Development of a Speed Limit Strategy for the Highways Agency – Proposed Strategy

by Adrian Fails, David Lynam, Ryszard Gorell and Pat Wells

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Executive summary

TRL has been commissioned by the Highways Agency to develop a speed management strategy suitable for implementation on motorway and trunk roads in England. This strategy will provide better information on the effect on safety of speed changes on these roads and will provide a tool which will allow route managers to optimise between reducing the speed limit or making changes to the road layout to support a high limit.

The work is divided into a number of phases. The first phase involved a review of existing data and policies. Work undertaken during the first phase was reported in the first project report UPR/SE/129/04 “Development of a Speed Limit Strategy for the Highways Agency – Interim Report”. The main conclusions from the interim report are:

- The Highways Agency strategy should build on the principles already applied to an analogous policy developed by TRL for the Department for Transport
- Accident costs and mean speeds for Highways Agency roads need to be identified and combined with economic costs based on the potentially different vehicle mix on HA roads.
- There needs to be consistency of speed management policies between local and trunk road authorities.
- The practices currently used by HA’s managing agents also need to be considered to enable roads to operate safely at high speeds.
- Where that is not a suitable option, the strategy should then lead to measures available to assist with encouraging or enforcing compliance with the speed limit.
- The procedures for implementation of the policy need to encourage solutions that are in keeping with the Agency’s objectives.

The purpose of this report is to build on the conclusions of the interim report and present a detailed proposal for the Highways Agency Speed Limit Strategy and proposals for a trial of the strategy before it is fully implemented.

The methodology used to formulate the economic model for developing a rural road speed limit policy for DfT is employed to assess the same issues for the trunk road network, with its different flow and vehicle mix. Minimum cost curves are established for Motorways and Dual Carriageways and the assumptions used in generating these are discussed. The conclusions from this lead to target speed limits for the various road types, which are reviewed in terms of their comparison with local routes and with international equivalents.

Threshold accident rates are defined, to identify routes where these target limits do not appear appropriate. The length of roads in the whole of the current network, and in the core network alone, that would be affected by such thresholds at present accident rates is assessed. Other potential descriptive factors differentiating such sections are discussed and the issues involved in using different limits based on transient features such as poor weather or restricted lanes are considered.

Potential measures for improving the safety of higher risk parts of the network, to achieve a lower accident rate, are discussed along with their likely effects and current justifications. For circumstances where provision of such improvement measures is not possible, potential measures for reducing speeds are discussed, similarly in terms of their justifications and likely outcomes.

The application of the strategy is set out in terms of the process of dividing up and assessing the network, selecting appropriate action and estimating the accident savings and the costs of those measures. Finally, this report sets out the objectives for applying the policy as a trial and reviewing the appropriateness of the guidance based on the outcomes it would generate for a sample of highways.

1 Introduction

1.1 Previous conclusions

The interim report on the development of a Speed Limit policy for Highways Agency roads (Fails, 2004) concluded that the strategy development should build on the principles already applied to an analogous policy developed by TRL for the Department for Transport, but be applicable to all parts of the trunk road network.

To do this, accident costs and mean speeds for high-volume single carriageways, for dual carriageways and for motorways needed to be identified, and combined with economic costs based on the potentially different vehicle mix on HA roads. Lessons learned from other countries and from local authorities here in the UK need to be taken into account in order to maximise the consistency of speed management policies between local and trunk road authorities. The practices currently used by HA’s managing agents also need to be considered and included, so that their actions encourage measures to improve the safety inherent in the highway infrastructure to enable roads to operate safely at high speeds. Where that is not a suitable option, the strategy should then lead to consideration of the measures available to assist with encouraging or enforcing compliance with a lower speed limit.

The procedures for implementation of the policy need to encourage solutions that are in keeping with the Agency’s aims (for example, increasing safety and reliability in preference to reduction of traffic speed). In the guidance, if possible, each of the key aspects – safety, economy, environment, accessibility and integration – should be included in a manner that allows their relative weight to be taken into account in selecting the most appropriate speed limit.

1.2 Scope of this report

This report presents the detailed proposal for the HA Speed Limit strategy and describes a desk based trial of the strategy.

The methodology used to formulate the economic model for developing a rural road speed limit policy for DfT is employed to assess the same issues for the trunk road network, with its different flow and vehicle mix. Minimum cost curves are established for Motorways and Dual Carriageways and the assumptions used in generating these are discussed. The conclusions from this lead to target speed limits for the various road types, which are reviewed in terms of their comparison with local routes and with international equivalents.

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2 Appropriate target speeds and limits for HA roads

The first stage in developing the detailed strategy for speed limit setting policy on HA roads is to determine appropriate target speeds and thus speed limits for each road type within the network. At these targets, for each of the different road types, the network would operate in a balanced safe, reliable and economic way to benefit society and all of its users. The process of defining appropriate speeds is consistent with that used for assessing rural single carriageways to provide the speed regime recommended in the Department for Transport consultation on the revision of Circular 1/93 (DfT, 2004a).

2.1 Minimum economic operating costs for HA roads

The total cost of operating the road at a particular speed is calculated as the sum of the time costs, fuel costs and accident costs. The appropriate speed for a road can be considered to be the speed at which these total cost curves reach a minimum. However the curves are relatively flat, particularly for high speed roads, resulting in a wide band of speeds over which total cost is similar. Thus although the minima provide the theoretical best balance of accident and other costs, it is important to consider the shape of the curve as a whole , and to take into account factors that cannot be costed in this way.

The relationship between speed and accident costs differs for the different road types, so separate total cost curves, with different minima, can be calculated for each principal type of road in the HA network – Single Carriageway (SC), Dual Carriageway (DC) and Motorway (M).

The modelling of costs due to fuel consumption and time expenditure are relatively well validated with the speeds typically involved in assessing the HA network.

It is reasonable to assume that the relationship between mean speed and accident rate for Highways Agency single carriageway rural roads is consistent with that derived for the highest quality speed group defined in Taylor et al (2002), but no similar research has been done to establish relationships for motorways and dual carriageways. If a similar general form of relationship is assumed to exist for these road types, accident curves of the type shown in Figure 2-1 can be derived, by fitting this relationship to points (highlighted in Figure 2-1) representing the known average speed and accident rate on each road type. It is clear that the curves for motorways and dual carriageways are relatively flat up to speeds around 70mph, so the precise form of the curve below these speeds is unlikely to affect the conclusions substantially. The shape of the curve at higher speeds is less clear.

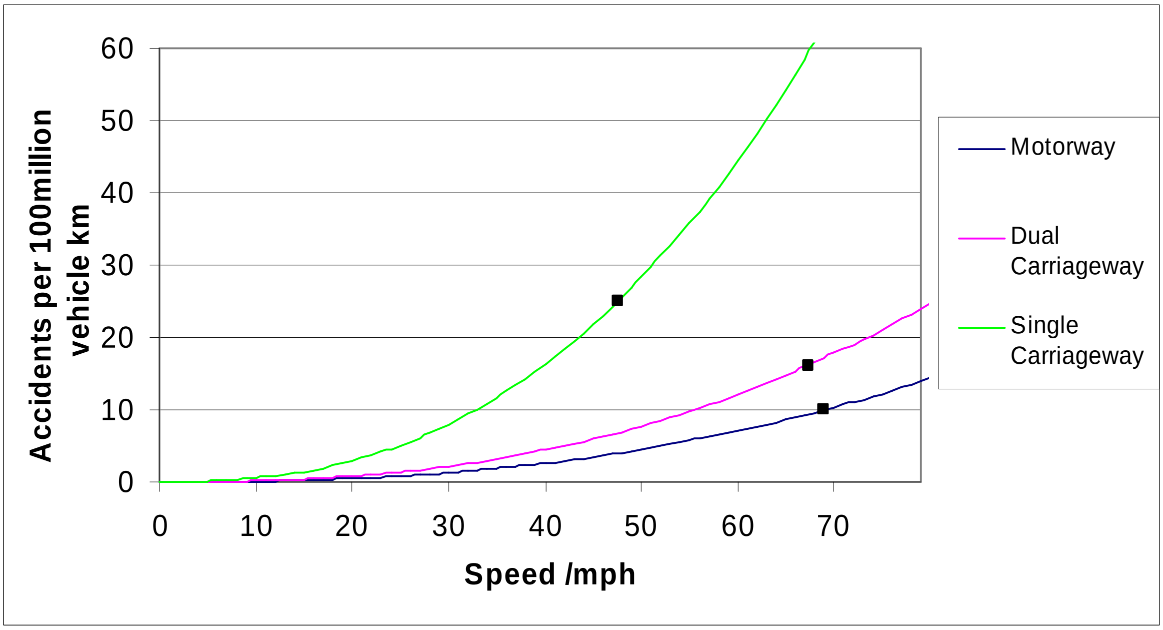


Figure 2-1:. Assumed relationship between speed and accident risk on HA roads

Given that the HA network's accident rate is lower than the rate typical for local roads, the impact of accidents will have a relatively lesser total economic effect than it does on local roads.

Using these assumed relationships and 2003 data for the flow, average speed and accident rate on the HA's network, minimum costs have been estimated as a function of average speed. These are presented as curves in Figure 2-2.

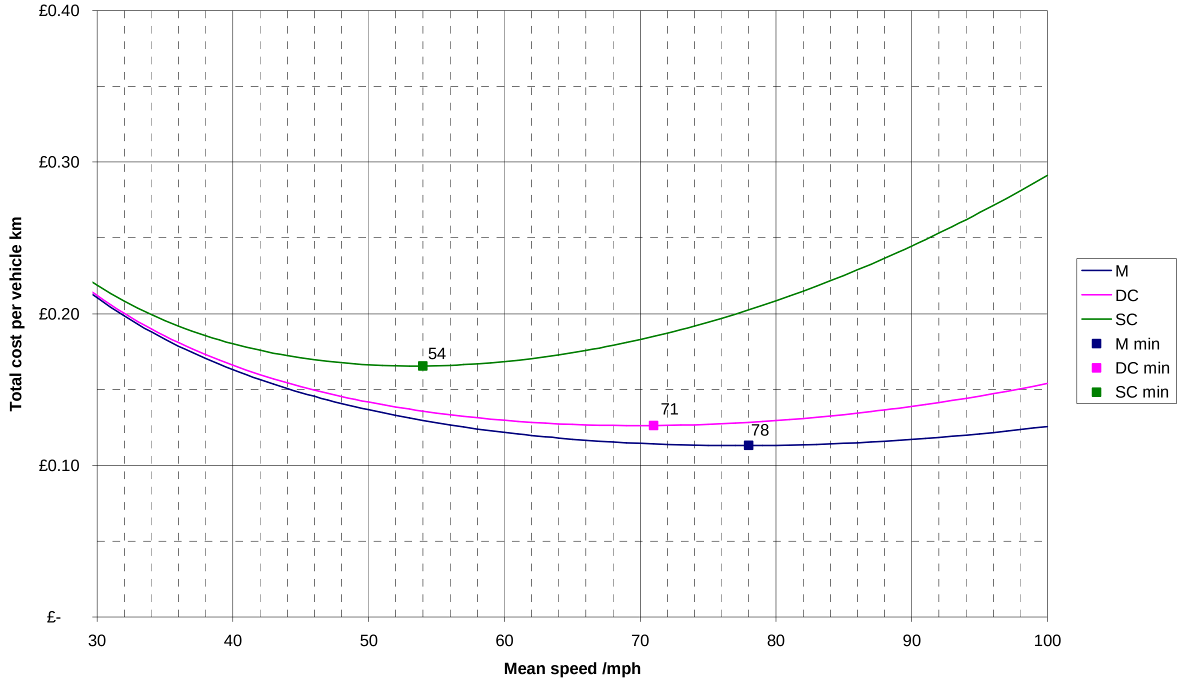


Figure 2-2: Cost per vehicle kilometre by mean speed on the three main types of HA road

It can be seen that the minimum total costs per vehicle kilometre are achieved at mean speeds of 54mph for single carriageways, 71mph for non-motorway dual carriageways and 78mph for motorways. If the mean speed of light vehicles were used (rather than the overall mean) the minima occur at very similar speeds – just 1mph higher on Motorways, for example.

2.1.1 Limitations of the economic model

The accident curves up to speeds of 70mph are based on average data from several sites on each type of road and are unlikely to be improved significantly by further speed data collection either at these sites over a longer period or at additional sites. Although some sections of motorway have mean speeds above 70mph, there are no data on which to assess curves for general speeds above 70mph. The accident rate curves presented in this report show extrapolation beyond the speed range for which there are reliable data. It is acknowledged that these curves would need to be modified if there was evidence that the relationship of accident rate to speed altered at these higher speeds. The curves do however give the best estimate of what the accident rate is likely to be at high speeds, provided the well-established relationship does not change significantly above 70mph.

It is anticipated that the cost of traffic disruption is likely to be much greater on motorways than on other routes. The delay caused by each personal injury accident on a motorway has been estimated as approximately 1300 vehicle hours and this enables a refinement of the accident-cost for motorways in the economic model. Including these delay costs would increase the value of prevention of each accident from £92420 to around £104700 – only a 13% increase. Adjusting the curves generated in Section 2.1 to include this increased cost this would reduce the mean speed at which minimum cost per vehicle kilometre is achieved on motorways from 78mph to 77mph.

The overall “flatness” of the accident cost curve, along with its magnitude relative to the other costs, means that minor changes in its shape are not likely to change greatly the overall cost.

Pollution is not included in the model since it is not straightforward to assign a monetary value to the societal cost or benefit of any increase or decrease. However, it is worthy of note that as speed increases so does each type of emission once speeds exceed 60mph. This feature did not present a notably different cost across the range of lower speeds studied for local roads, but may do so for Agency roads. The main emissions are shown in Figure 2-3.

