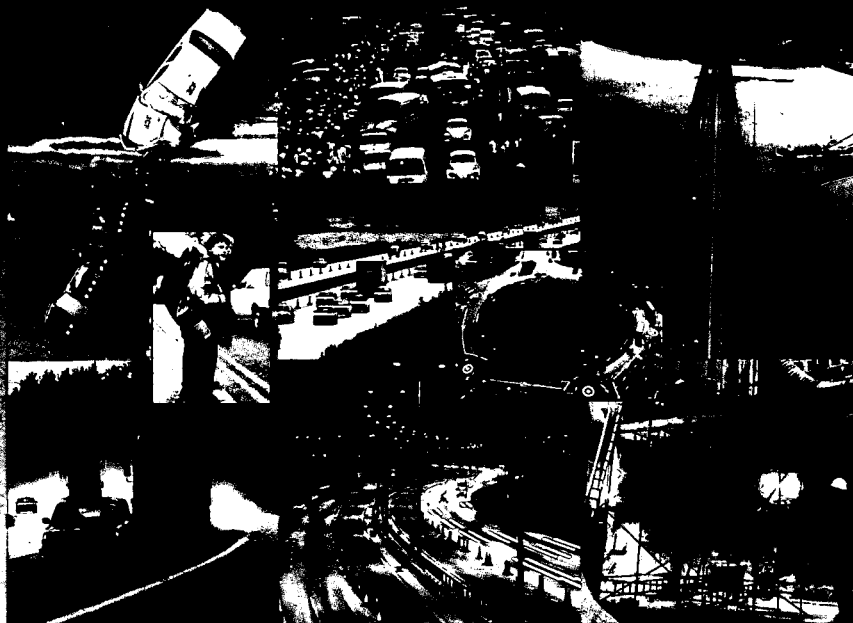


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Traffic calming - vehicle activated speed limit reminder signs

by David C Webster

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TRL REPORT 177

**TRAFFIC CALMING - VEHICLE ACTIVATED SPEED LIMIT
REMINDER SIGNS**

by **David C Webster**

Prepared for: Project Record: UG46 Innovative Traffic Calming Measures
Customer: DITM Division, DOT (Mr E H E Wyatt)

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EXECUTIVE SUMMARY

Speed limit signs are installed to inform drivers of the maximum speed allowed on each stretch of road. Many drivers exceed the speed limit and vehicle activated speed limit reminder signs ('secret' signs) have been used to alert the drivers to their excessive speed by signs activated when they exceed a pre-set speed. The objective of the use of 'secret signs' is to reduce vehicle speeds and hence improve the safety of the treated road.

The main advantage of 'secret' speed limit signs over physical traffic calming measures such as road humps and chicanes is that they may reduce speeds without increasing passenger discomfort, and they do not affect the speeds of emergency service vehicles. As they generally do not include any enforcement or physical measures however, their potential for speed reduction is likely to be small.

This report was prepared for Driver Information and Traffic Management Division, DOT and reviews the available information on thirteen 'secret' speed limit reminder sign sites which include full studies of nine sites from the UK and a further four sites from Europe and the USA. An additional eight sites in the UK which were installed in May 1995 are also considered. These additional sites, and six of the original UK sites, are being monitored by TRL for Road Safety Division, DOT.

Eight of the nine sites in the UK were on 'A' class roads at villages with 30 or 40 mph speed limits; the other was an 'A' road with a 60 mph limit but the sign advised drivers to travel at 45 mph. The four USA and European sites were either on roads with speed limits of 19 mph (30 kph) or of about 50 mph. The speeds at which the signs were activated were generally up to 10 mph above the relevant speed limit.

Most of the sites used 'secret' signs (sign blank with an illuminated message activated by speeding vehicles). An 'enhanced' sign (sign visible to all drivers but enhanced by flashing lights) was used at only one site.

The cost of the purchase and installation of equipment at a single-sign 'secret' site in the UK was about £5,000 to £10,000 at 1995 prices. The costs were variable and dependant upon local factors such as connection costs to the electricity supply.

The location of monitoring points is an important factor in making any assessment and it is clear from the data that only limited conclusions can be reached because of the large variation in monitoring locations and the type of signs. The most common locations for speed measurements were at the 'secret' sign, about 100m to 200m downstream from the sign and, where relevant, in the village centre some distance downstream from the sign.



R705/81/4

Example of a vehicle activated speed limit reminder sign (note flashing lights)

Further sites are being installed and will provide more information on the speed reductions at the signs and downstream within the villages and give a better estimate of the potential safety benefits of these schemes before any widespread use of the signs can be recommended.

The following conclusions can be drawn from the data:

1. 'Secret' or 'enhanced' vehicle activated speed limit reminder signs appear to reduce vehicle speeds by a few mph at the sign and some of this reduction can be maintained some distance downstream in the village centre.
2. A limited amount of injury accident data was available for the sites studied. The accident numbers are small and the changes in accidents are not statistically significant. However, the results are promising because all of the sites where data was available showed a reduction in accidents. When compared to control sites, there was an overall non statistically significant reduction in accident frequency of 42 per cent due to the installation of the 'secret' signs.
3. The speed reductions appeared to be maintained over time.
4. Enforcement of the speed limit, by using speed cameras in the Netherlands, had the effect of reducing vehicle speeds by a further few mph compared with no enforcement. The other sites had no enforcement with speed cameras.
5. Vandalism of the camera and measuring equipment was described as 'quite a problem' at sites in the Netherlands (theft, paint, fire) and USA (rifle shots). It was not mentioned as a problem by the local highway authorities in the UK.

TRAFFIC CALMING - VEHICLE ACTIVATED SPEED LIMIT REMINDER SIGNS

ABSTRACT

'Secret' vehicle activated speed limit reminder signs have been used as a means of warning drivers that they are travelling too fast by the activation of a sign triggered when the speed of the vehicle is above a preset level. This report reviews the published results from 13 of these 'secret' sign sites which have been used in the UK, other European countries and the USA. Single 'secret' signs were used at ten sites and a pair of 'secret' signs were used at three of the sites. The main conclusions are that 'secret' vehicle activated speed limit reminder signs can lead to reduced vehicle speeds of about 2 mph at the sign and some of this reduction is maintained some distance downstream. There was an encouraging 40% reduction in accidents but the accident numbers were small. Vandalism was reported as a problem at some non-UK sites.

1. INTRODUCTION

On entering a lower speed limit area, e.g. a village, some drivers often do not slow down to comply with the lower speed. This is likely to be due to many different factors, including that some drivers may not be aware of the lower limit or that they may assume that they are unlikely to be detected. A 'secret' sign which is activated by a vehicle exceeding a preset speed limit can warn the driver that the limit has been exceeded and encourage the driver to take the appropriate action. The main objective is therefore to reduce vehicle speeds and hence improve the safety of the treated road.

