are given.


Measures  Humps.

Comments  Describes a Leicester ‘Safe routes to school’ scheme.


Measures  Humps, cushions, chicanes and narrowings.

Comments  Urban and village sites considered. Speeds, accidents and public acceptability are reviewed.


Measures  Humps, narrowing, chicanes, gateways, roundels, 20 mph zone, variable 20 mph sign.

Comments  Reviews Kent schemes implemented before June 1991 (in 1992 review) and 6 more schemes implemented before 1994 (in 1996 review). Accident studies and costs are given.

- **Measures**: Humps, narrowings, chicanes, road closures.
- **Comments**: Contains reviews of Kent schemes.


- **Measures**: Cushions.
- **Comments**: Describes Kent cushion trials which used cushion widths of 1.6 to 1.7 m and heights of 60 to 75 mm.


- **Measures**: Pedestrian refuges.
- **Comments**: This report describes the effect on accidents when refuges were installed at junctions for safety reasons. It also describes the effect if they were not installed for safety reasons. The effect of illumination of the refuges was also discussed.


- **Measures**: Signing and lining of roads.
- **Comments**: Case studies of sites reviewed including the effect on speed and accidents.


- **Measures**: Engineering, enforcement and planning.
- **Comments**: Covers objectives and approach to road safety.


- **Measures**: Humps, cushions, narrowings.
- **Comments**: Traffic calming guidelines from the bus operator’s point of view.


- **Measures**: Chicanes.
- **Comments**: Reviews the results obtained at chicanes in Cromer, Norfolk.


- **Measures**: At Starston village signs and road markings were removed to give a village feel.
- **Comments**: Describes the effect on speeds during the trial period without signs and other highway clutter and compares with when the lines and signs were reinstated.


- **Measures**: All traffic calming measures.
- **Comments**: Includes references and also a list of cycling videos at various schemes.


- **Measures**: Pedestrian crossings, humps and chicanes and new traffic signals.
- **Comments**: Measures to assist pedestrians, bus users and traffic redistribution are discussed.


- **Measures**: Various including: rising bollards, VMS signs, SCOOT controlled junctions.
- **Comments**: Describes the above measures. Note that rising bollards can be used to limit access.


- **Measures**: Flat-top humps and 20 mph zone.
- **Comments**: Describes a scheme which was part of the bypass demonstration project. Gives traffic volumes, speed and noise plus journey times and pollution (Nitrogen dioxide). Gives views of fire brigade and experience of cyclists with the measures.


- **Measures**: All traffic calming measures.
- **Comments**: Discusses the traffic calming carried out in Europe for cyclists and also the interaction of cyclists and pedestrians. The road surface is also considered for motorcyclists and cyclists.


- **Measures**: Safe routes to school including traffic calming and speed limit reductions.
- **Comments**: Sustrans working with 10 pilot schools and 4 local authorities to encourage walking and cycling to school.


- **Measures**: Chicanes and build-outs.
- **Comments**: Planting of trees and shrubs at chicanes can be used to give the message that estates should be used safely. Discusses application and some unjustified problems.
Measures Road humps.
Comments Four sites described with speed, accident, cost and flow results.

Measures All traffic calming measures, humps, chicanes and pinch points.
Comments Five town case studies considered (Aberdeen, Hemel Hempstead, Ipswich, Sunderland and Swansea). 40 further Towns/Cities listed where bus access has been affected by traffic calming. Effective consultation has led to modification of some schemes.

Measures Rising bollards.
Comments Cambridge has 3 operational schemes and one was upgraded in August 1999.

Measures Humps and cushions.
Comments Recommendations for Caldmore area, Walsall and Small Heath, Birmingham 20 mph zones. Accidents were studied and the traffic calming measures proposed to reduce accidents are discussed.

Measures Humps, narrowing road from 12 to 6 metres.
Comments Extensive traffic calming scheme using 75 mm high humps to lessen effect on boat trailers. Parking spaces created by narrowing. Cost given for the scheme.

Measures Mini-roundabout, speed tables, chicane, tabled zebra crossing, speed roundels and build-outs.
Comments Describes schemes in Croyland Road, Wellingborough (mini roundabout, speed tables, chicane, tabled zebra crossing). Also South Tonbridge had 20 mph roundels on road. ‘Combination staggering’ at Norwich Road, Cromer. Design details given on each scheme and some costs given for schemes.

