Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

Cambridgeshire County Council

AA Foundation for Road Safety Research

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Accident
An incident involving personal injury occurring on the public highway (including footways) in which a road vehicle is involved and which becomes known to the Police within 30 days of its occurrence. No records are kept by Cambridgeshire County Council of incidents involving damage to property only.

Cars
Includes three-wheel cars, four-wheel cars, taxis and invalid tricycles.

Casualty
A person killed or injured in an accident. Casualties are sub-divided into killed, seriously injured and slightly injured.

Fatal accident
One in which at least one person dies, within 30 days, from injuries sustained in the accident (excludes suicides, deaths by natural causes while in control of a motor vehicle, and deaths occurring on roads within the jurisdiction of British Transport Police i.e. accidents at railway crossings).

Forward visibility
Parameter used by engineers in the design of roads. For this study, forward visibility is sub-divided into Good and Poor. Good is where the forward visibility is greater than or equal to 295 metres, and Poor is where forward visibility is less than 295 metres. (295 metres is the minimum stopping site distance defined in DMRB – TD9/93 – Highway Link Design.)

Free flow 'T' junction
A 'T' junction with merging and / or diverging lanes.

HORT7
Form completed by a Police Officer at the scene of an accident.

Heavy Goods Vehicles
All lorries which, when fully laden, weigh more than 3.5 tonnes.

KSI
Accidents: those involving death or serious injury. Casualties: people killed or seriously injured.

Light Goods Vehicles
All vans and lorries weighing up to 3.5 tonnes fully laden.

Major Road
The road which is assigned a permanent priority of traffic movement over that of the other road or roads.

Minor Road
The road which has to give priority to the major road.

Motor Cycles
Mopeds, motor scooters, motor cycles and motor cycle combinations.

Odds
Of an accident type: is the probability of an accident being of a particular type divided by the probability of an accident being of any other type.

Pedestrian
Includes persons wheeling or holding a bicycle; a driver or passenger who has alighted from a vehicle; a person herding animals.

Public Road Junction
Any junction maintained by the highway authority. These include T and staggered junctions, cross road, Y-junctions and multiple junctions.

Private Access
Any junction not maintained by the highway authority. This junction group incorporates the entrances to farms and fields, private houses, roadside petrol filling stations, restaurants and cafes.

Rural Roads
Roads with a speed limit in excess of 40 miles/h.

Serious Accident
One in which at least one person is seriously injured but no person (other than a confirmed suicide) is killed.

Serious Injury
An injury in which a person is detained in hospital for any of the following: fractures, concussion, internal injuries, crushing, severe cuts or lacerations, severe general shock requiring medical treatment, or injuries causing death 30 or more days after the accident.

Severity
Of an accident: is the severity of the most severely injured casualty (either fatal, serious or slight).

Slight Accident
One in which at least one person is slightly injured, but no person is killed or seriously injured.

Slight Injury
One in which a casualty receives an injury of a minor character, such as a sprain, bruise or cut.

Stacking Accident
An accident involving rear end shunt or evasion due to a breakdown in the flow of traffic.

STATS19
An accident reporting form which is completed by the Police for road accidents on the public highway which involved human injury or death.

'T'-junctions
Junctions where a minor road perpendicularly joins the dual carriageway.

Urban Roads
Roads with a speed limit less than or equal to 40 miles/h.

The AA Foundation for Road Safety Research

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Registered as a charity (number 295573), the objectives of the Foundation are:

> to carry out, or procure, research into all factors affecting the safety use of public roads;
>
> to promote and encourage the safe use of public roads by all classes of road users through the circulation of advice, information and knowledge gained from research;
>
> and
>
> to conceive, develop and implement programmes and courses of action designed to improve road safety, these include the carrying out of any projects or programmes intended to educate young children or others in the safe use of public roads.

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> AGF, Bishopsgate, Commercial Union, Corinthian Policies, Cornhill, Drake, Eagle Star, GAN, Guardian, Hiscox(Economic), Iron Trades, Norman, Orion Personal, and St Paul International.

Chapter 1 Introduction

1.1 Background

Evolving from a study which started in 1993, this report is the last of a trilogy commissioned from Cambridgeshire County Council by the AA Foundation for Road Safety Research. The subject material of all the reports was *'Accidents on rural roads'*.

The first report presented a broad overview of the rural road accident situation in Cambridgeshire (Hughes, 1994). The picture which emerged was that traffic accidents were predominantly occurring on the rural 'A' class road network. Despite only representing a quarter of the whole road network, two-thirds of accidents occurred on this class of road. Subsequent reports focused on these roads.

The second report (Hughes and Amis, 1996) examined the nature of accidents on the single carriageway 'A' class rural road network. This third report examines the nature of traffic accidents on **two lane dual carriageway** 'A' class rural roads. The period of study covers the eight years between 1988 and 1995.

1.2 Study outline

Eight lengths of dual carriageway were examined. All have speed limits of 70 miles/h and fall within the boundary of Cambridgeshire (Figure 1.1).

- Three of the lengths, (totalling 56.2 kilometres) are part of the A1 trunk route which passes north-south through the County.
- Two of the selected lengths (23.4 kilometres of the former A604 trunk road and 17.2 kilometres of the former A45 trunk road) now form part of the much longer A14 trunk route which extends from the M1/M6 junction at Catthorpe to Felixstowe. Whilst this route was completed to dual carriageway standard along its whole length during the period of the study, no major physical changes were made to the study lengths. This has resulted in a significant traffic volume increase on some sections of these study routes. Where appropriate, the impact of these changes has been highlighted in the report.
- The three remaining lengths of dual carriageway are based in the north west of the County within the City of Peterborough. The 6.6 km A47 is a section of a much longer trunk road which traverses the north of the County, while the 3.6 kilometre A1260 and 11.9 kilometre A1139 are County roads which form part of the City of Peterborough Parkway network.

Throughout the rest of the report:

- The three lengths of A1 dual carriageway will be referred to as the **A1 Group**
- The sections of the old A604 and A45 routes will be referred to as the **A14 Group**
- The A47, A1260 and A1139 will be referred to as the **Parkways Group**

The basic accident data were derived from the STATS19 traffic accident data of Cambridgeshire Constabulary. Some of the data were modified in order to extend the scope of the analysis and to make the data more representative of dual carriageways.

The Transport Research Laboratory (TRL) were commissioned to help with implementing a driver questionnaire survey. The questionnaire was sent out to drivers who had been involved in accidents during 1994 and 1995 on the routes being examined.

Environment information was collected from a variety of sources, including video, field surveys and 'as-built' construction drawings (where these were available). The information collected was the same as for single carriageways, but in many ways it was easier to collect as many of the environment features, for example central crash barriers, edge and centreline markings, were broadly consistent across all the dual carriageway routes examined.

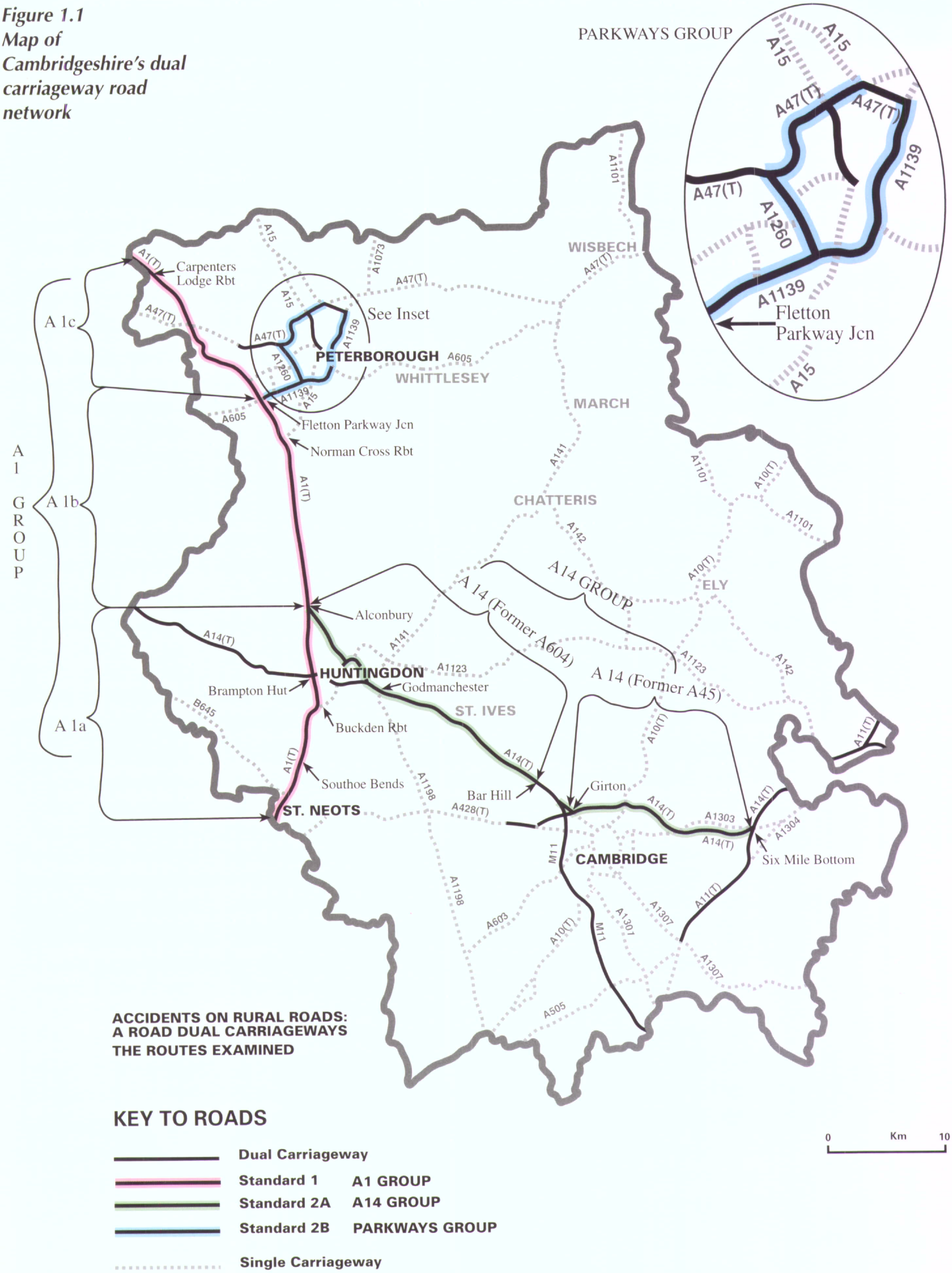


***Figure 1.1* Map of Cambridgeshire's dual carriageway road network**

Statistical models were used in order to examine the interaction between STATS19, questionnaire and environment variables, and to isolate those significant factors associated with accidents. The implications of the findings are discussed and remedial measures suggested.

In order to aid direct comparison with data contained in the single carriageway report, a comparable methodology for data collection was implemented and a similar format for the driver questionnaire was adopted for the dual carriageway survey.

1.3 Report Content

This report consists of seven chapters whose contents are as follows:

Chapter 2 – Methodology introduces the data sources used in this study. Accident-related variables are introduced and any modifications carried out to them are explained. Road environment variables and categories are defined, and the methodologies and procedures used in their collection are discussed. The qualifying criteria for inclusion in the driver questionnaire survey are explained.

Chapter 3 – Accidents, traffic volumes and route characteristics examines the distribution of accidents by route. The interaction between accidents and traffic volume is examined and the distribution of accidents along each route is characterised by location. The interaction between accidents, lighting conditions, road surface conditions, accident severity and location is examined for significant associations. The casualty severity characteristics of each route are determined and a figure is presented outlining the cost to society of these accidents.

Chapter 4 – Accident types, drivers and vehicles involved characterise the dual carriageway accidents from the perspective of the drivers and vehicles involved in the accidents. Interactions between accident location, driver age, gender, vehicle type and manoeuvre are examined.

Chapter 5 – What the drivers say establishes the factors identified by drivers as having contributed to their accidents. The driving habits and experience of the respondent drivers are established, and their opinions of the factors which they thought contributed to their accident are recorded. Questions relating to how individual drivers perceive various driving tasks are also analysed, and compared against actual involvement.

Chapter 6 – Accidents and the road environment uses statistical models to explore the relationship between accident and environment variables. The first part of this chapter establishes the environment characteristics of each of the routes being examined. These characteristics include aspect, forward visibility, the presence of hedges and trees, type of carriageway markings and skidding resistance. Subsequently, statistical models are used to find those environment variables which have an association with the occurrence of accidents at junctions of different design, and on the links between junctions.

Chapter 7 – What are the main conclusions collates and summarises the findings of the entire report. The implications of the findings are discussed, and, based on these, remedial measures are suggested for improving the accident record of two lane, dual carriageway, 'A' class rural roads. These suggestions include discussion based on possible changes in traffic engineering, design standards, enforcement and driver education practices.

Chapter 2 Methodology

This chapter introduces the dual carriageway 'A' class routes which were chosen for inclusion in this study and establishes some of their basic characteristics. The procedures and methodologies followed when collecting the traffic accident, questionnaire and road environment data are explained.

2.1 Route selection and traffic flows

The first criterion for selection was that only dual carriageway routes which had been operating for the entire eight year period between 1988 and 1995 would be considered. The A1, A604 and A45 (both now A14), A1139, A47 and A1260 met this criterion.

When the research specification for the dual carriageway project was being drawn up, it was envisaged that, in keeping with the single carriageway project (Hughes and Amis 1996), distinction between routes would be possible by examining the ratio of the Average Annual Daily Traffic Flow (AADT) relative to the current design capacity standard for two lane dual carriageways. This approach was found not to be straightforward as two standards apply to the design of two lane all purpose dual carriageways (Design Manual for Roads and Bridges (DMRB) TD20/85 – Traffic Flows and Carriageway Width Assessment). The first design standard is based on a **maximum AADT of 30,000 vehicles** and the second design standard on a maximum **AADT of 46,000 vehicles.** The standards differ on the basis of access treatment and on the junction options relating to flow.

The use of the different standards produces roads of markedly different character. Among the roads examined in this study, three clear design standard groupings occur:

- Standard 1
- Standard 2A
- Standard 2B

In **Standard 1**, the lower of the two design standards for roads with a 120 kph design speed, the treatment of major road junctions is through at-grade roundabouts, with more minor road junctions being priority junctions accessible via gaps in the central reservation. Other accesses are limited in number. In this study, the A1 showed the above design characteristics, but these are gradually being removed along the middle section of the A1 where the road is being upgraded to four lane motorway (see section 2.2).

In **Standard 2A**, the higher of the two design standards for roads with a 120 kph design speed, major and minor junctions are generally grade separated. Restriction of access is rigorously enforced, with movements limited to left turn only. No gaps are allowed in the central reserve. The A604 and A45, which form the **A14 Group**, both show the above design characteristics.

In **Standard 2B**, the A1139, A47 and A1260 routes, which form the **Parkways Group** show similar design characteristics to the A14 Group, but have been separated from the latter because all these routes were built to a lower design speed of 100 kph for an urban environment. Nevertheless, all these routes retain a 70 miles/h speed limit.

While it was possible to categorise the chosen routes by standard, it was not possible to further classify the routes on the basis of the traffic flow to design standard ratio as most of the dual carriageways were operating at either between half capacity and capacity, or at over capacity.

2.2 Route description

A description of each of the routes follows.

Standard 1

The whole length of the **A1** was considered in the study – a length covering 56.2 km between the County boundary with Bedfordshire in the south west and the boundary with the then Leicestershire in the north west. Upgraded to dual carriageway predominantly in the 1950s, this route contains sub-standard central reservation gaps, junctions where vehicles are allowed to cross the dual carriageway, and has a generally poor horizontal and vertical alignment. Numerous piecemeal improvements have been made on this route, including route straightening, gap closures and the erection of crash barriers in the central reserve. There are still sections where one or other of the carriageways follows the route of the old single carriageway Great North Road.

As the distribution of traffic on the A1 is not uniform, the route was split into three sections carrying different traffic volumes. The sections are:

A1a between the County boundary in the south west and the A14 junction at Alconbury (19.8 km)
A1b between the A14 junction and Fletton Parkway (A1139) to the west of Peterborough (18.7 km)
A1c between Fletton Parkway and the County boundary in the north west (17.7 km)

The middle section of the A1 is currently being upgraded to motorway standard under a Design, Build, Finance and Operate (DBFO) initiative. Though major changes are affecting this length of the A1, enough historical data was available to warrant the inclusion of this section of dual carriageway in the current study. Many of the original junction designs found on this length of A1 can be found on dual carriageways country-wide. It was therefore important that the 'older' junction configurations were included in the accident analysis in order to rate their safety record relative to other, more current junction configurations.