The main advantage of 'secret' vehicle activated speed limit reminder signs over physical traffic calming measures such as road humps and chicanes, is that they may reduce speeds without increasing passenger discomfort and they do not reduce the speeds of the emergency services. As they generally do not include any enforcement or physical measures however, their potential for speed reduction is likely to be small. 'Secret' vehicle activated speed limit reminder signs and variations on the same theme have been tried at a number of sites in the UK Europe and the USA.

This report has been prepared for Driver Information and Traffic Management Division, DOT and reviews speed reducing schemes using various types of 'secret' speed limit reminder signs and assesses the reported results from the trials which have been carried out. This study is based on a total of 13 sites which included 9 from the UK and a further 4 sites from Europe and the USA. The results are taken from studies by Eagle and Homans (1976), Hunter et al (1976),

Gerdorn (1978), Berggren (1991), Oei (1991), Norfolk County Council (1993) and from TRL reports of monitoring 6 of the UK sites for Road Safety Division, DOT: Helliar-Symons and Wheeler, 1983, Wheeler et al (1994) and Barker et al (1995). The study is based on reported results only and therefore there could be other sites which have not been reported, possibly because they were regarded as not being effective at reducing speeds and/or accidents.

'Secret' vehicle activated speed limit reminder signs have also been used at major roadworks giving a speeding message, the speed and registration number of the vehicle speeding; they are not considered here. Other applications of 'secret' vehicle activated signs include warning drivers that they are too close to the vehicle in front (Helliar-Symons, 1983; Helliar-Symons and Ray, 1986), alerting drivers to the presence of entering/right-turning vehicles at junctions (Lyles, 1980; LTT, 1995), and warning drivers of over-height vehicles that they are approaching a low bridge (HMSO, 1988). A variation on the 'secret' signs are the 'Part Time' or 'Variable' speed limit signs which are on trial, throughout the country, outside some schools. These are not vehicle activated and have a sign of 20 mph which can be switched on for a set time prior to the school start and after the school finish (the speed limit at other times would normally be 30 mph). The advantage of this type of sign is that drivers can appreciate the need for lower speeds which is not always the case at many other sites.

2. TYPES OF SIGNS

The vehicle activated speed limit reminder signs discussed in this report can be split into two types namely 'Secret' signs and 'Enhanced' signs.

2.1 SECRET' AND 'ENHANCED' SIGNS

'Secret' signs are wholly or partly blank until they are activated by a vehicle which is travelling above the speed limit (see Figs 1, 2 and 3). The driver is reminded or made aware of the speed limit by an illuminated message or speed limit sign (see Section 2.3). Flashing lights may be used to draw the drivers attention to the sign.

'Enhanced' signs are visible to all drivers but additional features can be activated by excessive vehicle speeds or by all vehicles regardless of their speed as at Site 1 Burland (see Fig 4). The signs are 'enhanced' by an extra feature such as flashing lights which draw the driver's attention to the sign (approximately 60 - 90 flashes/minute).

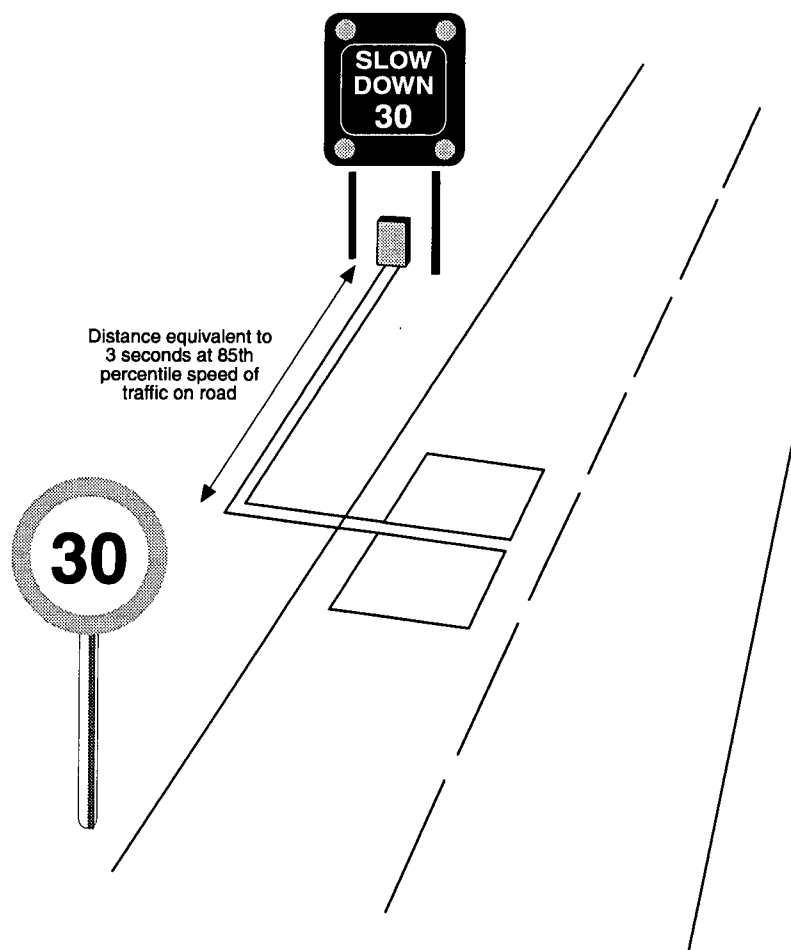


Fig 1 Layout of typical site

2.2 SCHEMES STUDIED

This study is based on a total of 13 sites which included 9 from the UK, and a further 4 sites from Europe and the USA. Details of the site location, road type, sign type and speed limit are given in Table 1. Some of the sites contain a number of schemes which are described in more detail in Appendix A.

Most of the sites used 'secret' signs; 'enhanced' signs were used at only one sites. Eight of the nine sites in the UK were on 'A' class roads at villages with 30 or 40 mph speed limits; the other (site 5) was an 'A' road with a 60 mph limit but the sign advised drivers to travel at 45 mph past an army base adjacent to the village, the boundaries of which were not clearly defined. The four USA and European sites were either on roads with a 19 mph (30 kph) or on roads with speed limits of about 50 mph.