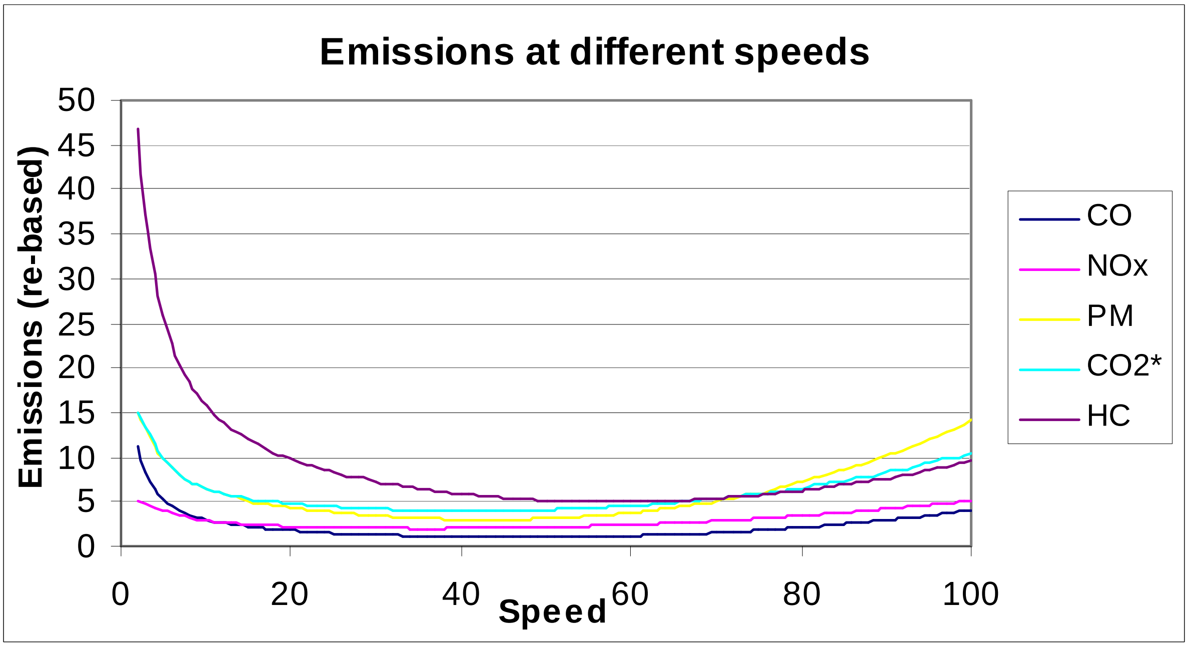


Figure 2-3: Emissions at various traffic speeds

In conclusion therefore, on the validity of the model,

- it is unlikely that any further speed and accident data could be obtained to improve knowledge of the shape of the accident cost curves
- below speeds of 70mph on motorways and dual carriageways there is little scope for any substantial variation in these curves
- no data exist on which to base the shape of the curve at higher speeds
- adding allowance for incident delay costs appears to make little change to the speed at which costs are minimum costs
- the effect of non-costed factors such as environmental costs could be important for motorways and dual carriageways for which a similar total cost is achieved for a wide range of speeds. Curves of emission rates suggest that these increase for speeds above about 60mph, so even small costs associated with these would drive down minimum total-cost speeds.

Thus it is reasonable to use the model to develop the HA speed limit strategy, providing the potential influence of environmental costs is also considered for the higher speed roads.

2.2 Conclusions on appropriate target speeds for HA roads

The overriding conclusion on appropriate target speeds is that this model does not show any economic need for a widespread change in the speed limits that are the current norms for HA roads. Identifying specific thresholds for intervention on specific links will be dealt with later, but in general the following target speeds and limits appear to be appropriate.

Single carriageway trunk roads

> Roads of this class operating with a mean speed of around 50-59mph will typically be incurring a cost close to the minimum amount per vehicle kilometre. Even allowing for enforcement thresholds, a 50mph limit would be too low for most of these roads. Therefore a target limit of **60mph** is appropriate for Single carriageway trunk roads.

Dual carriageway trunk roads

> Roads of this class operating with a mean speed of around 65-75mph will typically be incurring a cost close to the minimum amount per vehicle kilometre and therefore a target limit of **70mph** is appropriate for Dual carriageway trunk roads.

Motorways

> Roads of this class operating with a mean speed of anywhere over the range 70-85mph will typically be incurring a cost close to the minimum amount per vehicle kilometre, based on time, fuel and accident costs. However, taking account the fact that emissions increase over this speed range, a target speed towards the lower end of this range would appear appropriate. This suggests that the present limit of **70mph** is an appropriate target limit for Motorways. The infrastructure on these roads is currently designed to provide protection at this speed, and, with this limit, the advisory threshold for Police enforcement is 79mph.

In making a choice of target speeds for motorways and dual carriageways it should also recognised that as speeds increase over the range for which minimum costs are similar, safety benefits are being traded for mobility benefits. Table 2-1 illustrates the trade-off between these benefits by comparing the operating (time & fuel) costs and accident costs for the minimum-cost speed and speeds that are economically equidistant from it. These speeds can be found using the curve found in Section 2.1.

Table 2-1: Examples of same cost per vehicle km either side of the minimum

	Mean speed	Cost per veh-km	Proportion of total that is due to	
			operating costs	**accident** costs
£0.004 above economic minimum	65 mph	£0.117	93%	7%
At the economic minimum	78 mph	£0.113	89%	11%
£0.004 above economic minimum	90 mph	£0.117	85%	15%

Clearly, the exact cost of a mean speed of 90mph is beyond what can be predicted reliably by the model, however the point illustrated here is that there will be pairs of mean speeds on either side of the minimum that achieve costs equal to each other by prioritising one benefit over the other.

It must be noted that the accident costs include a sizeable element based on a “willingness to pay” methodology of assigning a value to casualty prevention. Therefore, in this respect, a preference-based weighting between the benefit types has already been included in the calculation. It should be recognised that making a choice between the two near-minimum cost speeds in the illustration above would mean that the value of casualty reduction is actually being counted twice within the same process although the actual saving will be made only once. The debate then would focus on whether it is appropriate to choose a lower speed to gain a reduction in expected casualties or to choose a higher speed and apply the saved costs to targeted accident reduction measures at specific sites where the rate is above the acceptable limit. It must also be noted explicitly that the cost savings due to reduced travel time would benefit individuals and businesses rather than the Highways Agency directly, and so the link to investment in accident reduction measures might not be established. Conversely, the value of prevention of casualties will represent an overall societal – rather than widespread individual – benefit, so individuals may not to see their increased time costs as representing good value for themselves.

Dual carriageways have been treated as one class but there may be considerable merit in examining the differences between at-grade and grade-separated dual carriageways due to the likely differences in their respective flows and accident histories. In the interests of consistency for motorists, however, any need for difference in limit should be clear from the layout differences in the road itself.

The target limit for single carriageways is consistent with that for upper tier local authority roads, which provides consistency between the strategies of HA and DfT as presented to the motorist as he considers switching between the roads under the stewardship of each authority.

The thresholds for acceptable accident rates at which limits might be reduced below these target values are discussed in section 3.

2.3 Comparison of target speeds with speed limits in other countries

The target limits set out in the previous section are broadly comparable to those selected by other countries for their strategic networks. The more fully developed strategies include economic assessments, however it is unclear whether most countries take this into account in as structured a way as is proposed in this strategy.

Table 2-2 summarises the speed limits (quoted in km/h) applicable in various European countries. Of note is the reasonable consistency with which motorway limits are set at 120 or 130 km/h. The exceptions to this are few, with the Italian limit of 150km/h applying only where deemed “suitable” – based on having good layout, signage, weather conditions and a consistent casualty history over five years.

Table 2-2: Speed limits in European countries

Country	Outside built-up areas		Motorways
	Single	Dual	
Austria	100		130
Belgium	90		120
Germany	100		No limit. 130 recommended
Denmark	80 or 90		110
France (raining)	90 (80)	110 (90)	130 (110)
United Kingdom	96	112	112
Greece	various		120
Italy	90 or 110		130 or 150 (specific criteria)
Ireland	100 (trunk)	100	120
Luxembourg	90		130
The Netherlands	100 (trunk roads)		120
Portugal	90		120
Sweden	70		110

http://europa.eu.int/comm/transport/road/publications/trafficrules/reports/annex_02/topic_tables/annex_2_topic_tables_05_11_speed_limits_en.pdf

2.3.1 Motorway accident rates in EU countries

Motorway accident rates (per vehicle km) vary considerably throughout Europe. This is likely to be due to many factors, of which the speed limit will be only one. Therefore it would not be useful for this work to compare these rates in a simple way with the distribution of limits used in the different countries.

2.3.2 Metrication of speed limits in the Irish Republic

The Republic of Ireland recently changed to a metric system of speed limits, to harmonise with their metrication of distance signage some years ago. In essence, their Motorway speed limit has increased to 120 km/h (75 mph); National roads (analogous to the HA network) of single carriageways and non-motorway dual carriageways have a limit of 100 km/h (62 mph); Regional and Local rural roads are set to 80 km/h (50 mph) and urban areas are 50 km/h (31 mph). The 120 / 100 / 80 limits correspond to their colour-coded blue / green / white route signage. In addition, there is a fairly uniform limit of 80 km/h (50 mph) everywhere for all vehicles that are articulated or towing, are over 3500 kg or can carry more than 8 passengers. A limit of just 65 km/h (40 mph) applies to all double deck vehicles. This would seem to encourage greater differences between the speeds of different vehicle types than was the case before, especially on motorways, where the Irish working group had recommended 90 km/h rather than 80 km/h for larger vehicles.

Additionally, the Irish national speed limit sign has been superseded and every limit change will be marked with a numerical sign. Presumably this has been introduced for reasons of absolute clarity (they all bear the km/h unit as well as the limit value) and to reinforce everywhere that there has actually been a change of limit – not just a change of the units in which it is measured.

The working group report (Department of Transport, 2003) appears to be limited to the application of what was considered to be best practice across Europe without relying on quantified attempts to include economic or safety costs and benefits. There is no explicit link with attempts to reduce the frequency or costs of accidents.

The 2002 Irish speed survey data show a rather low degree of compliance with their previous limits – especially on urban arterial roads where 30 mph limits were exceeded by 99% of the observed vehicles and 40 mph limits by 82%. Within residential 30 mph areas the Irish speeds were somewhat lower, with 61% exceeding the limit and an 85^{th} percentile speed of 38 mph. Even this is markedly higher than overall built-up area speeds in GB, where data for all types of built-up zones in 2003 show approximately 30% and 55% exceeding 30 and 40 limits, respectively.

For national primary routes, the compliance was broadly similar to that in GB, with the mean speed being close to the speed limit and a similar proportion exceeding the limit in each country. For motorways there was a lower mean and much more frequent compliance with the limit in Ireland, where 24% of cars (rather than GB's 57%) travel at over 70 mph.

The Working group noted that 70%-81% of articulated vehicles were exceeding their speed limit on dual carriageways and motorways, and cited this along with technology developments and a lack of European speed limit uniformity as evidence to support a 90 km/h limit. However this recommendation was not adopted and the same limit is applied for articulated vehicles on both single and dual carriageways.

3 Definition of accident rate thresholds as boundaries to higher limits

Since the optimum operating mean speed for a road is related to the accident rate, there will be specific accident rates at which this optimum (for each road type) drops below each speed limit increment. Once the optimum mean is below one of these limits then the economic model suggests that the road quality is too low to sustain traffic above that speed: either the accident problem should be treated or the speed limit should be considered inappropriately high.

3.1 Threshold speed definitions for trunk roads

Curves showing the optimum speed for Motorways, non-Motorway dual carriageways and single carriageways (currently with a 60mph limit) have been developed by extension of previously used modelling methods that were developed for local single carriageway roads (Lynam et al, 2004a). The new work assumes a similar relationship between mean speed and accident rate as for the single carriageway roads but takes into account the much greater flow and higher speeds associated with the trunk road network. It is reasonable to assume that the same relationship underlies the contribution of mean speed to accidents on each road type but this work calibrates the predicted curves against observed speed and accident data for dual carriageways. The value of prevention of each personal injury accident used is set out in Highways Economic Note 1 for 2003 (DfT 2004d), and includes an allowance for damage only accidents. Different prevention values were applicable for Motorways and other roads.

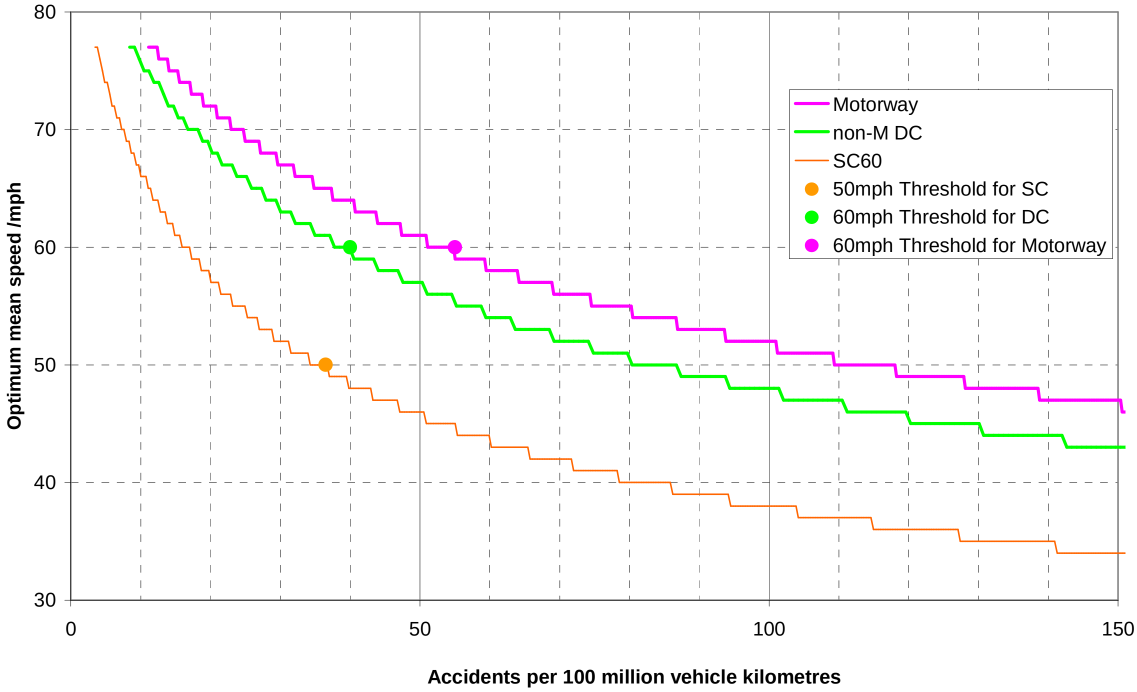


Figure 3-1: The optimum mean speed for each road type, by accident rate

For single carriageways, the current 60mph limit would be appropriate up to a rate of 37 personal injury accidents per hundred million vehicle km – at which point (marked as the 50mph threshold) the optimum speed falls below the next available speed limit demarcation of 50mph. This is in good agreement with the DfT strategy for setting single carriageway speed limits on high-quality local roads (the Group 3 and Group 4 local roads yielded thresholds of 35 and 40 PIA/100mvkm respectively) and indicates the point at which consideration would need to be given to improving the road or reducing the limit. Above 85 PIA/100mvkm, the problem is so serious that reducing the limit to 40mph would be appropriate if no remedial improvements could be made.

For non-motorway dual carriageways, the current 70mph limit would be appropriate up to a rate of 40 PIA/100mvkm. Above 86 PIA/100mvkm, consideration would need to be given to improving the road or reducing the limit to 50mph.

For motorways, a similar analysis indicates that the current 70mph limit is appropriate up to a rate of 55 PIA/100mvkm. Only a few kilometres of motorway are operating at rates above this level.