Standard 2A

A 23.5 km length of the **A604** (re-numbered **A14**) extending from the grade separated junction with the A1 at Alconbury to the end of the two lane section of dual carriageway to the north of the B1050 junction at Bar Hill. Though a more recent dual carriageway than the A1, there are sections where the carriageways are at split levels, and the route contains a variety of junction configurations. Many farms, businesses, dwellings and field entrances front onto this road in the section between Godmanchester and Bar Hill. Some local improvements have been carried out, including the closure in 1992 of the only junction with a central reservation gap at Lolworth.

A 17.2 km length of the **A45** (re-numbered to **A14**) between the grade-separated junction with the M11 to the north west of Cambridge and the westbound carriageway on-slip from the A1307 located between Newmarket and Bottisham. All junctions on this route are fully grade-separated, and no private accesses open onto the road.

The opening of the A14 route in 1993 has had a significant effect on traffic volumes on both these routes. For this reason, the post-A14 opening period has been separated from the rest of the data. Few physical changes, other than direction signing, were made on opening of the A14 route.

Standard 2B

An 11.9 km length of the **A1139** Fletton and Frank Perkins Parkways in Peterborough extending from the grade-separated roundabout over the A1 in the west to the at-grade roundabout with Paston Parkway in the north east. Most, but not all, of the junctions are fully grade-separated, and the entire route is kerbed and lit.

A 6.6 km length of Peterborough's **A47** Soke Parkway extending between the grade-separated junction with the A1260 Nene Parkway in the north west of Peterborough to the grade-separated roundabout with the Paston Parkway (A15) in the north east of Peterborough. All the junctions are grade separated, there are no private accesses and the entire route is kerbed and lit.

A 3.6 km length of the **A1260** Nene Parkway in Peterborough between the grade separated roundabout over Fletton Parkway (A1139) in the south and the grade separated roundabout below Soke Parkway (A47) in the north. Though all the junctions on this route are fully grade-separated, they are close together. This route has kerbs and street lighting along its entire length.

2.3 Traffic flow

The traffic flow data used were 16 hour Average Annual Weekday Flows (AAWF). These figures are generally accepted to be equivalent to the Average Annual Daily Traffic Flow (AADT) (Traffic Monitoring Report – Cambridgeshire County Council, 1996).

The characteristic 16 hour AAWF for each of the A1 and Peterborough Parkway routes described in section 2.2 was calculated as an eight year average – see Table 2.1. With several traffic flow measurements available for each route in a given year, a weighting process was used to get a representative 16 hour AAWF for each year before the eight year average calculation was undertaken.

For the A14 Group, the post-A14 opening period was separated from the rest of the data. Two 16 hour AAWF figures can be found for the A604 and A45 routes in Table 2.1 – the first figure for each route (A604(2) and A45(2)) is the six year (1988-1992) average AAWF for the pre-A14 opening period while the second set of figures (A604 (2) and A45 (2) represents the two year (1994-1995) 16 hour AAWF for the post-A14 opening.

Table 2.1 Selected routes: 16 hour Average Annual Weekday Flows (1988 to 1995)

Route	Std.	16 hour AAWF	Design Capacity	% Design Capacity	% HGV	Accidents
A1 GROUP						
A1a	1	27,000	30,000	90	15	361
A1b	1	47,000	30,000	157	21	599
A1c	1	34,600	30,000	115	24	398
A14 GROUP						
A604(1)	2A	39,600	46,000	86	24	240
A604(2)	2A	53,000	46,000	115	24	108
A45(1)	2A	34,400	46,000	76	21	108
A45(2)	2A	42,000	46,000	91	19	44
PARKWAYS GROUP						
A1139	2B	28,500	46,000	62	11	171
A1260	2B	32,700	46,000	71	6	75
A47	2B	31,300	46,000	68	8	62

A604(1) and A45(1) refer to the period 1988 to 1993
A604(2) and A45(2) refer to the period 1994 to 1995

Compared to the design standard selected for comparison, the middle and northern sections of the A1 and the A604 (since opening of the A14) operate at above design capacity.

2.4 Accident data

The period examined in this study covered the eight years between **1988** and **1995**.

The accident data used in this study were collected by Cambridgeshire Constabulary and stored on the Traffic Accident Reporting System (TARS) of Cambridgeshire County Council's Environment and Transport Department. Some changes were made to the database either through the modification of existing variables or by the introduction of new variables. This was necessary in order to exploit the maximum amount of information from the STATS19 data.

A full list of these variables is contained in Appendix A.

2.4.1 Modified variables

Vehicle manoeuvres was one of the existing variables which was modified.

- The codes of 'going ahead left bend' and 'going ahead right bend' were collapsed into a new code 'going ahead on bend'.
- The manoeuvre of 'overtaking a moving vehicle on the offside' was re-coded to either 'going ahead – other', 'changing lane to left' or 'changing lane to right'.
- For consistency, vehicle manoeuvres involving entering or leaving the dual carriageway on a slip road were changed from 'turning left' to that of 'changing lanes to right' for vehicles joining the main carriageway and 'changing lanes to left' for vehicles leaving the main carriageway. Only simple T-junctions, T-junctions served by a gap and staggered T-junctions retained the original 'turning left' manoeuvre coding.
- In the database, a distinction was made between those vehicles turning left when either entering or leaving the dual carriageway and those turning left when crossing the dual carriageway at a staggered junction.
- The manoeuvre of 'turning right' at junctions was only permitted where a priority junction was served by a gap in the central reservation.

Examination of junction accidents revealed that many accidents which had occurred within the zones on the dual carriageway covered by the merging and diverging slips were being coded as 'not occurring at a junction'. This characteristic of the data arises from the STATS20 definition of a junction accident. For a dual carriageway junction, the accident is only coded as being at the junction if it occurs within 20 metres of the point where an auxiliary lane or taper gives way to a slip road at the end of a diverging lane or beginning of a merging lane (Figure 2.1). Strictly speaking, any accidents occurring outside the defined zone but occurring on the diverging/merging lane should be coded 'as not occurring at a junction'. Accidents occurring outside the defined zone but on an auxiliary diverging or merging lane should be coded as having occurred on a 'dual carriageway – three lanes'.

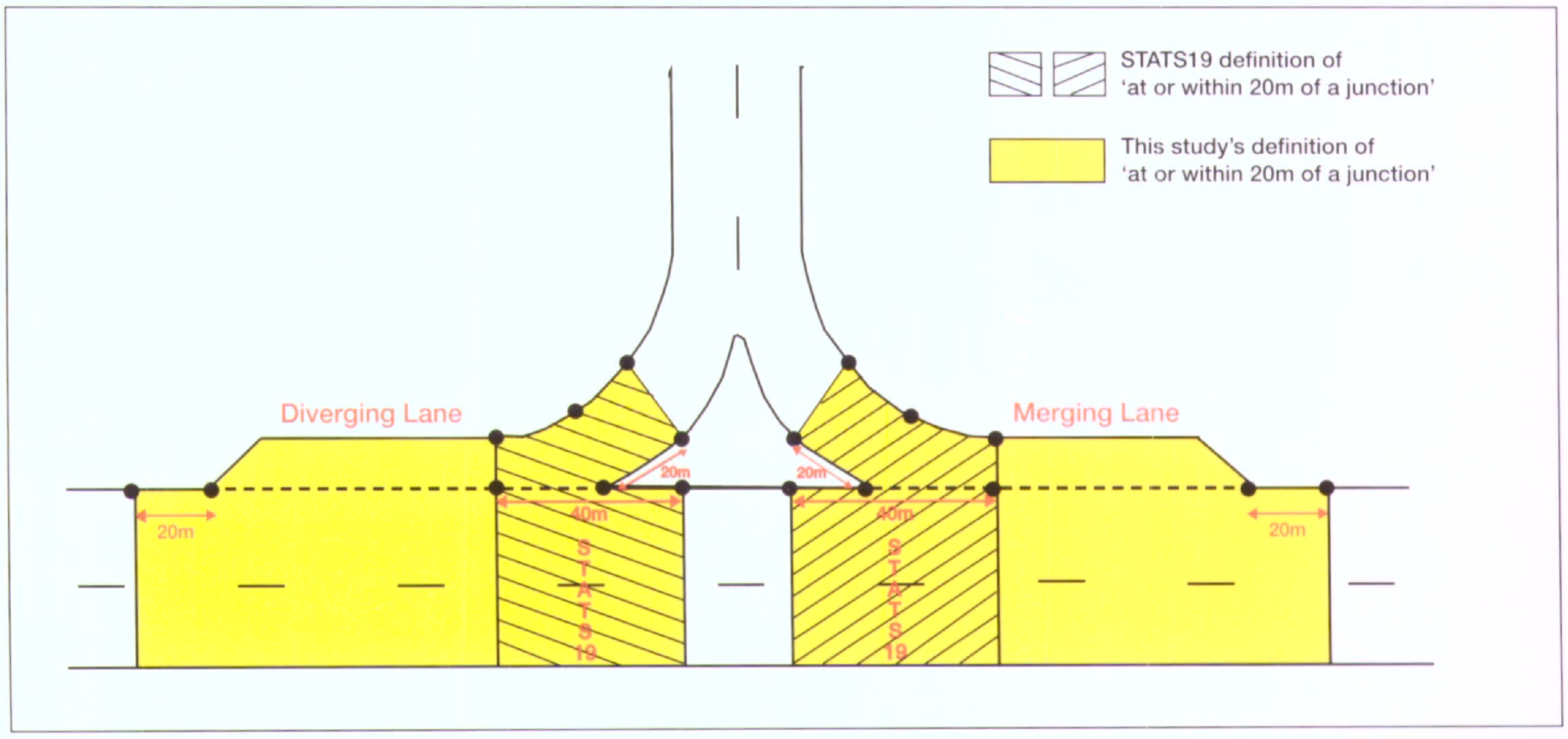


Figure 2.1 Typical 'At-grade' free-flow 'T'-junction

In this study, the definition of 'at, or within 20 metres of a junction' was broadened to include all accidents which took place on the carriageway adjacent to the merging/diverging lanes (Figure 2.1).

In order to account for the variety of junction designs present on the dual carriageways studied, the official STATS19 defined 'accident location' variable was modified. Only the categories of 'not at or within 20 metres of a junction', 'private access (in use),' 'grade-separated' and 'roundabout' were retained. The new categories introduced were:

- T-junction not served by a gap
- T-junction served by a gap
- Staggered or cross-roads
- Free-flow T-junction

2.4.2 New variables

A new variable called *lane* was introduced which gave the location on the dual carriageway of each vehicle involved in the accident:

- Minor road
- Lane 1 (nearside)
- Lane 2 (offside)
- Gap in central reservation
- In lay-by
- On hard shoulder

Vehicles coded to 'Gap in central reservation' were not necessarily located at junctions as these also occur adjacent to private accesses.

One of the more useful new variables introduced into the single carriageway, 'A' class road database was *acctype* (Hughes and Amis, 1996). This variable enabled each accident to be classified into an accident type related to the manoeuvres of the vehicles which came into conflict. As in the previous study of single carriageway accidents (Table 4.12 Hughes and Amis 1996), numerous accident types were identified, but they could all be consolidated into one of six categories. These were:

- Loss of control
- Turning related accidents
- Lane change accidents
- Stacking related accidents
- Vehicle drift accidents
- Other accidents

In all cases where a vehicle which was travelling in the same direction as other vehicles collided with, or took evasive action to avoid contact with the vehicle in front, the accident was coded as a stacking accident.

Vehicle drift accidents differ from loss of control accidents in that the initial factor which gave rise to the accident was that of a drifting vehicle rather than a loss of control.

Accidents were coded as 'other' if they involved pedestrians. Accidents where vehicles were travelling in the wrong direction along a carriageway, and those resulting from extraneous events such as broken windscreens etc. were also attributed to this code.

Special codes were used in all of the above categories where the accident involved a vehicle crossing the central reservation.

2.5 Environment data

Various methods were used in the collection of the environment information. Most of the data were collected during 1996. This involved:

- Conducting video surveys of all the routes
- Field surveys
- The compilation of accident strip maps on a 1:10,000 Ordnance Survey base map

Most of the environment data was added as an overlay map of each road. In contrast to the single carriageway survey, 'as-built' construction drawings were available for most of the roads being examined. The information contained on these drawings was used, in particular, for the purpose of getting vertical alignment. The absence of construction drawings for some of the routes being examined did not allow for actual vertical measurements to be used. Instead, a crude measure of vertical alignment was used for each accident with the following categories:

- Level
- Positive gradient (uphill in the direction of flow)
- Negative gradient (downhill in the direction of flow)

The presence of a bend, crest or sag within 500 metres of an accident was also recorded – irrespective of the severity of these features.

The main bend information collected for each accident was 'Bendiness'. This is a variable used in the speed prediction formulae for rural roads (COBA9 Manual – May 1981). It is defined as the total change of direction per unit distance (degrees per km).

Among the other information collected was that of how the route traversed the surrounding terrain. The following categories were used:

- At-grade
- Cutting
- Embankment
- Viaduct

2.5.1 Video data

Video surveys of each of the routes were used for gathering most of the environment information. Much of the information gathered could be confirmed from the as-built drawings, though care had to be taken to account for all the subsequent changes which had occurred. For example, some junctions had been modified since they were built, and all the routes had crash barriers erected in the central reserve. The width of any hard strip could be gleaned from the carriageway width information, and likewise, confirmed from the as-built drawings.

Many of the environment variables collected for the dual carriageway study were the same as those collected for the single carriageway study. The driver's perception of **aspect** was one such variable. It was classified into one of three categories:

- Open
- Normal
- Closed

As this variable varies between both sides of the carriageway, both offside and nearside aspect were recorded. In the single carriageway study, difficulties in collecting this variable and its subjective nature may have given rise to some spurious data (Hughes and Amis, 1996). In an attempt to make this variable more representative, an advanced driving instructor was asked to collect the information for all the routes in the study. Aspect examples are illustrated in Figure 2.2A through C.

Figure 2.2A
Open aspect

Figure 2.2B
Normal aspect

Figure 2.2C
Closed aspect

Forward visibility was classified into one of two categories based around certain critical distances associated with a road designed to carry traffic at a maximum speed of 120 kph – ((DMRB) – TD9/93 – Highway Link Design). These categories were:

- Good – greater than or equal to 295 metres sight distance
- Poor – less than 295 metres sight distance

The method for measuring forward visibility was the same as that followed in the single carriageway study. Checked against videos, measurements were taken from a scaled template which was moved over an Ordnance Survey map of each route. The videos proved particularly useful in this exercise, as reference points in the form of emergency telephone countdown markers and street light columns could be used to measure forward visibility. This variable was measured along the centreline of each carriageway. Examples of *good* and *poor* forward visibility are illustrated in Figures 2.2D and E.

Figure 2.2D Good forward visibility

Figure 2.2E Poor forward visibility

Methodology

Hedges and **trees** were categorised as:

- *High* where they could not be overlooked when travelling by car
- *Low* where they could be overlooked when travelling by car
- *None* present

They were recorded irrespective of whether they were present at carriageway level, or at the top of an embankment. The *high* code was also used to denote the presence of tall fences. This variable was recorded for both the nearside of the carriageway and the central reservation.

Verge width was recorded as *narrow or wide*, while **kerbing** was recorded as *present* or *not present*. Both these variables, along with **hedges** and **trees** were documented for the nearside of the carriageway and for the central reservation.

With the exception of kerbing, (which was either present or not for the whole length) all the variables were measured as an average per 100 metre interval.

It is important to note that the environment information extracted from the videos is necessarily a snap-shot of the features present throughout 1996. Changes to the road itself can be established from maintenance records where these are held, but it is difficult to make provisions for natural changes to the **hedge** and **tree** environment. Furthermore, for the northbound carriageway of the A1b, presently being upgraded to motorway, it was necessary to use a Department of Transport (DoT) video made in the 1980s in order to acquire the necessary nearside environment information.

2.5.2 Maintenance data

Not all the environment data could be extracted from the videos or from the as-built construction drawings. The latter were not available for all the roads. Gap closures, junction modifications, erection of crash barriers and new signing, and changes to the wearing course could only be established from the maintenance histories of the roads being examined. Details of all carriageway widths, wearing course materials and the wet road skidding resistance of each route were obtained from an established Pavement Management System (PMS), along with other information such as an inventory of all electrical items and crash barriers.