A typical layout, used at sites 3 to 5 (UK, West Meon, Droxford and M. Wallop), is given in Fig 1. The 'secret' sign was placed within the length of road covered by the relevant speed limits, with the speed detector loops placed in front of the 'secret' sign at a distance equivalent to 3

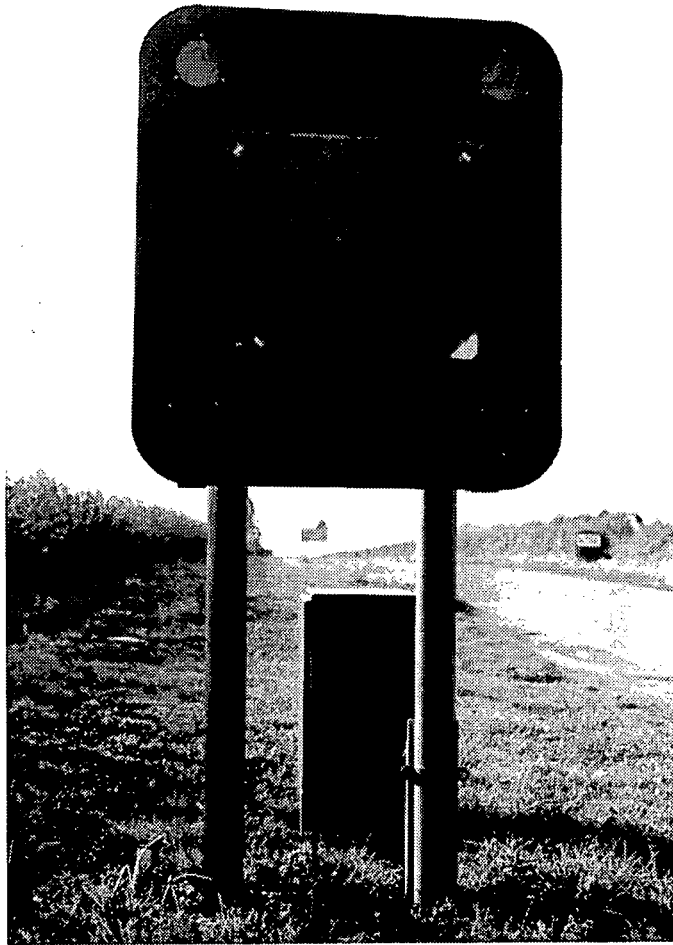
seconds at the 85th percentile traffic speed. The 3 second interval is based on the fact that drivers should have sufficient time to be able to read a sign of the type illustrated in Fig 1.

At sites 2, 8 and 9 (UK, Great Leighs, Long Compton (northbound) and Long Compton (southbound), two 'secret' signs were used with different messages on each sign (see section 2.4). At Great Leighs and both Long Compton sites the two 'secret' signs were 500 metres and 325 metres apart respectively.

2.3 MESSAGE ON SIGN

Many of the signs had a message which was illuminated when vehicle speeds exceeded a pre-set level (see Fig 5). The messages are summarised in Table 2 where the hatched text is the message. Sites 2, 8 and 9 (UK, Gt Leighs and Long Compton) used two illuminated signs with different messages.

Sites 3, 4 and 5 (UK, West Meon, Droxford and M. Wallop) originally had a message which was SLOWDOWNPLEASE but a brief opinion survey found that drivers preferred messages which contained speed information.



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Fig 2 A Blank secret sign (untriggered) at site 4, Droxford



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Fig 3 Illuminated secret sign (triggered) at site 3, West Meon



CR497/93/7

Fig 4 Enhanced sign at site 1, Burland. (note flashing lights, lower lit in photo)

TABLE 1

Locations of 'secret'/'enhanced' sign sites

Site No.	Country/County/Town	Road No.	Type of Sign	Speed limit (mph)	Trigger speed (mph)	Date installed
1	UK/Cheshire/Burland	A534	Enhanced	30	+	1993
2	UK/Essex/Gt. Leighs	A131	2-Secret	40	46	1990
3	UK/Hants/West Meon	A32	Secret	30	40	1979
4	UK/Hants/Droxford	A32	Secret	30	37	1979
5	UK/Hants/M. Wallop	A343	Secret	60	50	1979
6	UK/Norfolk/Scole	A140(T)	Secret	30	38	1992
7	UK/Sussex/Fernhurst	A286	Secret	30	35	1976
8	UK/Warwicks/L. Compton	A34 (NB)	2-Secret	30	35,30*	1986
9	UK/Warwicks/L. Compton	A34 (SB)	2-Secret	30	45,40	1990
10	USA/North Carolina	NC-55	Secret	55	55	1974
11	Sweden/Stockholm	In city	Secret	19	19	1989
12	Netherlands/Variou	Variou	Secret	50	50**	1990
13	Germany/Westphalia	Variou	Secret	19	-	1978

Notes

+ Activated by all vehicles

* Increased after trial from 35 to 45 mph for first sign and from 30 mph to 40 mph for second sign (see section 2.5)

** Trigger speed 90 kph (56 mph) during enforcement period

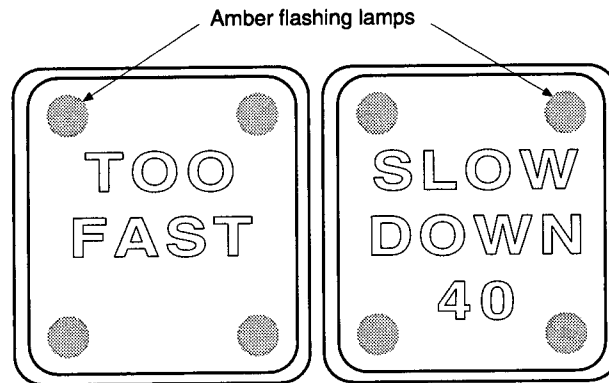


Fig 5 Messages on two signs at site 2, Great Leighs

TABLE 2

Type of secret message used on signs

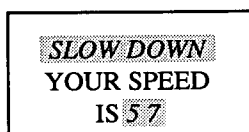
Site nos.	1st Sign	2nd sign
2 & 8	<i>TOO FAST</i>	<i>SLOW DOWN 40 or 30</i>
3, 4, 5	<i>SLOW DOWN 30</i> or <i>SLOW DOWN 45</i>	-
6	30 mph roundel sign	-
7	<i>POLICE YOU ARE SPEEDING</i>	-
9*	<i>SLOW DOWN 30 AHEAD</i>	<i>SLOW DOWN 30</i>
10	<i>SLOW DOWN YOUR SPEED IS '57'</i>	-
11 & 12	<i>YOU ARE DRIVING TOO FAST</i>	-
13	Various messages in German	-

Notes
* *Illuminated message*
Site 9 speed limit sign between 1st and 2nd sign

At site 6 (UK, Scole), there is no message but the coloured 30 mph roundel sign is illuminated from within the sign when triggered by a vehicle.

At site 7 (UK, Fernhurst), the *POLICE YOU ARE SPEEDING* message was used by the police on a trial basis to assess the potential of the sign.

At site 10 (USA, North Carolina), an example of the sign for a vehicle travelling at 57 mph would be as follows:-



 Illuminated message

where 57 is the speed (mph) of the vehicle which activated the sign. A *SPEED UP* sign was considered in addition to the *SLOW DOWN* because it was thought that the variable message on the sign would reduce the variability (spread) of vehicle speeds. The *SPEED UP* sign was not used because it was regarded as inappropriate at the time of the experiment.

2.4 TRIGGER SPEEDS

The speeds at which the signs were activated (trigger speed) are given in Table 1. Generally this was up to 10 mph above the relevant speed limit.

At site 1 (UK, Burland), the 'enhanced' sign was activated by all vehicles regardless of their speed.

