Rural Road Safety
a Literature Review

Transport Research
Planning Group

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ACKNOWLEDGEMENTS

The authors are grateful to Tom Lamplugh of Social Research at the Scottish Executive for his input to this project as the Project Officer and to the members of the project steering group.
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EXECUTIVE SUMMARY

Aims
The overall aim of this project is to identify, collate and review published research and other information relating to road accidents on rural roads, suggest how it may be applied to the situation in Scotland and provide recommendations for action. It consists of a review of published literature, mainly from the UK but also including some international papers, on issues and topics related to rural road safety.

Accidents on Scottish Rural Roads
The research found that a range of definitions are used for ‘rural’ and that this may hamper decision making. The following summarises the published statistics for accidents on non built-up Scottish roads:

- Non built-up roads accounted for 74% of fatalities and 52% of killed and seriously injured combined in 2003 in Scotland.
- The number of fatalities on non built-up roads has decreased at a much lower rate than on built-up roads over the last few years.
- Local ‘B’ and ‘A’ class roads have the highest accident rates (per vehicle kilometre) in Scotland.
- Fatalities on Scottish non built-up roads comprise 67% car occupants, 16% motorcyclists and 17% others.
- Most car occupant (70%), goods vehicle occupant (73%) and motorcyclist (62%) fatalities occur on non built-up roads.

Rural Road Accident Factors
As with all accidents, the main factors in rural road accidents can be split into three main groups: human factors (driver behaviour), environment factors (the road), and vehicle factors (defects).

The main driver behaviour factors associated with rural road accidents are identified as follows:
- Speed and speeding – there is a clearly established link between speed and accident frequency, with higher speeds also leading to more severe accidents. Young male drivers are most likely to drive at excessive speeds.
- Alcohol and drug use – there is considerable evidence to show the impairment effects of alcohol on driving but no concrete evidence that drink-driving is more prevalent in rural areas. Similarly there is little evidence to suggest that drug-driving is more prevalent in rural areas although it is suggested that it will not be confined to urban areas.
- Driver fatigue and sleepiness – this is almost exclusively a problem on rural roads due to the greater driver stimulation on urban roads. It has long been associated with motorways but recent research suggests that it could be the main factor in up to 20% of accidents on non-motorway rural roads. More work is required to quantify the extent of the problem in Scotland.
- Driver distraction – this can be split into external-to-vehicle and internal-to-vehicle distraction. There is little evidence to suggest that external-to-vehicle distractions are
a major problem on Scottish rural roads. However, internal-to-vehicle distraction, especially from mobile phone use, is recognised as a potentially major problem although there is no reported evidence that it is more prevalent on Scottish rural roads than on urban roads.

- **Seat belt usage** – there is little evidence to suggest that seat belt wearing rates are lower in rural areas than in urban areas in Scotland.

The main road factors are identified as follows:

- The most common accident types on rural roads are head-on, run-off-the-road and junction accidents.
- Over 97% of Scotland’s road network is single carriageway – this is a higher proportion than the rest of Great Britain.
- Modern roads (of all types) are safer than older designs because they contain hard-strips, safety barriers and fewer, better designed junctions.
- Most accidents on single carriageways occur on A roads, in 60mph speed limits away from junctions. They tend to be more severe than accidents in built-up areas.
- Single vehicle accidents account for around one third of all rural single carriageway accidents. They are most likely to occur on B or C class roads at night, on bends and involve young drivers.
- Road width, horizontal and vertical alignment, roadside characteristics, and junction frequency and design are all identified as factors contributing to rural road safety.

Other factors reviewed include:

- **Darkness** is recognised as being a contributor to rural road accidents and the case for adopting Single/Double Summer Time (SDST) is reviewed. The literature suggests that the adoption of SDST would result in a slight reduction in the number of killed and seriously injured casualties in Scotland although the data on which the analysis is based is limited.
- **Wild animals** (especially deer) are estimated to be a factor in at least 1.5% of all injury accidents and collisions with deer result in several fatalities every year. The literature suggests that this problem is likely to increase as traffic volumes increase.
- **Young drivers and motorcyclists** are identified as being particularly at risk on rural roads.
- **Tourist activity** has been found to increase the number of accidents in some rural tourist areas of Scotland. However, the overall rate of accidents does not increase significantly during tourist high season. Additionally, there is little evidence to suggest that foreign tourists are at greater risk than local drivers.
- **Emergency service response** is identified as a key issue in rural road accident survivability.

**Interventions for rural roads**

There appears to be a lack of publications dealing with education, publicity and training interventions specifically targeted at rural roads. However, the THINK! Campaign has recently targeted rural road safety and some campaigns from the USA and Australia have been identified although no evaluations were found.

Driver training has been found to focus on basic control skills and there is evidence to suggest that attitude rather than skill is related to crash involvement. This will be particularly
the case on rural roads because of higher speeds. Driver training should therefore address driving style and include awareness of personal skills and their limitations. There is a great deal of literature dealing with engineering measures specific to rural roads. The more important and innovative are discussed including:

- Rural speed management
- Vehicle activated signs
- Shared space and Quiet Lanes
- Self explaining roads
- Psychological traffic calming
- Safety barriers
- ‘2+1’ layouts

The role of enforcement is discussed and it is suggested that automatic enforcement may be particularly useful in rural areas.

**Recommendations**

**Further research**

- Further detailed quantification of the rural road safety problem in Scotland is required. It is recommended that a specific in-depth examination of the Scottish STATS19 database, with the emphasis on rural road issues, be carried out.
- It is recommended that a study to quantify the extent of fatigue/sleepiness as a factor in Scottish rural road accidents be carried out.
- A pilot publicity campaign, targeted at raising awareness of rural road safety issues should be devised and evaluated.
- Research should be carried out to ascertain the potential benefits of improving emergency service response in rural areas and identify best practice.

**Action**

The following recommendations for action are made:

**Short-term**

- Campaigns must be part of a strategy which includes enforcement and engineering changes. Therefore, it is recommended that a rural road safety strategy is developed and adopted.
- Education and publicity campaigns should continue to target young drivers who are disproportionately represented in rural road crashes.
- In addition, campaigns should be considered which highlight the dangers of rural roads to all drivers and try to erode the complacency that rural roads are safer because there is less traffic.
- Efforts should continue to remind drivers of the dangers of impairment, especially alcohol and fatigue.
- Recreational motorcyclists should be targeted through campaigns and training to reduce their risk on rural roads.
- Additional emphasis should be given to the potential for relatively low-cost engineering solutions and speed management tools.
Medium and long term

- Road infrastructure should be improved to reduce the potential for crashes and reduce the consequences when they do occur. The EuroRAP process provides a consistent way of identifying high risk roads and should be used to prioritise improvements.
- Consideration should be given to the use of innovative engineering solutions such as cable barrier medians on some single carriageways although it is recommended that these be carefully evaluated before widespread use.
CHAPTER ONE  INTRODUCTION

Background

1.1 The overall aim of this project is to identify, collate and review published research and other information relating to road accidents on rural roads, suggest how it may be applied to the situation in Scotland and provide recommendations for action. Specific objectives are:

- To highlight the main contributory factors to rural road accidents (i.e. speed, road types, fatigue, driver psychology etc.)
- To suggest which factors are likely to affect Scotland’s rural road network
- To highlight the particular characteristics of people likely to be involved in rural road accidents
- To highlight successful interventions that have been introduced to reduce rural road accidents in the UK, Europe and further afield (i.e. enforcement, road engineering, public education etc)
- To propose short term initiatives that can be taken to reduce rural road accidents
- To propose long term initiatives that can be taken to reduce rural road accidents
- To provide recommendations to relevant organisations in order to reduce rural road accidents
- To highlight gaps in the literature and areas where further research is required.

Search strategy

1.2 Two key documents were used as a starting point for the review. These were The Organisation for Economic Co-operation and Development’s “Safety Strategies for Rural Roads” (OECD, 1999) and The Institution of Highways and Transportation’s “Guidelines for Rural Safety Management” (IHT, 1999).

1.3 From these documents, it was clear that the scope of the topic is huge and therefore a diverse search strategy was adopted. This included keyword searches on the International Transport Research Documentation (ITRD) database supplemented by internet searches on Google and AltaVista. Abstracts were reviewed and interesting sources obtained. It should be noted that due to the large number of sources identified and limitations of time and resources, only the most important and relevant literature or that which usefully adds to the information contained in OECD (1999) and IHT (1999) is reported in this review.

Definition of rural roads

1.4 Many different definitions can be found in the literature and understanding what is meant by rural is the key to understanding the risks associated with it. Indeed, it has been recognised by the Organisation for Economic Co-operation and Development that the understanding of rural road safety is hampered because “no formal accepted international definition exists to classify rural roads” (OECD, 1999).
1.5 However, the OECD does give a definition for rural roads as those which are “outside urban areas that are not motorways or unpaved roads.” (OECD, 1999).

1.6 In terms of road safety research in the UK, the concept of a rural road has usually been operationally defined in terms of speed limit. A ‘built-up’ road is defined as a road having a speed limit of 40 mph or less, and ‘non-built up roads’ have speed limits of 50 mph or greater. This is the definition adopted by the Scottish road accident reporting system but it does not take account of the area through which the road passes. In other words a road with a 50 mph limit passing through a town (such as the A899 through Livingston) would be classed as non built-up. Non-built up roads encompass a wide range of road types and it is important to address this diversity, e.g. Gardner and Gray (1997) noted that ‘Many journeys on rural roads take place on the urban fringe’.

1.7 The Institution of Highways and Transportation (IHT) recognised that the definition of non-built-up roads would not include many small townships and villages which had lower speed limits but were, in any accepted sense, rural. Therefore, the IHT adopted a definition which included non-built-up roads and roads passing through settlements with a population of less than 3,000 (IHT, 1999).

1.8 In their review of tourist accidents in Scotland, Sharples and Fletcher (2001) plotted accidents and coded them based on urban and rural definitions where urban was classed as a settlement with a population over 500. They found good correspondence between the use of this system and the use of standard definitions of built-up and non built-up based on speed limits.

1.9 The DfT’s speed review (DETR, 2000) has attempted to classify rural roads to reflect the existing anomalies. The review divides rural areas into three categories: main roads, villages and country lanes. DfT acknowledges that defining a rural village is difficult in relation to settlement size and that achieving a workable definition will require local consultation, as well as research and discussion at a national level between departments and local authority associations.

1.10 In Road Casualties Great Britain 2003 (DfT, 2004a), rural roads are defined as those outside urban areas or in small towns having a population of 10,000 or less.

Outline of report structure

1.11 Chapter 2 describes the size and nature of the problem on Scottish rural roads, and summarises the published accident data for Scotland by road type and mode of transport. Chapter 3 reviews the literature on contributory factors to rural accidents. Chapter 4 reviews the literature on rural road safety interventions. Chapter 5 gives conclusions and recommendations, indicates gaps in the literature and suggests further research required.
CHAPTER TWO  ACCIDENTS ON SCOTTISH RURAL ROADS

Size and nature of problem

2.1 In 2003, non-built-up roads accounted for 42% of all casualties in Scotland. However, they accounted for 74% of fatalities and 52% of killed and seriously injured combined (Scottish Executive, 2004a).

2.2 Compared with 1994-98, the fall in the total number of casualties has been greater for built-up roads (20%) than elsewhere (10%), and the difference between the two types of road is even greater for the numbers killed i.e. down by 24% for built-up roads compared with 7% elsewhere.

2.3 However, over the years, some traffic will have been transferred away from built-up roads by the opening of city and town bypasses, and by the construction of non-built up roads with higher average traffic volumes. Therefore, these figures do not necessarily provide an accurate measure of the comparative change in the road safety performance of ‘built-up’ and ‘non-built up’ roads.

