TRANSPORT RESEARCH LABORATORY

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.

1 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.

2 TRL Reports

2.1 Published TRL Reports

Abbott P G, Phillips S M and Layfield R E (1995). *Vehicle and traffic noise surveys alongside speed control cushions in York.* Project Report PR103.

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.

Abbott P G, Hartley S, Hickman A J, Layfield R E, McCrae I S, Nelson P M, Phillips S M and Wilson J (1995). *The environmental assessment of traffic management schemes:A literature review*. TRL Report TRL174.

Measures All traffic management measures.

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

Abbott P G, Tyler J W and Layfield R E (1995). *Traffic calming:vehicle noise emissions alongside speed control cushions and road humps*. TRL Report TRL180.

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.

Baguley C J (1981). *Speed control humps - Further public road trials*. Laboratory Report LR1017.

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.

Barker J K and Helliar-Symons R D (1997). *Countdown signs and roundel markings trials*. TRL Report TRL201.

Measures Countdown signs and roundel markings.

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

Barker J K (1997). *Trials of rural road safety engineering measures*. TRL Report TRL202.

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.

Boulter P G and Webster D C (1997). *Traffic calming and vehicle emissions: A literature review*. TRL Report TRL307.

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.

Boulter P (1998). *The perceived environmental impacts of traffic management schemes: a literature review*. TRL Report TRL362.

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.

Boulter P (1999). *Remote sensing of vehicle emissions near two traffic calming measures in Gloucester*. TRL Report TRL423.

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.

Broughton J and Markey K A (1996). *In-car equipment to help drivers avoid accidents*. TRL Report TRL198.

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.

Cloke J, Webster D, Boulter P, Harris G, Stait R, Abbott P and Chinn L (1999). *Traffic calming: Environmental assessment of the Leigh Park Area safety scheme in Havant*. TRL Report TRL397.

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.

Davies D, Ryley T, Taylor S and Halliday M (1997). *Cyclists at road narrowings*. TRL Report TRL241.

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.

Davies D, Taylor M, Ryley T and Halliday M (1997). *Cyclists at roundabouts - the effects of 'continental' design on predicted safety and capacity*. TRL Report TRL285.

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.

Harris G, Stait R, Abbott P and Watts G (1999). *Traffic calming: vehicle generated noise and ground-borne vibration alongside sinusoidal, round-top and flat-top humps*. TRL Report TRL416.

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.

Hodge A R (1993). *Speed control humps - a trial at TRL*. Project Report PR32.

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.

Kennedy J V, Hall R D and Barnard S (1998). *Accidents at urban mini-roundabouts*. TRL Report TRL281.

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.

Layfield R E and Parry D I (1998). *Traffic calming - Speed cushion schemes*. TRL Report TRL312.

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.

Lockwood C R (1997). *Using the TRL driving simulator to evaluate traffic calming measures*. TRL Report TRL245.

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.

Mackie A (1998). *Urban speed management methods*. TRL Report TRL363.

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.

Morgan J M (1993). *Toucan crossings for cyclists and pedestrians*. Project Report PR47.

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.

Morgan J M (1998). *Roundabouts in Continental Europe designed with cycle facilities or cycle thinking*. TRL Report TRL302.

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.

Morgan J M (1998). *Contraflow cycling in one-way streets in Continental Europe*. TRL Report TRL372.

Measures Measures to assist cyclists.

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

Perret K and Stevens A (1996). *Review of the potential benefits of road transport telematics*. TRL Report TRL220.

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.

Sayer I and Parry D I (1994). *Speed control using chicanes - a trial at TRL*. Project Report PR102.

Measures Chicanes.

Comments This report details the results from a track trial using various chicane dimensions. The variables investigated were stagger length, lane width and free view width. Changing the free view width was found to give good speed reduction.

Sayer I A, Parry D I and Barker J K (1998). *Traffic calming - An assessment of selected on-road chicane schemes*. TRL Report TRL313.

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.

Sayer I A, Nicholls D A and Layfield R E (1999). *Traffic calming passenger and rider discomfort at sinusoidal, round-top and flat-top humps – a track trial at TRL*. TRL Report TRL417.

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.

Sumner R and Baguley C J (1979). *Speed control humps on residential roads*. Laboratory Report LR878.

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.

Taylor S B and Halliday M E (1997). *Pedestrians' and cyclists' attitudes to Toucan Crossings.* TRL Report TRL277.

Measures Toucan crossings.

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

Tootill W J and Mackie A M (1995). *Transport supplementary grant for local safety schemes - Local authorities schemes from 1992/93 Allocations*. TRL Report TRL127.

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.

Walker J S and Pittam S R (1989). *Accidents at mini-roundabouts: Frequencies and rates*. Contractor Report CR161.

Measures Mini-roundabouts.

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

Watts G R (1973). *Road humps for the control of vehicle speeds*. Laboratory Report LR597.

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.

Watts G R and Harris G J (1996). *Traffic calming: vehicle generated ground-borne vibration alongside speed control cushions and road humps.* TRL Report TRL235.

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.

Webster D C (1993). *Road humps for controlling vehicle speeds*. Project Report PR18.

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.

Webster D C and Layfield R E (1993). *An assessment of rumble strips and rumble areas*. Project Report PR33.

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.

Webster D C (1994). *Speeds at thumps and low height road humps*. Project Report PR101.

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.

Webster D C (1995). *Traffic calming - vehicle activated speed limit reminder signs*. TRL Report TRL177.

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.

Webster D C (1995). *Traffic calming - Four schemes on distributor roads.* TRL Report TRL182.

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.

Webster D C and Layfield R E (1996). *Traffic calming - Road hump schemes using 75 mm high humps.* TRL Report TRL186.

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.

Webster D C and Mackie A M (1996). *Review of traffic calming schemes in 20 mph zones*. TRL Report TRL215.

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.

Webster D C (1998). *Traffic calming - Public attitude studies: a literature review.* TRL Report TRL311.

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.

Webster D C and Layfield R E (1998). *Traffic calming - Sinusoidal, 'H' and 'S' humps*. TRL Report TRL377.

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.

Wheeler A H, Taylor M C and Payne A (1993). *The effectiveness of village 'gateways' in Devon and Gloucestershire*. Project Report PR35.

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.

Wheeler A H, Taylor M C and Barker J K (1994). *Speed reduction in 24 villages:details from the VISP study*. Project Report PR85.