3.2 Network length warranting speed limit reduction on the grounds of accident rate

The interim report on developing this Strategy included results on the personal injury accident (PIA) rate for different carriageway types and speed limits, expressed as an average for each road type. Below is an assessment of the actual length of the three road types that (in 2003) fell above the accident rate thresholds that are identified in section 3.1 as suggesting improvement works or speed reduction. Thus, Table 3-1shows:

- Single Carriageways that fall above and below the PIA rate used in the DfT guidance for single carriageway local roads (35 PIA/100mvkm, similar to the rate of 37 identified above).
- Dual Carriageways that fall above and below an accident rate of 40 PIA/100mvkm.
- Motorways that fall above and below an accident rate of 55 PIA/100mvkm.

Table 3-1: Length of HA roads that fell above and below PIA rate thresholds in 2003.

Road type	**Existing Speed Limit /mph**	**Whole or Core network**	**Length**		
			km above 35 pia/100mvkm	**km below 35 pia/100mvkm**	**% above 35 pia/100mvkm**
Single	**60**	Whole	518	2593	17%
	60	*Core*	*280*	*1188*	*19%*
			km above 40 pia/100mvkm	**km below 40 pia/100mvkm**	**% above 40 pia/100mvkm**
Dual	**All**	Whole	204	2671	7%
	All	*Core*	*100*	*2245*	*4%*
			km above 55 pia/100mvkm	**km below 55 pia/100mvkm**	**% above 55 pia/100mvkm**
M	**All**	Whole	5	2842	0%
	All	*Core*	*0*	*2794*	*0%*
			km above respective rate	**km below respective rate**	**% above respective rate**
All	**All**	Whole	1080	8629	13%
	All	*Core*	*408*	*6316*	*6%*

The data in Table 3-1 have been estimated using the accident history for each specific link in the network. The quoted speed limits and carriageway types are those recorded in the majority of the records of accidents on each individual link. Thus, these could be biased by a high density of accidents at a site that has an atypical speed limit or carriageway type for the whole link. Likewise a link that is of mixed type – a village and an open road, for example – would be wholly categorised as being only one of these types, with the one used relating to the section with the greatest number of accidents in 2003.

Notwithstanding this, the distances give an indication of the likely proportion of the network that currently has this level of accident risk.

It is clear that the core network has a lower accident rate than the network as a whole. Hence, as a large quantity of the roads outside the core are gradually handed back to local authority control, the proportion (as well as the length) of the Agency's roads with a high accident rate will become lower.

Assigning each individual road link to the speed limit under which it would most economically operate (using the 2003 data and in the absence of first applying remedial safety improvements) the total length of each road type suitable for each limit can be counted. This suggests that a negligible proportion of Motorway would merit a limit reduction to 60mph – the great majority of the Motorways appear capable of sustaining a high mean speed flow without an overall economic penalty. For dual carriageways, four percent of the length of the core network would merit the same reduction. The great majority of single carriageway also operates effectively under the target speed limit, with around one fifth of the core length economically requiring a reduction to 50mph. In summary, this supports the choice of target limits set out earlier.

The 2003 data for specific Motorway sites that have been surveyed for mean speed support this, with many of them showing a low accident rate in association with high flow and a mean speed in the mid 70s (DfT, 2004c). These sites were not chosen to be representative of the whole Motorway network, but they illustrate several places which are currently operating in this way and are therefore of interest to the development of this strategy.

3.2.1 Urban Motorways

Just over 50km of motorway links were identified as having a predominant speed limit of 60mph or lower at the accident sites in 2003. Apart from one very low-flow spur, none of these links had an accident rate above the 55 pia/mvkm threshold. Typical links such as M4 J1-2 and J2-3 had rates of 40 and 11 pia/mvkm respectively, while the few kilometres of partly undivided tidal A38(M) showed rates of 21 and 33 on its two links. Although based on very small numbers of accidents, there does not appear to be a concern over the accident level achieved through the existing measures for selecting a reduced speed on motorway links of this type. Accordingly, the introduction of lower limits where atypical design dictates the need for such action should be retained.

3.3 Identifying sections warranting a lower limit other than by accident rate

Although the theoretical basis for justifying a lower speed limit is the likelihood of unacceptably high accident rates with a higher limit, it would be highly beneficial to be able to communicate this to the driver through road design or road condition differences that could easily be observed.

For motorways, this is relatively difficult as all motorways need to meet high design standards. The fact that there are so few motorway sections appearing to have accident rates above the level warranting a lower limit confirms that this is generally achieved. The main situations likely therefore to justify lower limits on motorways are either sites where lower design standards have been accepted, or sites at which there are transient high risk conditions. Examples of the former might be use of narrower running lanes or of restricted width hard shoulders, or the absence of hard shoulder stopping areas as a result of hard shoulder running. At present only intermittent use has been made of restricted width hard shoulders and research studies (eg Fletcher and Summersgill 1998) have been unable to identify any increased risk at these sites. There is stronger evidence of increased risk associated with operating hard shoulder running at full motorway speeds from Fletcher at al (2004) and from the current risk assessment modelling which is being done to underpin the revised road restraint standard.

For dual carriageways, the most obvious design difference contributing to higher risk is the presence of at-grade junctions. These allow crossing movements rather than the well-controlled merging movements in grade separated designs. Data from EuroRAP analyses (Lynam et al, 2004b) suggest that the risk of fatal and serious accidents on roads with at-grade junctions is 50% higher than those with grade separated junctions. Data are not readily available to compare the overall PIA risk on these different types of dual carriageway, but the threshold accident rate for lowering the limit to 60mph on dual carriageways (40 PIA/100m vehicle km, section 3.1) is more than twice the average rate for these roads (17 PIA/100m vehicle km). On this basis it would be inappropriate simply to regard all at-grade dual carriageways as better suited to the lower limit. This analysis could be taken further by estimating an accident rate versus speed curve for each of the two groups separately, and calculating the accident rate for each group at which a reduction to 60mph is appropriate, but this would not help in aiding the driver’s understanding of the reason for the reduction.

Transient conditions which might justify lower speed limits on all three types of road include road works and weather conditions. The risk differences that would warrant reductions to 60mph limits on motorways and dual carriageways involve risk increases above the average of more than 5 times on motorways, and 2.5 times on dual carriageways. In contrast, risk differences on single carriageways justifying a reduction from 60mph to 50mph only involve a risk increase of 50%. Little is known about the variation of risk with weather conditions, but some conditions may well lead to several times the average risk. Typically, over the whole network, a general change to wet roads or to poor light conditions seems only to be associated with risk increases of the order of one third, but it is likely that drivers will already be reducing speeds as part of their response to these conditions.

Rather more is known about risk changes with road works. Recent research (Freeman, 2004) shows that the personal injury accident rate within motorway road works areas has been falling markedly over the years whilst there has been introduction of improved protocols for traffic and speed management through these sites. The motorway PIA rate now is not significantly different in works than away from them – a decade previously it had been over twice that without works. This has been achieved in part through the general use of 50mph speed limits at such sites. The report studied a total exposure of over 4 billion vehicle km at several sites over the period 2001-2003. This can be considered good evidence that the speed limit reductions and associated safety policies are well suited to providing the appropriate level of mitigation of the increased risk inherent in the presence of works on motorways.

A further factor that is relevant at these sites is that much of the risk is to those working at these sites and HSE recommend higher protection for such workers than for vehicle occupants because of their more continuous exposure to the risk.

The EuroRAP analyses also show that traffic flow levels have a major influence on fatal and serious accident rates per vehicle km. Most HA single carriageways are likely to have relatively high flows however, and the accident rate for roads with AADTs of 10,000-20,000 vehicles is only about 40% higher than that for roads with AADTs of over 20,000. Rates on dual carriageways with AADTs below 30,000 can be double those on dual carriageways with AADTs of over 40,000. However, part of this difference is likely to arise from the difference in junction standards described above. Also the higher risk at lower flows is counter intuitive to most drivers’ expectation of risk differences and thus lower flows alone are unlikely to provide a good basis for justifying lower limits to the driver.

Apart from road works and hard shoulder running, therefore, it is difficult to identify, on the basis of historical accident data for individual features, other design conditions which might automatically justify a limit lower than the general limit for the road group. Further research might be useful to assess the likely changes in risk with certain weather conditions. An additional approach to assessing the potential risk of individual road sections is through visual inspection, as proposed for example in the EuroRAP Road Protection Score. This scores the quality of each section of road, based on roadside edge treatment, median treatment, and junction design. The risk scores associated with each of these factors are based on traffic speed on the road, and thus higher or lower scores would be obtained if the speed limit (and vehicle speeds) on the road were changed. A process is already being trialled by the Swedish Road Administration whereby higher speed limits will only be considered for road sections if certain minimum scores are achievable at that speed limit. The Agency is proposing to investigate the value of defining RPS style scores for their own network during the next year, and this could provide an additional basis on which to assess road sections for speed limit changes. The principle is consistent with that proposed in this report as the RPS score is intended to act as a proxy for the accident rate – although at present it focuses on the more severe accidents. This approach could also provide drivers with a more visual justification for the differences in speed limit, if they were made aware of the features by which lower or higher scores were obtained.

4 Fitting Speed Management strategy within current procedures

The speed strategy developed under this work will need to fit within the procedures currently used by the Highways Agency to improve safety on the trunk road network. These procedures are set out within the Highways Agency "Strategic Plan for Safety" which in turn is supported by a number of documents within the "Operational Folder". This section reviews the documents and the procedures currently in place and considers what advice is currently provided regarding the justification for implementing measures for reducing accident rates (through improving road quality or through application of a speed limit change).

Having considered what is currently in place, the integration of the speed strategy into the existing procedures is considered and an approach recommended.

4.1 Strategic Plan for Safety

The Strategic Plan for Safety is one of the eight plans currently within the Highways Agency's overall strategy. (The others cover Maintenance, Operation, Improvement, Economy, Environment, Accessibility and Integration). It is built around the 'New Approach to Appraisal" which aims to assess trunk road investment proposals against the Government's five criteria of accessibility, safety, economy, environment and integration.

The Strategic Plan for Safety's main objective is to support the Government's road casualty reduction targets. It sets out a number of tools that can be used, which are:

Infrastructure	• Identify and address accident problem sites • Upgrade existing routes by improving the skidding resistance of road surfaces at junctions and crossings, using clearer signing and road markings and better junction layouts • Calm traffic through villages • Trial innovative ideas through the Agency toolkit, a programme of 70 or more techniques and innovative ideas
Technology	• Introduce high-technology control equipment to warn drivers of potential hazards • Use traffic data collection technology to control access on to and speeds on the congested sections of the motorway network • Introduce new trunk road communications systems • Develop new equipment to monitor the performances of road surfaces to assist in maintaining and improving a safe road surface • Use new materials such as colour surfacing to enhance safety measures • Provide new equipment for keeping roads safe in winter conditions
Education	• Disseminate research knowledge to others involved in road design and operation • Support road safety officers in delivering safety education to local communities

Encouragement	• Support safety initiatives by other agencies or outside bodies • Investigate the display of safety messages on variable message signs
Enforcement	• Strengthen and improve liaison with the police • Aid the targeting of offenders through the provision of high-technology equipment to assist the police
Partnerships	• Strengthen links with other agencies and outside organisations to deliver a co-ordinated approach to the strategy • Encourage users to play their part in safety improvements
Management & Monitoring	• Ensure that agents, local authorities and Design, Build and Finance Operators are clear on their roles and responsibilities in supporting and implementing the strategy • Provide quality data for planning, priority setting and monitoring purposes • Report on progress to Ministers and user groups

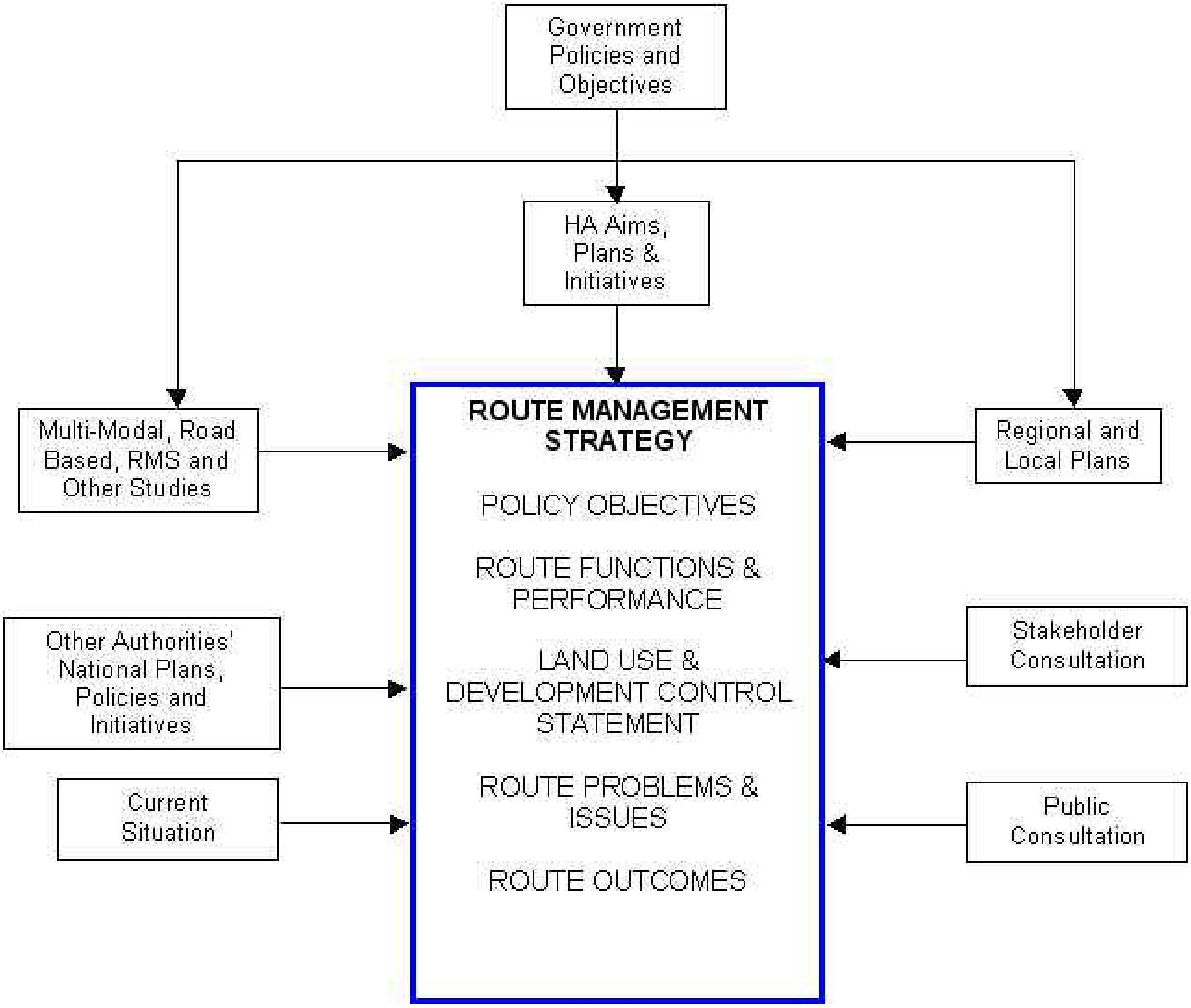
The items which are highlighted are the most relevant to the implementation of a speed management strategy. Addressing accident sites may involve some element of speed management (especially as the link between speed and accidents is well established.) Calming through villages is an important issue which has been investigated in recent research (Wheeler, 2002). There are also several technological options available including Safety Cameras (DfT, 2005) and Vehicle Activated Signs (Winnett and Wheeler, 2002).