Measures All traffic calming measures.
Comments Concentrates on accidents and road safety at schemes.

Measures Horizontal measures.
Comments Describes measures in a new development such as tight corners, roundabouts and the use of planting.

Sawers C (1997). Mini-roundabouts. Getting them right. EMC, 94 High Street, Wingham, Canterbury, CT3 1DE.
Measures Mini-roundabouts.
Comments A useful book for the road engineer to use when designing a mini-roundabout. Illustrates good and bad examples of design.

Measures Gateways, coloured surfaces, chicanes, signing.
Comments Local Government and Rating Act has granted new powers to Parish Councils to implement traffic calming measures. Berkshire and Oxfordshire schemes discussed as well as some consultation considered.

Measures Humps, speed cushions, chicanes and roundabouts.
Comments Environmental objections to signs often mean that the features are not marked and can be obscured by snow leading to problems of maintenance.

Measures Humps and chicanes.
Comments Discusses the use of road humps on busy bus routes in town centres.

Measures Speed cameras.
Comments Shows variation of speed reduction against enforcement of once a week, once a fortnight, once a month and once a quarter.
Strathclyde Regional Council (1992). *Road hump trials.*
Measures Humps, cushions and an ‘H’ hump.
Comments Comprehensive trial which assessed various vertical measures.

Surveyor 12th September 1996.
Measures Speed cameras.
Comments Discusses speed cameras in Cambridgeshire, particularly whether motorists obey the speed limit after implementation of the cameras.

Measures Speed cameras.
Comments Describes the effect on mean speeds and accidents.

Measures Humps, cushions and narrowings.
Comments Comprehensive report of attitudes in ‘Feet First’ traffic calming schemes.

Measures Urban Safety Project area schemes.
Comments Discusses the benefits of complicated analysis compared with a simple approach based on expert knowledge and the results of previous investigations.

Measures General traffic calming measures.
Comments Considers the effectiveness of the various measures and also the environmental effects of vehicle emissions including traffic noise.

Measures Pedestrian refuges.
Comments Considers 23 refuge schemes. Opinions of 461 residents interviewed are given and also the effect on speeds and accidents.

Measures Humps.
Comments Discusses damage to buses, particularly in Leicester, Highfields area. Springs plus damaged skirting and exhausts are also discussed. The effect of humps on double-decker buses and mini-buses are discussed.

Measures Humps, chicanes and narrowings.
Comments Case study of the Groves 20 mph zone traffic calming scheme.

Measures Long flat-top humps.
Comments Reviews Shenley Road Borehamwood and town centre Godalming, Surrey. The effect on speeds and flow are given.

Measures General traffic calming measures.
Comments Discusses the consultative approach to policy making (integration).

Measures Humps, narrowings and chicanes.
Comments Compares European countries pedestrian deaths/100,000 population with UK and describes humps, narrowings and chicanes.

Measures Humps.
Comments The accident reductions for 7 authorities are given. Problems for ambulances and fire engines are highlighted such as delays on emergency calls.

Measures Greenways (similar to Red Routes), cycle routes.
Comments Discussion of policy relating to cycle ways, bus routes and pedestrian routes.

**Measures** Includes humps and chicanes.

**Comments** Methodology used to highlight the most worthwhile areas for calming.


**Measures** Humps, cushions, mini-roundabouts, junction treatments, school treatments and a road closure.

**Comments** Describes a scheme in the St Mary’s area of the London Borough of Brent. The scheme covers 75 hectares and close co-ordination of the various contractors and phasing was an important consideration during the work.


**Measures** Humps, 20 mph zones, safe trails, restricted parking.

**Comments** Discusses schemes in Leicester (Highfields), Sheffield and Norwich 20 mph zones.


**Measures** Speed limit roundel markings, vehicle activated signs, speed cameras, countdown speed limit warning signs, rumble devices, humps, chicanes and buildouts.

**Comments** Gives results from VISP trial and also outlines research carried out by TRL for the Department of Transport (Now Department of Environment, Transport and the Regions).


**Measures** Cushions.

**Comments** Results from speed cushion trials which investigated various width cushions. The effect on vehicle speeds and passenger discomfort were measured and recommended widths discussed.

3.2 Australia


**Measures** Narrowing roads.

**Comments** A total of 55 sites were used to derive a formula which estimates the 85th percentile speed (kph) of vehicles on a road based on the Vehicles/day, the width and length of the street (metres).