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.

Wheeler A H, Godfrey N S, Lawrence D J and Phillips S M (1996). *Traffic calming on major roads: A49 trunk road at Craven Arms*. TRL Report TRL212.

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.

Wheeler A H, Abbott P G, Godfrey N S, Phillips S M and Stait R (1997). *Traffic calming on major roads:A47 trunk road at Thorney*. TRL Report TRL238.

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.

Wheeler A H (1997). *Traffic calming in historic core zones: Crossley Street, Halifax*. TRL Report TRL288.

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.

Wheeler A H, Harris G, Chinn L, Taylor M and Abbott P (1998). *A traffic calming scheme at Costessey, Norfolk*. TRL Report TRL364.

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.

Wheeler A H (1999). *Traffic calming in Historic core zones: High Street route Shrewsbury*.TRL Report TRL374.

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.

Wheeler A H and Taylor M C (1999). *Traffic calming in villages on major roads: Final report*. TRL Report TRL385.

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

Wheeler A H (1999). *Traffic calming in Historic core zones: Bury St Edmunds*. TRL Report TRL388.

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.

Windle R and Mackie A (1992). *Survey on public acceptability of traffic calming schemes*. Contractor Report CR298.

Measures Road humps.

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

Windle R and Hodge A R (1993). *Public attitude survey - the New Forest traffic calming programme*. Project Report PR14.

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

Abbott P, Taylor M and Layfield R (1997). *The effect of traffic calming measures on vehicle and traffic noise.* Traffic Engineering and Control, September 1997.

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.

Clarke P E, Watts G R and Savill T A (1997). *Review of audible locating signals used at pedestrian crossings*. Traffic Engineering and Control, October 1997.

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.

Farmer S, Barker J and Mayhew N (1998). *A trial in Norfolk of interactive speed limit signs*. Traffic Engineering and Control , May 1998.

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.

Helliar-Symons R, Butler N and Critchell P (1995). *Riblines in Hampshire*. Traffic Engineering and Control, July/August 1995.

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.

Jones S M and Farmer S A (1993). *Pedestrian ramps in central Milton Keynes:a case study*. Traffic Engineering and Control, March 1993.

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.

Layfield R E (1994). *The effectiveness of speed cushions as traffic calming devices.* 22nd PTRC transport forum 1994.

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.

Layfield R E and Webster D C (1998). *Urban traffic calming measures – design, effectiveness, public attitudes and environmental issues.* PTRC European Transport Conference 1998.

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).

Lines C J and Castelijn H A (1991). *Translation of Dutch 30 kph zone design manual.* Published Article PA2046/91.

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.

Lines C J (1993). *Road humps for the control of vehicle speeds*. Traffic Engineering and Control, January 1993.

Measures Humps.

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

Lines C J (1995). *Cycle accidents at signalised roundabouts.* Traffic Engineering and Control, February 1995.

Measures Signalised roundabouts.

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

Lockwood C R (1998). *Virtual traffic calming*. Traffic Engineering and Control, January 1998.

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.

Mackie A (1997). *Progress report: MOLASSES: Monitoring of local Authority safety schemes*. County Surveyors Society, 1997-03.

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.

Mackie A and Layfield R E (1998). *Safer City – the case of Gloucester*. Helsinki Transport Environment and Safety Week, May 1998.

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.

Taylor M and Wheeler A H (1993). *Studies of speed reducing measures in rural villages*. 21st PTRC transport forum 1993.

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.

Taylor M and Wheeler A H (1997). *Core calming. The Transport Research Laboratory reports on a traffic calming scheme installed in the historic centre of Halifax.* Highways December 1997.

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 manoevres.

Taylor M (1998). *Trafficking in history*. Surveyor, 5th March 1998.

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.

Taylor M and Wheeler A H (1998). *Traffic calming in villages on major roads.* PTRC European Transport Conference 1998.

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.

Webster D C (1993). *Grounding of vehicles on road humps*. *T*raffic Engineering and Control, July/August 1993.

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.

Wheeler A H (1994). *Speed reducing measures in villages*. Surveyor, 28th July 1994.

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.

Wheeler A H and Taylor M (1995). *Reducing speeds in villages. The VISP study*. Traffic Engineering and Control, April 1995.

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

Allott and Lomax (1998). *Urban street activity in 20 mph zones*. Literature review report. First update. Allot and Lomax, June 1998.

Measures 20 zones.

Comments DETR project looking at activity in 20 mph zones.

Amis G (1995). *Traffic calming in Cambridgeshire. Effects on accident frequency at calmed sites and on surrounding roads*. Cambridge County Council, August 1995.

Measures Humps, chicanes, narrowings.

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

Anon (1996). *Calming influence. Public consultation on a small-scale traffic calming project helped designers identify the major issues*. New Civil Engineer 4/11 April 1996.

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.

Anon (1996). *First warning sign for blind bends*. Surveyor, 28th November 1996.

Measures Warning sign for blind bend.

Comments Sign installed on a blind bend on A350 in Dorset. Sensors detect long vehicles and activate an electronic warning sign. Southbound traffic receive a 'WAIT HERE' signal and when northbound lorries have negotiated the bend, this changes to 'PROCEED WITH CARE'.

Astucia (1998). *Intelligent road studs being installed in Worcester*.Traffic Engineering and Control. December 1998.

Measures Self-illuminated road studs with microprocessor controlled circuitry which monitors ambient light levels to enable them to turn off at dawn.

Comments Being trialled on the A49T in Worcestershire for the Highways Agency.

Avon County Council (1994). *Residential roads in Avon. 2nd edition. Guidance on the design of residential road layouts to be offered for adoption in the County of Avon.* Avon CC 1994.

Measures Humps, chicanes and narrowings.

Comments Guidance based on Design Bulletin 32, Department of Transport (1992).

Bellotti P (1998). *Balancing act*. Surveyor, 12th March 1998.

Measures Cycle lanes and road humps.

Comments The Gloucester Safer City project has installed advisory cycle lanes.

Bennett G T (1983). *Speeds in residential areas*. The Highway Engineer, July 1983.

Measures Roads of various widths.

Comments This report describes the effect on vehicle speeds for carriageway widths of 4.5 to 6.1 metres.

Bicknell D (1993). *Traffic calming.* Proceedings of the Institution of Civil Engineers: Municipal Engineer, pp13-19, March 1993.