At site 6 (UK, Scole) with a 30 mph limit, the illuminated 30 roundel and flashing lights (see Fig 6) are visible after being activated by a vehicle travelling above the preset trigger speed of 38 mph which was the median speed (50th percentile) in the 'before' period. This trigger speed is generally slightly lower than the speeds of 40, 37 and 50 mph (equivalent to the 67th percentile) used at sites 3 - 5 (UK, West Meon, Droxford & Middle Wallop) respectively (Helliar-Symons and Wheeler, 1984).

At site 8 (UK, Long Compton) the trigger speeds at the 2 signs were increased after the trial was completed to 45 mph and 40 mph, the same as at site 9, because about two-thirds of all drivers activated the sign with the initial trigger speeds of 35 mph and 30 mph. This was regarded by the Local Authority as too high a proportion and it was thought to be more important to target the faster drivers rather than those just above the lower trigger speed.

At site 12 (Netherlands) the trigger speed was 50 mph in the initial phase but it was increased to 90 kph (56 mph) for the enforcement phase after consultation with the police and the local prosecutor.

2.5 COST OF 'SECRET' SIGN EQUIPMENT

The cost of the purchase and installation of equipment at a single-sign 'secret' sign in the UK was about £5,000 to £10,000 at 1995 prices. The costs were variable and de-

pendant upon local factors such as connection costs to the electricity supply.

3. EFFECT ON SPEEDS

3.1 GENERAL

The effectiveness of the signs in reducing the speeds of cars and HGV's has been assessed using the reported information available. The location of monitoring points is an important factor in making any assessment and it is clear from the data that only limited conclusions can be reached because of the large variation in monitoring locations and the type of signs. The most common locations for speed measurements were at the 'secret' sign, about 100m to 200m downstream from the sign and, where relevant, in the village centre some distance downstream from the sign.

The method of speed measurement varied between the tests (see Table 3). The speeds were measured either by automatic loop/tube equipment fixed to the road (all vehicles, large number of observations) or by radar speed meters (selected unimpeded vehicles, smaller number of observations). Because unimpeded vehicles are selected, the results from the radar speed meters give speed changes where driver behaviour is likely to have been directly affected by the 'secret' signs, and are independent of the magnitude/changes in traffic flow. However, they are less



Courtesy Norfolk County Council

Fig 6 Secret sign in operation at site 6, Scole

TABLE 3

Effect of sign on car speeds

Site No	Measurement location	Car speeds in mph				(A) - (B)		Comments No of readings
		Before(B)		After(A)		Mean	85%	
		Mean	85%	Mean	85%	Mean	85%	
UK. SINGLE SIGN SITES								
1a	at sign	-	-	34	-	-	-	17,000 automatic
1b	village centre	34	42	32	40	-2	-2	before and after
3a	at sign	42	50	40	49	-2	-1	Unimpeded vehicles
3b	village centre	24	30	24	30	0	0	Over 400 radar
								speeds recorded from
4a	at sign	39	45	35	43	-4**	-2**	0800 to 1800 on each
4b	village centre	30	35	29	33	-1	-2	monitoring day
6	200m after sign	38	43	33	36	-5**	-7**	300 before, 500 after
								Radar speeds
5a	at sign	44	51	44	51	0	0	As sites 3 & 4 but
5b	at Army base	44	52	44	51	0	-1	triggered at 50 mph
UK. TWO SIGN SITES								
8a	100m after sign 1	44	52	36	42	-8**	-10**	Unimpeded vehicles
8b	150m after sign 2	40	45	35	39	-5**	-6**	200 before, 400 after
8c	village centre	35	39	33	36	-2**	-3**	200 before, 400 after
9	150m after sign 2	38	44	34	38	-4**	-6**	300 before, 500 after
NON UK SITES								
10a	at sign	56+	-	54+	-	-2**	-	20,000 automatic
10b	2 miles after sign	55+	-	55+	-	0**	-	
11	at sign	<26	-	<20	-	-6	-	(3 hours of readings)
12a	at sign	48	54	47	52	-1**	-2**	Over 2,000 readings
12b	at sign (enforced)	48	54	45	49	-3**	-5**	for each period
								Site numbers
Overall at sign						-2	-2	3, 4, 13
100m after sign 1						-8	-10	8
150m after sign 2						-4	-6	8, 9
200m after sign						-5	-7	6
Village centre						-1	-2	1, 3, 4, 8

Notes + All vehicles, *statistically significant at the 5% level,
**statistically significant at the 1% level

statistically reliable because of the smaller numbers of observations; for example, with 200 'before' and 'after' radar speed observations, speed changes of less than 1 mph are not likely to be statistically significant at the 5% level. If the automatic loop/tube equipment functions correctly and no usual events occur, the speed changes measured by automatic equipment can be more statistically reliable than those measure by radar speed meters, and give a better picture of the speed changes involving all traffic throughout the day. However, the results may be influenced by the magnitude/changes in the level of flow and are be susceptible to unforeseen events affecting driver behaviour and

speed (e.g. road works, parked vehicles) during unattended periods.

The quoted statistical significance of the speed changes are given in Tables 3 and 4 and where possible estimates have been made for the rest. The original authors appeared to have taken care in the way in which the speed measurements were carried out (e.g. all radar measurements were carried out in dry conditions). The number of readings taken to obtain the 'before' and 'after' vehicle speed results are given when known.

TABLE 4

Effect of sign on HGV speeds at UK sites

Site No	Measurement location	HGV speeds in mph				(A) - (B)		Method of measurement
		Before(B)		After(A)		Mean	85%	
3a	at sign	36	44	36	44	0	0	Radar
3b	village centre	22	25	22	26	0	1	
4a	at sign	33	39	31	36	-2	-3	Radar
4b	village centre	27	31	27	31	0	0	
5a	at sign	41	44	41	43	0	-1	Radar
5b	at Army base	37	45	37	46	0	1	
9	150m after sign 2	33	37	31	34	-2**	-3**	Radar
						Site numbers		
Overall at sign						-1.0	-1.5	3, 4
150m after sign 2						-2	-3	9
Village centre						0	0.5	3, 4

** statistically significant at the 1% level

3.2 CARS

Table 3 and Fig 7 gives the 'before' and 'after' mean and 85th percentile speeds for cars at single-sign and two-sign sites. At the UK sites, the 'before' 85th percentile speeds were up to 20 mph above the 30 mph speed limit at the sign and up to 12 mph above the limit in the village centres.

For cars, the overall results showed that a single 'secret' sign reduced 85th percentile speeds on average by about 2 mph at the signs and 2 mph within the village centres. The highest speed reductions (up to 7 mph) were found 100 - 200 metres after the sign. There may be some advantage in

using two signs as this arrangement gave reductions in 85th percentile speeds of up to 10 mph (52 mph to 42 mph), immediately after the signs, but the number of sites were small. Mean speeds were generally reduced by a similar or slightly lower amount than 85th percentile speeds.