Carriageway width is stored as the average width of a 100 metre segment of carriageway – with smaller intervals near junctions. Each width measurement is accompanied by details of the wearing course material present. The categories of wearing course material are:

- Hot rolled asphalt
- Concrete
- Surface dressing
- Other

Information about the wet skidding resistance of each route was provided in the form of Sideways-Force Coefficient Routine Investigation Machine **(SCRIM)** data. Measured in the summer, and repeated at least three times, the skidding resistance values examined here are the **Mean Summer SCRIM Coefficient (MSSC)** which is the average of all the measurements, and the **SCRIM deficiency** which is the difference between the MSSC and some pre-determined intervention SCRIM level which is varied according to location. Negative values point to a deficiency in skidding resistance. A more complete discussion of this subject can be found in ((DMRB) HD28/94 – Skidding Resistance).

Though not measured every year, an interpolation package in PMS allowed MSSC and SCRIM deficiency to be given for all years between 1988 and 1995. Allowances were made in the interpolation for periods of maintenance and for variations in traffic flow levels – parameters which are known to influence skidding resistance.

The data does have limitations. Firstly, skidding resistance information is only available for Lane 1 of each carriageway. Secondly, there are lengths of some routes for which no skidding resistance information is available, in particular those sections of carriageway with concrete wearing course material.

The systematic way in which these variables were recorded on the PMS meant that it was quite easy to relate data to each vehicle in an accident. Where data could not be safely inferred, no attempt was made to assign a value of skidding resistance.

2.5.3 Traffic flow counts at dual carriageway junctions

One of the improvements sought in the research specification of the dual carriageway study compared to the single carriageway study was better traffic flow counts at the junctions. The first, and most desirable method considered was that of having 12 hour manual counts carried out at all the junctions, but this was ruled out on the basis of cost.

Full turning counts already existed for all the junctions on the A1 in Cambridgeshire. Though they were measured between 1982 and 1984, suitable scaling factors were available in order to change the data to 16 hour AAWF levels and in order to make them representative of 1992 data. 1992 was chosen as the flow averages of the whole eight year period were calculated to be similar to the traffic flow levels of this year.

Where gaps were closed, it was necessary to assume all the traffic remained at the junction and did not re-route. By making this assumption, it was possible to assign revised traffic flows.

For the remaining dual carriageway junctions, four hour peak flow counts were taken. The data were then factored up to 16 hour AAWF levels. In order to minimise data collection cost, categorisation of the traffic entering or leaving the minor road was limited to 'heavy goods vehicles' and 'all other vehicles'.

2.5.4 Speed

A factor not considered in the earlier single carriageway study was vehicle speed. In the current study several measurement methods were considered, including the use of radar guns, speed cameras and real-time in-vehicle speeds. In the end it was decided to make use of speed measurement inductive loops cut into the carriageways.

With several of the study routes operating at above capacity and heavily congested, the relationship between traffic flow and speed was investigated over a range of traffic loading. Two existing sites on dual carriageways served by automatic traffic counting (ATC) devices were exploited. The first site was on the uncongested A47 route (not within the study area) at Castor, while the second site was chosen at Swavesey on the overloaded A604 (A14) route which was part of the study. New loops had to be cut at Swavesey and the ATC configurations at both sites changed. Data were collected at both sites concurrently.

2.6 Questionnaire

In order to gain some understanding of what contribution individual drivers had to their accident, the Transport Research Laboratory (TRL) were commissioned to assist with the design and administration of a postal questionnaire, and with the compilation of the responses into a database.

The purpose of the questionnaire, which was specifically sent to drivers who had been involved in the more recent accidents in the study, was three-fold.

- Firstly, questions were asked about a respondent's driving experience and driving habits.

- Secondly, the respondent was asked to answer questions about the circumstances leading up to the accident and about the factors which contributed to the accident itself.
- Finally, the respondent was asked to rate various driving tasks (both general and dual carriageway driving) so that drivers' perceptions could be compared with data relating to involvement.

Only drivers involved in accidents during **1994** and **1995** on the routes being examined were considered for inclusion in the study. The list of drivers who were approached was obtained from the HORT7 records of Cambridgeshire Constabulary.

In order to protect the interests of the Police, and to avoid causing unnecessary distress to the families of people killed or involved in fatal accidents, the Protocols established in the single carriageway survey were retained. These are set out in Appendix C.

A total of 556 accidents and 1215 individuals qualified for inclusion in the dual carriageway questionnaire, though protocols and further restrictions reduced the actual number of individuals sent a questionnaire to 1007.

2.7 Summary

- A total of eight 'A' class dual carriageway roads were chosen for this study and divided into three distinct groups according to the design standards for this type of carriageway:

  A1 Group – three sections of the A1
  A14 Group – the former A604 and A45 (now A14)
  Parkways Group – The A1139, A47 and A1260 Peterborough Parkways
- The accident data for each route were derived from Police STATS19 data and modified to improve analysis.
- The environment data for each route were collected from as-built construction drawings, in the field, or from video surveys.
- Information about vehicle speeds in relation to traffic flow were obtained from speed loops installed in two of the carriageways.
- Turning counts were derived for all junctions along each route.
- A questionnaire was sent to a selection of drivers who had been involved in accidents during 1994 and 1995.

Chapter 3 Accidents, traffic volumes and route characteristics

In this chapter the routes being examined are compared for traffic volume and accident characteristics. The distribution of accidents along each route is established. Further comparisons are made between routes from an examination of accident and casualty severity, and of weather, light and road surface conditions. In all, a total of 2,166 accidents are examined.

3.1 Accidents and traffic volume

A snapshot of the relationship between traffic volume and accidents is provided by Table 3.1. Comparison of the pre- and post-opening periods of the A14 reveals that traffic volume, and accident rate per kilometre on both the A604(2) and A45(2) have increased compared to the pre-opening period (A604(1) and A45(1)). However, the accident rate per 100 million vehicle kilometres has not matched the traffic volume increase.

Table 3.1
Accident rates: 1988 to 1995

Route	Std.	Accidents	Traffic Volume (million veh km)	Road Length (km)	(a)	(b)
A1 GROUP						
A1a	1	361	59.4	19.8	2.27	22.7
A1b	1	599	132.2	18.7	4.01	23.6
A1c	1	398	75.0	17.7	2.81	23.7
A14 GROUP						
A604 (1)	2A	240	72.0	23.5	1.71	11.0
A604 (2)	2A	108	96.8	23.5	2.30	9.9
A45 (1)	2A	108	49.4	17.2	1.05	8.6
A45 (2)	2A	44	61.2	17.2	1.28	8.4
PARKWAYS GROUP						
A1139	2B	171	29.6	11.9	1.80	17.0
A1260	2B	75	21.5	3.6	2.60	27.2
A47	2B	62	21.2	6.6	1.17	10.5
ALL		2166		119.0		

(a) Accidents per kilometre per year
(b) Accident rate per 100 million vehicle kilometres
A604(1) and A45(1) refer to the period 1988 to 1993
A604(2) and A45(2) refer to the period 1994 to 1995

The accident rate per 100 million vehicle kilometres (column b) is broadly consistent within the A1 Group, displays some variation within the A14 Group but there is no consistency when the more lightly trafficked Parkways Group is examined.

Even at similar traffic levels, the A1 Group has a higher accident rate (column b) than the A14 Group. The A1260 has a localised problem with one junction, but the accident rate may be influenced by the short length of this route.

With the exception of the A1260, it is clear that the routes designed to Standard 2A and 2B have a better accident rate per 100 million vehicle kilometres than the A1 Group. **This suggests that, in addition to traffic volume, design factors are also a determinant of safety.** This will be further examined in Chapter 6.

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

Generally, the accident rates per kilometre are a little higher, and the rates per 100 million vehicle kilometres are lower for the dual carriageways examined than for the single carriageway 'A' roads considered in the previous study. For an individual driver therefore, the risk, per kilometre travelled, of being involved in an accident on a dual carriageway is somewhat lower.

3.2 Accident and traffic volume time series

In the following section the distribution of accidents is examined from an annual, quarterly, weekly and hourly viewpoint. Comparison was made with traffic volume data where this was available. In most circumstances, the data are presented by route groupings, rather than by individual routes. Only the annual accident and volume time series are examined by individual route.

Annual variation in accidents and traffic volume

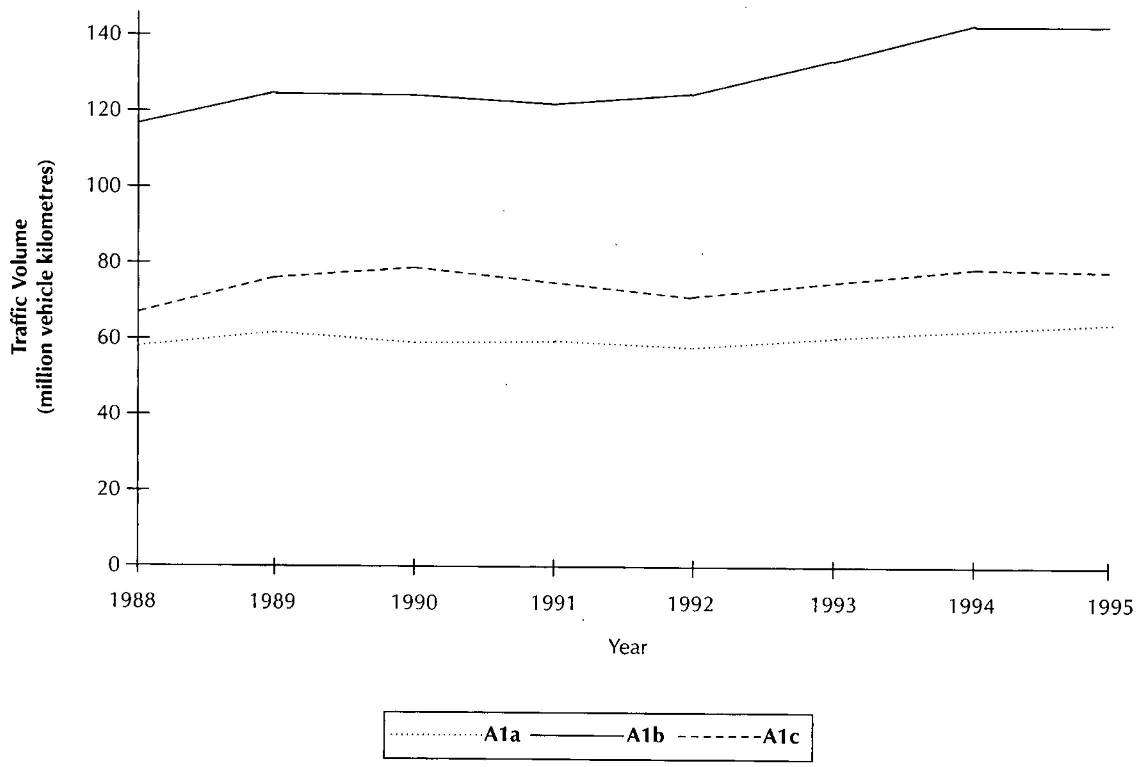
To varying degrees all the routes examined have shown long term traffic growth (see Figures 3.1). However, annual accident numbers have been more volatile.

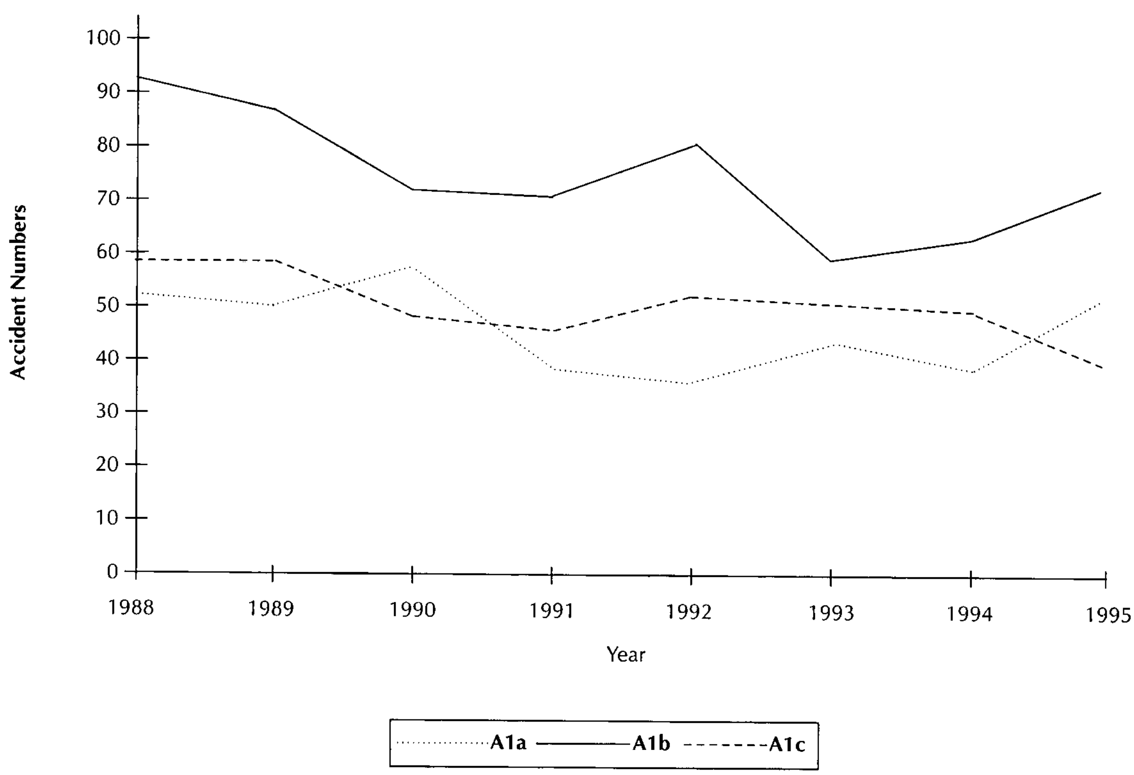
Over the longer term, the A1 Group of routes has tended to show a falling annual accident total despite traffic growth, possibly reflecting the impact of accident remedial measures over the study period. However, within the last two years, accident numbers have increased once again on the southern (A1a) and middle (A1b) sections (Figure 3.1 a).

The A604 route length of the A14 Group of roads has shown a sudden rise in annual accidents following opening of the A14 route. Though this is related to an increase in traffic volume on this route, the accident rate per 100 million vehicle kilometres has remained broadly constant. It is interesting to note that the A45, which represents the eastward continuation of the A604, has not experienced the same pattern of traffic and accident growth (Figure 3.1 b).

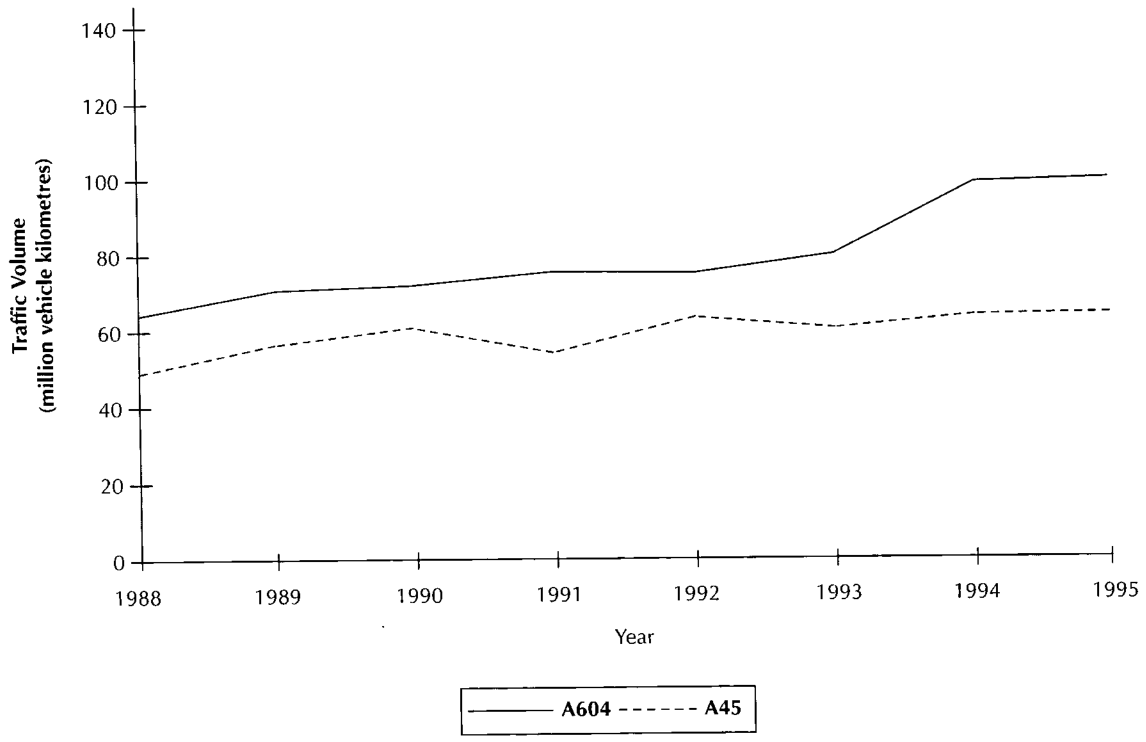
Traffic and accidents have increased on the A1139 over the study period, but the other two Parkways have exhibited no particular trends (Figure 3.1c).