Measures Humps, chicanes, build outs.

Comments Discussion and assessment of schemes in Kingston-Upon-Thames (and other London boroughs) mainly concerning speeds, speed range and hump spacing.

Bond R (1997). *Motoring towards the Millennium*. Surveyor, 16th January 1997.

Measures Variable speed limits.

Comments General discussion.

Bowrey D, Thomas R, Evans R and Richmond P (1996). *Road humps:accident prevention or hazard?* J Accid. Emerg. Med. 1996; 13:288-289.

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.

Boyd G and Noon A (1997). *Beneath the calm exterior*. Surveyor, 23rd January 1997.

Measures Humps and chicanes.

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

Braddock I (1998). *20 mph zones: public consultation procedures*. 'Road speed limits' conference at Aston University Held on 11th March 1998.

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.

Brennan D T (1994). *The evaluation of residential traffic calming: a new multi-criteria approach*. Knowsley MBC. Traffic Engineering and Control 1994.

Measures Includes humps and chicanes.

Comments Comprehensive assessment method for traffic calming schemes.

Broadbent K and Salmon A M (1993). *An alternative to road humps*. Highways and Transportation, August 1993.

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, refuges, 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, refuges, chicanes and narrowings on congestion is also discussed.

Buxton J and Newby L (1995). *Driver reaction to traffic calming. A survey of the effects of road humps on driver acceleration and braking*. Produced by Environ Trust Ltd. Research Report No. 21. February 1995.

Measures Road humps.

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

Carsten O, (1998). *Intelligent speed control 'could cut accidents by 35%'*. Traffic Engineering and Control. July/August 1998.

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.

Carter G (1995). *Traffic calming in rural and tourist areas: The New Forest 40 mph zone*. Traffex conference 27 April 1995: Managing traffic for sustainability.

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.

Challis S D (1992). *North Earlham estate, Norwich - the first UK 20 mph zone*. Norwich City Council. 20th PTRC summer annual meeting 1992.

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.

Cheeseborough T (1995). *Shirley 'streets ahead' traffic calming project, Southampton*. 23rd PTRC meeting 1995.

Measures Narrowing, surface changes.

Comments Shirley Street is an 'A' road and therefore humps were not appropriate.

Cheshire County Council (1996). *Design aid. Housing, industrial and commercial estate roads*. Cheshire County Council, 1996.

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

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

Chick C (1994). *An integrated approach to traffic calming, road safety and environmental improvements in the London Borough of Hounslow*. 22nd PTRC forum 1994.

Measures Cushions, humps.

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

Children's Play Council (1998). *Home zones, reclaiming residential streets*. Children's Play Council, London.

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.

Chorlton E (1990). *Burnthouse Lane traffic calming scheme*. Devon CC 1990-08.

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.

Chorlton E *et al* (1991). *Traffic calming guidelines*. Devon County Council, 1991.

Measures Humps, cushions, narrowings, chicanes, gateways.

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

Cole A (1990). *Traffic calming trail blazers*. Highways 1990-05.

Measures Humps, narrowings and mini-roundabouts.

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

Comte S L (1996). *Response to automatic speed control in urban areas: A simulator study*. Institute for Transport Studies, The University of Leeds, Working Paper 477, 1996.

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.

County Surveyors Society *et al* (1994). *Traffic calming in practice 1994*.

Measures Most traffic calming features.

Comments 85 case studies. Important book with scheme assessments.

Davies D (1996). *Cycle-friendly infrastructure:Guidelines for planning and design*. Cyclists Touring Club, Godalming, Surrey, 1995.

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.

Davies G (1996). *An education in health and safety*. Surveyor 18th July 1996.

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.

Department of Environment (1992). *Residential roads and footpaths*. DB32 second edition 1992.

Measures Humps and narrowings.

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

Departments of Environment & Transport (1995). *PPG 13 - A guide to better practice:Reducing the need to travel through land use and transport planning*. Stationery Office, 1995.

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

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

Department of the Environment, Transport and the Regions (1998). *Places, streets & movement*. A companion guide to Design Bulletin 32. Residential roads and footpaths.

Measures All traffic calming measures.

Comments This should be read with DB32.

Department of Transport (1995). *Better places through bypasses*. DOT, London.

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.

Department of Transport, Scottish Office, Welsh Office and Department of Environment Norther Ireland (1995). *The assessment of pedestrian crossings*. Local Transport Note 1/95. Stationery Office, London.

Measures Narrowings and humped pedestrian crossings.

Comments Design standard for crossings.

Department of Transport, Scottish Office, Welsh Office and Department of Environment Northern Ireland (1995). *The design of pedestrian crossings*. Local Transport Note 2/95. Stationery Office, London.

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.

Department of Transport, Scottish Office and Welsh Office (1997). *Keeping buses moving*. Local Transport Note 1/97. Stationery Office, London.

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.

Derbyshire M (1996). *New approach to residential roads*. Surveyor 17th October 1996.

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.

Dunne M and Birang V (1999). *A quiet revolution*. Surveyor, 4th March 1999.

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.

Easey J (1997). *Driving home the message*. Surveyor 18th September 1997.

Measures Transport telematics.

Comments Electronic messages, variable speed limits considered.

Evans D (1994). *Traffic calming: the first five years and the Oxfordshire experience*. Proceedings of ICE:Municipal Engineer 1994-03.

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.

Forni J F and Hasen D (1997). *The use of coloured surfacing in road layout*. 25th PTRC European Transport Forum Annual Meeting, 1997.

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.

Fox K *et al* (1995). *Integrated ATT strategies for urban arterials:DRIVE II project PRIMAVERA:3 The Dewsbury Road experiment*. Traffic Engineering and Control, July/ August 1995.

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.

Gilmour J (1994). *Road layouts help cut the speed of estate cars*. Urban Street Environment 1994, p 10 - 15.

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

Girven W (1995). *Traffic calming - A crime prevention technique?* The third UK national traffic calming conference.

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

Comments Four sites considered.
1 Blackbird Leys estate (Oxford) 'Joy riding'.
2 Toxteth area (Liverpool) 'Red light area'.
3 City of London 'Terrorism'.
4 South Shields pedestrian area 'Ram raiding'.

Glover A (1992). *Street furniture and highway design*. Highways and Transportation, February 1992.

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.