In the UK, at the single sign sites 1, 3 and 4 (Burland, West Meon, and Droxford), the mean speeds in the village centres were reduced by up to 2 mph whereas the mean speeds at the 'secret'/'enhanced' signs were reduced by up to 4 mph. The 'before' speeds at Burland were measured after the red patches of macadam had been laid (see appendix) at the site but before the sign was installed. The 'after' speeds were taken after the vehicle activated sign was installed and therefore any effect due to the red patches was minimised. It was apparent that vehicle speeds in the centre of West Meon and Droxford villages were influenced by the bends in the roads on the approaches to the villages between the signs and the villages. At site 6 (UK, Scole) the mean and 85th percentile speeds 200 metres after the sign were reduced by 5 mph (38 mph to 33 mph) and 7 mph (43 mph to 36 mph). Before the 'secret' sign was installed at Scole, 75 per cent of drivers were exceeding 35 mph; after the sign was installed, this dropped to 15 per cent.

Site 5, (UK, Middle Wallop) had one 'secret' sign but the site was different from the other single sign sites. The speed limit was 60 mph and the sign gave a message which recommended 45 mph for vehicles passing the army base and the village. It should be noted that the 'before' 85th percentile speeds, at 50 mph, were below the 60 mph limit and were not affected by the sign. Mean speeds were not

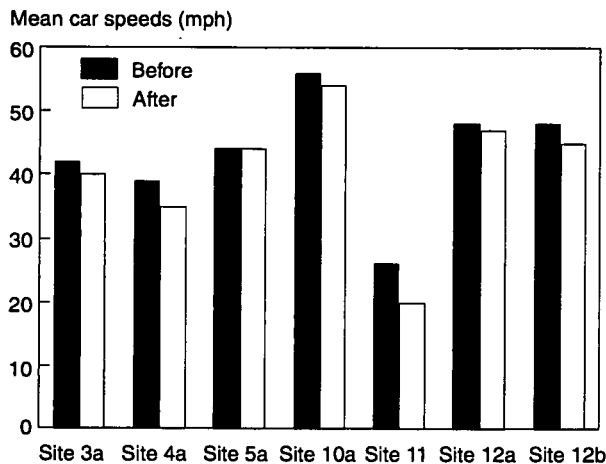


Fig 7 Car speeds at secret sign sites

affected by this 'secret' sign and 85th percentile speeds were reduced by 1 mph at the army base.

In the UK, at one of the two sign sites (site 8, Long Compton northbound), the mean speed in the village centre was reduced by 2 mph (35 mph to 33 mph). The mean speeds were reduced by 8 mph (44 mph to 36 mph) and 5 mph (40 mph to 35 mph) at 100 metres from sign 1 and 150 metres from sign 2 respectively. At site 9 (Long Compton southbound), gave similar mean speed reductions (38 mph to 34 mph) at 150 metres after sign 2.

Site 10, (USA, North Carolina), gave mean speed reductions of 2 mph at the sign which were similar to the UK sites and also to Site 12 (Netherlands) which gave a mean speed reduction of 1 mph. The reduction in mean speeds at site 11, (Sweden, Stockholm) was 6 mph which was reflected in the fact that the fastest speeds dropped from 50 kph to 30 kph (31 mph to 19 mph). At site 11, there were 19 mph speed limits between 0700 and 1800 on weekdays and 31 mph at all other times. The speed reductions given in Table 3 were recorded when the 19 mph limit was in operation.

The magnitude of the speed reduction at traffic calming measures may be related to the levels of the mean and 85th percentile 'before' speeds, with sites with higher 'before' speeds having larger speed reductions after implementation of the traffic calming measures. However, no clear relationship was found for the sites in this study.

3.3 HGV'S

Table 4 and Fig 8 gives the 'before' and 'after' mean and 85th percentile speeds for heavy goods vehicles (HGV's) at three single-sign and one two-sign sites in the UK. It should be noted that the 'before' mean speeds for HGV's were below the trigger speeds and thus any changes are likely to be limited to the faster vehicles.

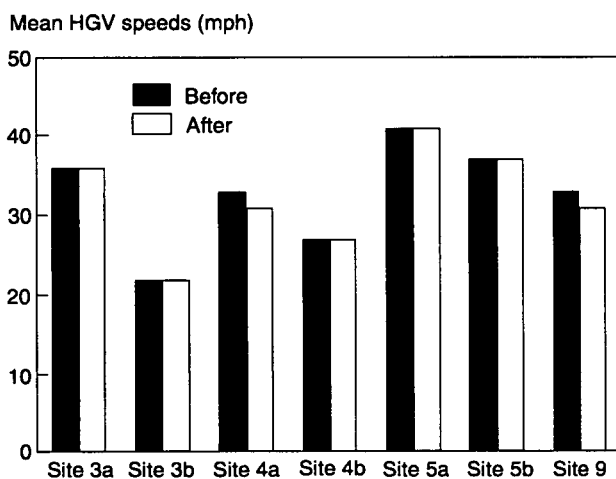


Fig 8 HGV speeds at secret sign sites

For HGV's at the single-sign sites 3 and 4 (West Meon, and Droxford), the overall mean and change in 85th percentile speeds was 1.5 mph reduction at the sign and 0.5 mph increase in the village centre. These changes are small and are unlikely to be of any importance.

Site 5, (UK, Middle Wallop) had one sign but it was unusual because the speed limit was 60 mph while the sign gave a message which recommended 45 mph for vehicles passing through the village. It should be noted that the 'before' 85th percentile speeds were below the 60 mph limit (45 mph) and all after speeds were within 1 mph of the 'before' speeds.

At site 9, (UK, Long Compton), the HGV mean and 85th percentile speeds were reduced by 2 mph and 3 mph to 31 mph and 34 mph respectively at a point 150 metres after sign 2. The HGV speed reductions are not as great as the car speed reductions but the HGV speeds remained 3 to 4 mph lower than the car speeds.

3.4 ENFORCEMENT AND VANDALISM

At site 12 (Netherlands), enforcement of the sign using speed cameras had the effect of reducing the 85th percentile vehicle speeds by an extra 3 mph (52 mph to 49 mph) compared with no enforcement. The enforcement level was set at 90 kph (56 mph) after consultation with the police and local prosecutor.

Vandalism of the equipment was a problem at site 10 (USA, North Carolina) and also at site 12 (Netherlands). At site 10, in America, the sign suffered from some large calibre rifle shots which passed through the sign and others which damaged the sign lights. At site 12 in the Netherlands vandalism was described as 'quite a problem' because it resulted in the equipment being made inoperative sometimes because the camera had been stolen or paint had been sprayed over the glass protecting the camera. Attempts were also made to burn the equipment post with gasoline.

All other sites were tested before speed enforcement cameras were widespread and therefore further speed reductions due to enforcement of the speed limits could be made. Tables 3 and 4 suggest that speed reductions appear to be maintained close to the sign (within 200 metres) even without enforcement and therefore it may be unnecessary at these locations.

3.5 VARIATION OF SPEED WITH TIME OF DAY

The mean and 85th percentile speeds of vehicles (in a given period) vary throughout the day due to various factors such as vehicle flow, number of HGV's, frequency of buses, location of bus stops etc. The most useful time periods

investigated were the day-time and night-time because they often have considerably different flow levels which can lead to variations in overall vehicle speeds. However, there was no consistent pattern of day/night variation in the speed reductions for the sites where results were available.