The Highways Agency also has at its disposal tools for managing speed in certain conditions. MIDAS has been around for some years and is a system for protecting the rear of queues by introducing reduced speed limits on Motorways. A similar approach is also used on controlled motorways (South-West quadrant of the M25).

Coloured surfacing can also be used to change the look of a road and in conjunction with other measures can bring about a reduction in speed.

The Strategic Plan for Safety also sets out actions which can be used to deal with target groups. For example, for Car occupants one of the actions is continuing the use of safety cameras at speed-related sites.

The relationships between the various elements of the Highways Agency strategy are shown in Figure 4-1. The Strategic Plans, including that for Safety, are part of the box labelled ‘HA Aims, Plans and Initiatives’. The Strategic Plan for Safety is supported by a range of other documents in the Operational Folder for the Strategic Plan for Safety



From HA Route Management Strategy Guidance 2003
(http://www.highways.gov.uk/roads/rms/guidance_manual/index.htm)

Figure 4-1: Relationship between various elements of the HA's strategy

4.2 The Operational Folder

The Operational folder presents the process by which roads are evaluated for safety including the criteria used for selecting sites for further investigation and, where appropriate, for the implementation of safety measures. The main stages of the process are presented in Figure 4-2.

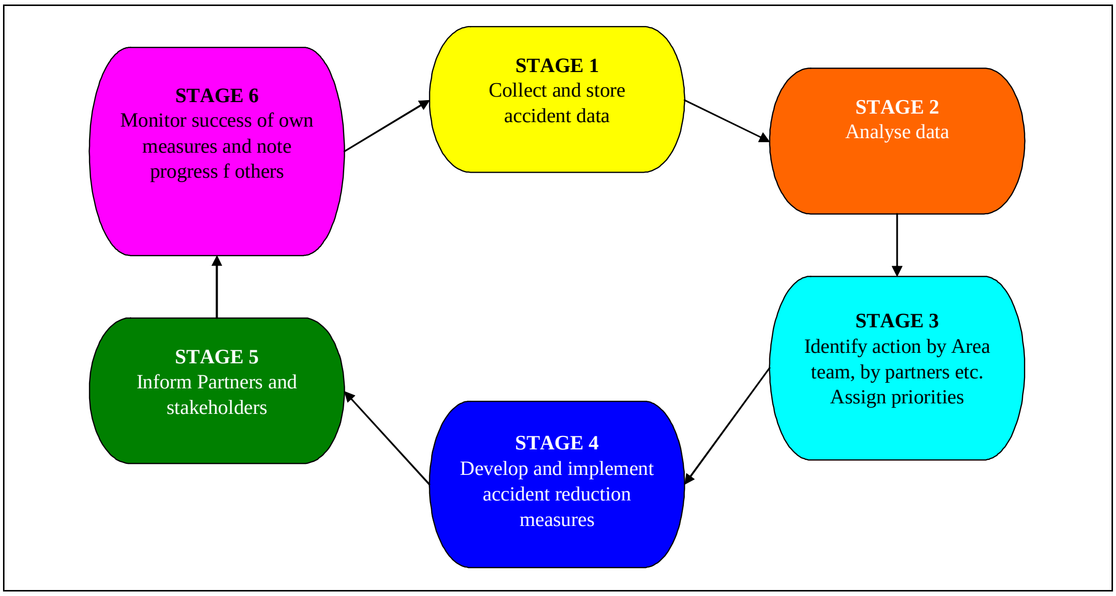


Figure 4-2: Evaluation Process

The process revolves around the collection of and interpretation of accident data which then feeds into an Annual Safety Report. This is now being replaced by the Area Safety Action Plan (see Section 4.2.1).

The Operational Folder makes reference to a number of other documents regarding the analysis of accidents these are:

- *Accident Reduction and Prevention. Institution of Highways and Transportation (1990),*
- *Road Safety Good Practice Guide, 1st edition. DTLR (2001),*
- *Road Safety Engineering Manual, 3rd edition. RoSPA (2002).*

4.2.1 Area Safety Action Plan

The Annual Safety Report brought together information on accident investigations and prioritising of schemes in the Area. The Area Safety Action Plan is a broader document which includes information about consultation, participation and the broader road safety issues of education, enforcement and health. It includes:

- Accident and casualty trends in the Area
- Road User Groups
- Stakeholder participation
- Management and co-ordination of road safety
- Resources and skills
- Management of accident database, analysis and road safety engineering
- Objectives
    - Road Safety Engineering Programme
    - Publicity, consultation and education
    - Enforcement
    - Health
- Budget

- Timescales and programming

Information from the Annual Safety Report or the Area Safety Action Plan is used in the formulation of an appropriate Area or Route Management Strategy (refer to Section 4.4).

4.2.2 Route Management Strategy Guidance

The accident data collection, accident analysis and identification of problem sites (as set out in the Operational Folder and summarised in the Annual Safety Report or the Area Safety Action Plan) are fed into the appropriate Route Management Strategy (Highways Agency 2003a), which sets out a strategic approach to improving a route. The process for developing the strategy is set out in the document “Route Management Strategy Guidance”.

The Route Management Strategy Guidance concentrates on evaluating the route in terms of function and performance and suggests that problem identification takes place through a number of methods including:

- Network Comparison (For example the Investigatory level approach – as described in Section 4.5 of this report)
- Current Conditions (including Route Characteristics and recorded incidents)
- Strategy and Wider Reference Group Consultation
- Public Consultation

The development of the strategy is dependent upon stating Policy Objectives and Existing Route Functions which will be addressed by the strategy. The Policy Objectives are sourced from various stakeholders and policy documents. An example of a policy objective may be to seek and ensure safe, easy access to facilities in local and rural centres.

The Existing Route Functions are more specific. An example may be to provide access to the Trans European Network (TEN) for freight traffic. Accidents on such a route would then be seen as a hindrance to this function and therefore a problem that needs to be addressed.

The combination of Policy Objectives and Existing Route Functions effectively provides the criteria for identify problems on the route and how they are to be prioritised.

Examples of the Policy Objectives that can be applied to a route are:

Economy

- To minimise road delays and congestion and to improve reliability of journeys.
- To continue to maintain the function of a trunk road.
- To provide information to travellers to contribute to a safe and economical journey.
- To contribute actively towards the efficiency and effectiveness of the route where this supports national and regional planning guidance and regional economic strategy.

Safety

- To reduce road casualties and their severity to produce a safer highway for all users.
- To produce a safer environment for non-motorised user groups.

Environment

- To protect and enhance the built and natural environment on the route.
- To reduce the impacts of traffic and transport on the environment including noise, light, air and water pollution.

- To enhance the living environment for communities along the corridor.

Accessibility

- To improve access to services and facilities along the route.
- To promote more frequent use of public transport and other motorised alternatives to the private car through influencing travel behaviour.
- To minimise the impacts of community severance caused by the route.
- To promote safer non-motorised travel for those using the route.

Integration

- To encourage improved interchanges and access between transport modes along the route.
- To support public transport services along the route.
- To encourage the evolution of a balanced and integrated transport system along the route.

4.2.3 Identifying and prioritising sites

The Operational Folder sets out a basic approach for accident analyses which is summarised in the following steps:

- Look at injury accident data for the relevant area for a period of 3 years[1]. The location of accidents should be plotted on maps (this can be done with a GIS system or an accident analysis package) to allow identification of specific accident sites and, equally importantly, route or area issues.
- Examine accident patterns in terms of type, contributory factors and location, considering accident numbers and rates, for each class and type of road[2]. This will be done by Safety Engineers in consultation with other road safety experts to consider both engineering and non-engineering causation factors.
- Identify any significant changes in accident trends and factors over time.
- For each road in the area, tabulate key results as you carry out the detailed analyses.
- Prioritise both within and between routes for further investigation/treatment.

4.2.4 Current justification for application of measures for improving road standard

Within the Operational Folder, there are no specific guidance or selection criteria for the types of measures to be applied in order to address identified problems.

Within the current Highways Agency procedures there are processes for carrying out an economic assessment of potential schemes (COBA for large schemes and the PAR form for other schemes). The main criterion for selecting one measure over another is simply the benefit divided by the cost, ie. First Year Rate of Return. Therefore, to obtain approval, a safety scheme will need to compete against others for funding out of the Local Network Management Scheme (LNMS) safety budget. This means that schemes using low cost measures are more likely to be prioritised.

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[1] Three years is generally preferred. If accident numbers are high (hundreds or thousands) then one year's data may be sufficient. However, if numbers are small and the data are broken down further into small groups by type of accident, for example, then the data will vary too much between years or sites for meaningful comparisons to be made and may be misleading. Much more than 3-5 years data will lead to a tendency for changes in flow and significant changes to the network to affect the accident picture

[2] This should include an analysis of types relevant to local and national targets and performance indicators, as appropriate – e.g. will include accidents including child casualties, vulnerable road user casualties and analyses by severity

However, it should be noted that the benefit of a scheme can be measured against the Government's five criteria of accessibility, safety, economy, environment and integration. Therefore a safety scheme might be perceived as having other benefits. For example, a scheme that leads to reduced speeds might lead to environmental (lower traffic noise) and access (easier to cross road) improvements.

Information on the potential benefits (in accident reduction terms) of different measures is not indicated in the various support documents. However, there are two existing documents that are relevant to the selection of measures; "Guide to Route Treatments" (HA 2003b) and "Road Safety Good Practice Guide" (DfT 2001).

The Guide to Route Treatments emphasises the importance of providing a predictable road environment for the driver by designing a route treatment which incorporates:

- Consistent types and levels of signing and markings appropriate to the road geometry (especially at different types of bends and junctions)
- Consistent speed limits
- Clear, uncramped directional signing
- Devices to alert drivers to particular unexpected hazards
- End points of the treated section of route that are compatible with the adjoining sections of road.

The document goes on to suggest options for treatment including:

For lengths of road
- Consistent speed limits with clear reasons for changes in limit
- Consistent signing
- Reduction in sign clutter
- Consistent road markings
- Enforcement by static and mobile safety cameras

For specific sites
- Village town gateways
- Junction signing and marking
- Improved footways
- Vehicle activated signs
- Anti skid surfacing
- Bend signing and marking
- Improved parking, crossing facilities

Although a list of potential treatments is provided there is no guidance on what treatment should be applied where and how effective the treatment is likely to be.

The "Road Safety Good Practice Guide" includes a section on treatment selection. With specific reference to 'rural' roads it emphasises the need to ensure that vehicle speeds are appropriate to the conditions.

Therefore, within the Operational Folder documentation there seems to be no mechanism for determining which measures should be used in different circumstances. For example, there is no guidance as to the likely impact on accident frequency of using Vehicle Activated Signs or Safety Cameras. The only justification for the application of a measure is in economic terms. For example, choosing a measure that gives the maximum FYRR, once a decision has been taken to improve the road. (The First Year Rate of Return requires that an estimate is made of the effectiveness of the measure. It is this information which is lacking.)

It should be noted that in relation to this, information on the likely impact on safety of geometrical changes to rural roads and junctions has been incorporated into SafeNET2 (a computer program that implements both rural and urban accident frequency prediction models) developed by TRL (see www.trlsoftware.co.uk). By inputting information about expected vehicle, pedestrian flow and geometric changes into the SafeNET program the expected effectiveness of geometrical measures can be determined.

On the question of whether there is a need for some form of remedial action on a road the Operational Folder is more explicit.

The Operational Folder (Annex 5), and the recently published ARRIL guide (TRL, 2005) to rural road accident analysis, both propose accident levels which might trigger investigation of the scope for improving the safety of a road. One set of these triggers relates to injury accidents per vehicle km. The investigatory levels are set at the average accident rate for the road type (based on 1997-1999 accident data). These are therefore substantially lower at 10 for motorways and 16 for dual carriageways than the rates of 55 and 40 estimated in this report to justify reduced speed limits on these roads. On single carriageways, the two rates are somewhat closer – 20 being recommended as the investigatory level and 37 as the rate for reducing the speed limit from 60mph to 50mph. This appears to emphasise the desirability of speed limit reductions only being made in the worst case and only when improvements to road standards are not likely to yield a benefit.

4.2.5 Current justification for speed reducing measures

There seems to be no justification for the use of speed reduction measures within current Highways Agency procedures. The COBA manual includes a calculation for determining the likely vehicle speed on a scheme but, crucially, speed limit is not included in this calculation and elsewhere in COBA there is no link between vehicle speed and the predicted frequency of accidents (which is exclusively based on vehicle flows and geometry).

4.2.6 Summary

Within the Operational Folder the criteria currently used to choose sites for improvement are the accident record and the comparison of that record with national accident rates or frequencies for similar locations. There is no reference to the speed of drivers along the routes or the quality or appropriateness of the route. There is little guidance on which measures should be implemented.

The Route Management Strategy Guidance indicates the need to develop Policy Objects and Existing Route Functions in order to identify what actions need to be undertaken on the route. Without specific guidance, issues like determining whether or not vehicle speeds are appropriate to the route may be missed.

4.3 Integration of a speed strategy into existing procedures

A speed management strategy will include an economic assessment that will balance the cost of vehicle speed reductions against the benefits in terms of reduced accidents and improving the road so that vehicle speeds are appropriate. Given the economic nature of the current measure selection criteria it would seem that this approach is wholly consistent with the procedure which is currently adopted.

Whether this will lead to the introduction of different measures is difficult to quantify. Without the use of a speed management strategy the measures will be directly focused at treating accidents. Those treatments may in themselves lead to a speed reduction – a form of speed management. However, the opportunity should be taken to improve guidance on the types of measure that are available and the likely impact of these measures. (This is considered in Section 5.)

There are two basic levels at which a speed management strategy could be implemented: Nationally and locally. Nationally would require a systematic assessment of all road sections at the same time. This would need a new procedure to be developed and progressed on a regular basis. Locally would involve regular local assessment, preferably integrated with existing well established procedures. It is important that local factors are fully understood and given appropriate weight in applying the strategy to each area, the final decisions ultimately being made locally.

As the vast majority of road sections on the trunk road network would seem to have appropriate speed limits in place, and regular Annual Safety Reports are already produced, it seems most appropriate to integrate the strategy into existing “local” procedures as set out in the Operational Folder.