Hall *et al* (1992). Implementing traffic calming: the Wolverhampton experience. Highways and Transportation 1992-10.

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.

Hall A (1996). *Running the rats out of town*. Surveyor 28th November 1996.

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.

Hampshire County Council (1996). *Traffic calming in Hampshire*. Report of the County Surveyor, 29th April 1996.

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.

Hargreaves A J (1997). *Public preferences for traffic calming: An investigation using multi-criteria procedures*. 25th PTRC European Transport Forum Annual Meeting, 1997.

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.

Hass-Klau *et al* (1992). *Civilised streets. A guide to traffic calming*. ETP 1992.

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.

Hass-Klau C and Nold I (1994). *Horizontal traffic calming measures - alternatives to road humps.*

Measures Horizontal deflections.

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

Hill J (1996). *Getting the hump*. New Civil Engineer 4th - 11th April 1996.

Measures Road humps.

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

Holland M (1997). *Making streets safer*. Highways and Transportation, October 1997.

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

Hook D (1994). *Traffic calming - engineering the highway for safer speed.* 59th ROSPA National Road Safety Congress March 1994.

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.

Hooke A, Knox J and Portas D (1996). *Cost benefit analysis of traffic light and speed cameras.* Police Research Series paper 20, Home Office Police Research Group, London.

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.

Hopper K and Cannon R (1994). *Traffic calming Hertfordshire's town centres.* Highways and Transportation. 1994-10, p14 - p18.

Measures Long flat-top humps.

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

Howard A (1998). *Street lighting for road humps and traffic calming measures: a proposal.* The Lighting Journal, February/March 1998.

Measures Various traffic calming measures.

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

Institution of Highways and Transportation (1997). *Transport in the Urban Environment.*

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.

Jeanes M (1996). *Suffolk's 30 mph speed limit initiative*. 24th PTRC meeting, September 1996.

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.

Jeeves M and Brown G (1996). *A safe path to education*. Surveyor 28th November 1996.

Measures Humps.

Comments Describes a Leicester 'Safe routes to school' scheme.

Kendrick M J (1995) *Review of Traffic Calming, 1995*. Northamptonshire County Council.

Measures Humps, cushions, chicanes and narrowings.

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

Kent County Council (1992 and 1996). *Review of traffic calming schemes in Kent. Kent CC 1992*. Also Second Review: 1996.

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.

Kent County Council (1992 and 1994). *Traffic calming a code of practice*. Second edition and Third edition.

Measures Humps, narrowings, chicanes, road closures.

Comments Contains reviews of Kent schemes.

Kent County Council (1995). *Cushioned comfort*.

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.

Lalani N (1977). *Road safety at pedestrian refuges*. Traffic Engineering and Control, September 1977.

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.

Lee G (1998). *The effectiveness of signing and lining*. Traffic Engineering and Control, July/August 1998.

Measures Signing and lining of roads.

Comments Case studies of sites reviewed including the effect on speed and accidents.

Local Authorities Association (1996). *Road safety - Code of good practice*. Revised edition 1996. Association of County Councils, Association of District Councils, Association of Metropolitan Authorities, Convention of Scottish Local Authorities.

Measures Engineering, enforcement and planning.

Comments Covers objectives and approach to road safety.

London Transport (1999). *Traffic calming measures for buses*. Technical information. London Transport Bus Priority Unit.

Measures Humps, cushions, narrowings.

Comments Traffic calming guidelines from the bus operator's point of view.

Mayhew N (1995). *A419(P), Norwich Road, Cromer, Norfolk, urban traffic calming*. 3rd UK traffic calming conference, 1995, London.

Measures Chicanes.

Comments Reviews the results obtained at chicanes in Cromer, Norfolk.

Mayhew N and Smith G (1998). *Village people*. Surveyor, 20th August 1998.

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.

McClintock H (1996). *Bicycle planning. A comprehensive bibliography. Vol 1: UK cycle planning. Sixth edition. Vol 2: International. Fourth edition, 1996*. Nottingham University.

Measures All traffic calming measures.

Comments Includes references and also a list of cycling videos at various schemes.

McVeigh R (1995). *Ayr town centre traffic calming, High Street*. 3rd UK traffic calming conference, 1995, London.

Measures Pedestrian crossings, humps and chicanes and new traffic signals.

Comments Measures to assist pedestrians, bus users and traffic redistribution are discussed.

Miles J, Walker J, Macmillan A and Routeledge I (1998). *Traffic Engineering and Control, December 1998.*

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.

Moore P (1995). *Egloshayle Road, Wadebridge*. 3rd UK traffic calming conference, 1995, London.

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.

New Civil Engineer (1999). *Gearing up for a revolution*. New Civil Engineer, 11th February 1999.

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.

Osborne P (1998). *Safe route versus the school run*. Surveyor, 22nd January 1998.

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.

Parker I (1997). *Green for safety*. Highways, December 1997.

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.

Parker R A (1989). *Road humps, do they really represent good value for money?* 17th PTRC summer meeting 1989.

Measures Road humps.

Comments Four sites described with speed, accident, cost and flow results.

Potter H (1995). *Bus access to town centres - fears and realities.* The Third UK National Traffic Calming Conference, 18 October 1995.

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.

Preston R (1998). *Meeting approval*. Highways, December 1998.

Measures Rising bollards.

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

Proctor S (1991). *Accident reduction through area-wide traffic schemes.* Traffic Engineering and Control (1991-12).

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.

Roberts A G *et al* (1994). *Sea front enhancements, Herne Bay Kent*. Proceedings of ICE. Municipal Engineer, September 1994.

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.

Rose M (1995). *Success at any cost*. Surveyor 23rd November 1995

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.

ROSPA (1995). *Road safety engineering manual, 2nd Edition.* ROSPA, Birmingham.

Measures All traffic calming measures.

Comments Concentrates on accidents and road safety at schemes.

Russell H (1995). *Lead role for a calm Hamlet.* Highways p22 & 23, June 1995.

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.

Shirley G (1997). *Parish power*. Surveyor, 4th September 1997.

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.

Silke E (1996). *Traffic calming blocks way for winter maintenance*. Surveyor 10th October 1996.

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.

Simpson B (1994). *The bumpy road to a calmer way*. Surveyor, 13th October 1994.

Measures Humps and chicanes.

Comments Discusses the use of road humps on busy bus routes in town centres.