Road type

2.4 Table 2.1 shows separate accident figures for trunk roads and for local authority roads. Trunk roads accounted for around one third of the total numbers of accidents on non built-up roads in 2003: 38% of fatal accidents, 33% of the total of fatal and serious accidents, and 34% of all accidents.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Trunk Roads</th>
<th>Local authority roads</th>
<th>All non built-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>80 (38%)</td>
<td>133 (62%)</td>
<td>213</td>
</tr>
<tr>
<td>Fatal and serious</td>
<td>429 (33%)</td>
<td>886 (67%)</td>
<td>1315</td>
</tr>
<tr>
<td>All Severities</td>
<td>1750 (34%)</td>
<td>3419 (66%)</td>
<td>5169</td>
</tr>
</tbody>
</table>

2.5 Because of current differences between definitions of rural and non built-up roads in Scottish statistics, it is not possible to directly compare traffic estimates for different roads with accident and casualty statistics. However, Table 2.2 shows accident rates by severity and road class for rural roads. It can be seen that in terms of accident rates, B roads are by far the most dangerous followed by local A roads. Trunk A roads and Motorways have the lowest accident rates for all severities in non built-up areas.
Table 2.2 – Accident rates (accidents per 100 million vehicle km) by severity and road class for non built-up roads (Scottish Executive, 2004a)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Motorways</th>
<th>Trunk A roads</th>
<th>Local A roads</th>
<th>B roads</th>
<th>C &amp; unclassified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>0.19</td>
<td>0.78</td>
<td>0.97</td>
<td>1.53</td>
<td>0.56</td>
</tr>
<tr>
<td>Fatal &amp; Serious</td>
<td>1.24</td>
<td>4.02</td>
<td>6.57</td>
<td>9.28</td>
<td>4.10</td>
</tr>
<tr>
<td>All severities</td>
<td>7.19</td>
<td>15.00</td>
<td>24.72</td>
<td>36.95</td>
<td>16.38</td>
</tr>
</tbody>
</table>

Mode of transport

2.6 Figure 2.1 shows the proportions of fatalities on non built-up roads by mode of transport. It can be seen that car occupants account for the majority of fatalities (67%) followed by motorcyclists (16%) and pedestrians (8%). Other road users account for the remaining 9% of fatalities.

![Figure 2.1 – Proportions of non built-up fatalities by mode of transport, 2003 (Scottish Executive, 2004a)](image)

2.7 Table 2.3 shows the numbers of killed and seriously injured casualties on non built-up roads by mode of transport. It can be seen that car occupants again account for the majority of casualties (70%), followed by motorcyclists (15%) and goods vehicle occupants (5%). The table also shows that high proportions of KSI casualties for goods vehicle occupants (73%), car occupants (70%) and motorcyclists (62%) occur on non built-up roads.

Table 2.3 – Killed and seriously injured casualties by mode of transport, 2003 (Scottish Executive, 2004a)

<table>
<thead>
<tr>
<th>Mode of transport</th>
<th>KSI (non built-up)</th>
<th>KSI (all roads)</th>
<th>% KSI on non built-up roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>1190</td>
<td>1685</td>
<td>70%</td>
</tr>
<tr>
<td>Motor cycle</td>
<td>258</td>
<td>417</td>
<td>62%</td>
</tr>
<tr>
<td>Goods vehicles</td>
<td>91</td>
<td>125</td>
<td>73%</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>78</td>
<td>771</td>
<td>10%</td>
</tr>
<tr>
<td>Pedal Cycle</td>
<td>35</td>
<td>138</td>
<td>25%</td>
</tr>
<tr>
<td>Others</td>
<td>35</td>
<td>135</td>
<td>26%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1687</strong></td>
<td><strong>3271</strong></td>
<td><strong>52%</strong></td>
</tr>
</tbody>
</table>
CHAPTER THREE  RURAL ROAD ACCIDENT FACTORS

Introduction

3.1  This chapter examines literature dealing with the main features of accidents on rural roads and focuses on some other factors which are particularly relevant to the rural situation.

3.2  The OECD (1999) suggests that much of the rural road safety problem can be categorised into three accident types:

   • Single vehicle accidents (especially running off the road)
   • Head-on collisions
   • Junction accidents

3.3  The OECD (1999) also points to the three hazard factors which contribute to accidents:

   • Driver behaviour
   • Vehicle factors
   • Road environment

3.4  In terms of the relative importance of these factors, Sabey and Staughton (1975), reporting on a detailed study of over 2,000 accidents between 1970 and 1974, showed that 95% of accidents involved a human factor with 28% involving a road factor and just 8.5% involved a vehicle factor. Whilst this gives an indication of the relative importance of these factors, Sabey (1980) cautions that

   “It is too easy to conclude that all effort should be applied to influencing human behaviour directly, without taking into account the detailed circumstances, the multiplicity of factors which lead to accident occurrence, and the chances of success of measures applied.”

3.5  For the purposes of this study, driver behaviour and road environment factors have been reviewed, whilst vehicle factors have not been examined. Additional factors, such as tourists/visitors and emergency service response times are also considered.

Driver behaviour factors

3.6  It is widely recognised that road user behaviour, and particularly driver and motorcycle rider behaviour, is a major factor in road accidents. The IHT point out that car drivers and motorcycle riders are most likely to be involved in accidents on rural roads and that their “skill, judgement, anticipation, state of mind and physical well-being” all contribute to the driver/rider’s ability to avoid an accident (IHT, 1999). The IHT also highlighted that speed, perceptual difficulties and drink driving are the most prevalent factors contributing to accidents.
Relationship between speed and accidents

3.7 In general, a reduction in mean speed is associated with a decrease in accident rate. An often quoted rule of thumb found by Finch et al (1994) states that a reduction of 1mph in mean speed leads to a 5% reduction in accident rate.

3.8 It is also the case that whilst the impact of speed on rural road safety is often the “subject of heated debate” (OECD, 1999), high speed contributes to more severe accidents. On this basis, all countries have imposed speed limits based, to some extent, on the road characteristics.

3.9 It should be noted that a change in the speed limit without suitable enforcement will be unlikely to reduce speed by the full difference between limits (Taylor et al, 2000). A change from the national speed limit from 60mph to 40mph on a single carriageway road with no accompanying changes to the road character is unlikely to make the road appear urban.

3.10 Modern vehicles are capable of travelling at speeds far greater than the posted legal limits, and many drivers state that it is easy to exceed legal speed limits without realising it (AA Foundation, 2001). As a counter-measure to this problem, in-vehicle technologies have been developed to warn drivers when they are exceeding the speed limit (e.g. see Carsten, 2001). Road design measures such as vehicle activated warning signs (see para. 4.36) might also be an appropriate way to do this and these might help people who are motivated to keep within the speed limit to do so. However, their effect will probably be limited to a small distance downstream.

3.11 In a comprehensive study following on from the MASTER (Managing speeds of traffic on European Roads) Project (European Commission, 1998), Taylor et al (2002a) established relationships between speed and accidents on four relatively homogeneous groupings of rural single carriageway roads in England. The road groups are summarised in Table 3.1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Roads which are very hilly, with a high bend density and low traffic speed. These are low quality roads.</td>
</tr>
<tr>
<td>2</td>
<td>Roads with high access density, above average bend density and below average traffic speed. These are lower than average quality roads.</td>
</tr>
<tr>
<td>3</td>
<td>Roads with a high junction density, but below average bend density and hilliness and above average traffic speed. These are higher than average quality roads.</td>
</tr>
<tr>
<td>4</td>
<td>Roads with a low density of bends, junctions and accesses and a high traffic speed. These are high quality roads.</td>
</tr>
</tbody>
</table>

3.12 Taylor et al (2002a) found that accident frequencies in all road groups increased with mean speed to the power of approximately 2.5 – indicating that a 10% increase in mean speed results in a 26% increase in injury accidents. Two other factors were found to increase the frequency of injury accidents: density of sharp bends and the density of minor crossroad junctions. The effect of mean speed was found to be particularly large for junction accidents which suggested that there is substantial potential for accident reduction by reducing speeds at junctions. However, this has to be considered in the context of Scotland’s lower than average number of accidents at rural junctions (see para. 3.39).
**Speeding, excessive and inappropriate speed**

3.13 In a recent study, Mosedale and Purdy (2004) examined contributory factor data, based on the system devised by Broughton et al (1998), for around 25% of all recorded injury accidents in Great Britain between 1999 and 2002, i.e. only data from those police forces that chose to participate in the trial of contributory factors.

3.14 Mosedale and Purdy (2004) looked at the occurrence of excessive speed as a contributory factor for accidents involving different vehicle types. They found that for all severities, all motorised vehicle types showed greater incidence of excessive speed on rural roads than on urban roads. Table 3.2 summarises the results. Overall, they found that excessive speed is a contributory factor in twice as many rural road accidents (18%) as urban road accidents (9%). It is not clear from the report what definitions of ‘rural’ and ‘urban’ were used.

**Table 3.2 – Percentage of accidents on urban and rural roads with excessive speed as a contributory factor 1999-2002 (Mosedale and Purdy, 2004)**

<table>
<thead>
<tr>
<th></th>
<th>TWMV</th>
<th>Car</th>
<th>LGV</th>
<th>HGV</th>
<th>All†</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal</td>
<td>43</td>
<td>37</td>
<td>11</td>
<td>5</td>
<td>24</td>
<td>263</td>
</tr>
<tr>
<td>Serious</td>
<td>25</td>
<td>18</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>2,019</td>
</tr>
<tr>
<td>Slight</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>9,834</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>11</td>
<td>8</td>
<td>6</td>
<td>9</td>
<td>12,116</td>
</tr>
<tr>
<td><strong>Rural</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatal</td>
<td>51</td>
<td>31</td>
<td>22</td>
<td>9</td>
<td>30</td>
<td>588</td>
</tr>
<tr>
<td>Serious</td>
<td>31</td>
<td>26</td>
<td>20</td>
<td>15</td>
<td>24</td>
<td>3,562</td>
</tr>
<tr>
<td>Slight</td>
<td>19</td>
<td>18</td>
<td>16</td>
<td>10</td>
<td>17</td>
<td>11,012</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>20</td>
<td>16</td>
<td>11</td>
<td>18</td>
<td>15,162</td>
</tr>
</tbody>
</table>

† Includes accidents where the precipitating factor is assigned to a pedestrian casualty or other vehicle type.

3.15 Data for Great Britain show that whilst nearly half of all vehicles on non built-up dual carriageways are exceeding the speed limit, the proportion of vehicles speeding on non built-up single carriageways is much less at 8% (DfT, 2003). The same data show that the percentage of vehicles exceeding the speed limit by 10mph or more has, in recent years, reduced on single carriageways but increased on dual carriageways. Articulated vehicles (which have lower speed limits on both dual and single carriageways) are particularly likely to exceed the speed limit on both dual and single carriageways. The data also show that motorcyclists are particularly likely to exceed the speed limit.
Webster and Wells (2000) provide a synthesis of research into the characteristics of speeders. The main findings of relevance were:

- Whilst the majority of drivers admit to speeding at some times, more speeders are young males in non-manual occupations.
- Company car drivers, drivers in large cars and drivers with higher annual mileages are more likely to drive faster.
- Speed choice (relative to the mean) seems to be consistent in all situations (ie drivers who drive fast in urban settings tend to drive fast in rural settings).
- Drivers may justify speeding by assuming that speed limits are unrealistic and many drivers fail to spot speed limit signs and are unable to ‘read’ the speed limit from the road design (ie roads are often not ‘self-explaining’).
- A large body of research exists which associates speeding behaviour with accidents. In particular, both speed over the speed limit and speed over the norm for any given road are critical factors in determining accident risk.

A recent Scottish Executive research project on speeding drivers (Stradling et al., 2003) contains several interesting findings. It showed, amongst other things, that levels of excess and excessive speed on faster rural roads have increased over the last decade. It also showed that, on faster roads, male drivers were more likely to choose a speed in excess of the limit than female drivers. This is in line with many previous studies which have concluded that male drivers are more likely to speed than females.

Alcohol and drugs

The impairment effects of alcohol on driving are well known and even at low blood concentrations, alcohol can have an impact on driver performance (Moskowitz and Fiorentino, 2000). However, the OECD suggested that there were no definitive studies to show that drink driving was more predominant in or specific to rural areas (OECD, 1999).

Research carried out for the Scottish Executive found no concrete evidence of a real difference in drink driving prevalence between urban and rural areas (Anderson and Ingram, 2001). However, the same study did find evidence that there was a public perception that drink driving was more of a problem in rural areas.

Tunbridge et al (2001) reported on a study looking at the incidence of alcohol and other drugs in road accident fatalities. They found that alcohol was present in 31% of casualties and at least one medicinal or illicit drug was present in 24% of the sample. The study looked at regional variations but not explicitly at urban/rural splits.

Ingram et al (2000) carried out a survey to estimate the prevalence of drug-driving in Scotland. The results showed that 9% of respondents reported having driven under the influence of drugs and 5% had done so in the last 12 months. No breakdown between urban and rural areas is given due to the relatively small number of drug drivers detected in the survey.