At site 1 (UK, Burland), the 'before' and 'after' mean and 85th percentile night-time speeds in the village centre were about 2 to 3 mph higher than day-time speeds. The reduction in night-time mean and 85th speeds (2.6 and 3.0 mph respectively) were about 0.5 mph higher than the reduction in day-time speeds. The vehicle speeds were measured using automatic speed measuring tubes laid across the road and therefore the results include all vehicles and not only free flowing lead vehicles as at most of the other sites.

At site 10 (USA, North Carolina), the numbers of speeding motorists, at the sign, were reduced by 10% (from 67% to 57%) during the night-time but the reduction was 20% (from 70 % to 50%) during the day-time. These results indicate that the night-time speeds were affected less than the day-time speeds but the night-time variance increased marginally from 67% to 68% whereas the day-time variance reduced from 58% to 49%. The variance of speeds have been shown to be important by Solomon (1964) and Finch et al (1994) in relation to accident involvements.

3.6 VARIATION OF SPEED WITH TIME SINCE INSTALLATION

It is important that any new device for controlling or influencing the speeds of drivers is monitored over an extended period to determine if any initial effect is sustained in the long term after the novelty effect of the sign has been eroded.

The available evidence presented below indicates that the small speed reductions that occurred at some sites appeared to be maintained over time.

At site 1, (UK, Burland) the speed reductions were largely maintained in the village and only slightly eroded at the 'gateways' after 8 months.

At sites 3 and 4 (UK, West Meon and Droxford) the measured speeds tended to decrease over a year (Helliars-Symons, 1984) but the decrease was small and variable.

At site 5 (UK, Middle Wallop) the mean speeds were still unaffected after 1 year.

Site 6 (UK, Scole) was monitored at intervals of 1, 3 and 12 months and the data did not show any long term trend.

Sites 8 and 9 (UK, Long Compton) were both monitored for a year at intervals of 1, 3, 6 and 12 months but no long term trend was reported once the initial settling down period had passed.

4. ACCIDENTS

A limited amount of accident data was available for the sites studied. Injury accident data was reported for 6 sites and all accidents (including damage only) were reported for 1 site. The results are summarised in Table 5. The accident numbers are small and the individual and overall results are not statistically significant, but clearly the results given in Table 5 are promising because all 6 sites have shown a reduction in accidents.

At those sites (3,4,5,8 and 9) where there were three or more years of before and after injury accident data, the overall accident frequency was reduced by 60 per cent from 9.1 to 3.6 accidents per year. The accident frequency at control sites was reduced by 32 per cent from 7.3 to 5.0 accidents per year in the same period, giving an overall non statistically significant reduction in accident frequency of 42 per cent due to the installation of the 'secret' signs.

A number of further sites (see Section 5) are required for a rigorous accident analysis to be carried out to confirm if this reduction is real. Large numbers of accidents are needed to be confident that even large observed accident reductions are not due to chance. For a change in accident frequency of 40 per cent relative to control sites to be statistically

TABLE 5

Summary of accidents at 'secret' sign sites

Site Nos	Accidents/Year Before	Accidents/year After	Accidents % reduction
3,4,5	5.8 (6.0)*	2.3 (4.0)*	60 (33)*
6	1.0	0	100
8,9	3.3 (1.3)*	1.3 (1.0)*	60 (25)*
12**	-	-	46 (32)*

Notes. * Control sites in (brackets)

** Site 12 includes damage only accidents.

significant at the 5 per cent level, about 75 accidents would be needed in the 'before' period at both the test and control sites. However, one must be careful about choosing sites for treatment based on a temporary increase in accidents during the 'before' period because of the possibility that any subsequent reduction could be due to 'regression to the mean' rather than the treatment selected.

At sites 3, 4 and 5 (UK, West Meon, Droxford and Middle Wallop) the combined numbers of accidents for the 3 sites combined was reduced from 23 to 9 accidents in 4 years (5.8/year to 2.3/year) 'before' and 'after' the signs were installed. This accident reduction was regarded as 'not significant' by the authors.

At site 6, (UK, Scole), the accidents were reduced from 3 in 3 years (1/year) 'before' to 0 accidents in 1 year 'after'. The 'after' period is too short at this site for any conclusions to be drawn at the moment.

At sites 8 and 9, (UK, Long Compton), the combined numbers of accidents was reduced from 10 (3.3/year) to 4 (1.3/year) accidents in 3 years 'before' and 'after' the signs were installed respectively giving an overall accident reduction of 60%.

At site 12, (Netherlands), the accidents (including damage only accidents) were reduced by 46%. The accidents at the control sites were also reduced but by only 32%, implying a real reduction due to the signs. Damage only accidents are not usually included in accident analysis in the UK, but there is no reason to presume that injury accidents would be too different.

5. FURTHER SITES

Six new sites have been installed in May 1995 in Norfolk by the County Council on Principal and B class roads at Acle, Carbrooke, Horstead, Swaffham, Wells and Wroxham in collaboration with Road Safety Division DOT and TRL (See Sites 14 to 19, Appendix C).

At each site, one 'secret' sign will be located a few hundred metres inside the village speed limit zone. Trigger speeds of 35 mph and 44 mph will be used for 30 mph and 40 mph roads respectively to light up a coloured regulatory speed limit roundel. Two automatic classifier monitoring points at each site will be used to record speeds over a seven day period at the 'secret' sign and in the village/town. The distance from the sign into the village/town will vary from 300 metres to 1,000 metres. Measurements will be taken once 'before' and three times 'after' the signs are installed. The data will be sent to TRL for analysis as part of a project being carried out for Road Safety Division, DOT.

Two sites in Wiltshire on A class roads at South Newton and Chicklade (Wiltshire) are due to be approved by Road Safety Division shortly (See Sites 20 to 21, Appendix C).

The initial speed reading results from these schemes are likely to be available later in 1995 with the long term measurements available in 1996. Accidents for the full three-year 'after' period will not be available within the lifetime of the current UG46 Project but the effect on accidents, while useful, is unlikely to be conclusive as there was only a total of 18 injury accidents (all 6 Norfolk sites) in the 3 year 'before' period.

6. SUMMARY AND CONCLUSIONS

This study is based on a total of 13 vehicle activated speed limit reminder sites which included 9 from the UK, and a further 4 sites from Europe and the USA.

Most of the sites used 'secret' signs (sign blank with an illuminated message activated by speeding vehicles). An 'enhanced' sign (sign visible to all drivers but enhanced features activated by vehicles) was used at only one site. Eight of the nine sites in the UK were on 'A' class roads at villages with 30 or 40 mph speed limits; the other was an 'A' road with a 60 mph limit but the sign advised drivers to travel at 45 mph. The four USA and European sites were either on roads with a 19 mph (30 kph) or on roads with speed limits of about 50 mph. The speeds at which the signs were activated were generally up to 10 mph above the relevant speed limit.