Stark D C (1996). *Urban speed management, 2. Automatic speed enforcement.* Traffic engineering and control, November 1996.

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 (1996). *Speed cameras in Cambridgeshire*. 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.

Swali L N (1993). *The effect of speed cameras in West London*. 21st PTRC Annual Summer Meeting, University of Manchester, September 1993.

Measures Speed cameras.

Comments Describes the effect on mean speeds and accidents.

Taylor D and Tight M (1996). *Feet first:public attitudes and consultation in traffic calming schemes*. A report for Transport 2000 Trust.

Measures Humps, cushions and narrowings.

Comments Comprehensive report of attitudes in 'Feet First' traffic calming schemes.

Teasdale M A, Bell M G H and Silcock D T (1991). *The definition of 'controls' for the assessment of area-wide road safety schemes*. 19th PTRC Summer Meeting, University of Sussex, 1991.

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.

The Slower Speeds Initiative (1998). *The slower speeds initiative. Policy briefing No. 1*. The slower speeds initiative, Norwich.

Measures General traffic calming measures.

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

Thompson S J, Heydon S J and Charnley C B (1990). *Pedestrian refuge schemes in Nottingham*. Traffic Engineering and Control, March 1990.

Measures Pedestrian refuges.

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

Trench *et al* (1995). *Current issues in planning*. Volume 2, 1995. Chapter 11. Buses and traffic calming.

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.

Vittles P and Pheby T (1991). *Democracy and decongestion using customer research to involve people in dealing with York's traffic problems*. Traffic management and road safety. PTRC summer meeting, 1991.

Measures Humps, chicanes and narrowings.

Comments Case study of the Groves 20 mph zone traffic calming scheme.

Walsh B (1994). *Top schemes for taming traffic*. Urban Street Environment.Oct/Nov 1994.

Measures Long flat-top humps.

Comments Reviews Shenley Road Borehamwood and town centre Godalming, Surrey. The effect on speeds and flow are given.

Wenban-Smith A (1994). *The south Birmingham study:reconciling local and strategic transport needs*. 22nd PTRC forum 1994.

Measures General traffic calming measures.

Comments Discusses the consultative approach to policy making (integration).

Which? (1992). *Stop, look and listen*. Which? 1992-10.

Measures Humps, narrowings and chicanes.

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

Williams D (1994). *Why Britain's got the hump*. Daily Express, 8th September 1994.

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.

Williams R L (1995). *Moving forward beyond 2000*. Urban Transport and the Environment for the 21st century, p146-153 1995.

Measures Greenways (similar to Red Routes), cycle routes.

Comments Discussion of policy relating to cycle ways, bus routes and pedestrian routes.

Wiltshire P J (1991). *A methodology for ranking area wide traffic calming schemes*. PTRC Summer Annual Meeting 1991.

Measures Includes humps and chicanes.

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

Wisher N and Sainsbury R (1998). *The streets of St Mary's*. Highways, August/September 1998.

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.

Wood C (1995). *Taking new routes to school safety*. The Urban Street Environment Aug/Sept 1995.

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

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

Wyatt E H E (1995). *Practical traffic calming on major roads*. Traffex conference 27th April 1995: Managing traffic for sustainability.

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).

York City Council (1992). *Speed cushion trials*. Amy Johnson Way, Clifton Common, York, 10 - 11 September 1992.

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

Armour M (1982). *Vehicle speeds on residential streets*. ARRB proceedings, Volume 11, part 4, 1982.

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).

Brindle R E (1990). *Traffic calming in Australia*. Seminar in Copenhagen 14-16 May, 1990.

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.

Brindle R E (1992). *Australia's contribution to traffic calming PTRC 20th annual meeting 1992*. Australian Road Research Board.

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.

Brindle R E (1994). *Living with traffic calming: twenty seven contributions to the art and practice of traffic calming, 1978 - 1992.*

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.

Brindle R E (1996). *Living with traffic. LATM and traffic calming.* ARRB Transport Research Ltd, Special Report 53, 03-1996.

Measures Includes humps and chicanes

Comments Discusses area wide schemes including speed control devices.

Brown S L (1995). *The effect on vehicle speeds of signs warning of police enforcement in rural areas of South Australia.* Road & Transport Research, Vol 4 No 1 March 1995 ARRB.

Measures Signs warning of police enforcement.

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

Claessen J G and Jones D R (1994). *The road safety effectiveness of wide raised medians*. 17th ARRB conference, Queensland, 1994.

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.

Fildes B, Godley S, Triggs T and Jarvis J (1997). *Perceptual countermeasures: Simulator validation study*. Monash University Accident Research Centre. CR 169 (FORS) RR 1/97 (RTA).

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.

Hagan W B and Tonkin B C (1985). *Physical design guidelines for residential street management. First Edition, 1985*. South Australia, Department of Transport.

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.

Hawley L et al (1993). *Towards traffic calming: a practitioner's manual of implemented local area traffic management and blackspot devices*. Western Sydney Regional Organisation of Councils Ltd.

Measures Includes humps, chicanes and narrowings.

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

Hidas P (1993). *Speed management in local streets:a continuous physical control technique*. Road and Transport Research, December 1993.

Measures Continuous vertical deflections 'waves' which are not humps.

Comments Discusses the use of 'waves' for controlling vehicle speeds.

Jarvis J R and Giummara G (1992). *Humps for use on bus routes*. Road and Transport Research, Volume 1, No.4, December 1992.

Measures Flat-top humps.

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

Jarvis J and Sweatman P (1982). *The loading of pavements in the vicinity of road humps*. ARRB proceedings Volume 11 Part 2, 1982.

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.

McDonald P E (1984). *Implementation of local area traffic management and streetscape improvement scheme in shire of Corio*. ARRB proceedings 1984.

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.

Oxley J, Fildes B, Ihsen E, Charlton J and Day R (1997). *Differences in traffic judgements between young and old adult pedestrians*. Accident Analysis and Prevention, Vol 29 No.6 pp839-847, 1997.

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.

Samuels S (1996). *Acoustic attributes of traffic calming devices*. Conference in Christchurch New Zealand, Roads 96 ARRB Part 6.

Measures Various traffic calming devices.

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

Twiney et al (1994). *North Sydney transport study:an exercise in community participation*. 17th ARRB conference Australia, 14-19 August 1994.

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.