As noted previously (section 4.2), the Operational Folder presents a process by which roads are evaluated for safety. This process involves six stages. If the speed strategy is to be integrated into this process, it will have to be integrated into Stages 2 and 3 where ‘investigatory’ levels are considered.

The current procedure requires that accident frequency per 100 million vehicle-km is determined and then compared with the average accident frequency for that type of road. If the frequency is greater than the average, an intervention should be considered. A way of integrating speed management into the process is to include a second set of investigatory levels above which speed limit reduction should be considered, but only if it is not considered possible to improve the road standard. This could either be integrated directly into the existing investigatory level tables, or form a separate procedure

The new procedure would only be invoked if the higher “Speed Management Investigatory” level is exceeded. The first consideration should be to improve road standard through the use of various interventions (as outlined in Section 5 of this report). Consideration should then be made to assessing whether further speed reduction measures are needed to reduce accident frequency. If the measures for improving the quality of the road are unlikely to lead to accident reductions on their own, consideration should be given to reducing the speed limit, supported by speed reduction measures. This should take into account the current speed of vehicles on the link and the likely compliance to the new limit.

Identifying sections where Speed Management Investigatory levels have been exceeded would be determined from a table similar to that presented in Table 4-1.

Table 4-1: Speed Management Investigatory levels and appropriate actions.

Road type	**Current Speed limit**	**Personal injury accident rate investigatory level (per 100millon vehicle-km)**	**Primary Action**	**Secondary Action (to be applied if primary action is ineffective at reducing accident rate to less than investigatory level)**
Single carriageway	60mph	Above 37 per 100 million veh km	Consider measures to improve road quality	50mph speed limit
		Above 85 per 100 million veh km		40mph speed limit
Dual carriageways	70mph	Above 40 per 100 million veh km		60mph speed limit
		Above 86 per 100 million veh km		50mph speed limit
	60mph	Above 86 per 100 million veh km		50mph speed limit
Motorways	70mph	Above 55 per 100 million veh km		60mph speed limit

As the Speed Management investigatory levels are higher than the existing investigatory levels, consideration should be made to making action mandatory on road sections which exceed the speed management invesytigatory levels.

In order to raise awareness of speed management within Route Management Strategies, it may also be appropriate to ensure that at least one Policy Objective refers to this. For example, it may be appropriate to ensure that one Policy Objective is “to ensure that Speed limits are appropriate to the standard of the road”.

Once a section has been identified by the Speed Management Strategy it is necessary to decide the most appropriate action, whether this is to improve the road standard or reduce the speed limit. To inform this decision it is necessary to identify what actions can be taken and what effect these actions will have. Potential measures for improving road standards are considered in Section 5, measures for reducing inappropriate vehicle speeds are considered in Section 6.

5 Potential Measures for improving road standard

There are a number of measures that can be applied to improve the road standard and reduce the frequency of accidents.

Several different types of measure have been recorded in the MOLASSES database (Gorell and Tootill, 2001) which contains details of safety schemes submitted by Local Authorities. The effectiveness of these schemes have been analysed and the results relevant to rural roads are presented in Table 5.1.

Table 5-1: Maximum effectiveness of treatments for rural roads for schemes recorded

Treatment	Urban or rural	Number of schemes	Average annual accidents saved	Total accidents			
				Before	After	Change	Change %
Cycle Schemes	Both	5	4.87	150	52	-98	-58
Anti skid surfacing	Rural	4	2.08	40	15	-25	-62
Markings	Rural	74	0.88	599	370	-229	-35
Guard rails and pedestrian barriers	Rural	3	2.01	49	26	-23	-41
Lighting	Rural	5	0.22	44	38	-6	-8
Pedestrian crossing	Rural	2	1.88	18	3	-15	-83.
New mini or conventional roundabout	Rural	15	2.62	216	45	-171	-76
New signals	Rural	8	1.93	93	20	-73	-75
Modification to Signals	Rural	10	1.96	135	66	-69	-48
Signing	Rural	136	0.70	879	521	-358	-37
Yellow bar markings	Rural	2	1.17	19	12	-7	-37
Mass action schemes	Rural	11	3.11	151	50	-101	-68
Route action schemes	Rural	15	1.31	128	64	-64	-49
Area wide schemes	Rural	1	6.67	23	3	-20	-87

Table 5-1 presents information for selected types of treatment for rural settings. The number of schemes refers to any schemes that contain the treatment type used. The treatment might be one of many applied at the same scheme. The Average Annual Accidents Saved, Total Accidents and percent change refer to the schemes and not the treatments, and so represent the maximum effect of the individual treatments. It should be noted that the effectiveness of measures presented in Table 5-1 is based on a sample of installed measures and therefore the overall effectiveness of all measures may be different to that shown.

Two studies have been carried out into the factors that influence safety on inter-urban single-carriageway (Walmsley, Summersgill and Binch, 1998b) and dual-carriageway roads (Walmsley, Summersgill and Payne, 1998c). The main conclusions from these studies are summarised below.

The factors that influence safety on ‘Inter-urban’ dual carriageway roads are presented in Table 5-2. This table also presents the influence each factor has on the overall frequency of accidents and the types of accident that are affected. Most if not all these factors could be influenced to improve road quality.

Table 5-2: Factors that influence safety on inter-urban dual carriageway roads

Measure or factor	Potential effect – all injury accidents combined	Accident type affected and likely effect where indicated
Edge Treatment	Roads with kerbs which were not set back behind a hardstrip have about 30% more accidents than those without kerbs or with set-back kerbs.	Kerbs which are not set-back on offside lead to 36% more overtaking accidents, 72% leaving carriageway on offside accidents and 58% more accidents involving a vehicle stopped or held up in carriageway.
Central reserve treatment	A 10% increase in the proportion of central reserve with continuous unprotected objects leads to a 15% increase in accidents	Overtaking Vehicle stopped or held up in carriageway.
Safety fence on median	Roads with safety fence on median have 3% less accidents	33% less accidents involving vehicle crossing central reserve (where more than half the road has median safety fence). 57% reduction in accidents at accesses. 11% increase in ‘other multi-vehicle accidents
Alignment - Bendiness		Bend accidents – Increase of 10 degree/km in bendiness increases accidents by 20% Single-vehicle not leaving carriageway accidents – Increase of 10 degree/km in bendiness increases these accidents by 6% All single-vehicle accidents combined – Increase of 10 degree/km in bendiness increases these accidents by 5% All two-vehicle accidents combined – Increase of 10 degree/km in bendiness increases these accidents by 4%
Alignment - Hilliness	Increase of 1m/km leads to 1% increase in accidents	Increase of 1m/km leads to 2-3% increase in single vehicle leaving the carriageway offside at a bend accidents Increase of 1m/km leads to 2-3% increase in vehicle crossing the central reserve accidents
Visibility		100m reduction in maximum visibility leads to 25% increase in pedestrian accidents
Accesses	An extra access results in 4% more accidents	Extra access leads to 20% more accidents for turning and access accidents
Design speed		Design speed of 120km/h was found to be safer than design speed of 100km/h for single vehicle accidents where the vehicle left the carriageway on the nearside

The factors that influence safety on ‘Inter-urban’ single carriageway roads are presented in Table 5-3.

Table 5-3: Factors that influence safety on inter-urban single carriageway roads

Measure or factor	Potential effect – all injury accidents combined	Accident type affected and likely effect where indicated
Carriageway width	Wide carriageways have 27% fewer accidents per scheme than standard width carriageways	
Hardstrip	Presence of hardstrip reduces accidents by between 16 and 30%	
Gradient		Up hill gradient reduces single-vehicle accidents by 4% per metre/km

In addition, there has also been a study into inter-urban roads which covered both single and dual carriageway roads (Walmsley and Summersgill, 1998a). The main conclusions with respect to the factors that influence safety are presented in Table 5-4

Table 5-4: General factors influencing safety on inter urban single and dual carriageway roads

Measure or factor	Single carriageways	Dual carriageways
Design standard (Roads opened since mid 1980s are safer than roads opened 1968 to 1980.)	14% fewer accidents	8% fewer accidents
Extra major junction	11% increase in accidents	22% increase in accidents
Extra minor junction	6% increase in accidents	6% increase in accidents
Hardstrip (both sides in comparison with roads with no hardstrip either side)		16% fewer accidents
Carriageway type (Dual compared with Single carriageway)	--	Between 37% and 56% fewer accidents

6 Potential measures for reducing inappropriate speeds

This section considers potential measures for reducing speeds if they are too high for the road quality and thus the appropriate speed limit.

6.1 Measures for reducing speed and their overall effectiveness

There are a number of measures which can be applied to reduce the speed of traffic on rural roads and/or motorways. These are:

- Live (or reactive) systems
    - Controlled Motorways
    - Safety cameras
    - MIDAS
    - Vehicle activated signs
- Static mechanisms
    - Speed limit change
    - Advisory speed limits
    - Coloured surfacing
    - Narrowing
    - Signing
    - Rumble devices
    - Gateways

6.1.1 Controlled Motorways

Controlled Motorways is a variable speed limit system on the M25. The system sets reduced speed limits depending upon traffic flow. The main difference between Controlled Motorways and MIDAS (see 6.1.3) is that the Controlled Motorway speed limit signs are mandatory as opposed to advisory.

There is no current or recent information on the impact of the system on mean speeds. However, the system has reduced injury accidents by 10% and damage only accidents by 30%.

An analysis of speed compliance at the M25 Controlled Motorway was undertaken shortly after the signs became active (Rees et al, 1996). When the mandatory speed limits were set at 60mph the average speed in lane 1 reduced from 62.3mph to 58.6mph. A second assessment was carried out with drivers encountering successive sections of the motorway with and without the 60mph speed limit applied. The overall average speed for the first controlled 60 mph speed limit section was 60.0 mph, compared with a speed of 64.9mph for the prior uncontrolled section. For the second controlled 60mph speed limit section the average speed was 59.3 mph.

In addition, speeds were also analysed when the mandatory speed limit was set to 50mph. In this case, drivers encountered a speed limit of 60mph before entering the 50mph speed limit section. The average speed before the 50mph limit was displayed was 53.8 mph, and the average speed after was 49.4 mph.

6.1.2 Safety Cameras

The DfT recently published a four-year evaluation report on the national safety camera programme (DfT, 2005). This report looked at how vehicle speeds had been affected by the introduction of cameras at rural sites. These results are summarised in Table 6-1.

Table 6-1 : Effectiveness of safety cameras at reducing speed on rural roads

Speed limit	**Sites**	**Change in Average speed**		**Change in 85th percentile speed**		**Percentage change in vehicles exceeding the speed limit**	**Percentage change in vehicles exceeding the speed limit by more than 15mph**
		mph	**%**	**mph**	**%**		
50mph	76	-1.9	-4%	-2.1	-4%	-24%	-53%
60mph	273	-1.4	-3%	-1.9	-3%	-22%	-35%
70mph	61	-1.7	-3%	-1.9	-3%	-16%	-8%
Rural Total	410	-1.5	-3%	-1.9	-3%	-22%	-36%

The reduced speeds were associated with a reduction in the frequency of personal injury collisions at camera sites. Within the partnership areas, the overall number of PIAs at rural camera sites fell by 22%, estimated using a statistical model that took into account factors such as seasonal and long term trends.

6.1.3 MIDAS

MIDAS is a queue warning system for Motorways. When in-road sensors detect a queue the advisory speed limit signs are activated. In a recent evaluation for the Highways Agency the system was found to have reduced accidents by 13% a year.

Although the system has been in operation for sometime, no evidence is available on how vehicle speeds change as a result of the activation of the signs.

6.1.4 Vehicle Activated Signs

A large scale evaluation (Winnett and Wheeler, 2002) was recently carried out on the effectiveness of Vehicle Activated Signs. The main conclusions from this evaluation were that at signs where an illuminated ‘speed limit roundel’ was used, mean speeds of the traffic as a whole were reduced by between 1mph and 14mph, the higher reductions being where the speed limit had also been reduced by 10mph. The average reduction in mean speed where there had been no change in the speed limit was 4mph (range 1mph to 7mph).

Where ‘junction’ and ‘bend’ warning sign logos were used, the mean speeds reduced by up to 7mph. Where a ‘safety camera’ logo was used it yielded a reduction of up to 4mph. Speeds exceeding the limit were also reduced, with the reductions tending to be greater at the roundel signs.

Most of the speed-limit roundel sites were on roads with 30 or 40mph speed limits. However, at the one site on a 50mph speed limit road, the mean speed reduced by 4mph.

There were more junction and bend warning vehicle activated signs on roads with 50, 60 and 70 mph limits. The average mean speed reduction at these sites was about 5mph.

6.1.5 *Effect of speed limit change*

A report carried out on behalf of the Department for Transport (Finch et al, 1994) suggested that in the absence of other measures a 10 mph reduction in speed limit produces a 2-3 mph reduction in speed.

An analysis of the effects of advisory speed limits on Motorways (Lines, 1979) suggested that the average speeds of light vehicles in the right-hand lane was reduced from about 77 mph to 69.5 mph (9.5 per cent); in the centre lane from about 68 to 63 mph (7 per cent); and in the left-hand lane from about 55 to 52 mph (5 per cent). With regard to permanent advisory limits a study of advisory speed signs for bends (Rutley, 1972) suggested that these signs could have a significant effect on the mean speed of vehicles negotiating the bends when the advised speed was different from the mean speed of vehicles prior to the posting of the advisory speed. If the mean speed of vehicles was initially higher than the advisory limit, mean speeds reduced by up to 1.5 mph. However, if the advisory speed limit was higher than the mean speed, it could produce an increase in mean speed of up to 3 mph. Therefore, the advisory speed should always be less than the measured mean speed.

6.1.6 *Coloured surfacing, Gateways, Narrowings, Signing and Rumble devices*

These measures are likely to be applied at a specific location to warn of a particular hazard. The evidence of the effectiveness of these measures on vehicle speed is very limited. However the effectiveness of some of these measures were reviewed in 2002 (Wheeler, 2002). Most of these measures were applied near or within villages, although it should be noted that calming traffic through villages is a tool within the current Highways Agency strategy. The results are summarised in Table 6-2.