National statistics (ISD Scotland, 2002) show that whilst drug misuse is more prevalent in large urban areas, it is not confined to such areas. It is therefore reasonable to expect that a degree of drug-driving takes place outside urban areas.
Fatigue and Sleep-related Crashes

3.23 Driver fatigue and sleepiness is now recognised as being a significant accident causation factor. Crashes involving the driver falling asleep are rare on urban roads because driving conditions are relatively stimulating. These crashes typically occur on rural roads, especially motorways, where the driving task can be monotonous and undemanding (Horne and Reyner, 2001).

3.24 Identifying accidents caused by fatigue or sleepiness is a difficult task, principally because the driver involved either dies or will not admit to having fallen asleep. The best method devised to date uses circumstantial evidence from detailed police accident files to classify accidents as possibly or probably ‘sleep-related’ based on a series of criteria (Horne and Reyner 1995). The aim in this method is to exclude all other likely causes to arrive at those crashes where sleep is the most likely factor. Horne and Reyner (1995) assert that this method is likely to under-report sleep-related crashes because it excludes crashes which may be sleep-related if, for example, bad weather is also present. However, as the method relies on very detailed police records being available, it is likely to be less robust when applied to slight injury or damage only crashes.

3.25 Researchers have used this method to examine accidents on several UK motorway sections and rural dual and single carriageway roads (Reyner et al, 2001 and Flatley et al, 2004). These studies have estimated the proportions of crashes which are sleep-related to range from 3% on a rural ‘B’ road to 30% on a section of English motorway. The recent study (Flatley et al, 2004) highlights that the problem is not confined to motorways and estimates that 16% of all accidents on rural non-motorways could be sleep-related.

3.26 Sleep-related crashes tend to occur at night and to be more severe due to higher impact speeds. They tend to involve drivers who are at work or driving company cars (Maycock, 1996, 1997) and younger male drivers (under-30) are particularly at risk (Reyner et al, 2001).

3.27 Flatley et al (2003) found that the occurrence of sleep-related crashes was related to traffic density although they found different relationships on motorways (where more sleep-related crashes occurred when traffic density was lower) and on ‘A’ and ‘B’ roads (where more sleep-related crashes occurred when traffic density was higher). This might suggest that on lower trafficked Scottish ‘A’ and ‘B’ roads, the problems associated with sleep-related crashes may be less than elsewhere.

3.28 Research has shown that the onset of fatigue is exacerbated by the time on task (ie the length of time actually driving), sleep deprivation and circadian rhythm (time of day effect). Drivers are therefore advised to avoid long journeys if tired and in the early hours, to take a break of at least 15 minutes every 2 hours and stop in a safe place if sleepy. Based upon research by Horne and Reyner (1997), drivers are also advised that a caffeine drink and a short nap are the most effective countermeasures to fatigue although the benefits may be relatively short-lived (DfT, 2004b).

3.29 Obviously, for drivers to follow the above advice, there needs to be adequate provision of convenient stopping places such as lay-bys, rest areas and service facilities which are available 24 hours. This may be particularly difficult to achieve in the more rural parts of Scotland as traffic volumes would not sustain commercially viable service areas. Also, on one strategic trunk road in Scotland, existing planning policies have restricted the
provision of roadside services although it is understood that this policy is currently under review (SODD, 1996 and Scottish Executive, 2004b).

3.30 Jackson (2004) highlights the particular problems faced by professional drivers and gives advice on how awareness of fatigue and sleepiness can be raised within industry. In particular, Jackson (2004) discusses the ‘Awake’ programme which aims to minimise fatigue, raise awareness, reduce accident risk, improve performance and improve quality of life. It seeks to achieve this by addressing the main reasons why drivers continue to drive when they are tired. Jackson (2004) describes these reasons as being: driver tiredness is not taken seriously enough; drivers overestimate their capabilities; drivers have a poor knowledge on when to act on their sleepiness; and drivers have mixed knowledge of effective countermeasures.

**Distraction and inattention**

3.31 Several research studies have examined the detrimental effects of driver distraction on performance. These distractions can be either external to the vehicle (for example an advertising sign) or internal to the vehicle (for example tuning the radio or using a mobile phone).

3.32 Brown et al (1969) first identified the potential driver impairment effects of distraction through phone conversations. With the recent widespread availability and use of mobile phones, this issue has become more prominent.

3.33 Burns et al (2002) reported on a simulator study into the effects of mobile phone use on driver performance. The study compared the effects of having phone conversations to the effects of alcohol consumption and it was found that certain aspects of driving are impaired more by using a phone (whether hands-free or not) than by having a blood alcohol level at the legal limit (80mg/100ml). It therefore concluded that driving behaviour while talking on a phone is not only worse than normal driving, but can be described as dangerous.

3.34 The use of a hand-held mobile phone whilst driving was made an offence in the UK in December 2003.

3.35 Wallace (2003) carried out an extensive literature review on driver distraction with the emphasis on external-to-vehicle distractions and particularly advertising billboards. His study also included an investigation of potential accidents involving external-to-vehicle distraction in Central Scotland. The study found less than 1% of accidents in the database were attributable to external-to-vehicle distraction although Wallace suggests that distraction is likely to be under-represented as a cause in accident databases. In addition, he found very little data on billboard distraction pertaining to the British or even European environment. In contrast to this, it is understood that some countries e.g. France, deliberately erect features of this type on motorways with the aim of keeping drivers more alert.

**Seat Belt use**

3.36 Several studies have shown the benefits of seat belt use in terms of casualty and severity reduction (eg Tunbridge, 1989). In addition, Williams et al (1991) found a 19.5% reduction in the number of road deaths in Scotland after the introduction of compulsory front seat belt usage in 1983.
3.37 Studies have shown that seat belt wearing rates vary by time, location and car occupant demographics. For example, Broughton (2003) reported on seatbelt wearing rates in England and found that wearing rates were higher for women than for men, higher on non-built-up roads, and rise with increasing age with the highest rates amongst older drivers. Broughton (2003) also reports that seat belt wearing rates are lower for rear seat passengers, especially amongst young adults but again were higher on high speed rural roads than urban roads.

3.38 Recent research into seat belt wearing rates in Scotland (Burns et al, 2003) suggested that the following groups should be targeted in campaigns: all rear seat passengers, front seat male passengers and young male drivers. As in Broughton (2003), Burns et al (2003) found considerable variation in wearing rates between geographical areas with the more densely populated areas having lower rates. They also found evidence to suggest that the significance of age and gender varied by geographical location with some areas showing marked variation between male and female compliance. However, they found no significant difference between wearing rates on roads with 30mph limits and those with higher limits.

Road environment factors

General

3.39 Research has shown Scotland’s higher than average accident severity rates for rural areas can be partly accounted for by differences in the road network between Scotland and the rest of Great Britain (MVA, 1997). The three most important factors identified were: the estimated traffic flow at the time of the accident; junction type and; road type. In particular, Scotland had a greater proportion of accidents on single carriageways, on links (ie not at junctions) and at lower flows than the rest of Great Britain.

3.40 Scotland’s road network consists mainly of single carriageways – over 97% of the public road length is single carriageway and a large proportion of this will be in non built-up areas. For example, 80% of local authority A roads, 85% of B roads and 88% of C roads have speed limits greater than 40mph. Roads with speed limits of 40mph or less (ie built-up roads) make up just one-third (33%) of the total road length and over three-quarters (77%) of these are unclassified (Scottish Executive, 2004c). Table 3.3 shows that Scotland’s road network has more than double the proportion of rural A class single carriageway roads as England and double the proportion of B roads (which are almost all single carriageway) as England.

<table>
<thead>
<tr>
<th>Road Class/type</th>
<th>England</th>
<th>Wales</th>
<th>Scotland</th>
<th>GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorways</td>
<td>1.0%</td>
<td>0.4%</td>
<td>0.6%</td>
<td>0.9%</td>
</tr>
<tr>
<td>A roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual Carriageway</td>
<td>2.2%</td>
<td>1.6%</td>
<td>1.3%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Urban</td>
<td>0.9%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Rural</td>
<td>1.3%</td>
<td>1.3%</td>
<td>0.9%</td>
<td>1.3%</td>
</tr>
<tr>
<td>Single Carriageway</td>
<td>8.5%</td>
<td>11.0%</td>
<td>16.0%</td>
<td>9.9%</td>
</tr>
</tbody>
</table>
Urban | 2.4% | 1.3% | 1.1% | 2.1%  
Rural | 6.2% | 9.7% | 14.9% | 7.8%  
B roads | 6.6% | 9.0% | 12.3% | 7.7%  
C roads | 21.6% | 29.7% | 17.4% | 21.7%  
Unclassified roads | 60.0% | 48.3% | 52.4% | 57.9%  

3.41 The high proportion of rural single carriageways in Scotland is important because all three of the main accident categories identified by the OECD (1999) are more common on single carriageway roads.

3.42 The EuroRAP project, which is discussed in detail later, points out that single carriageways, at-grade junctions and low traffic flow roads are all features associated with high accident rates (EuroRAP, 2002).

*Dual and single carriageway A roads*

3.43 Two main studies in the UK have examined accidents on rural ‘A’ class single and dual carriageway roads.

3.44 Walmsley et al (1998a, 1998b) and Walmsley and Summersgill (1998) developed detailed models for schemes on modern rural single and dual carriageway trunk roads in England that were subject to the national speed limit. The models for single carriageways distinguish between wide (10m) and standard (7.3m) roads. They take account of traffic flow, length, the numbers of major junctions and the numbers and types of minor junctions, as well as bendiness, hilliness, the numbers of accesses, presence or absence of a hard strip and (for dual carriageways) a median safety barrier.

3.45 They concluded that modern roads are safer than older roads due to improvements in road design. In particular this is due to the modern practice of providing hard-strips, safety barriers and the construction of fewer, better designed junctions.

3.46 In Cambridgeshire, Hughes et al (1996, 1997) reported on similar studies for rural single and dual carriageways. The main findings of these studies along with those mentioned in paragraph 3.44 are discussed later.

*Rural Single Carriageway Roads*

3.47 Barker et al (1998) examined all the reported injury accidents occurring in 1994-95 on rural single carriageway roads (RSCRs) in Great Britain. This updated a previous study of 1988-89 data with which comparisons were made. A few of the more notable findings were:

- Most accidents occurred on A roads (53%); on 2-lane roads (90%); in 60 mph speed limits (96%); and away from junctions (63%). They mostly involved 2 vehicles and no pedestrians (55%); occurred during daylight (71%); and occurred in fine weather (53%).
- Compared with accidents in built-up areas, those on RSCRs were more severe; only about a half as likely to be at a junction; almost one sixth as likely to involve a pedestrian and a quarter as likely to involve a pedal cycle; but they were three times as likely to involve a single vehicle (with no pedestrian).
• The accident severity ratio (ratio of KSI accidents to all injury accidents) for RSCRs was higher on the more major, wider roads, away from junctions, in the dark and in fine weather. It was also greater when male drivers, the oldest drivers, two-wheeled vehicles, public service vehicles, or heavy goods vehicles were involved.

• The most frequently involved vehicle manoeuvre was ‘going ahead - other’ (44% of accident-involved vehicles at junctions and 44% away from junctions). Away from junctions ‘going ahead on a left/right hand bend’ featured next most frequently (35%) while at junctions, ‘turning right’ did so (21%).

• Single-vehicle accidents accounted for almost one third of all accidents. They were more likely than other accidents to be associated with B/C roads, night-time, the youngest drivers and with ‘going ahead on a bend’. Young drivers were also disproportionately associated with positive breath tests and with accidents in the dark.

• Accidents involving vehicles doing the faster manoeuvres (‘going ahead’, ‘overtaking’) were more likely than other accidents to involve young drivers, male drivers, TWMVs, a pedestrian, skidding, leaving the carriageway, hitting objects on or off the carriageway, and to be more severe. Accidents involving slower manoeuvres (‘right-turns’, ‘stopping’, ‘waiting’) were disproportionately associated with female and older drivers. ‘Parked’ and ‘stopping’ manoeuvres were disproportionately associated with PSV/HGVs.

• 4% of all accidents involved a pedestrian. More than half of these involved a single vehicle, ‘going ahead’, not at a junction.

• 8% of all accidents involved two (non-overtaking) vehicles travelling in opposite directions on bends, not at a junction.

• High-performance cars were disproportionately involved in non-junction accidents, in single-vehicle accidents and in overtaking accidents. Their accident involvement was particularly associated with male drivers and with drivers in the 25-39 years age group.