**Measures** Humps, horizontal deflections, flat-top humps.

**Comments** Review paper considers speeds, volumes, noise, accidents, property values. It also discusses opposition to flat-top humps which has ‘ominously’ received official support in South Australia.


**Measures** Humps, horizontal slow points, road closures and combination measures.

**Comments** Background and case study, reference to buses and cycles. Road closures fell out of favour by 1980. Speed reductions reported at humps, horizontal slow points and combination measures. Attractive schemes and property prices are discussed.


**Measures** Includes humps and chicanes.

**Comments** Brief review of 27 papers with a figure which shows how they are connected by lines of significant influence/derivation.


**Measures** Includes humps and chicanes

**Comments** Discusses area wide schemes including speed control devices.


**Measures** Signs warning of police enforcement.

**Comments** Describes the results of speeds on the exit of a sign.


**Measures** Wide raised medians.

**Comments** Describes the effect on accidents.

Donald D (1997). *Speed zoning principles and their applicability to different road environments*. Road & Transport Research, Vol 6 No 3 September 1997 ARRB.

**Measures** Humps, chicanes and speed limits including variable speed zones at schools.

**Comments** Describes the use of speed limit zones from 10 kph (6 mph) to 110 kph (68 mph) in increments of 10 kph (6 mph) to suit the type of location.

**Measures**
- Rumble lines, stop sign, roundabout, left curve and right curve.

**Comments**
- Describes the speed reductions obtained in the simulator compared with the actual measurements on the road.


**Measures**
- Closures, chicanes, single lane slow points, two lane slow points, single and two lane angled slow points, roundabouts and humps.

**Comments**
- Discusses advantages and disadvantages of each device plus design requirements, constraints and ancillary treatment.


**Measures**
- Includes humps, chicanes and narrowings.

**Comments**
- This manual includes plans, photographs and assessments of many schemes.


**Measures**
- Continuous vertical deflections ‘waves’ which are not humps.

**Comments**
- Discusses the use of ‘waves’ for controlling vehicle speeds.


**Measures**
- Flat-top humps.

**Comments**
- Describes the use of 1:20 – 1:25 ramp gradients for humps on bus routes.


**Measures**
- Road humps

**Comments**
- Early tests which looked at loadings of heavy vehicles at road humps on a road with variable degree of incline/decline.


**Measures**
- Driveway entries (gateways), angled single centre lane (chicane), intersection remodel (horizontal deflection at junction) and humps.

**Comments**
- Speeds, flows and attitudes measured.
- Popularity of angled double lane treatments discussed. Costs of the treatments given.


**Measures**
- Build-out to narrow road on a two-way road.
- Crossing point on a one-way road.

**Comments**
- Gap acceptance measured for age groups 30-45 and over 65 years old. Results and further studies are discussed.


**Measures**
- Various traffic calming devices.

**Comments**
- Reports on noise at traffic calming devices particularly at road humps.


**Measures**
- Includes humps and chicanes.

**Comments**
- Attitude questionnaires sent to 28,000 households. Public meetings were also held to discuss the transport study. The study method led to a Traffic Calming plan flow chart and implementation spread sheet. Discusses local knowledge of the area and the solution proposed for the area.


**Measures**
- Speed humps, tables and mid block islands.

**Comments**
- 420,000 headways were measured from 7 survey sites (through 8 observation points at each site spaced at 30 metres before and after the device). The results and implications are discussed particularly in relation to pedestrians.


**Measures**
- Various traffic calming measures.

**Comments**
- Study looking at possibility of calming Armidale, NSW.
3.3 Austria


**Measures:** Humps.

**Comments:** The effect on bus speeds after installing road humps is discussed.


**Measures:** Speed roundels and signs.

**Comments:** Effect on speeds, accidents, emissions, noise and attitudes given.

3.4 Brazil


**Measures:** Humps and VMS signs.

**Comments:** In Brazil speed bumps are used to ensure slow vehicle speeds on many roads but an electronic screen VMS is now being used which shows the vehicle speed. If the driver ignores the speed limit, usually 40 kph, then a red light comes on, a photograph is taken and the driver fined accordingly.

3.5 Canada


**Measures:** Humps, refuges, roundabouts, chicanes, cushions, closures.

**Comments:** Traffic calming experiences from transportation professionals in 52 communities across Canada. Recommendations given. This is an important general article which is in Do’s and Don’ts format.