Figure 3.1
Annual trends in accidents and traffic volume
(a) A1 Group



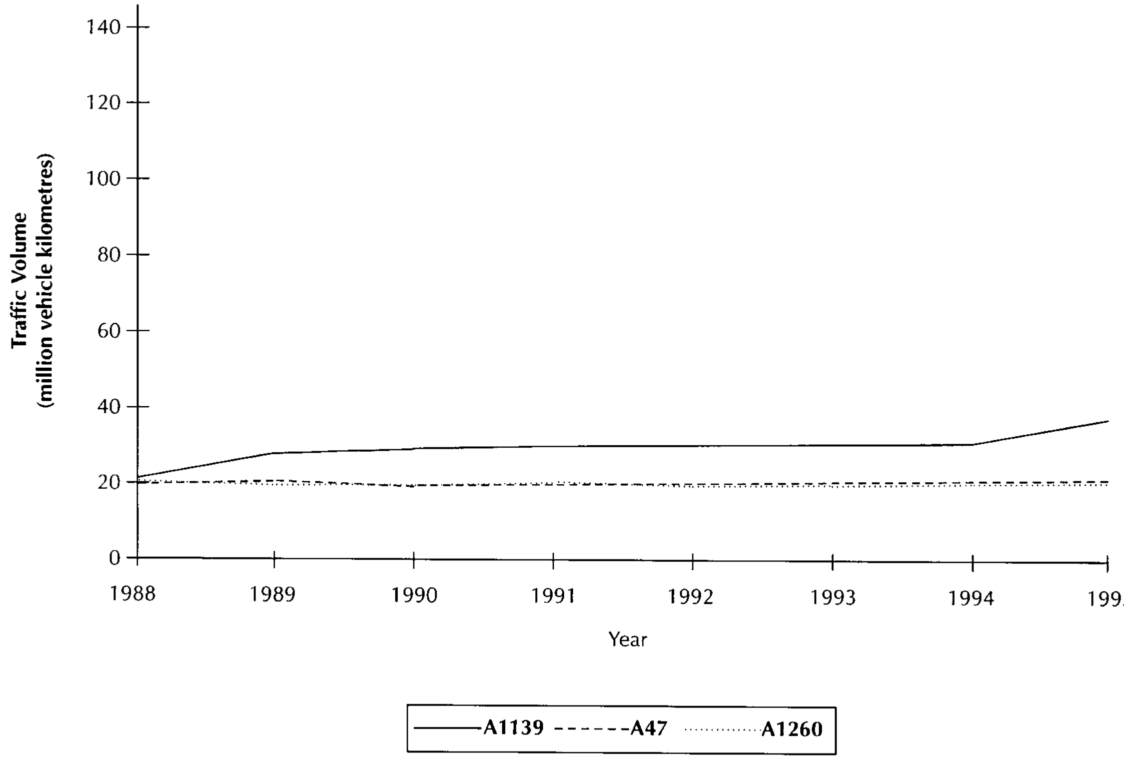


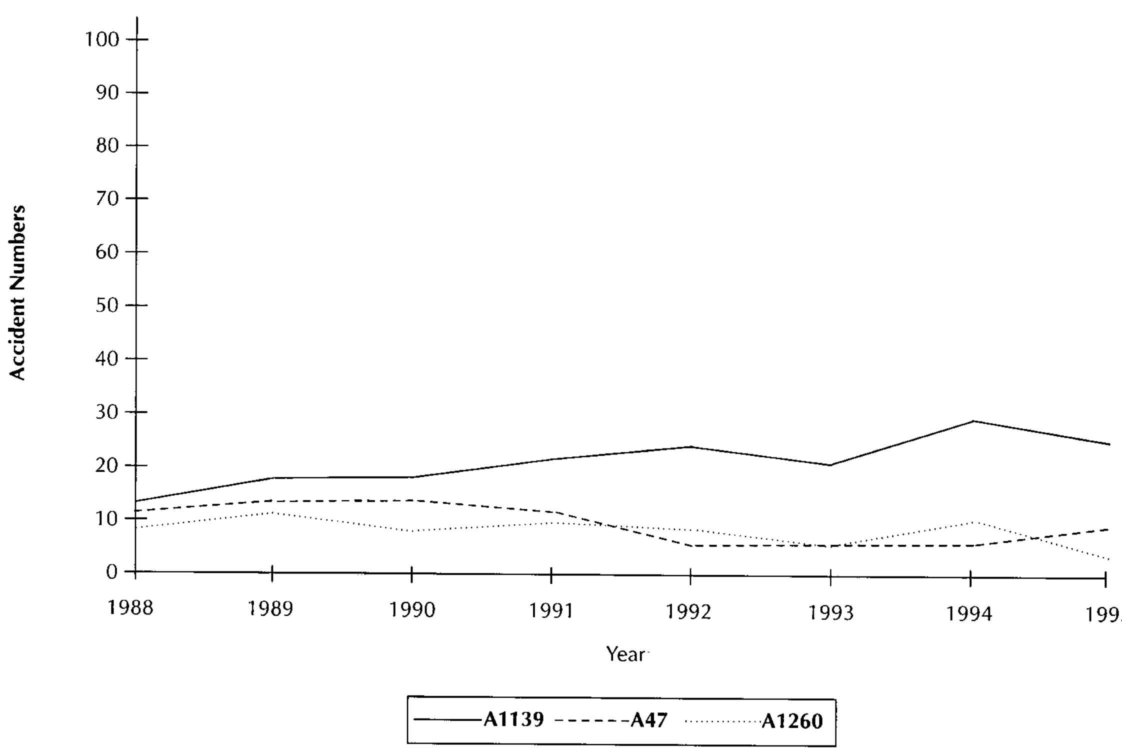
(b) A14 Group


140
120
100
80
60
40
20
0
Traffic Volume
(million vehicle kilometres)
1988
1989
1990
1991
1992
1993
1994
1995
Year
A604
A45


100
90
80
70
60
50
40
30
20
10
0
Accident Numbers
1988
1989
1990
1991
1992
1993
1994
1995
Year
A604
A45

(c) Parkways Group





Accidents by quarters of the year

The quarters of the year were examined to see whether there were any broad seasonal effects. Examining the accident data by groups of route, it is clear from Table 3.2 that the overall distribution of accidents is not uniform throughout the year. The overall distribution for all the dual carriageways is skewed towards the end of the year.

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

Table 3.2 Quarterly accident totals by percentage

	1st Quarter (row %)	2nd Quarter (row %)	3rd Quarter (row %)	4th Quarter (row %)	Total
A1 Group	20.5	23.6	25.4	30.5	**1358**
A14 Group	24.6	18.4	27.2	29.8	**500**
Parkways Group	28.2	22.1	21.8	27.9	**308**
All Dual	**22.5**	**22.2**	**25.3**	**30.0**	**2216**

Accident variation by weekday

No consistent pattern emerges when the weekday variation in accidents is examined by group (Table 3.3).

The A1 Group tends to have more accidents later in the week and at weekends; the A14 is more or less constant except for a Friday peak; and the Parkways have fewer accidents on Sundays. Similar variations between routes were observed for single carriageways in the earlier study. In both cases it was thought to be due to the particular mix of commuter, local, long haul and recreational traffic on any one route on any day.

Table 3.3 Proportional distribution of accidents by day of week

	Mon (row %)	Tues (row %)	Wed (row %)	Thur (row %)	Fri (row %)	Sat (row %)	Sun (row %)	Total
A1 Group	12.0	11.7	11.0	14.4	17.6	16.5	16.8	**1358**
A14 Group	15.0	14.0	10.0	14.2	23.4	11.6	11.8	**500**
Parkways Group	14.6	15.6	14.6	14.0	15.3	16.9	9.1	**308**
All Dual	**13.1**	**12.8**	**11.3**	**14.3**	**18.6**	**15.4**	**14.5**	**2166**

Percentage of weekly total shown

Accidents and traffic flow by time of day

As can be seen from Table 3.4, the pattern of accidents by time of day is broadly similar to that for single carriageways, but tends to be higher on the dual carriageway routes studied between 2200 and 0600 hours. Accident numbers bottom out in the early hours between 0200 and 0600.

Table 3.4 Accidents by four hour sectors of day

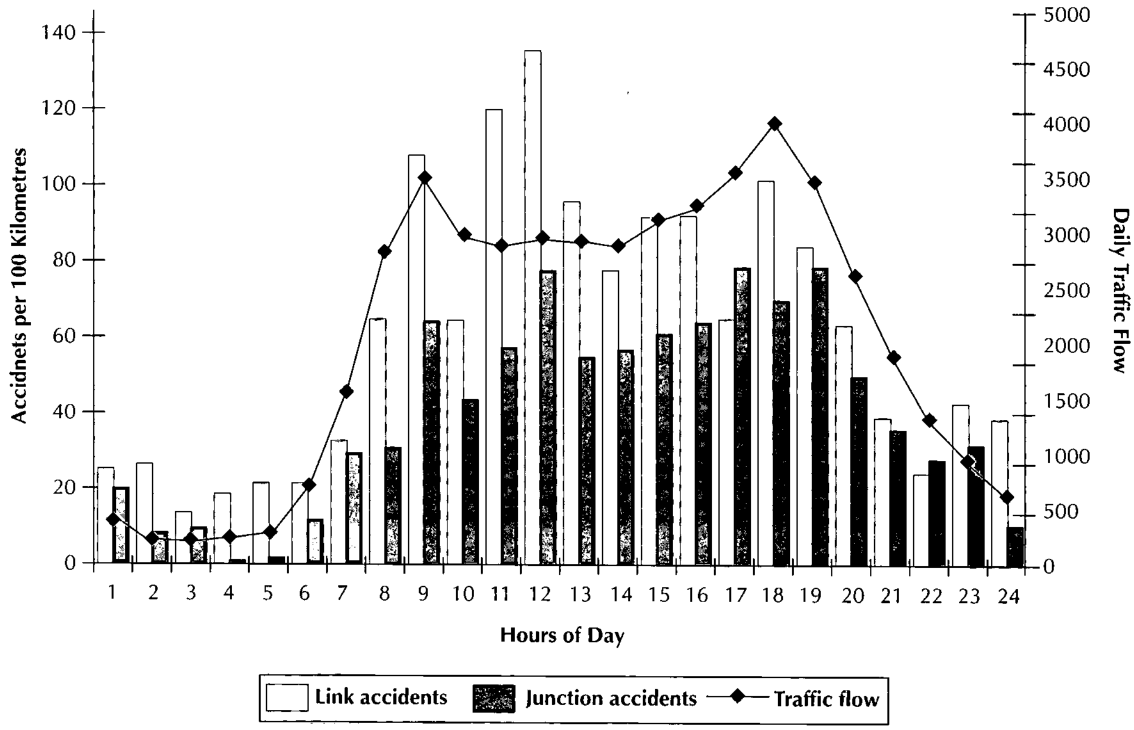
Type	Hour of day						ALL
	0201–0600 (row %)	0601–1000 (row %)	1001–1400 (row %)	1401–1800 (row %)	1801–2200 (row %)	2201–0200 (row %)	
Dual	5.4	21.0	24.5	25.7	15.6	7.8	**2166**
Single	3.2	23.4	21.6	26.5	19.5	5.8	**812**

Figure 3.2(a-c) shows the distribution of accidents per kilometre (disagregated into link and junction accidents) by time of day for each of the route groupings. The variations in hourly traffic flow are also shown as overlays on the bar charts.

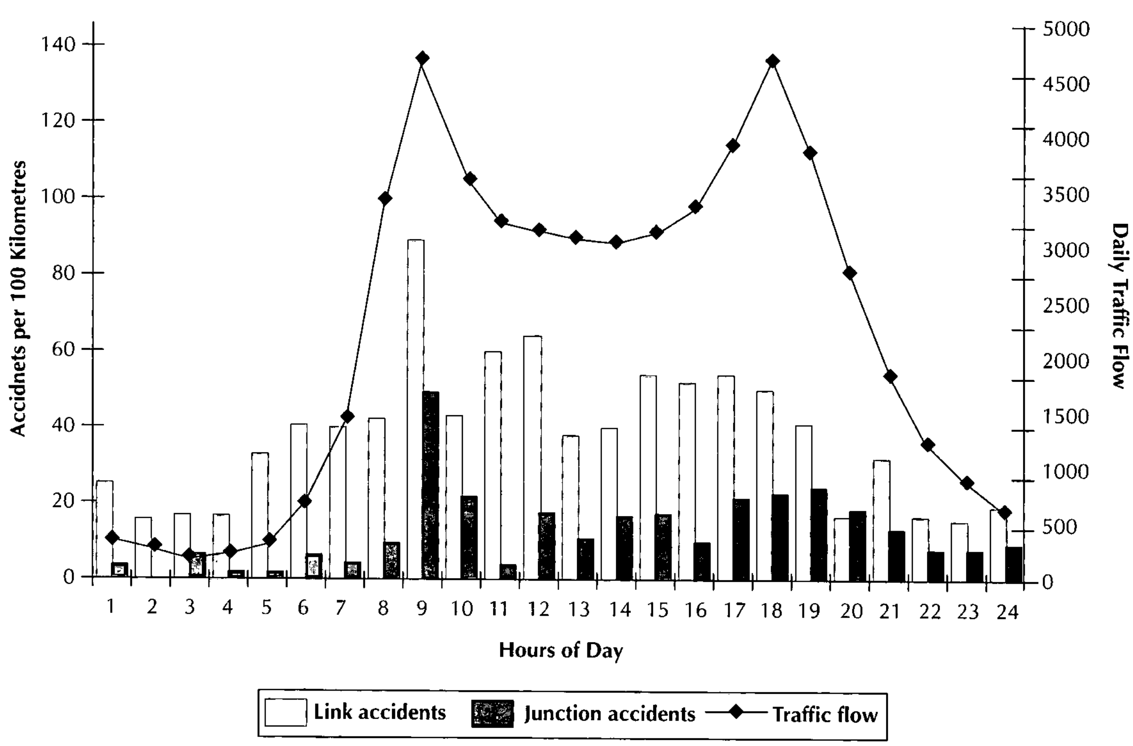
The traffic flow profiles for all route groupings are similar, with peaks in the morning and evening rush hours. These peaks are most pronounced, and overall traffic flows are highest on the A14 Group of routes (Figure 3.2b).

For the A1 Group of routes, link accidents show a clear peak in the morning rush hour period, but the highest peak occurs around lunch time. There is a smaller, less noticeable evening rush hour peak. The pattern of junction accidents is not too dissimilar, but the peaks are much less discernible (Figure 3.2a).