• Comparisons with the earlier study years of 1988/89 (Taylor and Barker, 1992) showed that accident characteristics were remarkably similar between the two periods.

EuroRAP

3.48 EuroRAP, an international not-for-profit association formed by motoring organisations and road authorities throughout Europe aims to provide comparative safety ratings for European roads. To date, roads in Great Britain, Sweden, the Netherlands and Spain have been assessed and rated. The research has highlighted many aspects of road design and use which could be improved to reduce the number of deaths and serious injuries on European roads.

3.49 EuroRAP uses two protocols (Lynam et al, 2003):

• Measurement and mapping of the rate at which people are killed or seriously injured
A standard road inspection for safety features known as the Road Protection Score (RPS)

3.50 The risk mapping allows decisions to be taken on road improvement policies and also presents information for individual road users. It is hoped that by informing road users of the level of risk presented, they can make decisions not only on route choice but also to modify their behaviour to minimise risk. Lynam et al. (2003) also point out that there must be a recognition that infrastructure changes cannot eliminate all risk and that road users must take a share in responsibility for a safe road system.

3.51 EuroRAP provides a clear indication of the effect of traffic flow on accident rates, especially on single carriageway roads. Table 3.4 shows the fatal and serious accident densities (ie accidents per kilometre) for single carriageway roads in the EuroRAP countries by traffic flow. It can be seen that as flow increases, the accident density generally increases.

Table 3.4 – Fatal and serious accident densities (accident per km) for single carriageway roads by flow group (from Lynam et al., 2003)

<table>
<thead>
<tr>
<th>Flow (AADT)</th>
<th>GB</th>
<th>NL</th>
<th>S</th>
<th>ESP</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5,000</td>
<td>0.14</td>
<td>0.11</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>5,000-10,000</td>
<td>0.23</td>
<td>0.29</td>
<td>0.29</td>
<td>0.26</td>
</tr>
<tr>
<td>10,000-20,000</td>
<td>0.35</td>
<td>0.35</td>
<td>0.48</td>
<td>0.49</td>
</tr>
<tr>
<td>20,000-40,000</td>
<td>0.46</td>
<td>0.59</td>
<td>0.38</td>
<td>0.77</td>
</tr>
<tr>
<td>40,000-100,000</td>
<td></td>
<td></td>
<td></td>
<td>0.61</td>
</tr>
</tbody>
</table>

3.52 The latest EuroRAP data for Great Britain (AA Foundation, 2004) highlights several roads in Scotland which are either ‘medium to high risk’ or ‘high risk’. This latest data also highlighted the contribution that motorcyclists make to fatal and serious injuries on some roads and contained a separate analysis for roads with motorcyclist accidents removed.

3.53 The EuroRAP Road Protection Score (RPS) indicates the extent to which road design protects the user in the event of an accident occurring (Lynam et al., 2003). The main RPS results show that:

- On many roads, but especially single carriageways, there is substantial scope to improve the potential for injury prevention.
- Many roads score poorly for run-off protection – the suggestion is that fatalities are likely to occur unless barriers or wide safety zones can be provided
- The lowest scoring roads score poorly for all three accident types (head-ons, single vehicle run-offs and junction accidents)
- Protection on single carriageways is limited by narrow safety zones, poor access provision (ie junctions) and by the lack of medians to “limit the interaction of opposing traffic streams”. The authors point to median treatment in Sweden and the Netherlands as good examples.

3.54 At present, the RPS does not include the contribution that road design, signs and markings can make to influencing driver behaviour and largely measures the ‘passive safety
of the road’. However, the RPS demonstrates that an appropriate balance between speed and road design can produce high levels of protection on most road types (Lynam et al., 2003).

**Road width**

3.55 The effect of width on accident rate was reviewed in an unpublished report by TRL in 1992, based on research on single-carriageway roads in the US. In general, wider roads were found to have a lower accident risk (e.g. Zegeer et al., 1981). The number of lanes had a similar effect to road width, but the two variables are correlated. More recently, Hughes and Amis (1996) found that for rural single carriageways in Cambridgeshire, a 1m increase in carriageway width was associated with a 19% decrease in accidents. Walmsley and Summersgill (1998) found that there was a 22% lower accident risk on 10m wide single carriageway trunk roads compared with 7.3m wide roads, for the same level of flow.

3.56 In research into road appearance which involved showing pictures in a questionnaire survey (Highways Agency, 2002), carriageway narrowing was found to reduce mean estimated driving speeds by as much as 7mph in one location. Other research projects in which reported speed has been measured (e.g. Fildes et al., 1987), and in which actual vehicle speeds have been measured (e.g. Kolsrud, 1985; Vey and Ferreri, 1968; Yagar and Van Aerde, 1983) support this finding.

**Horizontal and vertical alignment**

3.57 Walmsley and Summersgill (1998) found that bendiness and hilliness had only a small effect on accident risk on rural trunk roads, with a higher accident risk on roads that had poor alignment, probably because the trunk roads on which the models were based had relatively low values of hilliness and bendiness. They concluded that the effect of adding an extra bend or hill would be to increase accidents by less than 1 per cent for a single-carriageway scheme and about 4% on a dual-carriageway.

3.58 By contrast, Barker et al (1998) found that 1/3 of non-junction accidents occurred on bends.

3.59 Shrewsbury and Sumner (1980) showed that accident rates on rural roads decreased with increasing horizontal radius. Hughes and Amis (1996) found that for rural single carriageways in Cambridgeshire, an increase in bendiness of 1 degree per km was associated with a 1% increase in accidents. Hughes et al (1997) found a similar effect for rural dual carriageways in Cambridgeshire. More recent work by Taylor et al (2002a) on a variety of rural road types suggests that more sharp bends per kilometre are associated with a higher accident risk (see para 3.12). Sight distance is correlated with bendiness and has therefore not been considered separately by most authors.

3.60 Volume 6 of the Design Manual for Roads and Bridges gives advice and sets the geometric standards by which new trunk roads are designed. Advice note TA85/01 (DMRB 6.1.3) points out that high speed differentials occur at crests and sags in the alignment and this can result in increased numbers of accidents particularly where visibility is restricted.

3.61 Gradient was found to have a mixed effect (Shrewsbury and Sumner, 1980). Steeper downhill gradients were found to be associated with higher accident rates, but steeper uphill gradients had much less effect.
**Roadside characteristics**

3.62 Walmsley and Summersgill (1998) found that the presence of a hard strip on rural trunk roads was associated with a reduction in accident risk of 16% on dual-carriageways and 18% on single carriageways.

3.63 Hughes et al (1997) found that nearside kerbing was associated with a reduction in accident risk on rural dual carriageways, whereas Walmsley and Summersgill (1998) found the opposite.

3.64 On rural roads, verge width was found to be important in some early studies (Zegeer et al, 1981, McLean 1985), but not others.

3.65 Safety barriers are required in appropriate circumstances on trunk roads with a speed limit above 50mph (IRRRS, 2002). However, this requirement takes no account of the level of traffic flow. Roads with low flow may also have lower risk, but a relatively high proportion of Scottish roads will have steep embankments close to the road and these will require protection.

**Junctions and accesses**

3.66 The trunk road accident models by Walmsley and Summersgill (1998) take into account the effect of major junctions (roundabouts or traffic signals) and three- or four-arm major/ minor junctions. Accidents were found to increase with the number of junctions per kilometre. Walmsley and Summersgill found that adding an extra access to a typical single-carriageway trunk road scheme would have only a small effect (less than 1 per cent). On dual carriageways, it was the number of offside accesses (that is, across the reservation) which were significant. Adding an extra access to a typical dual-carriageway scheme would increase accidents by 2 to 3 per cent.

3.67 Hughes et al (1997) examined several different factors associated with increased accident frequency at rural dual carriageway junctions. These included the number of vehicles entering and leaving the main road at grade-separated junctions; minor road traffic flow at T-junctions, vertical alignment issues, and issues associated with gaps in the central reserve. They found that increasing the distance between junctions, providing a wide verge on the off-side of slip roads, and/or increasing on-slip merge lengths decreased the accident frequency.

3.68 Hughes et al (1997) also found that older drivers had greater involvement in accidents involving a right turn or crossing the main carriageway at junctions.

3.69 In their complementary study of single carriageways, Hughes and Amis (1996) found a significant proportion of accidents at private accesses on some routes. These accidents tended to be more prevalent at ‘business’ accesses, tourism spots and Sunday market locations where traffic movements were higher.

3.70 Hughes and Amis (1996) also found that accident frequencies at rural T-junctions are influenced by major road traffic flow, minor road traffic flow and carriageway width.
Weather/climate and seasonality

3.71 Seasonality of accidents will largely be influenced by traffic flow and weather conditions. Summer flows will be swelled by tourists, leading to more accidents in summer (see paragraph 3.98). However, winter conditions may be more severe, thereby increasing the accident rate for those who still use the roads although this will be off-set to some degree by drivers choosing not to travel in the worst conditions. Poor weather can also affect emergency response times and the cold may decrease the chances of survival.

Light conditions

3.72 Green (1980), in a study to examine the effects of darkness on accident rates, studied the number of accidents in the five working days before and after the Sundays in 1975, 1976 and 1977 when the clocks changed. The study examined six regions of Great Britain, including Scotland, separately and the data was confined to non built-up roads. Green (1980) found that in the evening period studied, the frequency of all injury accidents is about 50 per cent higher and of fatal and serious accidents about 100 per cent higher. Green (1980) also noted that “the changes appear to be consistent over the country”.

3.73 The evidence that casualty rates, particularly fatal and serious injuries, are higher in darkness has led to several investigations of the potential road safety effects of adopting so called Single/Double Summer Time (SDST). SDST would involve setting clocks to one hour ahead of Greenwich Mean Time (GMT +1) from October to March and two hours ahead (GMT +2) from March to October.

3.74 A recent study into the potential effects of adopting SDST (Broughton and Stone, 1998) found that the effects of darkness are greater for pedestrians than for vehicle occupants and greater for fatalities than non-fatalities. Overall, Broughton and Stone (1998) predicted that KSI casualty rates for the whole of Great Britain for the period 1991-94 would have been 0.8% lower had SDST been in place. The predicted reduction for Scotland was slightly lower at 0.7%. However, it should be noted that the separate analysis for Scotland was limited by sparse data – particularly in the morning. The data could not be disaggregated by severity, time of day or into pedestrian and vehicle occupants. Therefore, the effect of SDST on rural casualty rates in Scotland is not clear.

3.75 On the basis of the evidence, several road safety organisations support the adoption of SDST. For example, RoSPA has suggested that SDST be introduced on a trial basis for two to three years so that the effects can be directly measured (RoSPA, 2003).

Wild animals

3.76 In 2003, there were 222 reported injury accidents in Scotland involving an animal other than a dog in the carriageway (Scottish Executive, 2004a); this represents approximately 1.5% of all reported injury accidents. However, there is no breakdown by animal type or by built-up or non built-up roads given in the national statistics.

3.77 Staines et al (2001) report on a study into road accidents involving deer in Scotland. They found, albeit from limited data, that deer-related incidents are less common in the south and south-east and more common in the Highlands and south-west Scotland. The highest proportion of deer accidents is recorded on trunk or other A class roads and their incidence peaks in May-June and September-November. The highest proportion of accidents occurs.
between 2000-2400hrs with additional peaks at dawn and dusk. Organisations consulted considered that deer accident rates had increased in recent years but many felt that there were other issues associated with road traffic accidents which were of higher priority.

3.78 In order to more accurately quantify the problem of deer-related crashes, the Deer Initiative has created a web based database (www.deercollisions.co.uk) to allow incidents to be directly reported. This site also contains advice to drivers to help avoid accidents with deer.

3.79 In a recent follow-up study, Putman et al (2004) suggest that road traffic accidents involving deer may be expected to increase due to the distribution and abundance of deer in Scotland combined with increasing traffic and higher speeds associated with road improvements. They point to research from Europe and the USA which supports this suggestion. The main focus of their study is into the costs and cost-effectiveness of various measures to reduce deer accidents.

3.80 Putman et al (2004) recommend that deer fencing is the most appropriate mitigation measure for motorways and high speed trunk roads. For more minor roads, or where deer fencing is not a feasible option, mitigation measures should be targeted at reducing driver speeds in areas of known high deer collision risk.

Vulnerable road users

Young drivers/passengers

3.81 It has long been recognised that young drivers are over-represented in accident statistics. The OECD highlighted the fact in its 1975 report (OECD, 1975). In Scotland, young drivers/riders and passengers in the 16-22 age group have the highest killed and seriously injured casualty rate per head of population (Scottish Executive, 2004a) out of all age groups. However, the published statistics give no indication of the split between urban and rural areas.