*Safety, speed and speed management: A Canadian review.*

**Measures:** All traffic calming measures.

**Comments:** A comprehensive review which looks critically at a wide selection of papers and articles. Lists measures which are promising for speed/accident control and recommends further research which could be carried out.

3.6 Denmark


**Measures:** Gateways, rumble strips, narrowing and chicanes.

**Comments:** Describes good and bad examples of each measure with photographs as illustrations.

**Danish Road Directorate** (1991). *Urban Traffic Areas, Part 7 Speed reducers.* Road Data Laboratory, Denmark.

**Measures:** Speed reducing measures, sinusoidal, round, flat & ‘H’ humps, chicanes, gateways, narrowings, roundabouts and cycle tracks.

**Comments:** Useful book with data on speed reduction measures and their effectiveness in terms of speed.


**Measures:** Humps, chicanes and narrowings.

**Comments:** Describes results from an experiment in 39 streets which were restricted to 30 kph (19 mph) and 5 streets restricted to 15 kph (10 mph). Gives a formula for predicting the ‘after’ speed based on ‘before’ speed, distance to next (and from last) measure, height of hump, type of lateral (horizontal) dislocation and street narrowing.


**Measures:** Gateways, rumble strips, chicanes.

**Comments:** Review and evaluation of 3 towns includes speeds at 4 locations. Accidents and drivers attitudes are also discussed.

Measures: Gateways, sinusoidal, round, flat & ‘H’ humps, narrowings, chicanes roundabouts and cycle tracks. Wide range of various measures.

Comments: Review of 23 schemes. Section 7 is speed reduction techniques (see next reference). Includes background, planning, design and speed, flow, accident results.


Measures: Modified sinusoidal road humps (100 mm high and 9.5 m long).

Comments: Discusses the effect on vehicle speeds at the hump and the attitude of drivers.


Measures: Round-top humps (100 mm high, 9.5 m long) and humps modified with a 0.75 m feathering.

Comments: Describes 14 sites in Frederiksborg County with round-top humps and gives the effect on speeds, accidents and public reactions. Discusses the effect of ‘feathering’ the leading edge of the hump.


Measures: Roundabouts converted from 4-arm give way.

Comments: Gives the effect of the conversion on accidents for cars and cyclists.


Measures: Chicanes, hump trials including ‘H’ hump.

Comments: Designs for staggerings given as well as hump designs for cars and buses. Trials resulted in the ‘K’ hump which is now known as the ‘H’ hump.


Measures: Sinusoidal road humps.

Comments: This report describes the use of 100 mm high sinusoidal road humps of various lengths (4.0, 6.5 & 9.5 m long). It discusses the effect on speeds and public reactions for the various humps.


Measures: Road humps.

Comments: The report discusses hump spacings required for 40 kph and 50 kph roads. A formula is given for predicting the maximum speed (kph) between the humps.


Measures: Variable message signs displaying delay time in Aalborg.

Comments: Interviews were carried out to determine drivers attitudes to the signs.

3.7 Europe (General)


Measures: Various measures.

Comments: Discusses schemes in Freiburg and Strasbourg and the Dutch Cycling Master Plan for cyclists.


Measures: Various traffic calming.

Comments: 20 countries/132 cities analysed including the potential of traffic calming.


Measures: Traffic calming measures.

Comments: Discusses the integration of environmental and safety objectives for various countries.


Measures: Includes humps and chicanes.

Comments: Based on published data and study visits to Denmark, Netherlands and West Germany. Discusses the effect on speeds and accidents and also the popularity of measures.


Measures: Humps, narrowing chicanes and roundabouts.

Comments: Analysis of questionnaire to EU member states. Traffic calming through small towns and villages. Effect on accidents is discussed for the measures considered.

Measures ‘Woonerfs’ 30 kph (19 mph) zones, cushions, humps, narrowings and horizontal deflections.

Comments Discusses various schemes in Germany and Netherlands. Results of effect on speeds and accidents. Contains many photographs of measures.

3.8 Finland


Measures Roundabout.

Comments Describes the effect of converting a four-arm junction to a roundabout in the built-up area of Lammi. The radius of the central island was 6.5 metres. The effects on speeds and accidents are discussed.


Measures Humps, horizontal deflections (chicanes and narrowings) and roundabouts.