Weerasekera K, Hidas P and Dunne M (1997). *Negative effects of speed control devices on vehicle and pedestrian flow characteristics*. 21st Australian transport research forum, Adelaide, September 1997.

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.

Witherby A W (1994). *Traffic calming a city*. Australasian transport research forum, 1994. University of Melbourne.

Measures Various traffic calming measures.

Comments Study looking at possibility of calming Armidale, NSW.

3.3 Austria

Machala F (1994). *Reduced speeds in residential areas*. Public Transport International, 2-1994.

Measures Humps.

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

Wernsperger F and Sammer G (1995). *Results of the scientific investigations accompanying the pilot trial of 30 kph (19 mph) limit in side streets and 50 kph limit in priority streets*. 23rd PTRC European Transport Forum, September 1995.

Measures Speed roundels and signs.

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

3.4 Brazil

Karlsson M (1996). *Electronic speed bump*. Traffic Technology International p22 Oct/Nov 1996.

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

Drdul R and Skene M (1994). *Traffic calming Do's and Don'ts*. ITE Compendium of Technical Papers. Canadian.

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.

Persaud B, Parker M and Wilde G (1997). *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.

Zein S R, Geddes E, Hemsing S and Johnson M (1997). *Safety benefits of traffic calming*. Transportation Research Board 76th Annual meeting, January 12-16 1997.

Measures Forced turns, diagonal diverters, closures, diverters, traffic circles, buildouts, one-way streets, stop signs, road humps.

Comments Accident data reported included damage only accidents. International experience reviewed and table given which shows accident reductions for traffic circles, chicanes, narrowings, humps, stop signs, refuges, speed limit restrictions and combinations of measures.

3.6 Denmark

Bang H and Nyvig A (1990). *Road aesthetic aspects - good and bad examples*. Seminar in Copenhagen 14-16 May 1990.

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.

Engel U (1990). *Safety effects of speed reducing measures in Danish residential areas*. Seminar in Copenhagen 14-16 May 1990.

Measures Humps, chicanes and narrowings.

Comments Desribes 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.

Herrstedt L (1992). *Traffic calming design - a speed management method: Danish experience on environmentally adapted through roads*. Accident Analysis and Prevention, Volume 24, No.1 pp 3-16, 1992.

Measures Gateways, rumble strips, chicanes.

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

Herrstedt L *et al* (1993). *An improved traffic environment - a catalogue of ideas*. Danish Road Directorate Report 106, 1993.

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.

Jakobsen P (1994). *Bump i byer (Bumps in towns)*. Dansk Vejtidsskrift NR 1, p3 - 5.

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.

Jensen S (1995). *Fartdaempning med cirkalbump i Frederiksborg Amt (Speed restriction with circular humps)*. Dansk Vejtidsskrift NR 6/7.p22 - 23.

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.

Jorgensen E (1995). *Traffic safety at 82 Danish roundabouts constructed after 1985*. Nordic Road & Transport Research No 2, 1995.

Measures Roundabouts converted from 4-arm give way.

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

Kjemtrup K (1990). *Speed reducing measures*. Conference paper in Copenhagen 1990.

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.

Lahrmann H and Mathiasen P (1992). *Bumpudforming*. Dansk Vejtidsskrift NR 9.p16 - 22.

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.

Neilsen M and Kjemtrup K (1993). *Hastighedspavirkning, afstand mellen bump, for referencehastigheder pa 40km/t og 50km/t (Effect on speed, distance between humps for reference speeds of 40 kph and 50 kph)*. Notat 7, Vejdatalaboratoriet, Herlev 1993.

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.

Vithen C, Dorge L, Lund-Sorensen P (1997). *Nordic Road & Transport Research No 1, 1997*.

Mesures Variable message signs displaying delay time in Aalborg.

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

3.7 Europe (General)

McClintock H (1995). *Putting Europe in the saddle*. Review of Velo-City conference in Basle, 1995.

Measures Various measures.

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

OECD (1995). *Urban travel and sustainable development*. OECD, 1995.

Measures Various traffic calming.

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

OECD (1997). *Integrated strategies for safety and environment*. OECD, 1997.

Measures Traffic calming measures.

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

Pharoah T M and Russell R E (1989). *Traffic calming: policy and evaluation in three European countries*. South Bank Poly Occasional paper OP 2/89.

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.

Slop M and Catshoek W D (1995). *Recommended safety measures for application on interurban roads in the short term*. SWOV, Institute for Road Safety, Leidschendam, 1995.

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.

Tolley R (1989). *Calming traffic in residential areas*. Brefi press, Tregaron, Dyfed.

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

Beilinson L and Kulmala R (1993). *Traffic effects of a roundabout*. Nordic Road & Transport Res. No1, 1993.

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.

Huttunen I (1995). *The effects of traffic calming on the dynamics of a vehicle*. Helsinki University of Technology 1995.

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

Comments Discusses vehicle speeds, accelerations and decelerations.

Luoma J, Penttinen M, Rämä P and Harjula V (1997). *Driver responses to variable road condition signs*. Tielaitoksen selvityhsia 22/1997. Finnish National Road Administration.

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.

Luoma J and Rämä P (1998). *Effects of variable speed limit signs on speed behaviour and recall of signs*. Traffic Engineering and Control, April 1998.

Measures Variable speed limit signs.

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

Pasanen E and Salmivaara H (1994). *40 kph (25 mph) speed limits in the inner city of Helsinki*. Helsinki City, Planning Department, Traffic Planning Division, 24th October 1994.

Measures Speed roundels.

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

Rämä P and Luoma J (1997). *Driver acceptance of weather-controlled road signs and displays*. Transportation Research Record 1573.

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.

Ranta S and Kallberg V P (1998). *Urban speed reducing measures often miss clear goals*. Ministry of Transport and Communications 7/98.

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.

Summala H, Pasanen E, Rasanen M and Sievanen J (1996). *Bicycle accidents and drivers visual search at left and right turns.* Accident Analysis and Prevention, Volume 28, No.2, pp 147-153, 1996.

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

Ymparistoministerio *et al* (1989). *Irjalankatu Street, follow up study of the reduced speed street.*

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

Cetur (1992). *Guide to the (30 kph) 19 mph zone. Methodology and recommendations*. Cetur. 1992.

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.

Cetur (1994). *Guide. Ridge and trapezoidal type speed humps*. Texts and recommendations, September 1994.