Table 6-2: Effectiveness of some speed reduction measures

Measure or factor	Application	Speed reduction
Gateway treatments	Signing/marking	1-2mph
	More comprehensive marking	5-7mph
	With physical measures	10mph
Bar markings	Away from villages –varying colours and locations	1-7mph
Rumble Strips	Away from villages	6mph

6.2 Route treatment example – Area 4 (A21, Kent)

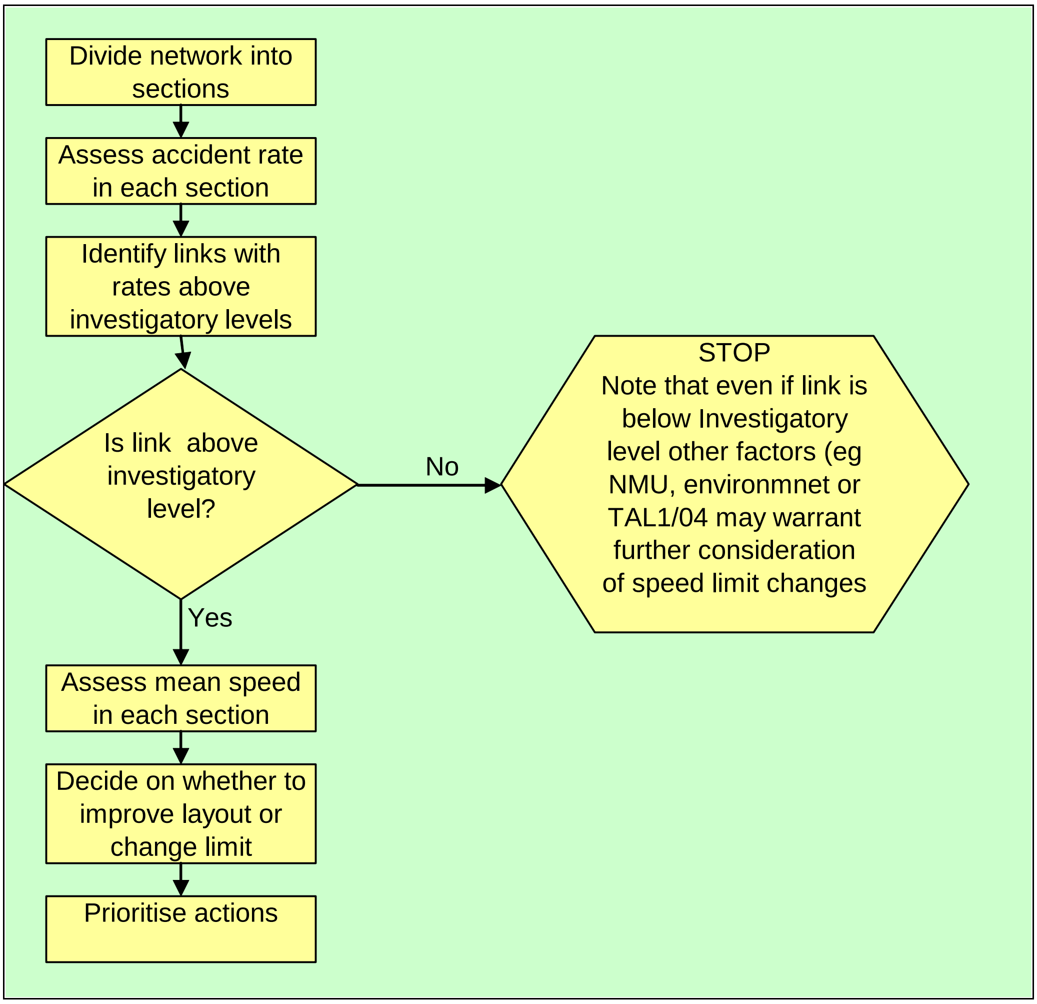
Excellent feedback was received from the managing agent for the A21 in Kent to the general request for information on current practice. Further to the interim report’s comments on the treatment of this road, the agent’s presentation of their concerns and solutions was instructive. It is clear that the route is being approached firstly to make it safe to carry the required traffic flow at high speed, then secondly to reduce the speed where it is impossible to mitigate the physical hazards that are presented to drivers along the route.

Much of the treatment is based on solving particular types of accident problems at particular locations. Often these are due to layouts of junctions that have poor visibility, such as on the crest of a hill on a short section of dual carriageway which provides a rare opportunity for overtaking and is consequently associated with high speeds. The solutions to these appear to be considered firstly from the standpoint of physical engineering improvements to the layout and secondly in respect of selecting an appropriate speed limit for the new layout. Additionally, there was some frustration evident with regard to local political pressure which led to the imposition of a reduced limit in an area of low density residential access to the detriment of treating an adjacent link which has an objectively measured higher risk of accidents due to poorer alignment and other features. The agent was clear in expressing his concerns that such inconsistencies generate a poor level of understanding in drivers and thus fail to be effective in promoting safer use of the route.

Overall, existing practice in this area represents a clear endorsement for the wider application of a strategy that meets the aims set out for the HA policy.

7 Application of speed limit strategy

The following six steps will be needed to implement a speed limit strategy.



1. <u>Divide the network into sections over which different limits might be considered</u>

Any change in speed limit needs to be applied over a sufficiently long length for

- drivers to understand the justification for it
- drivers to be aware and adjust speeds appropriately
- effective enforcement to be practical
- the change to be cost effective

The section ends are likely to be points where either the layout of the road or the management of traffic on the road changes.

For all-purpose roads, a minimum length of **600m** is recommended in Circular 1/06 for any change in speed limit, although this can be reduced to 400m in extreme cases. Given the higher speeds on motorways and dual carriageways, a minimum distance of say 1000m might be considered appropriate on these roads.

In the case of limited access roads (eg those with grade separated junctions) it might also be appropriate to start or end sections at junctions. This could also make steps 2 and 3 (defining speed and accident data for the section) much easier if existing databases are generally based on junction to junction lengths.

2. Assess mean speed in each section

It would be convenient to extract accident data directly from HAPMS if the road section structure could be matched to that for which changes in speed limit might be considered. Flow data will need to be obtained from the TRADS database to calculate the accident rate (accidents per 100 million veh km).

3. Identify links operating at the target speed limit with accident rates above the investigatory limits

Accident rates obtained from step 2 can be compared with the investigatory levels defined in Section 5 above for different speed limits for the relevant road type.

Decision Point

Further steps are only carried out if there are links which have accident rates above the investigatory levels.

Nevertheless, for all purpose roads, it is proposed in Circular 1/06 that the presence of substantial vulnerable road user activity or other environmental concerns should also be taken into account in the choice of speed limit. Traffic Advisory Leaflet 1/04 details some of the considerations for roads passing through villages, where non-motorised users (NMUs) are of primary concern. In these cases there is still an expectation that speed limits will be reduced and managers will need to consider their correspondence with road users and residents in assessing priorities.

It is possible that some roads may be operating at a lower speed limit than is necessary. In these cases consideration can be given to local conditions and to the possibility of increasing the limit. For example there may be cases where a road has undergone a number of improvements and measured speeds are higher than the limit, but there is no an accident problem. In these cases it may be appropriate to consider raising the speed limit.

4. Assess mean speed in each section

Circular 1/06 specifies that mean speeds should be used to determine local limits as this is felt to reflect what the majority of drivers perceive as the appropriate speed for the road. The aim should be to align the local speed limit so that the original mean speed driven on the road is at or below the new posted speed limit for that road (Circular 1/06)

These will generally be ‘free flow’ speeds. TA 22/81 - Vehicle Speed Measurement on All Purpose Roads – describes the use of radar or inductive road loops to measure speed and defines ‘free flow’ conditions. It would be very convenient if estimates of mean speed could be based on journey time data collected for the purposes of general monitoring of network congestion and journey time performance. In the absence of such data, the Traffic Appraisal Manual describes the moving observer method which would provide appropriate estimates. For the purpose of the overall speed limit, it is car speeds that are relevant; speeds of other vehicles will be affected by their own vehicle limits. Modern video techniques exist for recording in-car speeds and camera technology using number plate recognition can establish speeds over reasonably long lengths of road. However, it is important that whatever method is used it should be inconspicuous and should not make drivers change their normal behaviour

5. Decide whether to improve the layout or reduce the speed limit

Where there is a mismatch between the speed limit under which the road is currently operating and its accident level (i.e. it is above the accident investigatory level), this could be resolved by either improving the road design to reduce the accident rate below the investigatory level or by reducing the speed of traffic on the road to reduce the risk. In general the strategic role of the network means that road improvements to allow the higher speed limits will be the preferred option. However, it may be appropriate to consider a lower speed limit as a temporary measure pending improvement of the road, or as a more permanent measure where road improvements are not practicable or appropriate. In either case it will be necessary to ensure that drivers comply with the lower limit, either voluntarily or after the provision of speed reducing measures. This may require higher levels of enforcement, but could also make use of other technological developments such as Vehicle Activated Signs. In some cases it may also be appropriate because of local conditions to make relatively minor changes to the layout but to also reduce the speed limit to reduce the accident risk.

To decide on road quality improvements it will be necessary to investigate accident patterns as for other LNMS. This is fully described in Annex 3 of the Operational Folder and will involve consideration of detailed analysis of accident types on the road section, as well as traffic flows and manoeuvres. The scope for traditional improvements to surfaces, junction design or road markings will be part of the decision making process but it may also be appropriate to consider innovative ideas from the ‘Good Ideas’ section of the Operational Folder. More information on potential measures available is given in section 7 below.

If a speed limit change (either as an interim measure, or as a permanent solution) is appropriate it will be necessary to go through the standard procedures for limit setting laid down in Section 81-84 of Part VI of the Road Traffic Regulation Act 1984.

It should be noted that Area Managers have the delegated power to make the speed limit decisions. This does not need to be referred to SSR.

6. Prioritise action within the existing improvement programme

Routine accident data monitoring carried out by agents should already be highlighting sections of road with high accident numbers. The procedures used may need to be modified slightly to look also at accident rates in relation to traffic flow. Any schemes for layout improvements and speed limit changes resulting from the review of speed limits will be taken forward as part of the LNMS programme and will be subject to the LNMS value management process, which includes an assessment of rates of return. There will inevitably be a comparison of the rates of return from these changes with those available through investment in other LNMS. However there will also be a need to take a wider view to ensure consistency of approach along routes as well as across the network

8 Trial of application of the strategy

8.1 Objectives

The main objectives of this trial were to:

- Check the ease of defining road sections to consider for revised limits; the trial should provide guidance to future users on the length of sections to consider.
- Investigate the availability of data to make the relevant assessments as to whether sections complied with the rules proposed in the strategy
- Review the appropriateness of the proposed accident rate thresholds in terms of their face validity and the integrity of the speed limit pattern they produce.
- Estimate how many road improvements or speed limit changes might be needed to comply with the proposed strategy.

It was originally envisaged that the trial might need to access local data, but a methodology was developed based on data held nationally to illustrate the issues involved. In practice, assessments would be done at local level using both local accident data and local knowledge of the suitability of the road link to remedial treatment.

8.2 Identification of links with a high accident rate to assess in more detail

Section 3.2 showed the number, and total length, of Agency roads with accident thresholds above those assessed as appropriate for their road type, assuming the standard speed limit for these roads. But some of these roads may also be operating in part or throughout at lower speed limits. To assess more accurately on how many roads remedial action may be needed to meet the criteria proposed in the strategy, a more detailed analysis was carried out for all the links that had been identified in Section 3.2 as falling outside the criteria. The aim of this was to explore the extent to which the higher accident rates resulted from either the existence of sections which already had lower speed limits, or the existence of concentrations of accidents around major junctions such as roundabouts. In the latter case, it might be expected that remedial work would focus on the junction itself rather than speed limit reduction over a longer length of the link. In the case of mixed character links it was also relevant to assess the extent to which a higher rate arose mainly from a high proportion of accidents occurring on a single carriageway section of road even if this did not comprise the majority of the route.

Data is not available on the current speed limits on these roads, but a good approximation is obtained by using the coding of speed limit at the time of the accident.

Table 8-1: Motorway links with high accident rates.

Identifier	Route	Length (km)	Accidents	Acc/100 mvkm	% less than 70mph	% at round-abouts	Percentage on SC part of link
117527	M40 Spur at J3	0.4	1	56	0%	0%	0%
117838	A308(M)	1.2	6	60	33%	100%	0%
117796	A40 Spur at J8	2.2	2	67	100%	0%	50%
118020	M5 Spur at J22	0.5	3	74	33%	33%	0%
117919	M275	0.6	7	85	14%	14%	0%

None of these appeared likely to warrant speed limit changes despite their high rates, as they were all very short length, and the two with longest lengths either already had lower limits or had all their accidents concentrated at a roundabout.

Table 8-2 Non-Motorway Dual Carriageway links with high accident rates.

Identifier	Route	Length (km)	Accidents	Acc/100mvkm	% less than 70mph	% at roundabouts	% on SC part of link
108348	A449	5.0	19	41	37%	11%	32%
102552	A556	9.8	33	41	36%	18%	15%
102532	A5	0.8	3	41	0%	0%	0%
102641	A52	8.7	53	42	64%	49%	9%
102216	A419	5.7	40	42	23%	45%	0%
102780	A38	3.0	16	42	31%	56%	0%
102198	A417	17.6	18	42	67%	22%	44%
102064	A20	14.0	55	43	71%	31%	25%
103140	A580	7.7	29	45	10%	7%	0%
103718	A19	3.9	18	46	17%	11%	0%
103192	A5117	3.4	19	46	16%	21%	0%
102743	A5	4.8	21	46	76%	10%	43%
102185	A423	1.9	16	47	50%	50%	0%
271841	A50	6.0	48	47	100%	21%	2%
102116	A49	1.1	8	47	100%	0%	13%
103156	A41	10.3	50	48	100%	6%	40%
102022	A27	6.9	55	48	55%	9%	15%
102644	A6514	3.5	27	49	100%	22%	0%
102506	A12	1.1	6	52	83%	83%	0%
102360	A41	2.2	12	53	42%	33%	8%
108363	A405	2.8	15	54	40%	33%	13%
102269	A41	1.2	10	54	90%	30%	0%
103503	A52	0.6	1	55	100%	100%	0%
103150	A570	8.8	25	55	28%	4%	12%
102980	A43	1.6	3	55	67%	33%	0%
102182	A44	0.8	6	56	67%	67%	0%
108359	A10	4.0	40	57	48%	8%	0%
102253	A10	2.3	21	58	0%	0%	0%
102189	A40	3.6	22	60	45%	41%	0%
103444	A1	0.7	8	60	25%	25%	13%
102218	A40	2.4	21	61	67%	48%	0%
104116	A6	2.0	15	63	100%	0%	53%
103827	A5036	5.4	37	64	89%	3%	8%
101971	A63	1.9	21	64	100%	29%	0%
103886	A6514	3.8	27	64	100%	15%	22%
101956	A303	3.5	18	66	6%	56%	6%
104174	A6120	2.1	16	67	100%	38%	25%
102250	A14	1.5	10	68	0%	0%	0%
103792	A565	2.6	22	70	100%	0%	9%
102867	A516	1.0	9	72	67%	44%	0%
104148	A5111	9.1	69	75	99%	14%	25%
102544	A4123	5.3	39	76	97%	8%	5%
102224	A4123	3.9	22	76	100%	0%	0%
103715	A19	1.6	13	81	54%	15%	0%
102580	A34	1.2	5	81	100%	60%	0%
103221	A663	4.1	33	83	100%	0%	21%
102741	A4123	3.8	32	85	100%	13%	6%
102966	A10	0.8	5	92	100%	100%	0%
102358	A30	2.4	40	98	55%	55%	0%
102796	A46	1.1	9	118	78%	67%	0%
103789	A41	0.5	6	131	100%	50%	17%

Table 8-3 Single Carriageway links with high accident rates.