Comments Discusses vehicle speeds, accelerations and decelerations.


Measures Variable warning sign for slippery road and variable sign recommending minimum headways between vehicles.

Comments The effect on vehicle speed of the slippery road sign is reported.


Measures Variable speed limit signs.

Comments Discusses the advantage of Fibre-optic technology signs compared with electromechanical technology signs.


Measures Speed roundels.

Comments Discusses the effect on speed and accidents of the speed roundels.


Measures 36 Variable message signs and 5 speed limit signs controlled by weather conditions on 14 km experimental road scheme.

Comments The paper gave the results of surveys into the driver acceptability of the signs.


Measures Speed limits, humps, road narrowings and roundabouts.

Comments This literature review included reconstruction of residential streets and through roads in small villages and also traffic calming on single streets or areas of many roads.


Measures Humps, cycle crossings, stop signs and cycle path.

Comments A limited study which investigated how drivers look at junctions. The study reported the proportion of dangerous drivers and safe drivers at the four junctions sites studied.


Measures Various.

Comments Contains information on effects of traffic calming, views of street users, traffic volumes, traffic speeds and noise levels studied.

3.9 France


Measures Humps, chicanes etc.

Comments Definitions, features, measures, study procedure and follow-up. Chicane dimensions are given for various applications including roads which contain bus routes.


Measures ‘Ridge’ and ‘Trapezoidal’ type speed humps.

Comments Describes the use of road humps in residential roads. Humps are not used on bus routes. Round-top humps are 4.00 metres long. Flat-top humps are 2.5 m - 4.00 m long with ramp gradients of 1:10 to 1:14. Both types of hump are 100 mm high.
3.10. Germany


Measures Humps, narrowed roads and 30 kph signs.
Comments Describes the effect on vehicle speeds.


Measures Closures, offsets, shortened vistas, narrowing, gateways, tables/humps, road markings and planting.
Comments Dimensions of humps and chicanes. Speed, accident and noise results are given.


Measures Humps, cushions, horizontal, narrowings, 30 kph (19 mph).
Comments Concentrates on accident study for 6 towns. Note this reference has plans of Berlin-Moabit, Berlin-Charlottenburg and Buxtehude.


Measures Humps, cushions, horizontal deflections, narrowings.
Comments Describes schemes in Berlin-Moabit, Borgentreich, Buxtehude, Esslingen, Ingolstadt, Mainz-Bretzenheim. 30 kph (19 mph) zones. Reports the effect on accidents in the schemes.


Measures Humps with 10% ramps for cars crossing the bicycle street, narrowings for cyclists and pedestrians.
Comments The effect on cyclist injury accidents are given. Costs of the scheme are given.


Measures Gateways, cushions, humps, narrowings, 30 kph limits and roundabouts.
Comments Designs for pedestrians, cyclists, buses. Speeds and emissions measured.


Measures Long/wide central islands, build-outs, chicanes, narrowings, gateways, roundabouts, 4-arm junctions.
Comments Good and bad examples of measures illustrated with photographs of each side by side.


Measures Mainly cushions, humps and narrowed roads.
Comments Describes schemes in Berlin Moabit, Buxtehude, Ingolstadt and small villages.


Measures 30 kph zone (19 mph) cushions, chicanes, narrowings.
Comments Vehicle speeds and noise are discussed.


Measures Variable speed limit signs.
Comments Extensive report which discusses visibility and wetness of roads. The relationship between Acceptance of variable speed limits and The extent of the particular speed limit imposed is discussed.


Measures Humps and narrowings, 30 kph zones (19 mph).
Comments Gives speeds and accidents (speed reduction/accident reduction). Also discusses the effect on the environment, noise and the reactions of the public to the schemes over time.


Measures Gateway, narrowings, islands, rumble strips and roundabouts.
Comments Results are given for speeds at various locations including the gateways and the central area.
3.11 Israel


**Measures** Chicanes.

**Comments** Speed width inclination of chicane discussed. Only suitable for very low flow roads due to road width. Tables showing lane width, offset, cutting radius, width of chicane.