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

Baier H (1994). *Area wide traffic calming measures in Darmstadt*. Conferenza Internazionale vivere e camminare in citta urbano p135 - 140. Italy.

Measures Humps, narrowed roads and 30 kph signs.

Comments Describes the effect on vehicle speeds.

Bowers P H (1986). *Road design in residential areas, German approaches to environmental traffic restraint*. Occasional paper no.4. Ed. Alan Middleton. September 1986.

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.

Brilon W and Blanke H (1990). *Traffic safety effects from traffic calming*. Urban Safety Management seminar, November 1990, TRL.

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.

Brilon W (1994). *Area wide traffic calming measures and their effect on safety in Germany*. Conferenza Internazionale vivere e camminare in citta urbano p145 - 155. Italy 1994.

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.

Doldissen A and Draeger W. *Environmental traffic management strategies in Buxtehute, West Germany.* The greening of transport 1990. R Tolley (Ed) Chapter 19.

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.

German Federal Ministries of Planning, Transport and Environment (1992). *Flachenhafte Verkehrsberuhigung. Forschungsvorhaben. Folgerungen fur die Praxis*. (Area wide traffic calming: results and guidelines) Bonn, 1992.

Measures Gateways, cushions, humps, narrowings, 30 kph limits and roundabouts.

Comments Designs for pedestrians, cyclists, buses. Speeds and emissions measured.

Haller W (1990). *Road aesthetic aspects - good and bad examples from Germany*. Seminar in Copenhagen 14-16 May, 1990.

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.

Keller H H (1986). *Environmental traffic restraints on major roads in the Federal Republic of Germany.*

Measures Mainly cushions, humps and narrowed roads.

Comments Describes schemes in Berlin Moabit, Buxtehude, Ingolstadt and small villages.

Keller H H (1990). *Traffic calming policies in Germany*. CETUR, Paris conference 29-31 January 1990.

Measures 30 kph zone (19 mph) cushions, chicanes, narrowings.

Comments Vehicle speeds and noise are discussed.

Mangold M, Trager K, Lindenbach A and Zacker H (1996). *Forschung Strassenbau und Strassenverkehrstechnik Heft 729. Wirksamkeit von Streckenbeeinflussungsanlagen unter besonderer Berucksichtigung der Umfelddatenerfassung. (Effectiveness of Traffic Control Systems taking particular account of the collection of ambient data).*

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.

Schleicher-Jester F (1990). *Tempo 30 in towns - results of a German experiment*. CETUR, Paris conference 29-31 January 1990.

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.

Schnull R and Lange J (1990). *Speed reduction on through roads in Nordrhein-Westfalen*. Seminar in Copenhagen 14-16 May 1990.

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

Craus *et al* (1993). *Geometric aspects of traffic calming in shared streets.* 63rd annual meeting The Hague 1993.

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.

Zaidel D, Hakkert A S and Pistiner A H (1989). *A critical evaluation of the use of humps in urban areas*. Research Report No.89 - 139, Technion-Israel, Institute of Technology.

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

Biora F (1995). *Integrated ATT strategies for urban arterials: DRIVE 11 Project PRIMAVERA. 4. The Corso Grosseto experiment*. Traffic Engineering and Control, November 1995.

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.

Gandino B (1994). *Traffic calming in Italy:experiences and problems*. Conferenza internazionale vivere e camminare in citta urbano p239-244, 1994.

Measures Includes humps, chicanes.

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

3.13 Japan

Fujitsuka T (1990). *From community streets to 'road-pia'*. Wheel extended 1990 n73 p3-8. Toyota Motor Corporation.

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.

Kubota Y and Kubota H (1994). *Effectiveness of the landscad system for the citizen participation process in traffic environmental improvements in residential areas.* Environment and Planning B:Planning and Design 1994, Volume 21, pages 109 - 120. Japanese report.

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

CROW (1998). *Recommendations for traffic provisions in built-up areas.* ASVV Record 15.

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.

de Wit T and Slop M (1984). *Traffic humps as recommended by SVT:Design and effects*. PTRC Summer Meeting, 1984.

Measures Humps.

Comments Covers design of sinusoidal profile humps.

de Wit T (1993). *Dutch experiences with speed control humps*. ITE 63rd Annual Meeting, 1993 The Hague.

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

Comments Construction and speed reductions for each profile discussed.

Dijkstra A and Bos J (1997). *ACEA – Dutch contribution; road safety effects of small infrastructural measures with emphasis on pedestrians.* SWOV, Netherlands.

Measures Humps, narrowings, islands, junction treatments and roundabouts.

Comments Discusses accidents including pedestrian accidents at the various features.

Hunt S (ed) (1998). *Prospects for fuel saving devices in cars. The results of experiments with cruise controls, econometers and on-board computers*. The Netherlands Agency for Energy and the Environment, Novem Utrecht.

Measures Cruise controls, econometers and on-board computers.

Comments Proper observance of speed limits would save energy and reduce CO_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.

Vis A and Dijkstra A, (1990). *Safety effect of 30 kph zones*. Seminar in Copenhagen 14-16 May, 1990.

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

Gadd M L (1996). *Traffic calming in New Zealand*. NZ Concrete Construction April/May 1996.

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.

Moses P J (1992). *Traffic management in New Zealand - 1991 - A perspective.*

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

Amundsen F H and Lundebye S (1982). *Measures for reducing vehicle speeds on residential roads*. Seminar in Amsterdam (1982).

Measures Chicanes, humps, 20 mph zones with speed reductions.

Comments Effect on speed of narrow roads.

Elvik R (1997). *The effects on accidents of automatic speed enforcement in Norway*. Transportation Research Board Annual meeting, 1997.

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.

Hvoslef H (1993). *Automatic speed enforcement in Norway*. Nordic Road & Transport Research No 3, 1993.

Measures Detectors in road and camera.

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

Hvoslef H (1993). *Environmentally adapted through roads - Implementation in Norway*. Nordic Road & Transport Research No 3, 1993.

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.

Muskau R and Christensen P (1993). *Norwegian drivers accept automatic traffic surveillance*. Nordic Road & Transport Research No 3, 1993.

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) *Reorganisation of the existing traffic network. Possibilities and consequences.* Nordiska Veagtekniska Foerbundet (NVF) Rapport 14 Sweden. 1992 (In Norwegian).