3.82 As mentioned in paragraph 3.47, Barker et al (1998) found that on rural single carriageways, accidents involving ‘faster’ manoeuvres such as going ahead and overtaking were more likely to involve younger drivers, particularly male drivers. This was also the finding of Hughes and Amis (1996).

3.83 A large body of work has tried to establish whether young drivers are more at risk because of immaturity or lack of experience. The reader is directed to Grayson and Sexton (2002) and Williamson (2003) who give summaries of the issues.

Motorcyclists

3.84 Motorcyclists accounted for 15% of all killed and seriously injured casualties on Scottish non built-up roads in 2003 (Scottish Executive, 2004a). However, they constitute less than 1% of traffic on Scottish rural roads (Scottish Executive, 2004c).

3.85 Recent research (Sexton et al, 2004) has shown that whilst most motorcyclist accidents in Scotland occur on built-up roads, the majority of fatal and serious injuries to motorcyclists occur on non built-up roads. These accidents tended to be the fault of the motorcyclist, resulted from a ‘loss of control’, involved ‘sports bikes’ and occurred on single
carriageways with 60mph speed limits. Accidents on non built-up roads tended to occur at weekends reflecting recreational use. The research found that 20% of accidents occurred on bends and most of these involved the rider losing control.

3.86 Sexton et al (2004) also found that there has been a sharp increase in the numbers of killed and seriously injured motorcyclists on non built-up roads in recent years and that this rise coincided with a doubling in the numbers of licensed motorcyclists and corresponding rises in motorcycle traffic.

3.87 Clark et al (2003, 2004) report on a study of over 1,000 accidents involving motorcycles in the Midlands. Their findings are broadly in line with Sexton et al (2004). They found that motorcyclists and drivers were approximately evenly to blame for all accidents involving motorcyclists. However, other drivers (ie not the motorcyclist) were found to be responsible for the majority of those accidents involving two or more vehicles. The authors suggest that any initiatives in motorcycle safety should address the behaviours of both riders and other road users. However, this suggestion is based on addressing all motorcycle accidents – not just those on rural roads.

3.88 As mentioned previously, the contribution of motorcyclists to fatalities and serious injuries on some rural roads was highlighted in the most recent EuroRAP data for Great Britain (AA Foundation, 2004).

**Children**

3.89 Road Accidents Scotland 2003 does not give any indication of the relative proportions of child casualties on built-up and non built-up roads.

3.90 However, Christie et al (2002) examined STATS19 data in Great Britain to establish the main features of accidents involving children in rural areas. They found that there were considerably fewer accidents involving children in non built-up areas compared to built-up areas. In those which did occur, the child casualties tended to be car passengers and the children tended to have a lower severity ratio than adult car occupants.

3.91 They also found much fewer child pedestrian and cyclist casualties in non built-up areas than in built-up areas although they highlighted issues with children walking with their back to traffic and child cyclists being vulnerable at private driveways.

3.92 Christie et al (2002) examined various sources of exposure data and concluded that children in rural areas may be more exposed to accident risk as car passengers because of the greater car ownership, longer trip lengths and higher levels of travel to school by car. They concluded that in-car safety interventions and educational interventions which improve restraint use and focus on driver behaviour, especially regarding speed and alcohol, may be particularly important.

**Cyclists**

3.93 As shown in Chapter Two, whilst cyclists account for just 3% of fatalities on non built-up roads, one quarter of all killed and seriously injured cyclist casualties occur on non built-up roads. On average in Scotland, nearly two-thirds of all cyclist fatalities occur on non built-up roads (Scottish Executive, 2004a).
Gardner and Gray (1998) examined the issues affecting cycling on rural roads. They pointed out that, whilst all fatalities and a substantial proportion of serious accidents are reported, cycling accidents generally (and single vehicle accidents in particular) tend to be under-reported. Their main findings are summarised below:

- The rate of fatal cycling accidents per 100 million veh. km. on non built-up roads is almost three times that of built-up roads.
- Accidents on rural roads tend not to be clustered making spot treatment and even route treatment difficult and expensive.
- The severity of cycling accidents increases with the speed limit of the road.
- Rural traffic growth could increase the danger to cyclists and will be a disincentive to cycling.
- At the time of the report, local authorities had only just begun to tackle rural traffic management.
- They suggest that a rural road hierarchy is defined on the basis of the character and function of roads to provide a network where all roads are used optimally for road safety, movement and environmental requirements.

**Tourist/Visitor accidents**

The question of whether tourists and visitors to rural Scotland have a higher road accident risk than local drivers was examined by Sharples and Fletcher (2001). They pointed to previous research which indicated that visitors, especially foreign visitors, have a higher road accident risk than local people. In particular, some research has shown that visitors can be unfamiliar with the roads and potentially the driving rules and conventions, and may be distracted (reading maps or viewing scenery).

Briganti and Hoel (1994) devised design guidance for roads which are promoted as ‘scenic byways’ (tourist routes) in Virginia, USA. They indicated that particular problems were experienced by unfamiliar drivers on single carriageway roads because these roads are less likely to have consistent traffic/information signage and geometric design standards.

Sharples and Fletcher (2001) examined STATS19 postcode data to establish the ‘localness’ of drivers involved in crashes in 1999. However, this exercise could only be completed for UK drivers. They found that over half of drivers were within 5km of their home address at the time of the accident. However, in the more rural police areas of Northern Constabulary and Dumfries & Galloway, a markedly greater proportion of drivers were more than 240km from their home address at the time of the accident.

Sharples and Fletcher’s (2001) main conclusions were:

- Tourist activity does significantly boost road accident numbers in rural tourist areas of Scotland.
- The overall rate of road accidents per vehicle mile is not increased significantly during tourist high season.
- The exposure data for foreign drivers is not adequate to establish whether they are at greater risk of an accident than local drivers.
A recent study in New Zealand (Nind et al., 2004) examined tourists’ attitudes, knowledge and experience of driving in the Otago and Southland regions. Whilst many of the findings are specific to that local area, there were a few interesting results. They found that tourists who drive are mainly experienced drivers who drive everyday in their home country – only a small minority of tourists risk driving in New Zealand with limited driving experience. Tourists perceived New Zealand roads as good with most negative perceptions relating to weather, terrain, remembering to keep to the left and keeping below the speed limit. These concerns could well apply to many rural parts of Scotland and it may be beneficial to carry out a similar survey in Scotland to help identify areas where better information could be targeted.

Emergency Medical Service Response

Emergency medical service (EMS) response time is known to be a critical factor in the mortality associated with road traffic crashes, especially in rural areas. Several studies have suggested that the higher fatality rate on rural roads can, at least partly, be explained by the emergency service response time. Unpublished research carried out by the University of Leeds in 1994, cited by MVA (1997) suggested that factors such as light and weather conditions, response time by emergency services and size and age of vehicles may play a role in different severity rates on Scotland’s rural roads.

Williams et al. (1991) examined geographical distributions of male and female road traffic fatalities in Scotland between 1979 and 1988. They found significantly higher mortality rates in areas with low population densities such as the rural Highlands, Borders and Dumfries & Galloway. This effect was more profound in Scotland than in other rural parts of the UK and the researchers suggested that this may in large part be due to the population and geographical characteristics of Scotland affecting EMS response times.

The OECD points to research which identifies three clear time periods in which trauma death can occur. It states that 50% of trauma deaths occur within a few minutes of injury, that only a few of such casualties can be successfully treated, and then only in large urban areas where rapid treatment is available. The second period, often called ‘the golden hour’, is the period in which early treatment could make a significant difference to survival. The third period occurs several days or even weeks after the initial injury and the OECD asserts that early treatment may not have a significant effect on the outcome (OECD, 1999). Therefore, strategies to improve EMS response within the ‘golden hour’ would appear to have the most merit.

There appears to be a fairly large body of research on EMS response times and associated effects on road crash survivability although the findings are sometimes conflicting. For example, Grossman et al. (1997) compared differences in response times, scene times and transport times by paramedics to trauma incidents in both urban and rural locations in Washington State. Mean response times and transport times (from incident to hospital) in rural areas were found to be nearly double those in urban areas. They found that rural victims were more than seven times more likely to die before arrival at hospital if the response time was more than 30 minutes. By contrast, Jones and Bentham (1995) reported that ambulance response times made no difference to mortality rates amongst road traffic casualties. It is difficult to judge how applicable this is to the rural situation in Scotland but it is clear that longer response times could lead to an increased risk of death.
3.104 Estochen et al (1998) point out that providing EMS in rural areas requires a different approach to urban areas due to lower population densities. In rural areas, the service must be provided over a large geographical area with limited resources. In urban areas, services can be consolidated to a smaller number of locations.

3.105 Since response time is potentially such a significant factor, quick accurate identification of the accident location is crucial. In rural areas, this can present an additional challenge as there may be fewer identifying landmarks. In addition, on many lightly-trafficked rural roads, a significant time might pass before the accident is discovered and reported.

3.106 Automatic crash notification systems, also known as ‘Mayday’ systems, consist of vehicle crash sensors combined with a geographic positioning system and can automatically alert EMS controllers to the occurrence and location of a crash using mobile phone technology. Systems with some of this functionality are available in the UK (see http://www.ractrackstar.com/). Research in the USA (Evanco, 1999 and Clark & Bushing, 2002) suggests that such systems could reduce road traffic fatalities by up to 11% and would be most useful in rural areas. The European Commission intends that, by 2009, all new cars sold in the European Union will be fitted with a ‘Mayday’ system known as ‘eCall’ (European Commission, 2005).

3.107 The OECD points out that there is a role for publicity in improving accident reporting and response. The public could be made aware of the steps to take in the aftermath of an accident and the information required by the emergency services (OECD, 1999).

3.108 In addition, the OECD suggests that the number of road users able to administer first-aid could be increased by increasing the availability of first-aid and resuscitation training in rural areas (OECD, 1999). High risk groups and professional drivers can also be targeted and recent initiatives in the rural West Highlands of Scotland have targeted first-aid training at motorcyclists (Scottish Ambulance Service, 2004).

**Agricultural vehicles**

3.109 Several studies from abroad have examined the issues associated with the use of farm vehicles on public roads. For example, in a USA study, Luginbuhl et al (2003) highlighted that the speed differential between farm vehicles (slow speeds) and normal traffic was a major concern. Another issue highlighted by Luginbuhl et al (2003) was use of proper lighting on farm vehicles. It is not clear how these findings would relate to the Scottish situation.

3.110 Published accident statistics do not separately identify agricultural vehicles – these are included in ‘other vehicles’ along with emergency vehicles, refuse collection vehicles and road sweepers amongst others. Also, some farm vehicles will be classed as cars or goods vehicles. However, ‘other vehicles’ accounted for less than 1.5% of all vehicles involved in Scottish road accidents in 2003 (Scottish Executive, 2004a).

3.111 Even though they account for a small proportion of accident-involved vehicles, the issue of agricultural vehicle use on public roads is a concern in Scotland. In 2002, the Perthshire Machinery Ring, supported by Perth & Kinross Council published a code of practice for using agricultural machinery on the public roads. (Perthshire Machinery Ring, 2002).
In a study by Knight (2001) into fatal accidents involving ‘other motor vehicles’, drivers of agricultural vehicles were far less likely to be responsible for the accident than other parties. The study also highlighted that tractors may pose a specific risk to motorcyclists (presumably related to the high speed differential) and that there was a possible issue of agricultural vehicles not always being roadworthy. As in the US research, proper vehicle lighting was highlighted as an issue and it was estimated that, in the accidents studied, improved lighting or conspicuity of the agricultural vehicle could have saved the lives of 15% of car occupants, 15% of motorcyclists and 15% of tractor occupants themselves.
CHAPTER FOUR  INTERVENTIONS FOR RURAL ROADS

Education, training and publicity campaigns

Background
4.1 The main aims of driver education, training and publicity campaigns are firstly, to teach novices how to drive and secondly, to improve standards of existing drivers. Their use has two important benefits compared with engineering measures:

- it addresses the root cause of the problem - the interaction between road user and road layout or traffic situation;
- any resulting safety improvements are not likely to be offset by reductions in capacity, which can occur as a result of geometric changes to improve safety

4.2 As a consequence, the potential benefits of effective driver training, education and publicity are very great. However, the direct benefits can be difficult to measure. The drink-driving campaign is an example that has substantially reduced the incidence of drink-driving over the years. The Scottish ‘Foolsspeed’ campaign is recognised as having had a positive effect on attitudes to speeding (Stead et al, 2002) although it is also recognised that interventions designed to change people's attitudes have had little observed impact on driving speeds (e.g. Parker et al, 1996). Stead et al (2002) note that advertising alone is unlikely to impact on behaviour unless part of a multi-faceted strategy including enforcement and environmental changes.