**Polus A and Craus J (1996). Planning and geometric aspects of shared streets.** Transportation Research Record 1523.

**Measures** Chicanes in shared streets.

**Comments** Discusses parking and some new designs of shared streets.


**Measures** Humps (rumble strips, round-top, flat-top, sinusoidal and negative humps).

**Comments** Review of vertical deflections in 13 countries; Australia, Belgium, Canada, Finland, Great Britain, Netherlands, Israel, Japan, New Zealand, Norway, South Africa, Sweden, USA. The effect on vehicle speeds, accidents, noise and vibration are discussed. The opinions of the emergency services and bus operators are also discussed.

3.12 Italy


**Measures** VMS speed signs.

**Comments** Signs used in 50 to 70 kph speed limits (30 to 45 mph). Journey times investigated on the route at various times of the day.


**Measures** Includes humps, chicanes.

**Comments** Traffic calming is virtually unknown. (Quote from English abstract, report is in Italian).

3.13 Japan


**Measures** Humps, narrowings.

**Comments** Describes the effect on traffic volumes entering the area, traffic speeds, the number of parked cars and injury accidents.

**Griffin L and Reinhardt R N (1996). A review of two innovative pavement patterns that have been developed to reduce traffic speeds and crashes.** AAA Foundation for Traffic Safety, Washington DC.

**Measures** Chevrons and yellow bar markings.

**Comments** Converging chevron patterns used at 6 Japanese locations. Speed and accident results given.


**Measures** Humps, chicanes, narrowings, planting.

**Comments** Case study to test LANDSCAD (Landscape computer-aided design) system. Residential designs on video used to assist in decision making.

**Yamanaka H and Odani M (1990). Measures for traffic calming in residential areas.** The wheel extended, 1990 no.73.

**Measures** Humps and chicanes.

**Comments** Gives Japanese approach, techniques and objectives. Humps are less than 100 mm and longer than 3.6 metres to lessen the severity.

3.14 Netherlands


**Measures** All traffic calming measures.

**Comments** This is a comprehensive book which contains the following for each measure. Area of application. Construction. Dimensions. Combination options. Positive aspects. Negative aspects.


**Measures** Humps.

**Comments** Covers design of sinusoidal profile humps.


**Measures** Humps, sinusoidal and trapezium (flat-top).

**Comments** Construction and speed reductions for each profile discussed.

**Measures**

Humps, narrowings, islands, junction treatments and roundabouts.

**Comments**

Discusses accidents including pedestrian accidents at the various features.


**Measures**

Cruise controls, econometers and on-board computers.

**Comments**

Proper observance of speed limits would save energy and reduce CO\textsubscript{2}. The econometer is a simple device which indicates how ‘heavily the driver is stepping on the gas’. Autonomous Intelligent Cruise Control system (AICC) which adjusts to the speed of the vehicle in front of the driver.

SWOV (1985). *Reclassification and reconstruction of urban roads in the Netherlands*.

**Measures**

Humps, narrowings, horizontal deflections, ‘woonerfs’.

**Comments**

Results from Eindhoven and Rijswijk including flows, accidents, speeds, opinions, noise, commerce.


**Measures**

Humps, narrowings, 30 kph signs and mini-roundabouts.

**Comments**

Speed reduction results given for each type of measure.

Wegman F (1994). *Road safety in residential areas - the Dutch experience*. PIARC.

**Measures**

Humps and chicanes.

**Comments**

Injury accidents in 30 kph (19 mph) zones are given. The problems caused by moped riders are discussed.

3.15 New Zealand


**Measures**

Humps, narrowings, cushions, closures.

**Comments**

Darwin Matrix (Brindle) includes social aspects of traffic calming. ‘Hawkes Bay matrix’ suggests maximum flows for Local, Collector, Minor arterial and Major arterial roads.


**Measures**

Plateaux, road humps, raised zebra, sine wave (sinusoidal) humps.

**Comments**

Study tour of New Zealand. Discusses hump gradients, speeds and discomfort at humps.

3.16 Norway


**Measures**

Chicanes, humpas, 20 mph zones with speed reductions.

**Comments**

Effect on speed of narrow roads.


**Measures**

Speed cameras.

**Comments**

Introduced in Norway in 1988. 64 road sections analysed and accident reduction given. Includes a summary of other studies and pools all results to give an overall effect of cameras.


**Measures**

Detectors in road and camera.

**Comments**

32 road sections under test with 100 control sites. Accident reduction given.


**Measures**

Street width reductions, pedestrian crossings, renewed lighting, street furniture and trees.

**Comments**

Initially 5 towns have received economic support to carry out calming and further sites are being planned.