The location of monitoring points is an important factor in making any assessment and it is clear from the data that only limited conclusions can be reached because of the large variation in monitoring locations and the type of signs. The most common locations for speed measurements were at the 'secret' sign, about 100m to 200m downstream from the sign and, where relevant, in the village centre some distance downstream from the sign.

The following conclusions can be drawn from the data:

1. 'Secret' or 'enhanced' speed limit reminder signs appear to reduce vehicle speeds by a few mph at the sign and some of this reduction can be maintained some distance downstream in the village centre.
 - a) For cars, the overall results showed that a single 'secret' sign reduced 85th percentile speeds on average by about 2 mph at the sign and 2 mph within the village centre. The highest speed reductions (up to 7 mph) were found 100 - 200 metres after the sign. There may be some advantage in using two 'secret' signs as this arrangement gave reductions in 85th

percentile speeds of up to 10 mph, immediately after the signs, but the number of such sites was small. Mean speeds were generally reduced by a similar or slightly lower amount than 85th percentile speeds.

b) For HGV's, the speed data was more limited. At two single-sign sites in the UK, the overall change in 85th percentile speeds was a 1.5 mph reduction at the sign and a 0.5 mph increase in the village centre. These changes are small and are unlikely to be of any importance.

2. A limited amount of injury accident data was available for the sites studied. The accident numbers are small and the changes in accidents are not statistically significant. However, the results are promising because all of the sites where data was available showed a reduction in accidents. When compared to control sites, there was an overall non statistically significant reduction in accident frequency of 42 per cent due to the installation of the 'secret' signs.

3. Some sites had a **SLOW DOWN PLEASE** message but a brief opinion survey found that drivers preferred messages which contained speed information.

4. The speed reductions appeared to be maintained over time.

5. There was no consistent pattern of day/night variation in the speed reductions for the sites where results were available.

6. Enforcement of the speed limit, by using speed cameras in the Netherlands, had the effect of reducing mean and 85th percentile speeds by a further 2 mph and 3 mph respectively compared with no enforcement. The other sites had no enforcement with speed cameras.

7. Vandalism of the camera and measuring equipment was described as 'quite a problem' at sites in the Netherlands (theft, paint, fire) and USA (rifle shots). It was not mentioned as a problem by the local highway authorities in the UK.

8. Further sites have been installed in the UK and will provide more information on the speed reductions at the signs and downstream within the villages and give a better estimate of the potential safety benefits of these schemes.

7. ACKNOWLEDGEMENTS

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APPENDIX A: VEHICLE ACTIVATED SPEED LIMIT REMINDER SIGN SITES IN THE UK

CHESHIRE

1. Burland A534 (Ref. Wheeler et al, 1994)

Location	Single carriageway approach to village
Type of sign	30 sign. Flashing lights above and below the sign are activated by sensor for 10 seconds by each vehicle regardless of speed
Layout	Loop detector, 115 metres to 'secret' sign, further 80 metres (western), 140 metres (eastern) gateway) to 30 limit signs at the village
Status	Installed 1993. Still operational (VISP site)
Results	The mean speeds were reduced in the village by approx 2 mph to 32 mph due to the gateway sign which is 480 metres from the village
Comments	5 metre long red patches of macadam across road at 'secret' sign and at 100 metre intervals in 30 mph speed limit zone. Night time speeds were generally 2 - 3 mph higher than daytime speeds.

ESSEX

2. Great Leighs A131 (Ref. direct from Essex CC)

Location	Single carriageway 'Main Road', through village
Type of sign	First sign 'TOO FAST', Second sign 'SLOW DOWN 40'
Layout	Village 40 mph sign, 300 metres to 'TOO FAST' sign 500 metres to 'SLOW DOWN 40' sign. 'Secret' signs have been installed on both the northbound and southbound village entrances
Status	Installed early 1990's. Still operational
Results	Affected by roadworks, may be unreliable.

HAMPSHIRE

3. West Meon A32 (Hants) (Ref. Helliar-Symons and Wheeler, 1984)

Location Single carriageway approach to village

Type of sign 'SLOW DOWN 30'

Layout Southbound. 30 mph speed limit sign, 30 metres to detectors, 60 metres to 'SLOW DOWN' sign.

Northbound. Detector, 20 metres to 30 mph sign, 34 metres to 'SLOW DOWN' sign.

Status Operational 1979

Results Southbound.

At sign. Mean speeds reduced from 42 mph to 40 mph for light vehicles. Mean speed for heavy vehicles showed no change at 36 mph.

At village. Mean speeds showed no change at 24 and 22 mph for light and heavy vehicles respectively.

Northbound.

At sign. The mean speeds were generally 6 mph lower than the southbound speeds.

At village. The mean speeds were comparable with the southbound speeds.

Accidents reduced from 7 to 4 (4 years 'before' and 'after')

Comments The effect on the 85th percentile speeds were similar to the mean speeds. Speeds monitored for 1 year after.

4. Droxford A32 (Hants) (Ref. Helliar-Symons and Wheeler, 1984)

Location Single carriageway approach to village

Type of sign 'SLOW DOWN 30'

Layout 30 mph speed limit sign, 5 metres to detectors, 52 metres to 'SLOW DOWN'.

Status Operational 1979

Results At sign. Mean speeds reduced from 39 mph to 35 mph for light vehicles. Mean speeds for heavy vehicles reduced from 33 mph to 31 mph.

At village. Mean speeds reduced from 30 to 29 mph for light vehicles. Mean speeds at 27 mph unchanged for heavy vehicles.

Accidents reduced from 11 to 0 (4 years 'before' and 'after')

Comments The effect on the 85th percentile speeds were similar to the mean speeds. Speeds monitored for 1 year after.

5. Middle Wallop A343 (Hants) (Ref. Helliar-Symons and Wheeler, 1984)

Location Single carriageway approach to Army base

Type of sign 'SLOW DOWN 45'

Layout 70 metres from detectors to 'SLOW DOWN' sign. National 60 mph limit applied at site.

Status Operational 1979

Results At sign. Mean speeds for light vehicles were unchanged at 44 mph. Mean speed for heavy vehicles unchanged at 41 mph.

At Army Base. Mean speeds unchanged at 44 mph and 37 mph for light and heavy vehicles respectively. Accidents unchanged at 5 (4 years 'before' and 'after')

Comments The effect on the 85th percentile speeds were similar to the mean speeds. Speeds monitored for 1 year after.

NORFOLK

6. Scole A140(T) (Ref. Norfolk County Council, 1993)

Location	Single carriageway approach to village
Type of sign	30 sign with flashing lights activated by sensor
Layout	30 mph speed limit sign, 125 metres to detectors, 75 metres to flashing light sign.
Status	Operational in 1992 but site has been bypassed
Results	At point 200 metres after sign. Mean speeds after 12 months were reduced by 6 mph from 39 mph to 33 mph.
Comments	The effect on 85th percentile speeds was similar with a reduction of 7 mph. The speed reductions recorded could have been influenced by drivers who assumed that the speed sign was being enforced by speed cameras which were not visible.