4.3 Very little information exists on education, training and publicity campaigns which are specific to rural areas. However, several initiatives (especially publicity campaigns and driver training) have targeted issues and groups which are relevant to rural areas and these are discussed in the following sections.

Education
4.4 Education in road safety begins in schools and may be aimed at various user groups including, for example, child pedestrians, cyclists or young drivers (e.g. Driving Standards Agency education package). Many of these initiatives are facilitated or delivered via local authority or police road safety units.

4.5 Christie et al (2002) carried out a survey of local authority policy with respect to road safety applicable to children in rural areas. They found a number of common policies and strategies although none were targeted at or exclusive to children in rural areas. The education initiatives highlighted include:

- Classroom-based road safety education in the National Curriculum
- Theatre in Education campaign against speeding involving newly qualified drivers
- Children’s Traffic club for 3 to 4 year-olds
- Young driver education courses
• ‘Crucial Crew’ – incorporation of road safety education into broader events on safety targeted at 10-11 year olds
• Cycle training schemes

4.6 Christie et al (2002) point out that education initiatives are rarely evaluated and even then, the evaluation is usually informal.

Publicity campaigns
4.7 Some campaigns are aimed at the general public and focus on issues such as speed or fatigue whilst others target particular categories of driver, for example young males, who are disproportionately involved in accidents. Like education initiatives, the effects of campaigns appear to be rarely evaluated.

4.8 The THINK! Campaign recently focussed on the dangers of driving at inappropriate speeds on rural roads. It emphasised the potential problems encountered by drivers travelling too fast on these roads and highlighted that rural roads can present unforeseen hazards such as blind bends or animals in the road. The campaign included a radio advert aimed at younger drivers which highlighted the dangers of driving too fast on rural roads (DfT, 2004c).

4.9 Quiros and Shaver (2003) report on initiatives to reduce crash fatalities on rural roads in the USA. They point out that most funding is given to projects in higher population areas but that there are some initiatives specifically targeted at rural roads. For example, they point to ‘Partners for Rural Traffic Safety Action Kit Guide’ which was a publication designed to educate rural community leaders on how to promote a seat-belt use campaign and measure its success. It should be noted that seat belt laws in the USA vary from state to state and seat belt usage is typically much lower than in Scotland, at around 75% (Glassbrenner, 2003).

4.10 In a survey of education literature regarding driver sleepiness mainly in the UK, Australia and the USA, Flatley and Reyner (2000) found three main approaches to driver education. These were:

• Education of the general public about the dangers of driving whilst sleepy
• Targeting high risk groups using appropriate material and;
• Education of other opinion formers (such as employers, teachers, law enforcement personnel)

4.11 They also identified some innovative schemes in the USA and Australia including roadside restaurants encouraging drivers to stop with free coffee and the novel audio cassette and booklet entitled ‘Wake Up!’ which was distributed to radio stations and drivers in Australia.

4.12 Recently in the UK, the Department for Transport’s ‘THINK! Campaign has included radio advertising to alert drivers to the dangers of driving whilst tired.

4.13 The issue of older drivers turning right has been highlighted as a potential problem on some rural roads. For example, Faulkner (1975) found that the risk of an accident at the junction of a minor road with a rural major road increased with the age of the driver. Hughes and Amis (1996) also found a ‘significant association between car driver age and manoeuvre
which was independent of gender’. In particular, they found that right turn manoeuvres were riskier for drivers aged over 60. However, unpublished research for the Highways Agency found that it was more difficult to target older drivers through publicity campaigns than younger ones.

4.14 Australia is one country where rural road safety issues have been recognised with a national rural road safety strategy (Federal Office of Road Safety, 1996). This plan has included several public education programmes specifically targeted at issues affecting rural areas. These have included fatigue, drink driving and seat belt usage (all major issues in rural road accidents in Australia). The latest campaign related to speed and targeted young males aged 17 to 25. The campaign was based on research which suggests that young males are less likely to respond to messages which warn of death or injury (either to themselves or to others) but more likely to respond to messages that they might lose their licence and the likely consequences of this (ATSB, 1999).

Driver training/ licensing

4.15 There is very little literature which deals with driver training or licensing specific to rural areas. However, there is a great deal of literature relating to these topics in general and some of the more relevant papers are discussed here.

4.16 The driving test is regarded as the key element in driver training. It continues to be improved over time and has included a written, as well as a practical component for a number of years. Recently, video clips to improve learner drivers’ hazard awareness (Grayson and Sexton, 2002) have been adopted as an integral part of the test.

4.17 Unpublished research by TRL for the Highways Agency directed at young male drivers was intended to address their lack of driving experience and the likelihood that they would be over-confident in their own abilities. A video-based hazard perception training package developed by the Driving Standards Agency as an extension of those now included in the driving test was used with a group of newly qualified drivers. The clips were designed to stimulate discussion within the group and to demonstrate good practice. A control group received no training. However, because accidents are rare events and can occur at any point in the road network, it was not possible to conclude how effective the training was.

4.18 A number of organisations offer post-test on-road training in the UK:

- IAM (Institute of Advanced Motorists)
- RoSPA (Royal Society for the Prevention of Accidents)
- Drive & Survive UK PLC
- Driving Services
- DriveTech
- BSM (British School of Motoring)

4.19 However, there is no legal requirement for drivers to undertake post-test training and, therefore, it is undertaken by only a small proportion of drivers. The novice driver scheme called ‘Pass Plus’ is linked to reduced insurance premiums which may increase take-up.

4.20 Traditionally, mastery of traffic situations has been the main component of driver training (e.g. Hatakka et al, 2002). However, it is the case that excellent skills for this are not necessarily enough for safe driving (see Lonero et al, 1995). By concentrating on the
technical aspects of driving and increasing the self-confidence of novice drivers, the more skilled drivers may simply drive faster, overtake in heavier traffic or listen to the radio (Evans, 1991). There is evidence to suggest that it is attitude rather than skill that is related to crash involvement, assuming that driving skill has reached a minimum standard (DETR, 2000 and see Lonero et al., 1995). Several personality characteristics have been associated with unsafe driving, the most prominent of these being hostility/aggression, thrill-seeking and impulsiveness. To avoid this, driver training should address driving style and include awareness of personal skills and their limits.

4.21 Various European initiatives have been undertaken by CIECA (the international commission for driver testing authorities) with regard to driver training (www.cieca-drivinglicense.org):

- BASIC
- Advanced
- GADGET
- NovEV

4.22 Advanced is an EU project that undertook a study of post-licensure driver and rider training. It describes and analyses voluntary, post-licensure training and makes a series of recommendations on how to improve such training. It emphasises the importance of avoiding overconfidence amongst trainees and indicates how training can be more effective and balanced. The CIECA website contains a report on the project with guidelines on how to evaluate the effects of training on participants and a Risk Awareness Database of exercises which can be used in the training. The report highlights the lack of relevant research into the effects of post-licence road safety training.

4.23 Advanced is accompanied by a sister project called BASIC on new training methods for (pre-licence) learner drivers.

4.24 The GADGET project developed a matrix depicting four levels of driver behaviour and the focus needed on each of these levels to make “a good driver”. The matrix is based on the assumption that the driving task may be described as a hierarchy such that abilities and preconditions in a higher level influence the demand and preconditions on a lower level. The levels are:

- Goals for life and skills for living - lifestyles, social background, gender, age and other individual preconditions influence attitudes, driving behaviour and accident involvement
- Goals and context of driving – why, where, when and with whom driving is carried out e.g. time of day, whether fatigued, trip purpose
- Mastering traffic situations – adjust driving in accordance with traffic e.g. at junctions
- Vehicle manoeuvring – control of vehicle, injury prevention systems e.g. seat belts, air bags

4.25 NovEV is a successor to the Advanced project which included recommendations for countries wishing to introduce compulsory “2nd phase” training for novice drivers (after passing the driving test), including advice on the methods used to evaluate the effects of the training on participants.
Williamson (2003) reviews the specific issues associated with young drivers and in particular covers Graduated Licensing Schemes (GLS). She suggests that the issue of inexperience is well tackled by GLS but other issues such as risk-taking may not be specific to young drivers. She recommends that more work is carried out on finding the best ways of tackling so-called ‘problem drivers’ who may or may not be young drivers.

Fleet driver training

As highlighted in Chapter 3, driver fatigue is a recognised factor in rural accidents. Large goods vehicle drivers commonly experience driving pressure from tight schedules and long hours, and these may increase at particular times of year (Jackson, 2004). There are often no official company rules or guidance related to driving safety. A prevalent attitude in the small haulage companies is that there is no need for rules or training and no point in accident reporting/feedback (DfT, 2004d). In addition to basic training, a Safety Management System (see e.g. British Standard 8800 (1996) ‘Guide to Occupational Health and Safety Management Systems’) is desirable to manage road safety for fleet drivers.

Engineering measures

In contrast to the education, publicity and training sectors, there is a very large volume of literature on engineering interventions specifically for rural roads. Many of the measures and evaluations are described in the IHT guidelines (IHT, 1999) and summarised in the Road Safety Good Practice Guide (DTLR, 2001). Advice note TA85/01 (DMRB 6.1.3) provides useful guidance on the assessment and design of minor improvement schemes for trunk roads.

The OECD (1999) highlights that safe road design must take into account the capabilities and limitations of road users. This safe design philosophy has two main strands: making human error less likely and forgiving human error if it occurs.

Rural speed management

As has been highlighted earlier in Chapter Three, speed management is a key issue in rural road safety. The setting of speed limits, appropriate to the needs and functions of the specific road section, is fundamental to the speed management philosophy.

The Department for Transport investigated the potential for setting a new rural road hierarchy (as suggested by a number of studies) but concluded that a new hierarchy would be costly (both financially and environmentally) and the benefits would take a long time to realise. However, this decision did not preclude the setting of more consistent speed limits within existing infrastructure constraints (Lynam et al, 2004).

Current guidance on the setting of speed limits has been interpreted in different ways by local highway authorities with the result that, over the last few years, different decisions have been made on the choice of appropriate speed limits for rural roads in different parts of the country (Lynam et al, 2004).

Lynam et al (2004) set out a new method for assessing and deriving speed limits on rural single carriageways. This divides roads into two groups: an upper tier (which would include most A and B roads) and a lower tier (which would include most minor roads). For
the upper tier roads, a speed limit of 50mph should initially be considered. For ‘higher
quality’ roads, a speed of 60mph may be appropriate provided that the accident rate is below
a set threshold. For lower tier roads, a initial speed limit of 40mph should be considered with
the potential for a 50mph limit on ‘higher quality’ roads, again provided that the accident rate
falls below a certain threshold. Where roadside development dictates, 30mph and 40mph
limits should be provided. Lynam et al (2004) predict accident savings of the order of 25%
on upper tier roads and half this on lower tier roads.

4.34 Based on the findings of Lynam et al (2004), the Department for Transport and the
Scottish Executive are currently consulting on a new process for the setting local speed limits
including, in particular, on rural single carriageways (DfT, 2004e and Scottish Executive,
2004d). If this guidance is adopted and implemented, it should result in more consistent and
understandable speed limits throughout the country.

4.35 However, the new guidance makes it clear that

“speed limits should be considered as only one part of rural safety management. The
first priority where accident rates are high should be to seek cost effective
improvements to reduce these rates, targeting the particular types of accidents taking
place.”

It points to research (TRL Limited, 2004) which gives guidance on how to assess rural road
safety and identify types of route or intervention measures which may be appropriate to
reduce speeds and accidents along the route. The TRL guidance suggests separate
intervention levels for single and dual carriageways (see also Barker et al, 1999) and points to
the use of engineering measures which can be implemented to manage speed in rural
situations (see DTLR, 2001). Some of the more important or innovative engineering
interventions applicable to the rural environment are discussed in the following sections.

**Vehicle-activated signs**

4.36 Vehicle-activated signs light up only for drivers exceeding a pre-set speed. They may
display a speed limit or advance warning of a hazard (e.g. a bend or a crossroads junction).
Reductions in mean speeds of 3-6mph have been observed following the introduction of such
signs on the approaches to bends, junctions or a speed-limit change (Barker, 1997, Farmer
traffic flows and before speeds. Winnett and Wheeler (2003) found that the signs led to a
substantial accident reduction.