**Measures**

Surveillance by police, at the roadside or in-car.

**Comments**

Public opinion surveys showed the acceptability of the various methods of surveillance.

**NVF (1992)**


**Measures**

Traffic calming and priority measures for buses and cycle routes.

**Comments**

Desk study of schemes. The establishment of bicycle route systems are discussed and the effect on accidents reported.

**Measures** Mobile roadside speedometer.

**Comments** The effect on vehicle speeds is given on roads with 50 mph and 37 mph speed limits.


**Measures** Traffic calming measures and road humps.

**Comments** Contains accident and speed analysis.

3.17 Saudi Arabia


**Measures** Humps.

**Comments** Discusses the effectiveness of smoothing the initial rise of road humps in terms of dynamic impact of the vehicle.

3.18 Singapore


**Measures** Humps.

**Comments** Mathematical car model used to compare hump geometry with vertical accelerations.


**Measures** Humps.

**Comments** Regression relationship between hump crossing speed and hump geometry (area-to-width ratio).

3.19 South Africa


**Measures** Humps, chicanes and narrowings.

**Comments** Report serves as a comprehensive national traffic calming guideline to assist local authorities with implementation of traffic calming. Very similar to the report by Lines and Casteljijn (1991). Also includes sections on measures for pedestrians and handicapped persons as well as geometric design criteria for roads eg skid resistance, sight distances, effect of gradients on stopping distances, truck speeds on hills. Junction sight distance for stopping situation and sight distance for yield condition. Passing sight distances are also given which are applicable to roads of 30 mph to 50 mph.


**Measures** Various traffic calming measures.

**Comments** Discusses traffic calming, public participation and flow chart for traffic calming procedure to be followed from identification of study area to feedback from monitoring of implemented scheme.

3.20 Sweden


**Measures** Various traffic calming measures.

**Comments** Tables giving opinions about traffic and traffic safety of some European drivers from 15 countries.


**Measures** Humps.

**Comments** Humps for buses with 1:20 slope added to a 100 mm high round-top hump. Modified hump has total length of 5 metres, both ramps are 1.5 metres with a 2 metres centre section. Discomfort rating used to assess hump.


**Measures** Various.

**Comments** Traffic calming related to pedestrians. Four categories of roads suggested; Pedestrian streets, Calmed local streets, Adapted through roads and Major roads.


**Measures** Humps and area wide schemes.

**Comments** Driver opinions on humps are given. Discusses the effect on speeds in area-wide calming schemes which have roads which contain no physical measures.


**Measures** Roundabouts, speed limit reduced to 30 kph.

**Comments** Speeds, accidents, attitudes, behaviour, journey times, emissions and noise measured.

Measures: Road humps

Comments: Two humps studied, 100 mm high (4.8 m ramps {1:48} and 4.8 m flat-top) 140 mm high (7.2 m ramps {1:51} and 7.2 m flat-top). Vertical accelerations were measured and reported.


Measures: Intelligent cruise control (ICC).

Comments: Informative ICC gave driver audible warnings and visual speed limit sign flickering. Automatic ICC controlled car speed and headway automatically via brakes and throttle.


Measures: Speed reducers used in conjunction with Public transport.

Comments: This is a review of measures used in various countries. This version is in Swedish but an English version is due later in 1999.


Measures: Humps, depressions, central islands, chicanes.

Comments: Speeds and noise monitored. Public attitudes are discussed and also the views from the public transport company.

3.21 United States of America


Measures: Traffic circles, humps, chicanes, medians, diverters, chokers, channels and cul-de-sacs.

Comments: Discusses the effectiveness of the measures particularly in terms of speed.


Measures: Humps.

Comments: The humps are 14 feet long round-top (4.27 metres), 22 feet long (6.7 metre) with a 10 feet long (3 metre) plateau with parabolic ramps. Speed measurements were taken for 6 different fire bureau vehicles at the humps and the results compared.


Measures: Traffic circles and humps.

Comments: Discusses the effect on vehicle speeds. The fire and bus operators are consulted to ensure that they are satisfied with the measures.


Measures: Humps.

Comments: Round-top humps used in Bellvue, Washington were 3 inch (75 mm high), recommended maximum spacing of 500 feet (152 metres) between humps. Results for speeds and flow are given.


Measures: Various traffic calming measures.

Comments: Book looks at safety related to cyclists in USA since 1981 and Section 6 of the book introduces traffic calming.