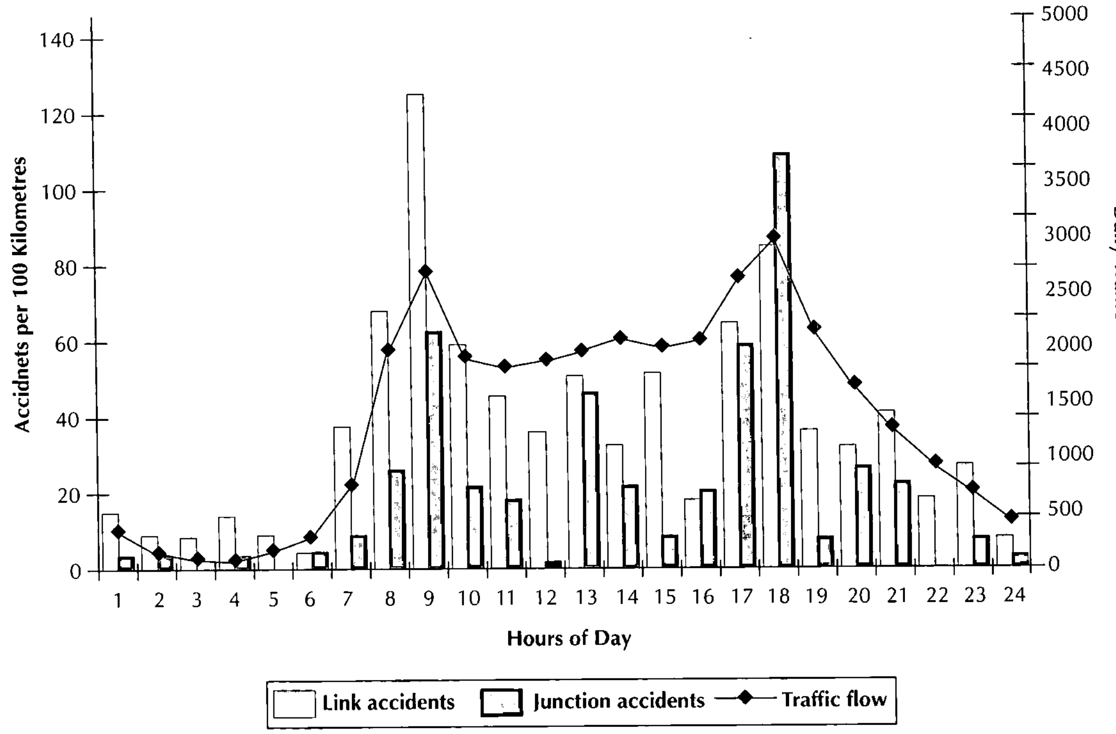
Figure 3.2
The variation of accidents (link and junction) and traffic flow by time of day
(a) The A1 Group



(b) The A14 Group



(c) The Parkways Group



Link accidents on the A14 Group of routes show one clear peak between eight and nine in the morning, but the majority are distributed evenly throughout the daylight working hours. Junction accidents are far fewer than link accidents on the A14 Group of routes (Figure 3.2b).

Accidents on the Parkways Group of routes peak strongly around the morning and evening rush hour periods (Figure 3.2c).

Vehicle speeds by time of day

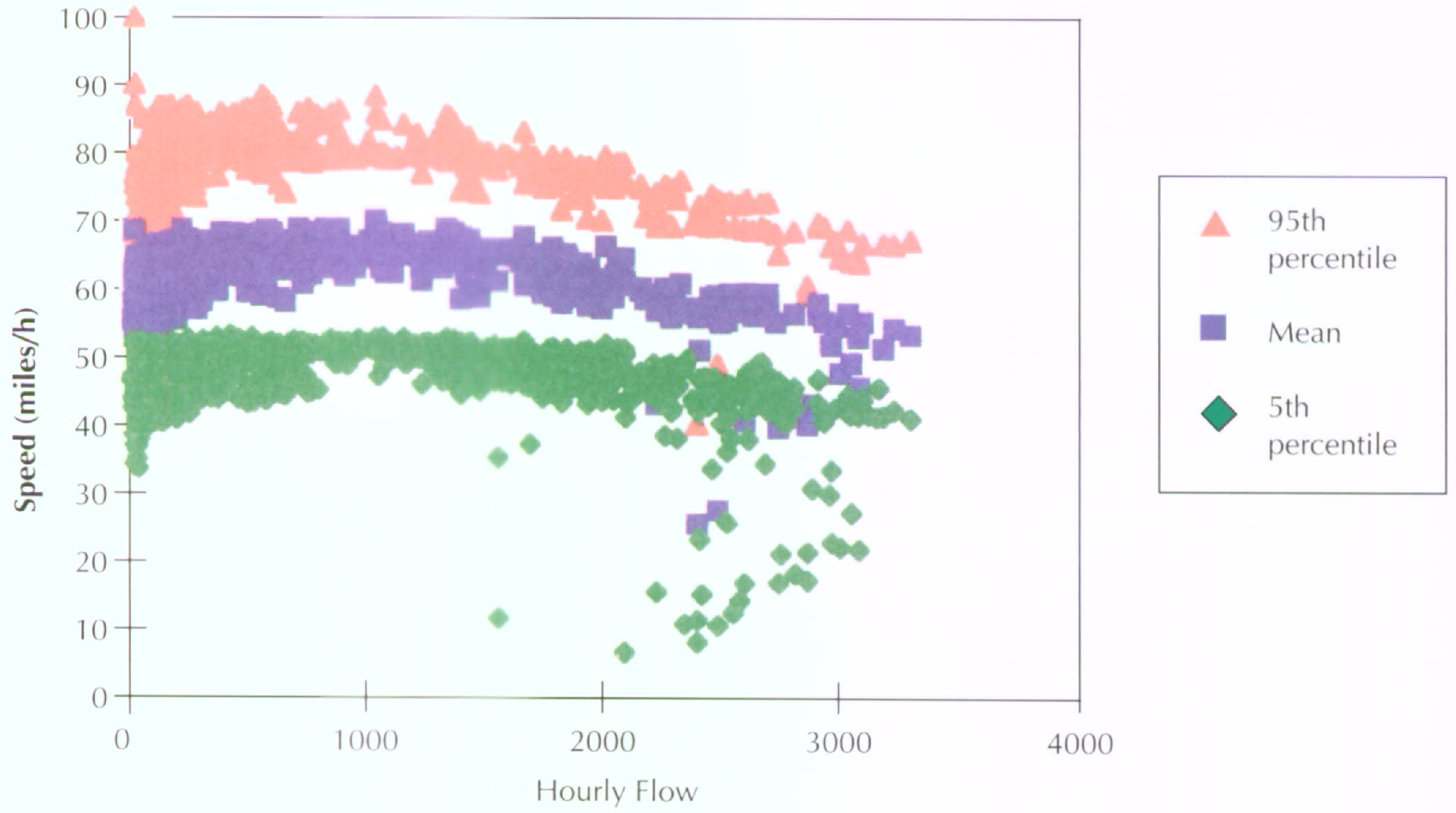
In the earlier single carriageway study, it was noted that the relationship between accidents and speed needed more investigation. In this study an attempt has been made to explore the relationship.

The basic problem is that the speeds of vehicles at the times of their accidents are not known from Police data. Therefore a way of estimating the likely general traffic speed was attempted using traffic flow as a proxy for speed. The method used consisted of taking readings, using inductive loops in each lane, of the speeds of vehicles at two ATC sites (both measured separately in each direction). One of the sites was on the A604 at Swavesey and the second was on the A47 near Castor in the north of the County which lies outside the present study area. The sites were chosen on the basis of cost and availability of data. The A47 site was relatively lightly trafficked, and no observations under heavy traffic loading were taken there.

The technique used was to gather the speed of all vehicles passing over the loops. The data were stored in 10 miles/h "bins", from 0-120 miles/h, for each hour of the day, and processed to give mean, 85th percentile, and 95th percentile speeds. The 5th percentile speeds were calculated separately. A comparison was then made between vehicle speeds and traffic volumes for each hour of the day at the same sites and the relationship between them examined.

The output from the speed recorders is shown in Figure 3.3. The data shown are the 5th percentile, mean and 95th percentile speeds.

Figure 3.3
Vehicle speed by hourly flows for A604 and A47 combined



The results were, to a degree, disappointing, but some interesting insights were gained. These were:

- At low traffic flows there were, on average, slightly lower mean speeds (much of this data was collected in the early hours of the morning when darkness may be a factor).
- There is a clear reduction in the mean speed at flows above about 1500 vehicles per hour.
- There is an increase in the variability of mean speed on the A604 eastbound carriageway at flow above around 2000 vehicles per hour. However this flow breakdown is not apparent on the A14 westbound carriageway at similar flow levels.

It is thought that this may be due to the tidal nature of the flow. The eastbound carriageway has its heaviest flows in the morning peak when traffic is joining the route to access Cambridge. The joining traffic causes flow breakdown as it enters the main traffic stream. Conversely the westbound carriageway is at its busiest in the evening peak when traffic is leaving the main traffic stream. Flow breakdown does not tend to occur as there are fewer joining vehicles and more gaps in the main traffic stream.

A consequence of the above findings is that the original approach of using traffic volume as some form of proxy for likely main stream speed was not possible.

3.3 Accident location

Nearly all the accidents on the dual carriageways being studied occurred either at public road junctions (defined in this study to include all merging and diverging lane lengths), or on the links between these junctions (Table 3.5). Less than two per cent of accidents on dual carriageways were at private accesses. Of the routes in this study, only the A1 and A604 have private accesses opening onto the main carriageway.

The proportion of link and public road junction accidents is similar for both the A1 Group and the Parkways Group of routes (Table 3.5). However, it needs reiterating that these two groups of routes are fundamentally different, both in design and character (see Section 2.2). The A14 Group of routes is different again to the others; three quarters of accidents on these routes were on the links compared to 64 per cent of Parkways Group accidents and 60 per cent of those on the A1.

Table 3.5
Accident distribution by location

Route	Location: Not at junction or access		Location: Public road junction		Location: Private access		SUM
A1a	240		118		3		361
row%		66.5		32.7		0.8	
A1b	356		228		15		599
row%		59.4		38.1		2.5	
A1c	223		158		17		398
row%		56.0		39.7		4.3	
A1 GROUP	**819**		**504**		**35**		**1358**
row %		**60.3**		**37.1**		**2.5**	
A604(1)	183		53		4		240
row%		76.3		22.0		1.7	
A604(2)	79		27		2		108
row%		73.1		25.0		1.9	
A45(1)	82		26		–		108
row%		75.9		24.1		–	
A45(2)	33		11		–		44
row%		75.0		25.0		–	
A14 GROUP	**377**		**117**		**6**		**500**
row %		**75.4**		**23.4**		**1.2**	
A1139	115		56		–		171
row%		67.3		32.7		–	
A1260	40		35		–		75
row%		53.3		46.7		–	
A47	42		20		–		62
row%		67.7		32.2		–	
PARKWAYS GROUP	**197**		**111**		–		**308**
row %		**64.0**		**36.0**		–	
DUAL	**1393**		**732**		**41**		**2166**
row%		***64.3***		***33.8***		***1.9***	***100.0***
SINGLE	**524**		**181**		**107**		**812**
row%		***64.5***		***22.3***		***13.2***	***100.0***

It is interesting to note that the opening of the A14 did not result in a significant shift in the proportion of accidents occurring at junctions (Table 3.5).

Although the proportion of route length which is junction is similar for all groups (Table 3.6), the A1 Group has more junctions per kilometre. Compared to the A14 Group and Parkways Group of routes, more of the junctions on the A1 are compact T-type junctions. It follows that the frequency of junctions may influence accident frequency, as may the standard of junction design. This is explored later.

Table 3.6
Junction characteristics by route

	% length of route that is junction (%)	Junctions per kilometre	% of all accidents occurring at junctions (%)
A1 Group	15	1.01	37.1
A14 Group	16	0.57	23.4
Parkways Group	20	0.72	36.0

Accidents, traffic volumes and route characteristics

Comparing with the earlier study on single carriageways, the proportion of accidents occurring 'not at junction or access' is almost identical for dual carriageways (64 per cent) – (Hughes and Amis, 1996). The main difference between dual and single carriageways is in the split of accidents between junctions and private accesses. Less than two per cent of accidents occurred at private accesses on dual carriageways compared to 13 per cent for single carriageways. This fact is not surprising as there are generally fewer private accesses to dual carriageways; only the A1 and A604 have private accesses opening onto the main carriageway. Even on these routes, the proportion of accidents occurring at private accesses is much smaller than the proportion of accidents occurring at private accesses on the single carriageway routes studied previously (Hughes and Amis, 1996). **Private accesses will not be considered any further in this chapter.**

Public Road Junctions

The distribution of accidents between different types of junction is presented in Table 3.7. The value given in the No. column of Table 3.7 represents the number of junctions which have had a particular junction configuration over the eight years between 1988 and 1995 (shorter periods apply to the A604 and A45 (A14 Group) routes – see Table 3.1). For example, seven junctions on the A1b have, at one stage or another, had a 'T-junction with a gap' configuration. However, only four of the junctions had this configuration throughout the entire eight year period. In calculating the average annual accident rate per junction, the problem of junction conversions was overcome by time averaging i.e. accident data are presented in terms of the annual average accident rate per junction.

A1 Group

Of all junction configurations on the A1, at-grade roundabouts average the highest accident rate per junction, with 3.2 accidents per roundabout. Within this category, Norman Cross on the A1b averages the highest rate, with just over five accidents per junction per year. All the roundabouts consistently average over two accidents per year.

Junctions on the A1 Group of routes which are served by a gap in the central reservation have a worse accident record than those without. Accidents at staggered T and cross roads junction configurations average 2.6 accidents per year. The highest individual accident rate per junction (6.4) for all routes is recorded for a junction of this type on the A1b route.

Grade separated junctions have a better accident record. This is further reinforced when it is considered that each grade separated junction consisted of all the on and off slip road elements at a particular location. If each exit and entry point at these locations was considered as a separate junction, the accident rate per junction would, in most cases, be expected to be a quarter of that shown.

On the evidence presented here, constructing an at-grade roundabout at a location where there are accidents associated with a gap in the central reservation may be counter productive. Only closing the central reserve gap or constructing a grade separated junction would be likely to improve the annual accident rate. This is an interesting contrast with single carriageways where at-grade roundabouts were one of the safest junction layouts.

However, on a cautionary note, it is important to stress that the number of roundabouts on the A1 is small and that in other circumstances, where there are well spaced, occasional roundabouts, the same accident statistics may not apply. Furthermore, only the at-grade lengths of the grade separated junctions considered in this study were examined. A direct comparison of roundabouts with grade-separated junctions would need to consider all elements of the junction.

A14 Group
On the A14 Group of routes, junction configurations consist mainly of grade separated junctions, free-flow T-junctions, or T-junctions without a gap. First impressions suggest that T-junctions without a gap have the best accident record while grade separated junctions have the worst on this group of routes. However, there is no traffic volume consideration in these figures. Generally, grade-separated junctions cope with the highest traffic volumes, whereas T-junctions without a gap generally have the lowest traffic volumes.

Parkways Group
Junctions on the Parkways Group of routes being examined were designed and constructed as either grade separated junctions or free-flow T-junctions. It is interesting that the grade separated junctions on the Parkways Group of routes performed similarly to those on the other groups.

Generally speaking, the simpler the junction arrangements, the lower the annual accident rate. However some variation between individual groups can be observed, possibly accounted for by details of junction design or usage. The A1 Group had the highest accident rate per junction and junction frequency, followed by the Parkways Group and finally, the A14 Group, which had the lowest accident rate and junction frequency. Therefore, there appears to be some relationship between design standard and accident rate at junctions. This is explored in more detail in Chapter 6 .

Table 3.7 Public road junctions: junction frequency and annual average number of accidents per junction

Standard	Route	Roundabouts		Grade separated		T-free flow		T-no gap		T-gap		Staggered or X		Average accidents per junction	Junctions per kilometre
		No.	Acc./Jcn	No.	Acc./Jcn	No.	Acc./Jcn	No.	Acc./Jcn	No.	Acc./Jcn	No.	Acc./Jcn		
1	A1a	2	2.54	1	0.12	6	0.52	5	0.11	6	1.07	2	0.66	0.82	1.01
1	A1b	1	5.38	1	0.88	3	1.50	9	0.26	7	1.32	2	6.36	1.58	0.86
1	A1c	1	2.50	2	0.75	3	1.25	6	0.19	8	0.96	3	1.71	1.04	1.16
	A1 Group	**4**	**3.21**	**4**	**0.80**	**12**	**0.95**	**20**	**0.20**	**21**	**1.11**	**7**	**2.57**	**1.10**	**1.01**
2a	A604(1)	–	–	3	1.15	7	0.55	6	0.22	1	1.05	–	–	0.55	0.68
2a	A604(2)	–	–	3	1.46	7	0.64	6	0.67	–	–	–	–	0.84	0.68
2a	A45(1)	–	–	6	0.62	–	–	–	–	–	–	–	–	0.62	0.41
2a	A45(2)	–	–	6	0.79	–	–	–	–	–	–	–	–	0.79	0.41
	A14 Group	**–**	**–**	**9**	**0.84**	**7**	**0.57**	**6**	**0.33**	**1**	**0.79**	**–**	**–**	**0.64**	**0.57**
2b	A1139	–	–	7	1.00	2	0.06	–	–	–	–	–	–	0.88	0.67
2b	A1260	–	–	3	1.46	–	–	–	–	–	–	–	–	1.46	0.83
2b	A47	–	–	5	0.50	–	–	–	–	–	–	–	–	0.50	0.75
	Parkways Group	**–**	**–**	**15**	**0.93**	**2**	**0.06**	**–**	**–**	**–**	**–**	**–**	**–**	**0.87**	**0.72**
	ALL	**4**	**3.21**	**38**	**0.86**	**21**	**0.75**	**26**	**0.28**	**22**	**1.10**	**7**	**2.58**	**0.95**	**0.81**

Acc/Jcn = Annual Accident rate per junction

3.4 Conditions of road surface, light and weather

Road surface and skidding resistance

The proportion of dual carriageway accidents which occurred on a dry road surface averaged 59 per cent (Table 3.8), a value which is similar to that observed for single carriageways. While the proportion of wet road surface accidents was broadly similar between groups, some significant variations exist between routes. Accidents on the A45 occurring on a wet road surface averaged 24 per cent prior to the opening of the A14, but has decreased to 18 per cent in the two years following opening. By contrast, nearly half the accidents on the A1260 and A1a were wet surface accidents.