Identifier	Route	Length /km	Accidents	Acc/100mvkm	% less than 60mph	% at roundabouts	% on DC part of link
102812	A5	12.0	36	35	22%	17%	39%
102083	A27	7.5	15	35	20%	0%	27%
102673	A5	16.4	14	36	29%	14%	0%
102837	A446	7.7	20	36	0%	20%	15%
102090	A21	19.8	52	36	15%	4%	12%
103513	A57	8.0	13	36	38%	54%	0%
103018	A134	8.0	6	36	33%	0%	17%
103013	A10	9.0	12	36	0%	8%	0%
102994	A47	9.0	22	36	5%	9%	0%
101997	A27	14.5	42	37	26%	2%	7%
103429	A1237	7.7	25	37	4%	48%	4%
103622	A65	4.3	7	37	0%	43%	0%
102439	A10	13.9	26	37	19%	8%	0%
102964	A10	19.3	46	37	0%	26%	0%
104021	A63	14.9	18	38	50%	6%	0%
103365	A500	3.6	13	38	0%	31%	0%
102111	A49	19.1	36	38	42%	8%	6%
108337	A595	69.5	78	38	44%	6%	4%
101958	A36	7.6	14	38	0%	21%	7%
108368	A21	16.7	31	39	35%	0%	3%
103501	A57	13.0	39	40	33%	28%	13%
102645	A614	9.8	21	41	0%	14%	0%
102882	A46	11.6	33	42	36%	45%	3%
103518	A614	5.4	6	42	0%	0%	0%
101985	A30	8.5	20	42	45%	0%	15%
103516	A57	15.8	20	42	0%	0%	0%
102019	A26	7.5	13	43	31%	0%	0%
102518	A49	7.2	11	44	55%	0%	0%
103544	A616	3.1	8	44	0%	25%	25%
104168	A41	11.1	17	45	0%	0%	41%
102960	A47	20.9	56	45	5%	29%	0%
104025	A65	15.7	21	46	24%	5%	5%
103999	A628	21.7	29	46	31%	0%	3%
102666	A449	8.5	23	46	26%	0%	17%
102179	A423	34.1	46	53	30%	7%	0%
103587	A5092	9.8	9	54	44%	0%	0%
103958	A40	10.0	23	57	39%	0%	4%
102363	A41	6.5	34	58	6%	9%	12%
102792	A5	0.1	1	73	0%	0%	0%
102614	A51	2.3	9	86	0%	0%	0%
103574	A16	5.8	9	97	0%	0%	0%
102615	A500	1.2	7	112	14%	57%	0%

When only the core network is considered, there are 280 kms of single carriageway with rates falling apparently outside the criteria, made up of 20 links, varying considerably in length. The 100 km of dual carriageway falling outside the accident rate criteria is made up of 21, generally shorter, links. Using the speed information from the accident coding, we can see that:

- For the single carriageway links, in most cases the predominant speed limit appears to be 60mph although in total about a quarter of the accidents are coded as occurring within speed limits that are already lower than 60mph

- Only about 70% of the dual carriageway links appear to be currently operating at 70mph speed limit, with some two-thirds of the total number of accidents on these links occurring at speeds lower than 70mph.

Even for those links where the overall accident rate still appears higher than the speed limit, it is likely that in some cases that higher risk will not occur over the whole link; in these cases, the remedial work or speed limit reduction might be needed over only part of the link to achieve compliance.

Examples of how the detailed assessment of separate single carriageway sections might be undertaken has already been shown in developing the procedure for all single carriageway rural roads (Lynam et al, 2004) so the examples investigated in section 8.3 below are for dual carriageway roads. Four core network and two non-core network examples were chosen from the list above, on the basis that they had

- A reasonable length;
- A reasonable absolute number of accidents (a minimum of about 50) in 2001-3;
- A small proportion of accidents within a speed limit lower than 70mph;
- A small proportion of accidents at roundabouts;

8.3 Assessment of individual links

8.3.1 GIS link: 101956 (A303)

A303 (dual carriageway) from A37 (N)/A372 junction to A37 (S) junction around Ilchester.

Traffic from one census point only (CP 47893), shown as an orange diamond on the accident plot (Figure 8-1), labelled with the AADT.

All accidents are recorded as 60mph or 70mph. Accidents recorded with speed limit of 60mph are generally at the A303/ A37(N)/A372 junction

The accident plot shows that there is a higher accident density on the eastern half of the link. Splitting the link into two sections gives the following accident rates for each section:

Table 8-4 Accident rates for sections of link 101956 (A303).

Section	Criteria	AADT	Length (km)	Traffic (10^8 veh-km)	Accidents (2001-2003)	Accident rate (per 10^8 veh-km)	Appropriate speed limit
A	E<352500	21536	2.3	0.181	2	3.7	70
B	E>352500	21536	1.7	0.134	54	134.7	50
Total		21536	4	0.314	56	59.4	60

The overall accident rate suggests a 60mph limit would be suitable for the entire link. However, when the link is split into two sections, section A has a low accident rate, and hence 70mph limit is suitable, but section B has an accident rate of 135 which suggests a 50mph would be more suitable.

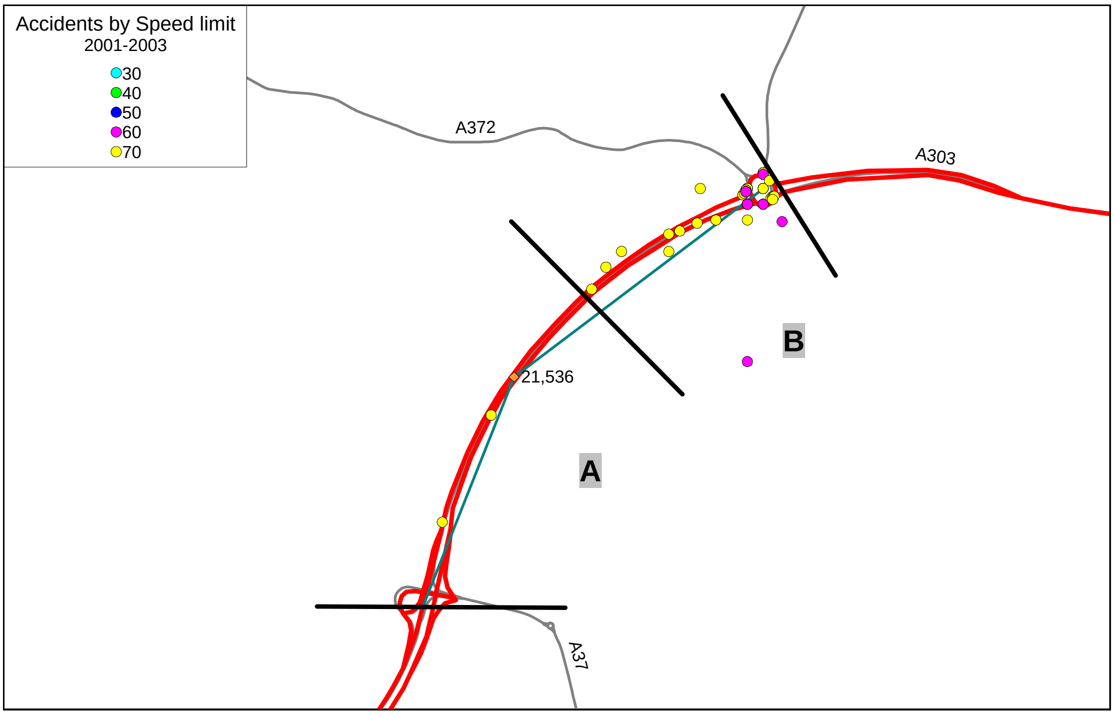


Figure 8-1: Accidents on sections of link 101956 (A303)

8.3.2 GIS link: 102216 (A419)

A419 (dual carriageway) from M4 to A420/A4132 Junction near Swindon

Traffic is from two census points: CP 7086 (A4259 to A420/A4132) and CP 56983 (M4 to A4259).

The accident rate for each length of road associated with each census point is as follows:

Table 8-5 Accident rates for sections of link 102216 (A419).

CP	Criteria	Length (km)	AADT	Traffic (10^8 veh-km)	accidents (2001-2003)	accident rate (per 10^8 veh-km)	Appropriate speed limit
56983	N<182400	1.6	49782	0.291	47	53.9	60
7086	N>182400	4.4	43828	0.704	53	25.1	70
Total		6.0	45416	0.995	100	33.51	70

The accident rate overall for the route over the three year period was 33.5 accidents per 10^8 vehicle km, which is a suitable rate for a 70mph road. Splitting the link into the section associated with each census points gave a lower accident rate (25.1) for the northern section, and a higher rate (53.9) for the southern section, which suggests a 60mph limit would be more appropriate.

Using the plot of accidents below (Figure 8-2), it is noticeable that there is a cluster of accidents around the junction with A4259, and in splitting into the sections above, the accidents at this junction were divided between the two sections. There is also a smaller cluster at the A420 junction.

The link was therefore split into four sections:

A. between M4 junction and 500m south of A4259 junction

B: 500m south of A4259 junction to 500m north of A4259 junction

C: 500m north of A4259 junction to south of A420/A4132

D: South of A420/A4132 to A420/A4132 junction

Table 8-6 Accident rates for sections of link 102216 (A419).

Section	Criteria	Length of CP 7086	Length of CP 56893	Total length (km)	Traffic (veh-km)	Accidents (2001-2003)	Accident rate (per 10^8 veh-km)	Appropriate speed limit
A	N<181900	0.0	1.1	1.1	0.200	19	31.7	70
B	N: 181900-182900	0.5	0.5	1.0	0.171	47	91.7	50
C	N: 82900-185500	2.8	0.0	2.8	0.448	13	9.7	70
D	N>185500	1.1	0.0	1.1	0.176	21	39.8	70
Total		4.4	1.6	6.0	0.995	100	33.51	70

This gives a low accident rate for section C, between the two junctions, and section B (A4259 junction) has a high accident rate of 92 accidents per 10^8 vehicle-km, which suggests a reduced speed limit of 50mph would be appropriate.

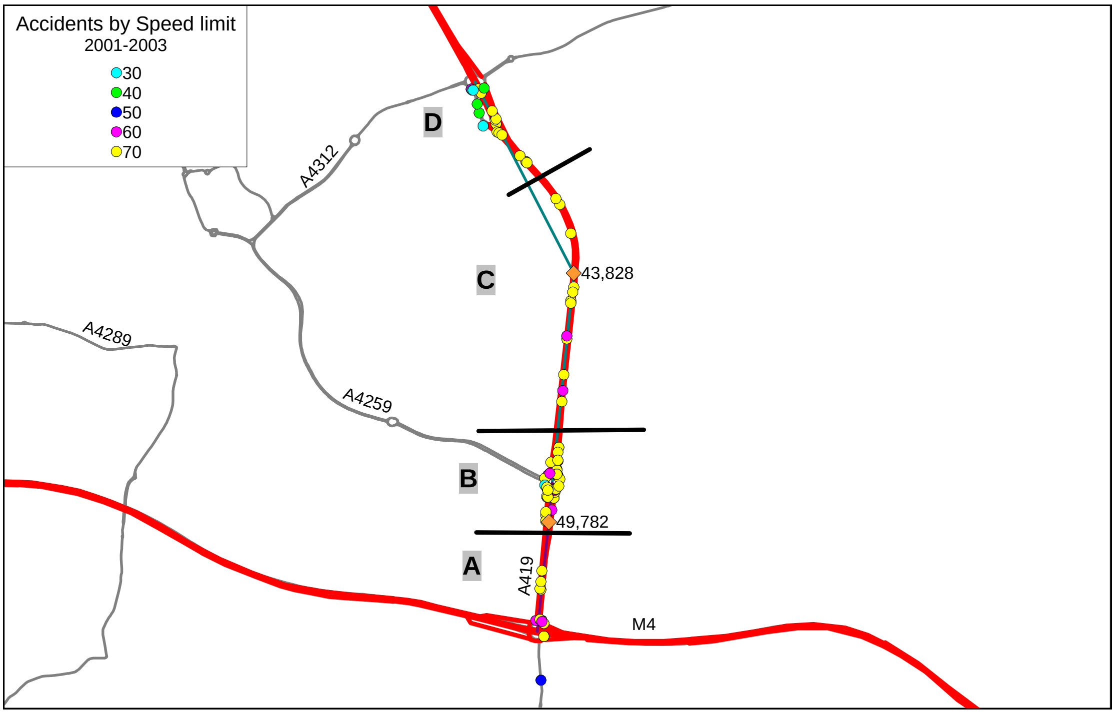


Figure 8-2: Accidents on sections of link 102216 (A419)

8.3.3 GIS link: 102253 (A10)

A10 (dual carriageway) from A414 junction to A414/A1170 junction (Hoddesdon to Hertford), including spur.

Traffic is from two census points (CP 6186 and CP 27103)

There were 44 accidents in three years, most recorded with a 70mph speed limit. The accident rate on the whole link was 32.6 accidents per 10^8 vehicle km.

The accident rate on each of the two sections associated with each census point is shown below (Figure 8-3). This gives a low accident rate on the main carriageway (17), and a much higher rate on the spur (134). This suggests a speed limit of 50mph for the spur

A: Main route of A10, A414 (Hertford) to spur

B: A10 spur, main route to A414/A1170 at Hoddesdon

Table 8-7 Accident rates for sections of link 102253 (A10).