**Countdown signs**

4.37 Barker (1997) found that countdown signs did not affect mean on-road speeds. However,
Pyne et al. (1995A and B) using a driving simulator, found they were more
effective than a speed limit sign alone. Wheeler & Taylor (1999) recorded large reductions in
mean speed when countdown signs were used in conjunction with other measures having a
high visual impact at a village gateway. Similar results were reported by Taylor et al (2002b)
using a driving simulator.
Road markings and surfacing measures

4.38 White edge lining is recommended to delineate the edge of the road and is used in conjunction with a hardstrip on major roads. Its use may lead to higher speeds at night because it is easier for drivers to see the line of the road ahead. Hatching can also be used at the edges of the road to reduce lane width. Longitudinal red strips with hatching on the edges and centre of a rural single-carriageway road were found to be effective in reducing mean speeds on a driving simulator by up to 5.6 mph (Taylor et al, 2002b).

4.39 Raised rib edge markings, which alert the driver if the vehicle crosses the line, have been used on motorways for a number of years and may be beneficial in reducing sleep-related accidents.

4.40 Centre lines (and lane lines) delineate lanes and again aid the driver to see his path ahead. The former are also used for hazard marking (e.g. use of double white lines at bends).

4.41 The absence of centre white lining can increase uncertainty for drivers and removal of the white lining on moderately narrow roads through rural villages has been suggested as a means of reducing vehicle speed. Results for the village of Stiffkey in Norfolk, where speeds were already low, indicated a slight reduction in mean speed when the centre white line was removed (Kennedy & Wheeler, 2001a). Unpublished research indicated a reduction of 7mph in mean speed in Starston, another Norfolk village, when the centre white line was removed. Yagar and Van Aerde (1983) found that the addition of a centre line had little effect on driving speeds. Removal of white lining has been successful in a number of villages in Wiltshire (Debell, 2003).

4.42 An idea tested in Drenthe in Holland (De Waard et al, 1995) combined a novel edge treatment with other measures. It was intended to reduce speed variance on rural roads with a lot of slow-moving farm traffic. The road was effectively narrowed by making it uncomfortable for occupants of cars when driving at over 50 mph unless they kept to the centre of the lane, whilst larger vehicles were not affected. The white edge lines were replaced by 4m long rectangles of rough surface (chippings) interspersed by 4m gaps where the road surface remained unchanged. Rough surfacing was also used between the white dashes in the widened centre line. The mean speed of subjects in an instrumented car was reduced by up to 3kph.

4.43 Marked speed limit roundels on the road surface can be used to complement signing as a reminder of the speed limit. They are usually adopted in conjunction with other measures, for example at a village gateway (see para 4.60). In the absence of other measures, 30 mph roundels were not found to have any effect, but 40 mph roundels reduced speeds by 3 mph (Barker, 1997, Barker & Helliar-Symons, 1996).

4.44 Coloured road surfacing is commonly used in two ways. The first is to emphasize a traffic calming feature, or to warn of a junction. A series of buff-coloured bands incorporating a SLOW marking at an isolated development on a rural road was found to be effective in reducing mean speeds by 6mph on a driving simulator (Taylor et al, 2002b). The second use of coloured surfacing is to delineate the road space (e.g. by use of cycle or bus lanes).

4.45 Rough road surfaces could include roughness caused by road surface materials (e.g. a brick or cobbled road) or simply "pot-holes" in the road surface. The rougher the road surface, the greater the noise and vibration, and thus driver discomfort, caused. Drivers can
be expected to make a rational decision to reduce speed based on utility when exposed to such discomfort when driving. However, care needs to be taken to ensure that road surfaces are not so rough that they result in damage to vehicles or decreased levels of safety due to too much of an adverse effect on the driver. In addition, rough road surfaces can cause problems for cyclists, and increased noise.

4.46 Research evidence shows that rough road surfaces are effective in reducing speeds (e.g. De Waard et al., 1995; Slangen, 1983; Te Velde, 1985; Van de Kerkhof, 1987, Kennedy & Wheeler, 2001a, Wheeler et al, 1997). Slangen (1983) suggested that as much as a 14-23% reduction in mean speed can be obtained due to rough road surfaces, whilst Van de Kerkhof (1987) stated that roughness of a road surface is the most influential factor in determining mean speed. Wheeler et al (1997) found a large reduction in mean speed when imprinted surfacing was combined with prominent visual measures at a gateway. Kennedy & Wheeler (2001a) reported a reduction of about 4mph in mean speed with imprinted surfacing; there was a change in character of the noise generated by vehicles on the imprinted surfacing compared with tarmac.

**Rumble devices**

4.47 Rumble devices are small raised areas across the carriageway with a vibratory, audible and visual effect. Rumble strips can be laid out in a single group or in a series of groups, usually with decreasing spacing between the groups. They act as alerting devices rather than causing discomfort. As a result, speed reductions at rumble devices tend to be small than at physical measures such as road humps (Webster & Layfield, 1993, Barker, 1997). Rumble devices can be noisy and are therefore unsuitable near to housing. Their effect tends to lessen over time, since there is less discomfort when they are traversed at higher speeds. They are often used in conjunction with other traffic calming measures.

4.48 More recently, a rumble device (Rumblewave) that alerted the driver but did not create noise nuisance for residents has been trialled (Watts et al, 2002, DfT, 2005).

**Junction specific measures**

4.49 Acceleration and deceleration lanes are used on high-speed roads to facilitate joining or leaving the road at priority junctions. Similarly, it may be appropriate to provide a right turn lane for traffic turning off a high speed road at these junctions.

4.50 Transverse yellow bar markings with reducing spacing in a reverse exponential pattern have been used on the approaches to dual-carriageway roundabouts and were shown to reduce accidents by about 50% relative to control roads (Helliar-Symons, 1981). The aim was to make drivers think they are travelling faster than they really are, and Denton (1973) recorded a reduction of 13kph in mean observed speed. However, Jarvis (1989) concluded that, although the markings do reduce approach speeds, they appear to act as a hazard warning device rather than through manipulation of drivers’ visual fields.

4.51 Haynes et al (1993) found a reduction in accidents of 15% when yellow bar markings were tested on motorway off-slips at grade-separated roundabouts, but the result was not statistically significant. It was anticipated that the effect would be less than that found by Helliar-Symons (1981) for at-grade roundabouts since drivers would already have made the conscious decision to leave the motorway.
4.52 Barker (1997) found little change in mean observed speed at 100m from the junction at sites with coloured bars on the minor arms of rural crossroads, whilst Meyer (2001) obtained reductions of up to 4kph on a high speed road in the US with white painted bars of different widths and patterns.

Bend specific measures

4.53 An advance warning sign, vehicle-activated or not, is normally used to indicate a severe bend. Double white lines used with hatching for channelization may be particularly desirable on bends in order to reduce lane width, increase the separation between the two directions of traffic and reduce the risk of head-on collisions. However, the increased segregation does not necessarily reduce speeds (e.g. Kennedy & Wheeler, 2001a).

4.54 Where a bend is severe, chevron signs are used on the bend itself. Research using the TRL Driving Simulator has shown that one large sign is more effective than four smaller ones (Taylor et al, 2002b).

4.55 Skid-resistant surfacing can give a warning of a bend and also enables drivers to travel round it more easily. However, anecdotal evidence suggests that it can lead to drivers continuing to speed, knowing that they are afforded a greater safety margin than where there is no such surfacing.

Shared space and Quiet Lanes

4.56 The concept of shared road space, whereby roads are designed to cater for pedestrians and cyclists as well as motorists, originated in the Netherlands (e.g. the “woonerf”) where large reductions in the number of accidents, particularly involving pedestrians and moped riders have been reported (Alink, 1990) following the implementation of such road environments.

4.57 Recently, this concept has been introduced to the UK as Home Zones, where speeds are limited to 15mph and no one type of road user has priority. However, this concept is not really applicable in rural areas, except possibly to minor roads in villages.

4.58 Quiet Lanes also use the concept of shared road space. They are narrow, single track country lanes in a rural area that form a network and are usually subject to the national speed limit (60 mph). They have low speeds and low flows and are intended to encourage shared use by vehicles, cyclists, pedestrians and equestrians. Traffic calming measures are kept to a minimum (and are usually non-existent over much of the network). The idea is to change the hearts and minds of local residents, persuading them to slow down or drive more carefully on the lanes.

4.59 Kennedy & Wheeler (2004a, 2004b) monitored traffic flows and speeds, numbers of non-motorised road users and public attitudes in two pilot areas. They found that there was a small decrease of about 10% in flow relative to control sites, but little change in mean speeds, which were already low because of the narrowness of the lanes and the limited forward visibility.
Villages

4.60 Measures on the approach to a village and/or a gateway are a way of informing drivers of a transition from one type of environment to another (where a different type of driving behaviour might be required). A gateway can involve using a variety of traffic calming measures to reduce vehicle speeds (e.g. signs, emphasis of speed limit sign by use of yellow backing board, countdown signs, roundels, coloured road surfaces, dragon teeth to create a visual impression of narrowing, physical road narrowing etc).

4.61 A number of TRL research studies have investigated the effect of different village gateway schemes on vehicle speeds (e.g. Wheeler, Taylor & Payne, 1993; Wheeler, Taylor & Barker, 1994, Wheeler & Taylor, 1999). Gateways with simple signing and marking measures may reduce mean speeds by about 1-2mph, whilst more comprehensive gateway measures with high visual impact (e.g. coloured road surfacing and dragon teeth) may reduce mean speeds by 5-7mph. When physical measures have been used at gateways (e.g. narrowing), even greater reductions in mean speeds have been found, up to about 10mph.

4.62 It should be pointed out that inhabitants of rural villages often object to the measures with the greatest visual impact as being too intrusive (e.g. red surfacing is often a source of complaint precisely because it is visually intrusive).

4.63 Measures need to be continued beyond the gateway in order to maintain speed reductions through the village itself. These measures are often similar to traffic calming measures used in urban areas, although many physical measures will only be suitable for minor residential roads.

Self-explaining roads

4.64 One reason people often give for driving faster than posted speed limits is that they were not aware of the posted speed limit, and therefore did not know the appropriate speed at which they should have been travelling (Cameron, 1978, 1980; Corbett & Simon, 1992, AA Foundation, 2001). The idea of Self-Explaining Roads (e.g. Kaptein & Classens, 1998; Theeuwes, 1998) is that roads are designed to indicate to drivers the speed at which they should drive through the features of the road itself (alignment, roadside features, etc).

Psychological traffic calming

4.65 Psychological traffic calming involves the use of traffic calming measures other than speed humps and chicanes. A Scottish Executive study (Scottish Executive, 1999) attempted to identify the underlying principles behind natural traffic calming, using ten small or medium towns on through-routes in Scotland as case studies. It was concluded that examples of natural traffic calming tend not to rely on a small number of key features but that drivers are influenced by a large number of different cues. The main components were identified as follows:

- the road corridor as a whole should be considered
- measures should fit the local environment
- location of measures should be matched to natural transitions (e.g. from rural to urban)
- measures should be matched to speed

37
TRL has undertaken major studies on behalf of the Highways Agency (2002) and DfT (current). The research for the Highways Agency (2002) suggested various design elements should be considered when developing traffic calming schemes, of which the following are relevant to rural roads:

- Context e.g. roadside type
- Scale e.g. road width and complexity
- Proportion (height of enclosing features such as buildings or trees)
- Horizontal and vertical alignment
- Landscape
- Colour and material of surfacing

The DfT research (to be published shortly) included a review of psychological principles (Elliott et al, 2003), questionnaire surveys, a simulator trial and on-road trials. The latter showed substantial reductions in mean speed for a psychological scheme in the village of Latton in Wiltshire.

Lay-bys and passing places

Unpublished research by TRL for the Highways Agency suggests that lay-by accidents, although very rare, are more likely when the lay-by is sited on a bend, or where drivers turn into a lay-by on the opposite site of the road, either to park or as a U-turn.

In some countries, e.g. the USA, ‘turn-outs’ are provided at regular intervals. The main purpose of these is to allow slow-moving vehicles a place to pull in and let faster traffic pass. It is a requirement that these vehicles use turn-outs if a queue has built up behind them.