Table 3.8
Accident distribution by road surface

Route	Road surface			SUM
	Dry (row %)	Wet (row %)	Snow/Ice (row %)	
A1a	50.1	47.1	2.8	**361**
A1b	60.4	38.7	0.8	**599**
A1c	63.1	35.7	1.3	**398**
A1 Group	**58.5**	**40.0**	**1.5**	**1358**
A604(1)	59.6	37.9	2.5	**240**
A604(2)	63.9	33.3	2.8	**108**
A45(1)	70.4	24.1	5.6	**108**
A45(2)	81.8	18.2		**44**
A14 Group	**64.8**	**32.2**	**3.0**	**500**
A1139	53.2	40.4	6.4	**171**
A1260	48.0	46.7	5.3	**75**
A47	59.7	38.7	1.6	**62**
Parkways Group	**53.2**	**41.6**	**5.2**	**308**
Dual Carriageways	**59.2**	**38.5**	**2.4**	**2166**
Single Carriageways	**56.3**	**40.1**	**3.5**	**812**

Assuming that the routes experienced similar degrees of dryness and wetness, a higher wet accident rate could be an indicator of a skidding resistance problem with the wearing course. The variation between routes might be explained by whether or not the route had a major surface treatment during the study period. However, a three-way log-linear model used to test for a relationship between skidding, road surface and route, revealed that a significant association existed between the incidence of skidding and the prevailing road surface condition, but there was no significant association with route. The data are summarised in Table 3.9.

Table 3.9
Skidding accidents by road surface

	% skid by road surface			SUM
	Dry (% skid)	Wet/Flood (% skid)	Snow/Ice (% skid)	
Dual Carriageways	**40.5**	**58.2**	**82.3**	**48.3**
Single Carriageways	**34.8**	**49.1**	**69.0**	**41.2**

Accidents, traffic volumes and route characteristics

The proportion of accidents which involved a vehicle skidding increases with the introduction of water or ice onto the road surface. On a dry dual carriageway surface, skidding was a factor in just over 40 per cent of accidents, whereas on a wet road surface, the incidence of skidding in accidents was 58 per cent. These observations are not new. However, it is interesting that, in each road surface category, the proportion of accidents where skidding was a factor is higher on dual carriageways than single carriageways. This may be a function of higher speeds.

Light conditions

On average, 28 per cent of dual carriageway accidents occurred when it was dark (Table 3.10): a similar figure to that found in the single carriageway study (Hughes and Amis 1996). However, differences exist between the different dual carriageway groupings. Only 26 per cent of accidents on the A1 Group of routes occurred in the dark compared to 30 per cent and 32 per cent on the Parkways and A14 Groupings respectively.

Table 3.10 Accident distribution by light conditions

Route	Light condition			SUM
	Day (row %)	Dark (lit) (row %)	Dark (unlit) (row %)	
A1a	71.7	3.3	24.9	**361**
A1b	76.6	2.0	21.4	**599**
A1c	70.9	6.8	22.4	**398**
A1 Group	**73.6**	**3.8**	**22.6**	**1358**
A604(1)	67.5	–	32.5	**240**
A604(2)	76.9	0.9	22.2	**108**
A45(1)	63.0	2.8	34.3	**108**
A45(2)	63.6	–	36.4	**44**
A14 Group	**68.2**	**0.8**	**31.0**	**500**
A1139	71.3	28.7	–	**171**
A1260	62.7	37.3	–	**75**
A47	75.8	21.0	–	**62**
Parkway Group	**70.1**	**29.9**	–	**308**

Dual Carriageways	**71.9**	**Darkness overall = 28.1%**	**2166**
Single Carriageways	**73.4**	**Darkness overall = 26.6%**	**812**

The fall in the proportion of darkness accidents on the A604 following the opening of the A14, from 33 per cent before (A604(1)) to 22 per cent after (A604(2)), is perhaps an artefact of an increase in daytime accidents associated with increased daytime traffic volumes.

The high proportion of Parkways Group accidents which occurred during the hours of darkness is of concern, particularly as all the routes are lit after dark. Poor light conditions cannot explain this observation, therefore other factors such as road design, alignment and the day / dark traffic mix may hold the key. This is explored further in Chapter 6.

Weather conditions

The association between dual carriageway traffic accidents and weather is examined in Table 3.11. On average, the majority of accidents occurred when it was fine (77 per cent). Fog, which was the prevailing weather condition in just four per cent of accidents (Table 3.11) had its highest presence in accidents on the overloaded A604 (seven per cent). There is minimal variation between groups but more variation between routes. The figures are comparable with those for single carriageways.

Fog conditions are not a major contributor to the accident total (four per cent of all accidents), although when fog occurs the accident risk is high.

Table 3.11 Accidents by weather conditions

Route	Weather condition			SUM
	Fine (row %)	Rain) (row %)	Fog (row %)	
A1a	70.6	20.8	3.6	**361**
A1b	77.8	15.2	3.3	**599**
A1c	81.2	13.3	5.0	**398**
A1 Group	**76.9**	**16.1**	**3.1**	**1358**
A604(1)	76.3	13.8	6.7	**240**
A604(2)	70.4	16.7	7.4	**108**
A45(1)	76.9	13.0	3.7	**108**
A45(2)	93.2	4.5	–	**44**
A14 Group	**76.6**	**13.4**	**4.4**	**500**
A1139	77.2	17.0	2.3	**171**
A1260	72.0	24.0	1.3	**75**
A47	79.0	17.7	1.6	**62**
Parkways Group	**76.3**	**18.8**	**2.9**	**308**
Dual Carriageways	76.7	15.9	4.0	**2166**
Single Carriageways	75.6	16.5	3.3	**812**

"Other" or "Unknown Weather" not shown hence row % does not sum to 100%

3.5 Statistical analysis of accident data – significant interactions

If all interactions between the variables were presented in this report, a large number of cross-tabulations would be required. In order to overcome this problem, log-linear modelling was used as an exploratory tool for focusing the analysis only on those interactions between variables which are significant.

With this aim in mind, the variables of location, severity, light conditions and road surface were modelled and significant interactions explored. The following significant interactions emerged :

- Severity depends on location
- Severity depends on light conditions
- An association exists between light conditions and road surface

An interaction also exists between light conditions and location. This is related to differing street lighting conditions at the locations (junction types and links) and will not be considered further.

The significant interaction between accident severity and accident location is highlighted in Table 3.12. It is shown that considerable variations in accident severity exist between locations. Accidents at roundabouts are predominantly slight (91 per cent). No fatal accidents were recorded at roundabouts on the dual carriageways being studied. In contrast, T or staggered junctions served by a gap in the central reservation have the worst severity record with nearly 37 per cent of accidents being fatal or serious (KSI). Although roundabouts have higher annual rates, their accident severities tend to be lower.

Table 3.12 Accident severity and location

Location	Fatal Number	Fatal row %	Serious Number	Serious row %	Slight Number	Slight row %	Total	% KSI
Link	56	*4.0*	324	*23.3*	1013	*72.7*	**1393**	**27.3**
Roundabout	–	–	9	*9.2*	89	*90.8*	**98**	**9.2**
T-junction or private access without gap	8	*3.9*	40	*19.3*	159	*76.8*	**207**	**23.2**
T or staggered junction with gap	19	*6.9*	82	*29.8*	174	*63.3*	**275**	**36.7**
Grade separated slip road	8	*4.1*	37	*19.2*	148	*76.7*	**193**	**23.3**
Total	**91**	***4.2***	**492**	***22.7***	**1583**	***73.1***	**2166**	**26.9**

The tendency for accidents occurring in the dark to have an increased severity relative to accidents occurring in daylight is clearly shown in Table 3.13. The proportion of fatal accidents occurring in darkness is twice that of fatal accidents occurring in daylight (irrespective of whether the route was lit or unlit). Unlit roads during the hours of darkness had the highest proportion of serious accidents.

Table 3.13 Accident severity and light

Light conditions	Fatal Number	Fatal row %	Serious Number	Serious row %	Slight Number	Slight row %	Total
Day	47	*3.0*	339	*21.8*	1171	*75.2*	**1557**
Dark (Lit)	11	*7.6*	30	*20.7*	104	*71.7*	**145**
Dark (Unlit)	33	*7.1*	123	*26.5*	308	*66.4*	**464**
Total	**91**	**4.2**	**492**	**22.7**	**1583**	**73.1**	**2166**

From Table 3.14 it can be seen that, on average, 36 per cent of daylight accidents occurred on a wet road surface. This proportion is similar to that found on single carriageway roads (Hughes and Amis, 1996). On average, the ratio of wet road surface accidents to dry road surface accidents was 1.8 times as great when it was dark as during daylight. As noted previously, this is probably related to the fact that, on average, roads remain wet for longer when it is dark.

One interesting feature of Table 3.14 is that the proportion of wet road surface accidents occurring during the hours of darkness is much higher on the lit sections of road (61 per cent) compared to the unlit sections.

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

Table 3.14
Light and road surface

Light conditions	Surface						Total	
	Dry			Wet				
	Count	row %	column %	Count	row %	column %	Count	column %
Day	989	63.5	77.1	568	36.5	64.3	**1557**	**71.9**
Dark (Lit)	57	39.3	4.4	88	60.7	10.0	**145**	**6.7**
Dark (Unlit)	236	50.9	18.4	228	49.1	25.8	**464**	**21.4**
Total	**1282**	**59.2**		**884**	**40.8**		**2166**	

3.6 The human and financial cost

Accidents

On average, fatal and serious accidents (KSI) accounted for 27 per cent of all dual carriageway accidents (Table 3.15). This is significantly less than the corresponding figure of 35 per cent for single carriageways. The separation of the carriageways and consequent lower relative impact speeds in vehicle to vehicle collisions may well account for the lower severities found.

Table 3.15
Accident severity (1988-1995)

Route	Severity			Accident Nos.	KSI[1] (%)
	Fatal (row %)	Serious (row %)	Slight (row %)		
A1a	5.0	19.7	75.3	**361**	24.7
A1b	2.7	20.9	76.5	**599**	23.6
A1c	3.5	27.4	69.1	**398**	30.9
A1 Group	3.5	22.5	74.0	**1358**	26.0
A604(1)	5.4	24.6	70.0	**240**	30.0
A604(2)	4.6	20.4	75.0	**108**	25.0
A45(1)	4.6	22.2	73.1	**108**	26.8
A45(2)	9.1	25.0	65.9	**44**	34.1
A14 Group	5.4	23.2	71.4	**500**	28.6
A1139	7.0	25.1	67.8	**171**	32.1
A1260	2.7	22.7	74.7	**75**	25.4
A47	3.2	17.7	79.0	**62**	21.0
Parkways Group	**5.2**	**23.1**	**71.8**	**308**	**28.3**
Dual	**4.2**	**22.7**	**73.1**	**2166**	**26.9**
Single	**7.1**	**28.0**	**64.9**	**812**	**35.1**

[1] KSI is the sum percentage of fatal and serious accidents

The proportions of fatal, serious and slight accidents are fairly consistent across the groups, but some notable differences can be seen between routes making up individual groupings. Among the A1 Group of routes, the highest KSI percentage (31 per cent) is found for the northern A1c section – this compares with less than 25 per cent on the other routes. Twenty nine per cent of accidents on the A14 Group of routes are KSI. Of the Parkways Group of routes, the A1139 has the highest proportion of KSI accidents at 32 per cent, with fatal accidents representing seven per cent of the total. Many of these involved vehicles either crossing the central reserve or hitting lamp posts in the central reserve before crash barriers were installed.

With more accidents occurring on dual carriageways compared to single carriageways in a given year, actual accident costs work out higher. At 1995 prices (Department of Transport 1996), accidents on the 119 km of 'A' class dual carriageway road being studied cost society, on average, £22 million annually (Table 3.16), or £190,000 per kilometre of carriageway. The difference compared with single carriageways (Hughes and Amis, 1996) is an increased cost of £30,000 per kilometre.

Table 3.16 Accident costs (August 1996 prices – rural roads)

Carriageway type	Average cost of accidents per year (million pounds)				Cost per kilometre
	Fatal	Serious	Slight	All injury accidents	
Dual	11.4	8.1	2.5	21.9	**0.19**
Single	8.3	4.1	1.0	13.4	**0.16**

Casualties

Table 3.17 shows the number of casualties per accident, categorised by severity, for each route. The number of casualties per accident is, as previously seen in the single carriageway study, higher among fatal and serious accidents than slight accidents, but there are no discernible differences between route groupings.

A particularly striking feature of this table is the decline in the proportion which fatal and serious casualties (KSI) form of the casualty totals on the A604 route following the opening of the A14. In the pre-A14 period, over a quarter of casualties were killed or seriously injured (A604(1)) compared to just 15 per cent in the following period (A604(2)). The same reduction is not seen for the A45.

Table 3.17 Casualty severity

Route	Casualties in KSI accidents	Casualties in slight accidents	All casualties	
	No. per accident	No. per accident	No.	% KSI
A1a	1.71	1.48	555	**18.7**
A1b	2.39	1.49	1020	**19.8**
A1c	2.11	1.49	671	**25.2**
A1 Group	2.12	1.48	2246	**21.1**
A604(1)	1.94	1.44	382	**25.7**
A604(2)	2.15	1.60	188	**14.9**
A45(1)	1.79	1.38	161	**21.7**
A45(2)	2.07	1.38	71	**21.1**
A14 Group	1.97	1.46	802	**21.9**
A1139	2.13	1.50	291	**24.0**
A1260	1.58	1.30	103	**19.4**
A47	1.54	1.49	93	**17.2**
Parkways Group	1.92	1.45	487	**21.7**
Dual Carriageway	2.05	1.48	3535	**21.4**
Single Carriageway	2.32	1.49	1447	**29.6**

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

The significant difference observed between single and dual carriageways in terms of KSI accident proportions is maintained for KSI casualty proportions. Nearly 30 per cent of casualties on single carriageways were fatally or seriously injured compared to just 21 per cent for dual carriageways. The average number of casualties per KSI accident is also lower for dual carriageways.

3.7 Summary

- Factors other than just traffic volume are determinants of safety.
- Compared to single carriageways, the risk, per kilometre travelled, of an individual driver being involved in an accident is lower.
- On average, vehicle speeds tend to fall above traffic volumes of around 1500 vehicles per hour.
- Flow breakdown was not found to occur consistently at high traffic volumes.
- The distinct differences in the character of the three groups of roads studied is reflected in the distribution of accident locations between links and junctions.
- In contrast to the single carriageway findings, accidents at private accesses were not found to be a significant problem (but private accesses to dual carriageways are generally limited, except on the A1 Group).
- Although their numbers were small, and they were only examined on the A1 group, at-grade roundabouts had the highest average annual numbers of accidents of any junction type. (This contrasts with the single carriageway findings where roundabouts were one of the safest forms of junction.)
- Junctions with central reserve gaps performed worse than junctions without. However such junctions were almost exclusively found on the A1 Group.
- Grade separated junctions and T-junctions without gaps had the lowest annual accident rates (however, in the former case, only the main carriageway / minor road elements were examined).
- There was found to be a significant association between skidding and road condition (i.e. wet, dry).
- The proportion of accidents involving skidding was higher than for single carriageways, perhaps reflecting higher traffic speeds.
- There is an association between accident severity and location, accidents at roundabouts being predominantly slight, with highest severities at junctions with gaps (both types of junction occurring mainly on the A1 Group).
- There is an association between accident severity and light, with higher severities in darkness.
- There is an interaction between light and road surface. The proportion of wet road accidents is 1.8 times as great in darkness as during daylight. This was similar to the findings for single carriageways.
- Overall, the average severity of dual carriageway accidents is lower than on the single carriageways previously studied. The average number of casualties per KSI accident was also lower.
- Accidents on the dual carriageways studied cost £22 million per year (£190,000 per km per year).