Section	CP	Criteria	Length (km)	AADT	Traffic (veh-km)	Accidents (2001-2003)	accident rate (per 10^8 veh-km)	Appropriate speed limit
A	6186	E<536000	2.3	46491	0.390	20	17.1	70
B	27103	E>536000	0.6	27211	0.060	24	134.2	50
Total			2.9	42502	0.450	44	32.6	70

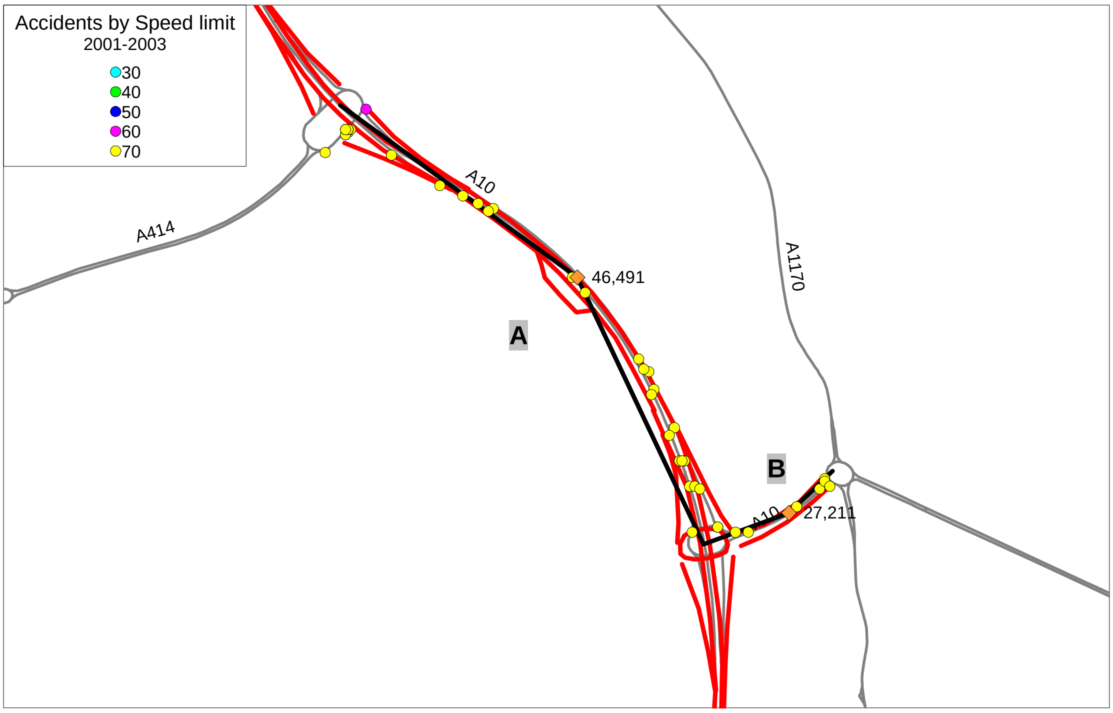


Figure 8-3: Accidents on sections of link 102253 (A10)

8.3.4 GIS link: 102022(A27)

A27 (mainly dual carriageway) from A24/A2032 junction to A283 junction, (Worthing-Shoreham)

There were 152 accidents in the three year period, 64 recorded as 70mph, 74 recorded as 40mph and 13 at 30mph. The accident rate for the whole link was 44 accidents per 10^8 vehicle km, which is higher than the recommended rate of 40 for a 70mph dual carriageway.

Traffic is recorded at two census points, CP 26302 for the length from A24 junction to A2025 junction, and CP 6298 for A2025 junction to A283 junction. The link was split into sections as follows

A: A24/A2032 junction to near B2222 junction (Upper Brighton Road). Single carriageway, (30/40 mph)

B: Near B2222 junction (Upper Brighton Road) to near Dampton Lane (70mph)

C: Near Dampton Lane to East of A2025 roundabout (mostly 40mph)

D: East of A2025 roundabout to A283 junction (70mph)

Table 8-8 Accident rates for sections of link 102022 (A27).

Section	Criteria	Length of CP 6298	Length of CP 26302	Total length (km)	Traffic (10^8 veh-km)	Accidents (2001-2003)	Accident rate (per 10^8 veh-km)	Appropriate speed limit
A	E<515300	0	1.2	1.2	0.178	38	71.1	Already 30/40
B	E: 515300-517000	0	1.7	1.7	0.253	33	43.6	60
C	E: 517000-519000	0.5	1.6	2.1	0.333	50	50.0	Already mainly 40
D	E>519000	2.0	0	2.0	0.383	31	27.0	70
Total		2.5	4.5	7.0	1.147	152	44.2	60

This gives a low accident rate for section D, and a 70mph limit is appropriate here.

Section C already has some accidents shown with a 40mph limit.

Section B has an accident rate of 44, which is higher than the recommended 40 for a 70mph limit, so this should be reduced to 60mph.

Section A is the section with the highest accident rate, and is mainly single carriageway. Many of the accidents on this section are already recorded as 30mph or 40mph; it is unlikely that a limit greater than 50mph would be appropriate on any short adjoining sections.

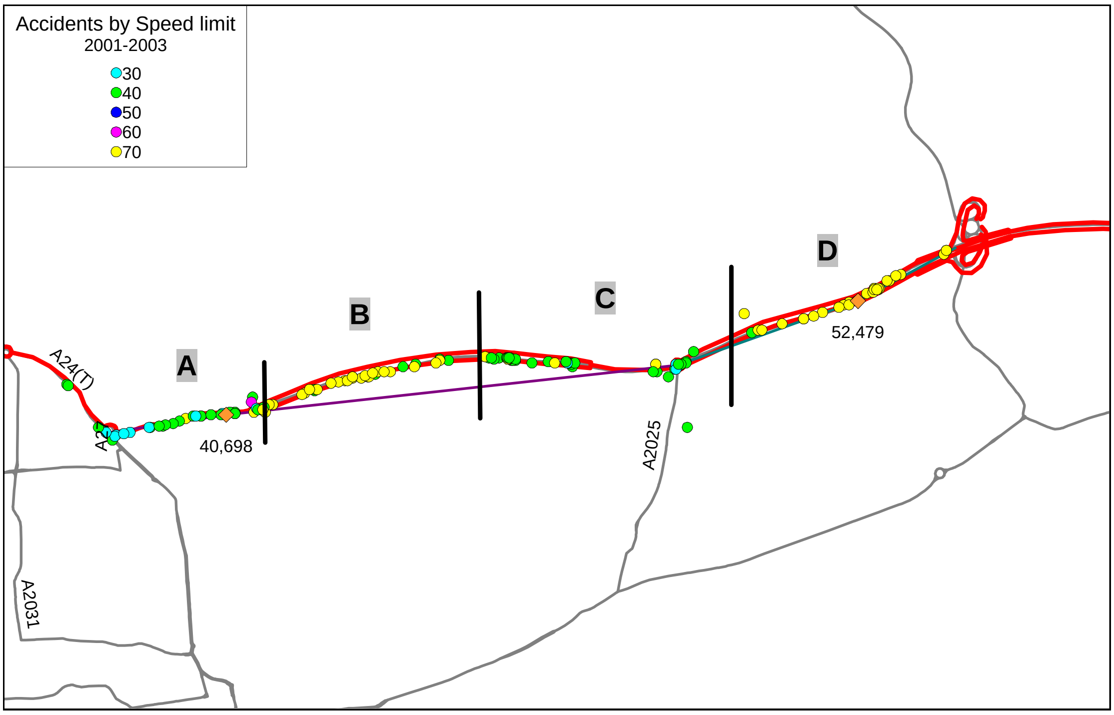


Figure 8-4: Accidents on sections of link 102022 (A27

8.3.5 GIS link: 103150 (A570)

A570: M58J3 to A580

There were 74 accidents in the three year period on this link, giving an accident rate of 48 accidents per 10^8 vehicle-km. This suggests that the speed limit should be 60mph. The map of accidents by speed limit shows no obvious long sections with lower speed limits; although a few accidents are recorded as 30 or 40mph, these seem likely top be associated with lower speed limits on joining roads.

This link includes traffic data from four census points. Table 8-9 shows the accident rates on the lengths of road associated with each census point.

Table 8-9 Accident rates for sections of link 103150 (A570).

Section	CP	Length (km)	AADT	Traffic (10^8 veh-km)	Accidents (2001-2003)	Accident rate (per 10^8 veh-km)	Appropriate speed limit
D	7284	2.5	14381	0.13	16	40.6	60
C	73683	3.0	14381	0.16	14	29.6	70
B	37346	3.4	13601	0.17	29	57.3	60
A	28470	1.1	14029	0.06	15	88.8	50
	Total	10.0	14077	0.51	74	48.0	60

This suggests that while there is a lower accident rate on section C which justifies the 70mph limit being maintained, the speed limits on other sections should be lowered if their accident rates cannot be improved.

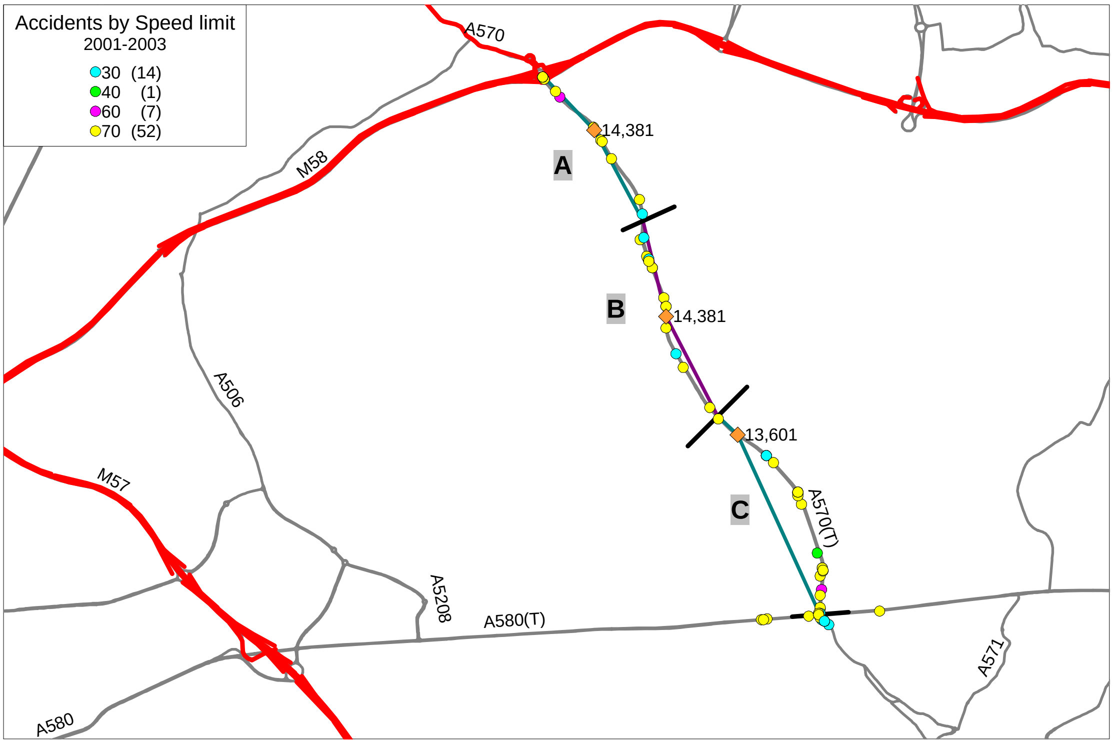


Figure 8-5: Accidents on sections of link 103150 (A570)

NB Section D not shown on map – small section south of A580

8.3.6 GIS link: 103140 (A580)

A580: M57J4 to A570 junction

99 accidents in three years, 87 recorded as 70mph. The accident rate for the whole link is 40.7 accidents per 10^8 vehicle-km.

Traffic for the link is from 9 census points. Table 8-10 shows the accident rates of three subsections of the link.

Table 8-10 Accident rates for sections of link 103140 (A580).

Section	Criteria	CPs	Length (km)	Traffic (10^8 veh-km)	Accidents (2001-2003)	accident rate (per 10^8 veh-km)	Appropriate speed limit
A	E>345700	47329, 17251, 73671	3.4	0.3137	61	64.8	60
B	E: 341840-345700	37360, 7298	3.9	0.3409	24	23.46	70
C	E<341840	28822, 48166, 57591, 58381	2.4	0.1556	14	30.0	70
Total			9.7	0.8102	99	40.7	60

The accident rate for the whole link suggests a limit of 60mph for the link would be suitable, however, by splitting into the three sections it can be seen that only section A has an accident rate which requires a 60mph limit; the other two sections have a lower accident rate.

Figure 8-6: Accidents on sections of link 103140 (A580)

8.4 Conclusions from sample investigations

Accident data for individual lengths of roads can be easily plotted out and combined with data from traffic count sites at either local or national level. This provides a simple method of calculating accident rates against which to compare the proposed thresholds. Plotting accidents by speed limit coded in accident form provides a good indication of the distribution of limits at the time of the accidents; although there are likely to be some errors at the national level coding, these should be easily corrected with local knowledge.

By examining the distribution of accidents within these plots, it is fairly easy to see which lengths of shorter sections that might need to be considered for separate lower limits, but final choice of any lengths over which to apply measures or reduced limits will depend on more detailed investigation, and on the need to provide a clear indication to drivers of the reason for any lower limit. Potential lengths over which limit changes might be considered for the examples investigated varied from 0.5km to 3.5km.

Detailed investigation of the six “high risk” links suggested that:

- Rates above the proposed criteria only occurred over about 30-40% of their length, and if only the core networks were considered, the proportion was reduced to around 25%
- Several of the high rate sections were clearly associated with an area around a junction, although may include substantial approach length
- Pattern of speed limits required to meet criteria did not appear unreasonable, although more detailed local assessment would be needed to confirm this.

On the basis of this more detailed investigation, it is possible that the total lengths of road that might actually need action are only some quarter to a third of the lengths suggested in section 3.2, ie 25-30kms of dual carriageway. At the same time, there may be some short lengths of road that should be considered for treatment that are not identified by the aggregated data used in section 3.2. For single carriageways, the accident proportions by coded speed limit suggest that perhaps only three quarters of the length identified in section 3.2 might need detailed investigation. In all cases, further investigation at local level for the reasons leading to a higher accident rate is needed before any action is decided.

9 Conclusions

An assessment balancing mobility costs and accident rates for Agency roads in a similar manner to that underpinning the current DfT proposals for single carriageway rural roads shows that the current limits of 70mph for motorways and dual carriageways and 60mph for single carriageways are generally appropriate, particularly when increased emissions levels above 70mph are taken into account.

Applying the same methodology to individual sections of roads that have higher accidents rates shows that, if alternative action cannot be taken to reduce these rates, then lower speed limits would be appropriate for these sections where their accident rate still exceeds those in the table below.

Table 9-1 Actions relevant to Investigatory levels

Road type	**Current Speed limit**	**Personal injury accident rate investigatory level** **(per 100millon vehicle-km)**	**Primary Action**	**Secondary Action (to be applied if primary action is ineffective at reducing accident rate to less than investigatory level)**
Single carriageway	60mph	Above 37 per 100 million veh km Above 85 per 100 million veh km	Consider measures to improve road quality	50mph speed limit 40mph speed limit
Dual carriageways	70mph 60mph	Above 40 per 100 million veh km Above 86 per 100 million veh km Above 86 per 100 million veh km		60mph speed limit 50mph speed limit 50mph speed limit
Motorways	70mph	Above 55 per 100 million veh km		60mph speed limit

Examination of averaged data across road links suggested that there are very few sections where changes might be required to motorway limits, with perhaps 4% of core network dual carriageway and 19% of core single carriageway needing further investigation, on the basis of their current predominant speed limits and current accident rates. More detailed examination suggests that some parts of these links are already operating at lower limits, and that in practice additional changes (remedial measures to reduce accident rates or lower speed limits) might to be considered on probably no more than 2% of the dual carriageways and 15% of single carriageways within the core network.

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