SUSSEX

7. Fernhurst A286 (Ref. Eagle and Homans, 1976)

Location	Single carriageway downward incline leading to a semi-concealed junction
Type of sign	'POLICE YOU ARE SPEEDING'
Status	Installed in April 1976 for a 2 month experiment.
Results	Speeds (Vehicles exceeding 35 mph was reduced from 40 to 20%)

WARWICKSHIRE

8. Long Compton (South) A34 (Warwicks) (Ref. Barker et al, 1995)

Location	Approach to village down a long hill
Type of sign	'TOO FAST' and 'SLOW DOWN 30'
Status	Installed in 1986 on entrance to village
Results	Mean speeds reduced from 44 mph to 36 mph and 40 mph to 35 mph at points after signs. Mean speeds in village reduced from 34 mph to 32 mph
Comments	Trigger speeds set at 35 mph and 30 mph for the first and second signs respectively. Increased to 45 mph and 40 mph after trial completed.

9. Long Compton (North) A34 (Warwicks) (Ref. Barker et al, 1995)

Location	Single carriageway approach to village
Type of sign	'SLOW DOWN 30 AHEAD' and 'SLOW DOWN 30'
Status	Installed in 1990 on entrance to village
Results	Mean speeds reduced from 38 mph to 34 mph for cars and from 33 mph to 31 mph for HGV's. Measured after second sign.
Comments	Trigger speeds set at 45 mph and 40 mph for the first and second signs respectively.

APPENDIX B: VEHICLE ACTIVATED SPEED LIMIT REMINDER SIGN SITES OUTSIDE THE UK

UNITED STATES OF AMERICA

NORTH CAROLINA (USA)

10. Carpenter NC-55 (Ref. Hunter et al, 1976)

Location	Single carriageway approach to 'village'
Type of sign	'SLOW DOWN YOUR SPEED IS XX'. Activated if vehicle above 55 mph speed limit
Status	Installed in 1974
Results	Reduction in mean speeds 56 mph to 54 mph and speed limit violation but an increase in the variance of speeds. The sign suffered from some large calibre rifle shots which passed through the sign and some which damaged the lights.

SWEDEN

11. Stockholm (Berggren, 1991)

Location	City streets (various)
Type of sign	'YOU ARE DRIVING TOO FAST' when vehicles exceeded 30 kph (19 mph). Illuminated sign was mobile with a radar gun incorporated. Amber rotating light on top of sign also activated
Status	Installed in 1989
Results	Mean speeds reduced by 10 kph (6 mph). Highest speeds reduced 50 to 30 kph. A 5 kph (3 mph) reduction reported between 'before' phase 1 and 'before' phase 2 during which time (5 weeks) the sign was removed

NETHERLANDS

12. Four Dutch provinces (Ref. Oei, 1991)

Location	Various two-lane rural roads
Type of sign	'YOU ARE DRIVING TOO FAST' when vehicles exceeded 80 kph (50 mph)
Status	Installed in 1990
Results	Mean speeds reduced by 2 kph without enforcement and by a further 3 kph with enforcement to 73 kph (45 mph). Percentage of drivers exceeding 80 kph (50 mph) reduced from 41 to 30 (no enforcement) to 11 (with enforcement)
Comments	Vandalism was a problem. Regional papers responsible for information campaign concerning schemes

GERMANY

13. Westphalia (Ref. Gerdorn, 1978)

Location	Various roads within 50 towns and districts
Type of sign	Speed warning installations give speed offenders visual instructions. Linked to speed cameras.
Results	Part of a large overall study covering a variety of measures in 50 towns. No results reported yet.

APPENDIX C: VEHICLE ACTIVATED SPEED LIMIT REMINDER SIGN SITES INSTALLED IN THE UK IN 1995

NORFOLK (Sites 14 - 19 similar to Scole site 6)

14. Acle B1140 (Norfolk)

Location	Single carriageway approach to village (3,500 vehicles/day)
Type of sign	30 sign with flashing lights activated by sensor
Layout	30 mph speed limit sign, 160 metres to detectors, 70 metres to flashing light sign. Speed measurements at sign and 300 metres into village.
Status	Operational May 1995

15. Carbrooke B1108 (Norfolk)

Location	Single carriageway approach to village (8,000 vehicles/day)
Type of sign	40 sign with flashing lights activated by sensor
Layout	40 mph speed limit sign, 115 metres to detectors, 85 metres to flashing light sign. Speed measurements at sign and 1000 metres into village.
Status	Operational May 1995

16. Horstead B1150 (Norfolk)

Location	Single carriageway approach to village (11,500 vehicles/day)
Type of sign	30 sign with flashing lights activated by sensor
Layout	30 mph speed limit sign, 145 metres to detectors, 75 metres to flashing light sign. Speed measurements at sign and 500 metres into village.
Status	Operational May 1995

17. Swaffham A1065 (Norfolk)

Location	Single carriageway approach to town (10,800 vehicles/day)
Type of sign	40 sign with flashing lights activated by sensor
Layout	40 mph speed limit sign, 75 metres to detectors, 75 metres to flashing light sign. Speed measurements at sign and 450 metres into town.
Status	Operational May 1995

18. Wells-Next-The-Sea A149 (Norfolk)

Location	Single carriageway approach to seaside town (4,000 vehicles/day)
Type of sign	30 sign with flashing lights activated by sensor
Layout	30 mph speed limit sign, 130 metres to detectors, 70 metres to flashing light sign. Speed measurements at sign and 300 metres into town.
Status	Operational May 1995

19. Wroxham A1151 (Norfolk)

Location	Single carriageway approach to village (17,500 vehicles/day)
Type of sign	30 sign with flashing lights activated by sensor
Layout	30 mph speed limit sign, 480 metres to detectors, 70 metres to flashing light sign. Speed measurements at sign and 500 metres into village.
Status	Operational May 1995

WILTSHIRE

20. South Newton A36 (Wilts)

Type of sign	30 sign with flashing lights activated by sensor
Status	To be approved by RS Division

21. Chicklade A303 (Wilts)

Type of sign	30 sign with flashing lights activated by sensor
Status	To be approved by RS Division

MORE INFORMATION FROM TRL

TRL has published the following other reports on this area of research:

- PR 14 Public attitude survey - The New Forest traffic calming programme, (1993), R Windle (RSL) and A R Hodge (TRL), Price code E
- PR 35 The effectiveness of village gateways in Devon and Gloucestershire, (1993), Allan Wheeler, Marie Taylor and Annabelle Payne, Price code F
- PR 33 An assessment of rumble strips and rumble areas, (1993), David C Webster and Roger E Layfield, Price code J
- PR 85 Speed reductions in 24 villages: Details from the VISP study, (1994), Allan Wheeler, Marie Taylor and Judith Barker. Price code L

ANNEX to PR 85 Colour photographs from the VISP study, Price code F (Video of schemes also available at £30 + VAT)

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