Chapter 4 Accident types, drivers and vehicles involved

This chapter examines dual carriageway accidents from the perspective of the vehicles and drivers involved. With a breakdown for each route, dual carriageway grouping, and a comparison with single carriageway accidents, vehicle involvement is examined by number of vehicles, vehicle types and conflicts. Drivers are examined by age, gender, the vehicles they were driving and the manoeuvres being carried out at the time of the accident. Vehicle manoeuvres are also used in the classification of accidents into different types. The chapter ends with the statistical modelling of driver-related and vehicle-related variables in order to highlight significant associations.

4.1 Vehicle characteristics

A total of 4546 vehicles were involved in the 2166 accidents which occurred on the dual carriageways being examined. With the exclusion of 43 accidents which had pedestrian involvement, the vehicle and driver total reduces to 4494. Just over 30 per cent of dual carriageway accidents involved a single vehicle (Table 4.1). This proportion is significantly greater than the 26 per cent of single carriageway accidents which involved a single vehicle. Forty four per cent of accidents on dual carriageways involved two vehicles, compared to 49 per cent on single carriageways (Table 4.1) – a difference which is largely explained by the increased proportion of single vehicle accidents.

Table 4.1 Accidents by numbers of vehicles involved

Route	Numbers of vehicles				Total
	1 (row %)	2 (row %)	3 (row %)	4+ (row %)	
A1a	45.2	41.3	9.3	4.2	**356**
A1b	23.9	43.1	18.2	14.8	**582**
A1c	34.3	44.2	15.0	6.6	**394**
A1 GROUP	**32.7**	**42.9**	**14.9**	**9.5**	**1332**
A604(1)	30.3	40.3	18.9	10.5	**238**
A604(2)	18.1	42.9	17.1	21.9	**105**
A45(1)	36.4	52.3	9.3	1.9	**107**
A45(2)	18.6	62.8	9.3	9.3	**43**
A14 GROUP	**28.0**	**45.4**	**15.6**	**11.0**	**493**
A1139	26.2	49.4	17.3	7.1	**168**
A1260	28.4	44.6	17.6	9.5	**74**
A47	37.5	42.9	12.5	7.1	**56**
PARKWAYS GROUP	**28.9**	**47.0**	**16.4**	**7.7**	**298**
Dual	31.0	44.1	15.3	9.6	**2123**
Single	25.6	49.1	16.6	8.6	**812**

There is no significant difference between dual carriageway groups when examined for number of vehicles involved, but some interesting differences emerge when individual routes are compared. These can be summarised as follows:

- For the southern section of the A1 (A1a), over 45 per cent of accidents involved just one vehicle. This compares with the A1 Group average of 33 per cent. For the middle

Section of the A1 (A1b), there are proportionally fewer single vehicle accidents, but proportionally more accidents involving three or more vehicles. These differences may be attributable to traffic volume or the road environment.

- The effect of the opening of the A14 route on accidents on the A604 and A45 dual carriageways has been to increase the number of accidents involving four or more vehicles (generally at the expense of single vehicle accidents).

As seen for single carriageway accidents, the majority of vehicles involved in dual carriageway accidents (Table 4.2) were cars (74 per cent). In most categories, the proportional representation of vehicle types in accidents is similar for both dual and single carriageway accidents. However, proportionally more heavy goods vehicles were involved in dual carriageway accidents (14 per cent) compared with single carriageway accidents (11 per cent) – Table 4.2. The higher heavy goods vehicle involvement in dual carriageway accidents is not surprising as these carriageway types represent the main arterial routes for goods traffic.

Table 4.2 Vehicles involved

Route	Vehicle Type							ALL
	Pedal cycle (row %)	TWMV (row %)	Car (row %)	Bus (row %)	Light goods (row %)	Heavy goods (row %)	Other (row %)	
A1a	2.2	3.2	76.5	1.0	6.7	10.1	0.3	**626**
A1b	0.4	2.6	79.5	1.0	5.0	10.7	0.7	**1371**
A1c	0.9	3.2	70.5	0.8	4.9	18.9	0.9	**783**
A1 GROUP	**1.0**	**2.9**	**76.3**	**0.9**	**5.3**	**12.9**	**0.7**	**2780**
A604(1)	1.7	2.3	60.5	1.2	6.7	25.5	2.1	**521**
A604(2)	-	1.5	69.6	0.7	4.4	21.5	2.2	**270**
A45(1)	1.1	4.7	60.5	1.6	9.5	21.1	1.6	**190**
A45(2)	2.0	2.0	69.7	-	7.1	19.2	-	**99**
A14 GROUP	**1.2**	**2.5**	**63.6**	**1.0**	**6.7**	**23.1**	**1.9**	**1080**
A1139	2.2	3.0	77.1	0.3	7.2	8.6	1.7	**362**
A1260	2.4	3.6	84.2	0.6	4.8	2.4	1.8	**165**
A47	0.9	11.2	77.6	0.9	2.8	4.7	1.9	**107**
PARKWAYS GROUP	**2.1**	**4.6**	**79.0**	**0.5**	**5.8**	**6.3**	**1.7**	**634**
Dual	1.2	3.0	73.6	0.9	5.7	14.4	1.1	**4494**
Single	1.2	4.2	74.6	1.2	6.7	11.3	0.9	**1173**

Despite recent concerns about the involvement of buses and minibuses in traffic accidents, there is not a large problem on the dual carriageways under review. Buses and minibuses were involved in less than one per cent of accidents on dual carriageways – Table 4.2.

Comment is frequently passed about the nuisance and alleged "danger" of tractors and other slow moving vehicles on dual carriageways. From mid-1989, tractors and a few other vehicle types were given their own categories on the STATS19 form to allow them to be distinguished from other vehicles in the general 'other non-motorised' and 'other motorised' vehicle categories. In this period, only ten of the other vehicles were agricultural tractors, nine were motor caravans and seven were milk floats. However, this does not preclude the possibility of slow moving vehicles causing a build up of traffic resulting in accidents perhaps some distance behind them. In such cases, their involvement may well not be known about or recorded. Twenty two (0.5 per cent) of the vehicles involved in accidents on dual carriageways were towing caravans, but 69 (1.5 per cent) were towing a single trailer.

Accident types, drivers and vehicles involved

Differences in traffic mix may account for the differences in the proportional representation of vehicle types in accidents between dual carriageway groups. The Parkways have proportionally more pedal cycles (two per cent), two-wheeled motor vehicles (five per cent) and cars (79 per cent), and proportionally fewer heavy goods vehicles (six per cent) involved in their accidents compared to the other route groups (Table 4.2). The highest involvement of heavy goods vehicles in accidents is observed on the A14 Group of dual carriageways (23 per cent). However, rather than indicating a specific problem for heavy goods vehicles on the A14 Group of dual carriageways, the proportional involvement is similar to the proportion of traffic made up by heavy goods vehicle (Table 2.1).

4.2 Vehicle involved – conflicting vehicles

4.2.1 Single vehicle accidents

Accidents on the three groups of dual carriageway which involved just one vehicle are examined in Table 4.3. The proportional involvement of different vehicle types in single vehicle accidents clearly varies between the groups of routes. The involvement of a two-wheeled motor vehicle in a single vehicle accident is most prevalent on the Parkway Group of dual carriageways accounting for 19 per cent of all vehicles (compared to an average of 10 per cent). Compared to other route groups, a high proportion of single vehicle accidents on the A14 involved goods vehicles (both heavy and light).

Table 4.3 Single vehicle accidents – vehicles involved

Vehicle type	A1 Group (column %)	A14 Group (column %)	Parkways (column %)	Dual (column %)
Heavy goods	8.5	14.5	3.5	**9.1**
Buses	0.5	2.2	–	**0.8**
Light goods	4.4	10.1	3.5	**5.5**
Car	76.6	66.7	73.3	**74.1**
Two-wheeled motor vehicle	9.7	5.8	18.6	**10.0**
Pedal cycle	0.5	0.7	–	**0.5**
Total number of vehicles	435	138	86	**659**

4.2.2 Two vehicle accidents

In accidents involving two vehicles, the predominant conflict on all the dual carriageway groups is that of conflict between two cars (Table 4.4). The proportion of car-car collisions ranges from 33 per cent for the A14 Group of dual carriageways to 55 per cent for the Parkways and 52 per cent for the A1 Group.

The most frequent two vehicle conflict after that of car-car is car-heavy goods vehicle (20 percent for the A1 Group, 26 per cent for the A14 Group and 10 per cent for the Parkways Group). Ten per cent of two vehicle conflicts on the A14 Group of routes are between two heavy goods vehicles (Table 4.4b).

On the Parkways Group (Table 4.4c), 13 per cent of two vehicle conflicts are between a car and a two-wheeled vehicle (either a two-wheeled motor vehicle or a pedal cycle). The urban distributor function of the Parkways may account for this high involvement of pedal cycles and two-wheeled motor vehicles.

Table 4.4 Accidents involving two vehicles – vehicles in conflict

a A1 Group

Other motor (OM)	–						
Heavy goods (HGV)	2 (0.3%)	19 (3.3%)					
Bus	–	–	–				
Light goods (LGV)	1 (0.2%)	–	1 (0.2%)	5 (0.9%)			
Car	**8 (1.4%)**	**112 (19.6%)**	12 (2.1%)	**37 (6.5%)**	**300 (52.4%)**		
Two-wheeled motor vehicle (TWMV)	1 (0.2%)	2 (0.3%)	1 (0.2%)	4 (0.7%)	25 (4.4%)	2 (0.3%)	
Pedal cycle (PC)	–	3 (0.5%)	–	1 (0.2%)	16 (2.8%)	–	–
	OM	HGV	Bus	LGV	Car	TWMV	PC

b A14 Group

Other motor (OM)	–						
Heavy goods (HGV)	11 (4.9%)	**22 (9.8%)**					
Bus	–	1 (0.4%)	–				
Light goods (LGV)	2 (0.9%)	9 (4.0%)	–	–			
Car	4 (1.8%)	**58 (25.9%)**	1 (0.4%)	**17 (7.6%)**	**75 (33.5%)**		
Two-wheeled motor vehicle (TWMV)	–	2 (0.9%)	–	2 (0.9%)	9 (4.0%)	–	
Pedal cycle (PC)	–	4 (1.8%)	–	–	7 (3.1%)	–	–
	OM	HGV	Bus	LGV	Car	TWMV	PC

c Parkways Group

Other motor (OM)	–						
Heavy goods (HGV)	2 (1.4%)	1 (0.7%)					
Bus	–	–	–				
Light goods (LGV)	–	2 (1.4%)	–	2 (1.4%)			
Car	3 (2.1%)	**14 (10.0%)**	1 (0.7%)	12 (8.6%)	**77 (55.0%)**		
Two-wheeled motor vehicle (TWMV)	–	3 (2.1%)	–	1 (0.7%)	**9 (6.4%)**	1 (0.7%)	
Pedal cycle (PC)	–	1 (0.7%)	–	2 (1.4%)	**9 (6.4%)**	–	–
	OM	HGV	Bus	LGV	Car	TWMV	PC

4.2.3 Accidents involving three or more vehicles

In accidents involving three or more vehicles in conflict, cars represent, on average, 79 per cent of the vehicles (Table 4.5). Variations between groups of dual carriageways in the proportion of heavy goods vehicle involvement in the accidents largely explains the differing proportion of car involvement. Once again, the A14 Group of dual carriageways has a high heavy goods vehicle involvement in these accidents (21 per cent). This compares with 12 per cent for the A1 Group and five per cent for the Parkways Group of dual carriageways (Table 4.5).

Table 4.5 Accidents involving three or more vehicles – vehicles involved

Vehicle type	A1 Group (column %)	A14 Group (column %)	Parkways (column %)	Dual (column %)
Pedal cycles	0.4	0.2	0.4	**0.4**
Two-wheeled motor vehicles	0.4	1.4	–	**0.6**
Cars	81.3	70.2	87.3	**79.3**
Buses	0.9	1.2	0.7	**1.0**
Light goods vehicles	4.6	5.6	4.9	**4.9**
Heavy goods vehicles	11.9	20.7	4.9	**13.2**
Other vehicles	0.5	0.6	1.9	**0.7**
Total number of vehicles	1201	497	268	1963

Note: Categories are not mutually exclusive

4.3 Driver characteristics

The distribution of vehicle drivers/riders by gender does not reveal any significant difference between dual and single carriageway accidents (Table 4.6). Male drivers once again predominate, accounting for 78 per cent of drivers.

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Though female drivers account for 22 per cent of the drivers involved in dual carriageway accidents, significant differences exist between routes. For the Parkways Group of dual carriageways, female drivers represent nearly 32 per cent of drivers in the accidents; this figure is as high as 40 per cent for the A47 (Table 4.6). In contrast, female involvement in accidents on the A14 Group of dual carriageways averages just 16 per cent, although on the A45(2) female involvement was as high as 26 per cent. The differences could be a reflection of the driving population using the different roads. With the Parkways Group of dual carriageways serving as the urban distributor system to Peterborough, a higher representation of females among the drivers using these routes might be expected. However, in the absence of detailed travel patterns to confirm this hypothesis, it may also be the case that female drivers experience a genuine problem when driving on the Parkway system. Why there has been an increase in the proportion of female drivers involved in accidents on the A45 following the opening of the A14 is unclear.

Table 4.6
Driver gender

Route	Gender of drivers/riders		Total
	Male (row %)	Female (row %)	
A1a	77.2	22.8	**609**
A1b	77.0	23.0	**1341**
A1c	80.2	19.8	**764**
A1 GROUP	**78.0**	**22.0**	**2714**
A604(1)	85.8	14.2	**501**
A604(2)	82.1	17.9	**263**
A45(1)	85.4	14.6	**185**
A45(2)	73.7	26.3	**95**
A14 GROUP	**83.7**	**16.3**	**1044**
A1139	72.8	27.2	**342**
A1260	64.6	35.4	**161**
A47	60.0	40.0	**100**
PARKWAYS GROUP	**68.5**	**31.5**	**603**
Dual	78.0	22.0	**4361**
Single	79.1	20.9	**1683**

Dual excludes 133 drivers of unknown gender. Single excludes 49 drivers of unknown gender.

Just over 36 per cent of the drivers involved in dual carriageway accidents were aged between 17 and 29 (Table 4.7). This proportion is significantly less than the 41 per cent of drivers aged 17 to 29 who were involved in single carriageway accidents. More of the drivers involved in dual carriageway accidents were middle aged (30 to 59) – 55 per cent, whereas the proportion of drivers aged 59 or more was similar to that for single carriageways (nine per cent).

It is clear from Table 4.7 that the age of the driver population involved in dual carriageway accidents varies between the routes. Nearly half the drivers involved in accidents on the Parkways were aged between 17 and 29. This contrasts with just 34 per cent for the A14 Group of dual carriageways. Drivers aged more than 60 had their highest involvement in accidents on the A1 Group of dual carriageways (10 per cent) and lowest on the Parkways (six per cent).

Accident types, drivers and vehicles involved

Another point of interest from Table 4.7 is that the age of the driving population involved in accidents on the A14 Group of dual carriageways has changed following the opening of the A14 route. For both the A45 and A604, the proportional involvement of drivers aged 17 to 29, and aged more than 60 has decreased, whereas the proportion of drivers in the intermediate age group has increased.

Table 4.7 Driver age

Route	Age of driver			Total
	17-29 (row %)	30-59 (row %)	60+ (row %)	
A1a	40.5	51.3	8.2	595
A1b	34.0	55.3	10.7	1330
A1c	30.6	58.4	11.0	757
A1 GROUP	**34.5**	**55.3**	**10.2**	2682
A604(1)	36.9	55.0	8.0	498
A604(2)	25.2	68.7	6.1	262
A45(1)	40.7	51.1	8.2	182
A45(2)	29.0	66.7	4.3	93
A14 GROUP	**33.9**	**58.8**	**7.2**	1035
A1139	48.8	43.3	7.9	330
A1260	48.4	49.1	2.5	161
A47	47.0	48.0	5.0	100
PARKWAYS GROUP	**48.4**	**45.7**	**5.9**	591
Dual	36.3	54.8	8.9	4308
Single	40.9	50.1	9.0	1678

Dual total excludes 186 drivers of unknown age. Single total excludes 53 drivers of unknown age.