Research by Walker et al (1964) showed that passing places on single track roads need to be located at frequent intervals to avoid the need for drivers to reverse. These roads are only acceptable where flows are very low, as they have considerably less capacity than two-way roads and can lead to road rage and poor driver behaviour (Kennedy et al, 2004).

Safety barriers

Safety barriers, which have been used on rural roads for many years, are designed to deflect errant vehicles back onto the road and therefore avoid collisions with roadside hazards such as trees or large sign posts. They are also used extensively in the medians of dual carriageways and motorways. Safety barriers are, therefore, mainly deployed to prevent the run-off-the-road type accidents on single carriageway roads and to prevent head-on collisions on dual carriageways.

Safety fences operate best when the errant vehicle hits the barrier at an angle of less than 20 degrees and this can be a problem on winding roads. The use of passively safe posts for large signs can reduce the need for safety barriers.

Research from Scandinavia has shown that the majority of fatal run-off-the-road accidents occur fairly close to the edge of the road (see VTT Finland, 1998). The explanation given is that this reflects the fact that most vehicles roll and/or hit an obstacle quite soon after leaving the road (therefore at higher speed). The most common roadside hazard over much
of the network in Scotland will be trees. Whilst these contribute to the attractiveness of the scenery, keeping the verge clear of large trees will reduce the need for safety barriers.

4.74 Safety barriers are not without problems. Motorcyclists in particular are more vulnerable to serious injury and death if they collide with a safety fence which has exposed posts. Work is ongoing to develop safety barriers which can reduce the risks posed to motorcyclists (DfT, 2004f).

4.75 As already mentioned, safety barriers are currently used in the median of all motorways and most dual-carriageways in the UK, to reduce cross-over accidents. However, recent trials in Sweden indicate that there may be potential to apply their use to separate opposing traffic streams on some single carriageway roads (see paragraph 4.79).

2+1 layouts

4.76 As noted in Chapter Three, single carriageways are more dangerous than dual carriageways. The reasons for this safety difference are numerous, but two of the key reasons are, the lack of separation between opposing traffic streams, and the potential for overtaking traffic to come into conflict with opposing traffic (at potentially catastrophic speeds). The OECD (1999) recognises that one way to reduce head-on collisions associated with overtaking manoeuvres is by providing conflict-free overtaking opportunities. One way of doing this is the ‘2+1’ layout.

4.77 The ‘2+1’ layout consists of two lanes in one direction and one lane in the opposing direction with the ‘extra’ overtaking lane ideally alternating in direction every 1-2.5km. The aim is to provide safer, regular overtaking provision on single carriageway roads (and therefore reduce accidents associated with overtaking) which do not justify the considerable extra costs and land-take associated with building traditional dual carriageways. This layout has been used for many years in Germany and has recently been introduced in Scotland on the A68 at Soutra Hill and on the A9 near Newtonmore.

4.78 On hills, climbing lanes (which are similar to 2+1 layouts) can be provided to allow faster vehicles to overtake ones that are slow-moving, thereby reducing delay and driver frustration.

4.79 In Sweden, the authorities have installed over 200km of roads with 2+1 layouts and have recently introduced the addition of cable barriers in the median to physically separate opposing traffic streams (Bergh et al, 2003). The Swedish authorities have developed extensive criteria for the introduction of such layouts which also include the introduction of cable barriers at the roadside to reduce run-off-the-road accidents. The initial results indicate that accident severity is significantly reduced (killed and seriously injured down by 30-50%).

4.80 However, the use of cable barriers as a median is not without problems. Bergh et al (2003) report that maintenance costs are increased, safety during maintenance work is affected and truck breakdowns in the single lane sections can cause lengthy delays.

Enforcement

4.81 The OECD (1999) asserts that “police enforcement is effective in reducing crashes”. It highlights a number of conclusions regarding traffic enforcement on rural roads. These include the fact that repeated enforcement (in contrast with ‘blitz’ campaigns) and random
enforcement produce longer ‘halo’ effects. Also, it recommends that automatic enforcement technologies targeted to address the principal rural road accident types may be the best approach in rural areas.

4.82 Lonero et al (1995) review various research studies on enforcement and suggest that for enforcement measures to be successful at modifying road user behaviour, the following attributes should be sought:

- Sanctions must have ‘real bite’ and be kept up-to-date with public perceptions of probable apprehension
- The ‘theory of games’ pattern where the strategy of the enforcement authorities influence the behaviour of the drivers (and vice versa) needs to be broken
- Crash investigation should contain improved behaviour analysis

4.83 Cliff (2003) highlighted the particular problems of road policing in rural areas in New Zealand. In particular, he points out that a small number of officers must cover large areas and carry out enforcement action against drivers who are often known to them personally. The paper reports on an initiative in one district of New Zealand where an integrated approach has been adopted which includes: improved crash reporting, individual officer performance monitoring and intelligence based deployment according to risk (with the emphasis on drink-driving). The conclusion was that the effectiveness of the approach could be demonstrated through improvements in seat-belt use, open road speeds, hospital admissions, reductions in fatal crashes and the proportion of alcohol-related crashes. Overall, the initiative is seen as a best-practice model for rural road policing.

4.84 Winnett (1994) suggests that enforcement measures such as speed cameras can have an important effect on the faster drivers, although it is recognised that their effect tends to be localised and repeated measures may be required. It should be remembered that speed cameras can not provide enforcement against drink-drivers, aggressive or dangerous drivers amongst others. Therefore, some level of traffic police enforcement is still required to back up publicity and engineering measures.

**Speed cameras**

4.85 Speed cameras are known to reduce speeds and accidents substantially. However, the exact quantification of the benefits is subject to debate since cameras are generally installed at accident blackspots and claims for their success do not always take this into account. In Great Britain, the fines revenue generated by cameras can be ring fenced for road safety but in order to use this revenue, there are strict rules governing camera installation (DfT, 2004c).

4.86 Speed camera housings and/or signs alone have been shown to reduce drivers’ travelling speeds, even in the absence of speed cameras themselves (Corbett & Simon, 1999). These measures are highly likely to influence drivers' speed by increasing perceived likelihood of enforcement. However, the deterrent effect of housings and/or signs is less than that of cameras.
CHAPTER FIVE  CONCLUSIONS AND RECOMMENDATIONS

Summary of issues

Rural definition
5.1 There is a certain degree of variation in the definitions of rural roads and this presents difficulties when trying to quantify the problems of rural safety and compare possible solutions. It is suggested that a single definition for both accident statistics and traffic estimates is devised and used throughout the UK.

Driver behaviour issues
5.2 From the literature, it appears that the main behavioural factors likely to affect rural road safety are speed (whether inappropriate or not), impairment (alcohol, drugs and potentially fatigue) and use of seat-belts. Young drivers (particularly males) are singled out as being particularly at risk as they are more likely to speed, drink or drug-drive and consequently are more likely to be involved in high speed accidents resulting in death or serious injury.

5.3 There are clearly-established relationships between accident occurrence, severity and mean speeds and, therefore, any measures which reduce speeds are likely to have a positive impact on rural road safety. The ‘speed management’ philosophy is cited as a potential tool for reducing speeds and it is hoped that the proposed assessment framework for speed limits will go some way to ensuring consistent speed limits across the rural road network.

5.4 There is little evidence to suggest that alcohol or drug use are more of a problem on Scottish rural roads than on urban roads but clearly, the consequences of impairment are potentially more serious on rural roads due to higher speeds. It is suggested that more research is carried out to establish the extent of the problem on Scottish rural roads and to identify specific measures.

5.5 Driver fatigue is clearly a problem which is almost exclusive to the rural situation. However, until fairly recently, it has been regarded as purely a problem on motorways. The most recent research suggests that there could be a significant number of sleep-related accidents on some rural non-motorways in England and it is suggested that a Scotland specific study is considered to quantify the extent of the problem here.

5.6 Driver distraction, particularly from mobile phone use, is an ongoing concern, although as with alcohol and drug impairment, there is little evidence to suggest that it is more prevalent on rural roads.

5.7 The literature suggests that seat-belt usage in Scotland (and Great Britain as a whole) may actually be higher on higher speed rural roads than on urban roads. However, this does not mean that Scotland should be complacent. The benefits of increasing seat-belt usage are most likely to be seen in reduced fatalities and serious injuries and, therefore, it is suggested that efforts directed at increasing seat-belt wearing rates should be continued.
**Road environment issues**

5.8 Scotland’s high proportion of single-carriageway roads has been cited as an explanation for the country’s higher than average rural accident severity rates. The three most common rural accident types are run-off-the-road, head-on and junction accidents.

5.9 The literature suggests two main aims – firstly to reduce the risk of accidents occurring and secondly to reduce the consequences when an accident does occur. Speed management is cited as a tool to achieve both of these aims. The concept of the ‘forgiving roadside’ addresses the second aim.

5.10 The literature revealed that modern road designs are safer than older designs and, therefore, continued effort should be applied to upgrade the highest risk sections of road to modern standards. The EuroRAP approach provides a way to prioritise such improvements.

**Other factors**

5.11 Some road users are particularly vulnerable to rural road accidents – in particular, young drivers and motorcyclists account for large numbers of deaths and serious injuries. Children, pedestrians and cyclists account for far fewer casualties on rural roads than on urban roads (primarily due to lower exposure) although cyclists are more at risk of dying on rural roads than in urban areas (per km travelled).

5.12 Research has shown that tourist and visitor traffic significantly increases the number of accidents in rural tourist areas of Scotland but that the overall rate of accidents is not increased during tourist high season. It is not clear whether foreign drivers are at greater risk of an accident than local drivers. However, it is suggested that it may be useful to ascertain tourists’ attitudes and experience of driving in Scotland to help target future intervention measures.

5.13 It appears that emergency service response times could have a more profound impact on rural accident survivability in Scotland than in other parts of Great Britain. It seems clear that improving emergency service response times to rural accidents could bring significant benefits. Technology may have a part to play in this area and the European Commission has aspirations to equip all new cars with ‘mayday’ systems from 2009. However, there is scope to better identify the benefits of improved response and it is suggested that a specific study be considered for a part of rural Scotland.
Gaps in literature / further research required

**Quantification of rural road problem in Scotland**

5.14 The current published statistics do not give enough detail about the accidents on Scottish rural roads. This makes it difficult to prioritise areas for action. It is suggested that a specific in-depth examination of the Scottish STATS19 database with the emphasis on rural road issues be carried out. This could be done relatively quickly and would help to prioritise action.

5.15 It is also suggested that future road accident statistical publications treat rural and urban roads separately and go into more detail on the factors associated with rural road crashes. This will give a better basis on which to evaluate any rural road safety strategy and monitor progress.

**Lack of knowledge of sleep-related crashes in Scotland**

5.16 There is no published research on the extent of sleep-related crashes specific to Scottish roads. As this cause could contribute to up to 20% of rural non-motorway crashes, it is suggested that a Scottish specific study is required.

**Benefits of education/publicity measures targeted at rural situation**

5.17 Very little literature was found dealing specifically with campaigns in the rural situation. It is suggested that a pilot project to inform drivers of the specific risks associated with rural roads could be developed and evaluated.

**Emergency service response specific to Scotland.**

5.18 Whilst there is some evidence of increased road accident mortality in rural areas of Scotland, the benefits of improving emergency response times are not clear. It is suggested that a multi-agency project, involving everyone involved in the emergency response process could be developed to evaluate the potential benefits and identify best practice.
Recommendations for action

Short term

5.19 In the short-term, there are a number of potential areas where effort should be targeted:

- Campaigns must be part of a strategy which includes enforcement and engineering changes. Therefore, it is recommended that a rural road safety strategy is developed and adopted.
- Education and publicity campaigns should continue to target young drivers who are disproportionately represented in rural road crashes.
- In addition, campaigns should be considered which highlight the dangers of rural roads to all drivers and try to erode the complacency that rural roads are safer because there is less traffic.
- Efforts should continue to remind drivers of the dangers of impairment, especially alcohol and fatigue.
- Recreational motorcyclists should be targeted through campaigns and training to reduce their risk on rural roads.
- Additional emphasis should be given to the potential for relatively low-cost engineering solutions and speed management tools.

Medium and long term

5.20 In the medium-term, effort should be directed at improving the road infrastructure to reduce the potential for crashes and reduce the consequences when they do occur. The EuroRAP process provides a consistent way of identifying high risk roads and should be used to prioritise improvements. Consideration should be given to the use of innovative engineering solutions such as cable barrier medians on some single carriageways although it is recommended that these be carefully evaluated before widespread use.
REFERENCES