Measures: Roundabouts.

Comments: The paper outlines the Florida Roundabout Guide in terms of roundabout characteristics, justification, performance, design and operation.


Measures: Humps, chicanes, diverters, narrowings (chokers), mini traffic circles and central islands.

Comments: Measures used in 17 states in the USA are reviewed with brief comments on each.

Ewing R (1994). Residential street design: do the British and Australians know something Americans do not?.

Measures: Humps, chicanes etc.

Comments: Compares traffic calming measures given in DB32, Australian model code, American AASHTO, American ITE and American ASCE/NAHB/ULI. Also compares road/footpath dimensions.
Measures Humps, chicanes, narrowings, roundabouts, closures, diverters and one-way roads.
Comments Survey of the use of traffic calming measures in Florida and in other US states outside Florida. Describes the results of the survey giving the types of measures used, before and after studies, implementation problems, liability issues and residents reactions.

Measures Measures to assist cyclists.
Comments This new edition includes a traffic calming section as well as European bikeway engineering, city planning sections.

Measures Speed limits, enforcement, traffic calming including humps, narrowings, roundabouts etc.
Comments Feedback on the article showed the opinions of readers on traffic calming as a means of slowing vehicles.

Measures Rumble strips.
Comments This report describes the effectiveness, placement and problems of using rumble strips in the USA.

Institute of Transportation Engineers (1993). The traffic safety toolbox: a primer on traffic safety pp263.
Measures Humps, chicanes, gateways, narrowings, buildouts.
Comments This book contains a traffic calming chapter which looks at the Advantages & Disadvantages of various measures.

Institute of Transportation Engineers (1997). Guidelines for the design and application of speed humps.
Measures Round-top humps.
Comments Describes the measures and their effectiveness, particularly in terms of speed and spacing.

Measures Humps, chicane and narrowing.
Comments American case studies of humps and 2 Dutch case studies, one chicane in Oosterhout and one narrowing in De Meern with cycle bypass (cars crossed onto cycle track); dimensions are given.

Measures All traffic calming measures considered.
Comments Contains a useful figure which shows street design/ street use and the types of applicable measures.

Measures Humps, chicanes, narrowings, roundabouts, closures, diverters and gateways.
Comments Gives a table of the types of traffic calming measures and lists the operational issues for each type. Also includes discussion of American Association of State Highway and Transportation (AASHTO) and Manual on Uniform Traffic Calming Devices (MUTCD) guidelines.

Measures Humps, chicanes, narrowings and roundabouts.
Comments Describes the various measures and gives details on good practice.

Measures All measures
Comments Gives a sample of definitions of traffic calming and also gives a number of related words and phases used to refer to traffic calming measures.

Measures Flat-top hump with circular on/off ramps.
Comments Some speed and flow results given.

Measures Humps.
Comments Hump speeds reviewed from the UK, USA and Australia. Compares ‘g’ accelerations for a passenger car and empty air suspension bus measured at drivers seat and at back passenger seat. The costs of humps are given.

Measures Humps
Comments Results from early road hump trials which measured speeds across the humps.

Measures  Humps, rumble strips, diagonal diverters, stop signs, speed limit signs, chicanes, narrowings and traffic circles.

Comments  Summary of relative effect of each measure in terms of speed, flow, noise, safety and access for the emergency service vehicles.


Measures  Round-top humps, traffic circles, roundabouts, narrowings and chicanes.

Comments  Discusses vehicle flows appropriate for round-top hump sites. The effectiveness in reducing speeds at chokers (narrowings) twisted chokers (chicanes) and traffic circles is discussed.


Measures  Traffic circles, raised crosswalks, curb extensions and medians.

Comments  Eugene, Oregon Local street plan for residential street design. This is similar to DB32 used in the UK for designing residential streets. Gives widths of roads and numbers of homes for each type of road.
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Abstract

TRL has been commissioned by the Charging and Local Transport Division of the Department of the Environment, Transport and the Regions to prepare a draft Local Transport Note providing comprehensive guidance on the design and performance of traffic calming measures.

A search of traffic calming literature has been undertaken as part of the preparation of the draft Local Transport Note. In total, 319 references were found comprising of 72 TRL reports, papers and articles and 247 other publications from the UK and around the world. This report lists all the references sorted by country and by author. A brief description of the content of each is given.

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