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.

Vaa T, Christensen P and Ragnoy A (1995). *Mobile roadside speedometer reduced speed.* Nordic Road & Transport Research No 2, 1995.

Measures Mobile roadside speedometer.

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

Vaa T (1997). *Speed limit reductions in built-up areas: Effects on speed and accidents.* Institute of Transport Economics, Norway, Working Report 1085/1997.

Measures Traffic calming measures and road humps.

Comments Contains accident and speed analysis.

3.17 Saudi Arabia

Essam K and Al-Nassar Y (1994). *Dynamic considerations of speed control humps*. Transport Res. Board Vol 16B, No 4 pp 291-302, 1994.

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

Fwa T F and Liaw C Y (1992). *Rational approach for geometric design of speed control road humps*. Transportation Research Record 1356, 1992.

Measures Humps.

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

Fwa T F and Tan L S (1992). *Geometric characterization of road humps for speed-control design.* Journal of transportation engineering, Vol 118 no.4, 593 - 598, 1992.

Measures Humps.

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

3.19 South Africa

Schermers G (1993). *National guidelines for traffic calming*. Report No. CR-96/036. Department of Transport, Pretoria, 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 Castelijn (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.

Snelco-Pro (1994). *A soother for safety - in pursuit of better traffic management*. Robot, June/July 1994.

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

Dahlstedt S (1995). *Large amount of useful data in the Sartre database*. Nordic Road & Transport Research No 33, 1995.

Measures Various traffic calming measures.

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

Garder P (1982). *Busstrafik Och Grupp, August, 1982*. University of Lund, Sweden. (In Swedish).

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.

Gunnarsson S O (1994). *The problems of the pedestrians*. Conferenza Internazionale vivere e camminare in citta urbano p57 - 65. Italy 1994.

Measures Various.

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

Hyden C, Garder P and Linderholm L (1982). *Short term evaluation of safety countermeasures - two examples of experiments with speed-reducing countermeasures in Sweden.* Seminar in Amsterdam (1982).

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.

Hyden *et al* (1995). *The effects of general speed calming in built-up areas.* Results of a large scale experiment in Växjö. 1 Main report.

Measures Roundabouts, speed limit reduced to 30 kph.

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

Magnusson G (1983). *Measurement of vertical acceleration on a driver's seat and a passenger seat in buses when passing over a road hump*. Swedish Road and Traffic Institute, Linkoping, Sweden.

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.

Nilsson L and Nabo A (1996). *Evaluation of Application 3: Intelligent Cruise Control Simulator Experiment*. Swedish National Road and Transport Research Institute.

Measures Intelligent cruise control (ICC).

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

Steen M and Hageback C (1999). *Bussar & bulor. Fartreducerande hinder I kollektivtrafiken (speed reducers in Public transport)*. VBB VIAK, Stockholm.

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.

Swedish Road Safety Office (TSV) (1985). *Effekter av olika fartdampare pa genomfartsgator (The effect of speed reducing devices on thoroughfares)*. Trafiksakerhetsverket.

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

Aspelin K, Baca C, Blewett C and Padilla C (1997). *The North Albuquerque acres transportation study*. Institute of Transportation Engineers, March 23-25, Tampa, Florida.

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.

Atkins C and Coleman M (1997). *The influence of traffic calming on emergency response times*. ITE journal, August 1997 p42 - p46.

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.

Burchfield R M (1995). *Traffic calming collector streets. Portland's experience*. Compendium of Technical Papers.

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.

Clarke A and Dornfield M J (1994). *National bicycling and walking study. Case study no. 19: traffic calming, auto-restricted zones and other traffic management techniques - their effects on bicycling and pedestrians.*

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.

Clarke A and Tracy L (1995). *Bicycle safety related research synthesis*.

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.

Courage K and Hoang L (1997). *Design and evaluation of modern roundabouts in Florida*. Institute of Transportation Engineers, March 23-25, Tampa, Florida.

Measures Roundabouts.

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

Datta T K and Datta S (1997). *Traffic calming initiatives in the USA - A critical review*. 25th PTRC European Transport Forum, 1997.

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.

Ewing R and Kooshian C (1997). *US experience with traffic calming*. ITE journal, August 1997 p28 - p33.

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.

Forester J (1994). *Bicycle transportation. A handbook for cycling transportation engineers, second edition*. Mit press, USA 1994-09 320p.

Measures Measures to assist cyclists.

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

Graham S (1997). *Why do people speed?* Traffic Safety, November/December 1997.

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.

Harwood D W (1993). *Use of rumble strips to enhance safety*. NCHRP Synthesis Of Highway Practice. Transportation Research Board.

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.

Klik M and Faghri A (1993). *A comparative evaluation of speed humps and deviations.* Transportation Quarterly. Vol 47, No 3, July 1993.

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.

Kulash W (1997). *What is traffic calming?* Institute of Transportation Engineers, March 23-25, Tampa, Florida.

Measures All traffic calming measures considered.

Comments Contains a useful figure which shows street design/street use and the types of applicable measures.

Leonard J D and Davis W J (1997). *Urban traffic calming treatments: Performance measures & design conformance*. ITE journal, August 1997 p34 - p40.

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.

Lewis D (1998). *The do's and don'ts of traffic calming*. Traffic Safety, March/April 1998.

Measures Humps, chicanes, narrowings and roundabouts.

Comments Describes the various measures and gives details on good practice.

Lockwood I (1997). *What is traffic calming?* Institute of Transportation Engineers, March 23-25, Tampa, Florida.

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.

Nicodemus D A (1991). *Safe and effective roadway humps. The Seminole County profile*. ITE Compendium of Technical Papers. Washington DC. Institute of Transportation Engineers.

Measures Flat-top hump with circular on/off ramps.

Comments Some speed and flow results given.

Stephens B W (1986). *Road humps for the control of vehicular speeds and traffic flow*. Public Roads, Vol 50,No 3, December 1986.

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.

Turturici A R (1975). *An evaluation of speed-curtailing bumps*. Public Works, August 1975.

Measures Humps

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

US Department of Transportation (1980). *State of the art report: residential traffic management.*

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.

Walter C E (1995). *Suburban residential traffic calming*. ITE Journal, September 1995.

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.

West J and Lowe A (1997). *Integration of transportation and land use planning through residential street design*. ITE journal, August 1997 p48 - p51.

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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