A comparison of the manoeuvres being carried out by drivers/riders at the time of their accident on dual and single carriageways is presented in Table 4.8. Due to the manoeuvre re-coding which had taken place for the dual carriageway study, a direct comparison of all the STATS19 data was not possible. For example, while overtaking was considered as an entity in the single carriageway study, this manoeuvre was coded to either "changing lane to the left", "changing lane to the right", or "going ahead – other" in the dual carriageway study. As "changing lane" was used as a general code in this study, it is not possible to make the distinction between vehicles which were changing lane when overtaking from those which were changing lane when leaving the major road at a grade-separated junction.

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Table 4.8
Vehicle manoeuvres in accidents

Manoeuvre	A1 GROUP (column %)	A14 GROUP (column %)	PARKWAYS GROUP (column %)	Dual (col %)	Single (col %)
Reversing	–	0.1	–	–	0.1
Parked	1.7	5.1	3.5	2.7	0.6
Waiting to go ahead	**12.6**	**10.7**	**8.4**	**11.6**	**4.3**
Stopping	**12.6**	**7.8**	**5.2**	**10.4**	**3.9**
Starting	0.1	0.1	–	0.1	0.1
Starting off from lay-by	0.1	1.4	0.2	0.4	*
U-turn	1.3	0.3	1.1	1.0	1.5
Turning left, waiting to or crossing	2.3	0.8	–	1.5	2.3
Turning right, or waiting to	**7.3**	**0.4**	–	**3.6**	**14.8**
Overtaking	*	*	*	*	14.7
Changing lane to left	2.3	2.7	3.3	2.5	*
Changing lane to right	5.0	5.9	10.3	6.0	*
Going ahead on a bend	15.5	15.7	19.9	16.2	14.6
Going ahead other	40.9	49.0	47.9	43.8	43.1
Total number of vehicles	**2780**	**1080**	**634**	**4494**	**847**

* Manoeuvres not directly comparable between single and dual carriageway

The manoeuvres of "waiting to go ahead" and "stopping" show clear distinctions between dual and single carriageways. For dual carriageways, the proportions of vehicles carrying out these manoeuvres are 12 per cent and 10 per cent respectively, compared to four per cent each for the single carriageways (Table 4.8). "Turning right" or "waiting to turn right" is a manoeuvre occurring more commonly in single carriageway accidents (15 per cent) compared to just four per cent in dual carriageway accidents (almost entirely due to the influence of junctions on the A1). This difference in proportions is not surprising when it is considered that this manoeuvre is severely restricted on dual carriageways but is commonplace on single carriageways. Other differences in the proportion of manoeuvres being carried out arise from the re-coding of the data.

Some of the differences in the proportion of manoeuvres carried out on the different dual carriageway groups is a reflection of the different design standards to which the carriageways were built. For the A1 Group, gaps in the central reservation account for the 10 per cent of vehicles involving turning right or left. Less than 1.5 per cent of vehicles on the A14 Group of dual carriageways, and none of the vehicles involved in accidents on the Parkways Group were carrying out these manoeuvres.

Just over a quarter of all vehicles on the A1 Group of dual carriageways were either "stopping", or were "held up waiting to go ahead". This compares with just 14 per cent of vehicles on the Parkways. Nevertheless, the predominance of these manoeuvres in dual carriageway accidents in general suggests a problem with stacking type accidents. This will be examined further in the following sections.

4.4 Accident types

Table 4.9 Accident types by route

Accident Type	Route Groupings		
	A1	A14	Parkways
STACKING			
Rear end shunt	376	165	52
Shunt on minor	17	10	38
Queue evasion	29	11	10
Shunt – parked vehicle	24	17	15
Section total	446	203	115
% of column total	**32.9**	**40.6**	**37.3**
TURNING			
Right turn *from main*	49	–	–
Right turn *from minor*	39	–	–
Joining via central reserve	30	4	–
Leaving via central reserve	18	–	–
Left turn other	25	8	–
Left turn crossing	31	–	–
Lane change *leaving*	3	1	9
Lane change *joining*	40	11	17
Lay-by *entry*	5	2	1
Lay-by *exit*	4	15	1
U-turning	37	3	8
Section total	281	44	36
% of column total	**20.7**	8.8	11.7
LANE CHANGE			
To right *shunt*	41	22	11
To right *evasion*	30	7	9
To right *loss of control*	24	12	9
To left *shunt*	15	7	2
To left *evasion*	5	4	3
To left *loss of control*	18	10	3
Section total	133	62	37
% of column total	9.8	12.4	12.0
LOSS OF CONTROL			
Other	134	104	57
Left bend	107	14	21
Right bend	86	10	17
Section total	327	128	95
% of column total	24.1	25.6	30.8
VEHICLE DRIFT			
Drift to nearside	73	22	6
Drift to offside	62	14	6
Drift to lay-by	1	12	–
Section total	136	48	12
% of column total	10.0	9.6	**4.0**
OTHER			
Pedestrian	21	7	7
Miscellaneous	13	8	6
Section total	34	14	13
% of column total	2.5	3.0	4.2
ALL ACCIDENTS	1357	500	308

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Table 4.10 Accident types by number of vehicles in accident

Accident Type	Number of Vehicles					
	1	2	3	4	5	6+
STACKING						
Rear end shunt	–	297	156	75	34	31
Shunt on minor	–	43	17	1	2	2
Queue evasion	17	18	9	4	1	1
Shunt – parked vehicle	–	44	9	2	1	–
Section total	17	402	191	82	38	34
% of column total	2.5	**42.6**	**58.8**	**70.1**	**84.4**	**81.0**
TURNING						
Right turn *from main*	2	38	6	–	1	2
Right turn *from minor*	–	33	6	–	–	–
Joining via central reserve	–	30	3	1	–	–
Leaving via central reserve	–	14	3	1	–	–
Left turn other	8	16	5	3	1	–
Left turn crossing	–	26	4	–	1	–
Lane change *leaving*	2	10	1	–	–	–
Lane change *joining*	2	44	15	6	1	–
Lay-by *entry*	1	7	–	–	–	–
Lay-by *exit*	–	12	5	3	–	–
U-turning	1	35	7	5	–	–
Section total	16	265	55	19	4	2
% of column total	2.3	**28.1**	**16.9**	**16.2**	**8.9**	**4.8**
LANE CHANGE						
To right *shunt*	–	54	18	1	–	1
To right *evasion*	1	29	15	1	–	–
To right *loss of control*	9	26	8	–	1	1
To left *shunt*	–	17	4	3	–	–
To left *evasion*	–	9	3	–	–	–
To left *loss of control*	18	13	–	–	–	–
Section total	28	148	48	5	1	2
% of column total	4.0	15.7	14.8	4.3	2.2	4.8
LOSS OF CONTROL						
Other	221	53	12	6	1	2
Left bend	127	11	2	–	1	1
Right bend	98	12	3	–	–	–
Section total	446	76	17	6	2	3
% of column total	**64.4**	8.1	5.2	5.1	4.4	7.1
VEHICLE DRIFT						
Drift to nearside	83	18	–	–	–	–
Drift to offside	64	9	7	2	–	–
Drift to lay-by	–	10	2	1	–	–
Section total	147	37	9	3	–	–
% of column total	**21.2**	3.9	2.8	2.6	–	–
OTHER						
Pedestrian	31	3	1	–	–	–
Miscellaneous	8	12	4	2	–	1
Section total	39	15	5	2	–	1
% of column total	5.6	1.6	1.5	1.7	–	2.4
ALL ACCIDENTS	693	943	325	117	45	42

Accident types, drivers and vehicles involved

A number of points are highlighted in Table 4.9. The high occurrence of turning accidents on the A1 (21 per cent of all accidents) reflects the types of junction prevalent along this group of routes. Stacking accidents are the largest single category, ranging from 33 per cent for the A1 Group of routes to 41 per cent on the A14 Group. Vehicle drift accidents make up only four per cent of accidents on the Parkways Group, compared to 10 per cent on the other two groups; this difference may be due to the Parkways being "short haul" routes.

Considering Table 4.10, it can be seen that as the number of vehicles involved increases so does the predominance of stacking accidents (accounting for over 80 per cent of accidents involving five or more vehicles). The opposite trend is found for turning accidents, which account for 29 per cent of two vehicle accidents but less than 10 per cent of those involving five or more vehicles. Sixty four per cent of single vehicle accidents involve loss of control, with a further 21 per cent being vehicle drift type accidents.

Table 4.11 shows accident types by type of vehicle involved. It can be seen that 44 per cent of two-wheeled motor vehicle accidents involve loss of control, compared to 22 per cent of accidents involving cars and less than 16 per cent of those involving goods vehicles. Stacking accidents predominate amongst those involving cars or goods vehicles (ranging between 37 per cent and 44 per cent).

Table 4.11 Accident types by vehicles involved

Accident Type	TWMV	Car	Light goods	Heavy goods	ALL
Stacking	30	680	106	202	768
column %	(22.2)	**(37.0)**	**(43.6)**	**(38.6)**	(35.5)
Turning	26	337	44	101	372
column %	(19.3)	(18.4)	(18.1)	(19.3)	(17.2)
Lane Change	12	211	40	80	229
column %	(8.9)	(11.5)	(16.5)	(15.3)	(10.6)
Loss Of Control	60	410	34	83	544
column %	**(44.4)**	**(22.3)**	(14.0)	(15.9)	(25.1)
Vehicle Drift	4	158	14	34	193
column %	(3.0)	(8.6)	(5.8)	(6.5)	(8.9)
Other	3	39	5	23	59
column %	(2.2)	(2.1)	(2.1)	(4.4)	(2.7)
COLUMN TOTAL	135	1836	243	523	2165

4.5 Statistical analysis of drivers and vehicles – significant interactions

Some of the variables presented in Section 4.3 were subjected to log-linear modelling in order to focus the analysis only on significant interactions. The variables included in the modelling were location, age, gender, vehicle type and manoeuvre.

Differences between the totals which appear in the following tabulations and those appearing in the basic summaries are due to drivers of unknown age or gender being omitted from this section of work.

When modelling the five variables together, the following significant interactions were found:

- Age and gender of drivers/riders are related
- Vehicle driven depends on gender
- Vehicle driven depends on age
- Manoeuvre at time of accident depends on age
- Manoeuvre is related to vehicle driven
- Location is related to vehicle driven
- There is an interaction between gender, location and manoeuvre

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Summarising each in turn:

The relationship between age and gender is shown in Table 4.12. With 78 per cent of all drivers being male, it is clear from Table 4.12 that this proportion varies between the listed age groups. The proportion of drivers (involved in accidents on the dual carriageways being studied) that are male increases with age. A similar trend was found among the drivers involved in accidents on single carriageways. This may be a reflection of the distribution of the driving population on the routes considered.

Table 4.12 Age and gender of driver

Gender	Age 17–29 Count	column %	Age 30–59 Count	column %	Age 60+ Count	column %	Total Count	column %
Male	1116	*71*	1936	*81*	329	*86*	**3381**	***77.9***
Female	452	29	450	19	56	14	**958**	***22.1***
Total	**1568**		**2386**		**385**		**4339**	

Table 4.13 shows the association between driver gender and type of vehicle driven or ridden. Ninety six per cent of females were driving cars at the time of their accident compared to only 68 per cent of males. Once again, this is likely to be related to the pattern of vehicle use (Table 4.13). An association between driver gender and the type of vehicle being driven was also found in the single carriageway study.

Table 4.13 Vehicle driven by gender of driver

Vehicle	Male driver Count	column %	Female driver Count	column %	Total Count	column %
Two-wheeled motor vehicle	124	*3.7*	9	*0.9*	**133**	***3.1***
Car	2301	*68.0*	920	*96.0*	**3221**	***74.2***
Light goods vehicle	231	*6.8*	14	*1.5*	**245**	***5.6***
Heavy goods vehicle	604	*18.0*	3	*0.3*	**607**	***14.0***
Bus or minibus	37	*1.1*	1	*0.1*	**38**	***0.9***
Other	84	2.5	11	*1.1*	**95**	***2.2***
Total	**3381**		**958**		**4339**	

Differences in patterns of vehicle use may explain the differences, by age, in the type of vehicle being driven or ridden at the time of an accident – Table 4.14. In the 60 plus age group, the vehicle being driven in 83 per cent of instances was a car, compared with an average of 74% in the younger age groups. As seen in the single carriageway study, the highest proportion of two-wheeled motor vehicle riders is found in the 17 to 29 age group, whereas the majority of heavy goods vehicle drivers were aged between 30 and 59.

Table 4.14 Vehicle driven by age of driver

Vehicle	Driver age 17–29 Count	column %	Driver age 30–59 Count	column %	Driver age 60+ Count	column %	Total Count	column %
Two-wheeled motor vehicle	77	4.9	49	2.1	7	1.8	**133**	**3.1**
Car	1213	77.0	1687	71.0	321	83.0	**3221**	**74.2**
Light goods vehicle	97	6.2	137	5.7	11	2.9	**245**	**5.6**
Heavy goods vehicle	143	9.1	434	18	30	7.8	**607**	**14.0**
Other	38	2.4	79	3.3	16	4.2	**133**	**3.1**
Total	**1568**		**2386**		**385**		**4339**	

The association between manoeuvre at time of accident and driver age is mostly due to two types of manoeuvres (Table 4.15). As seen in the single carriageway study, drivers aged 60 or more once again experience difficulty in crossing carriageways or lanes. Twenty per cent of these drivers or riders were either turning right, turning left to cross the carriageway or U-turning at the time of their accident. For younger age groups, the comparative figure was less than four per cent (Table 4.15).

A clear pattern also emerges among those accidents involving the negotiation of a bend. The proportion of drivers carrying out this manoeuvre at the time of their accident reduces from 20 per cent of 17 to 29 year olds to nine per cent of those aged 60 or more.

Table 4.15 Manoeuvre by age

Manoeuvre	Age 17–29 Count	column %	Age 30–59 Count	column %	Age 60+ Count	column %	Total Count	column %
Turning right, turning left crossing carriageway or U-turning	56	3.6	82	3.4	77	20	**215**	**5.0**
Going ahead on a bend	314	20	377	16.0	35	9.1	**726**	**16.7**
Other	1198	76.0	1927	81.0	273	71.0	**3398**	**78.3**
Total	**1568**		**2386**		**385**		**4339**	

Further associations involving manoeuvre emerge when vehicle type is considered (Table 4.16). Clear differences exist between the manoeuvres being carried out by drivers of different vehicle types at the times of their accidents.

Summarising, 6.5 per cent of goods vehicles were parked at the time of their accident compared to just 1.7 per cent of other vehicles. Goods vehicles also feature prominently as the vehicle type most commonly changing lane to the right (7.3 per cent compared to 4.4 per cent for the remaining vehicle groups). This may be explained by these vehicles having an inherent visibility difficulty to their rear and sides. Of the 15 vehicles leaving a lay-by when an accident occurred, 11 were goods vehicles.

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Table 4.16 Manoeuvre by vehicle type

Manoeuvre	Other Count	col %	Two-wheeled motor vehicle Count	col %	Car Count	col %	LGV or HGV Count	col %	Total Count	col %
Parked	3	2.3	1	0.8	55	1.7	55	6.5	**114**	**2.6**
Waiting to go ahead	6	4.5	3	2.3	**447**	**13.9**	53	6.2	**509**	**11.7**
Stopping	4	3.0	9	6.8	**366**	**11.4**	68	8.0	**447**	**10.3**
Turning right	11	8.3	5	3.8	103	3.2	26	3.1	**145**	**3.3**
Changing lane to right	10	7.5	6	4.5	137	4.3	**62**	**7.3**	**215**	**5.0**
Going ahead – bend	19	14.3	**33**	**24.8**	532	16.5	142	16.7	**725**	**16.7**
Other	80	60.2	76	57.1	1581	49.1	446	52.3	**2184**	**50.3**
Total	**133**		**133**		**3221**		**852**		**4339**	

The proportion of cars waiting to go ahead or stopping when an accident occurred, was greater than for all other types of vehicles. Such manoeuvres suggest that queuing and shunt accidents are common among those accidents involving cars (Table 4.16).

For two-wheeled motor vehicles, nearly a quarter of their riders were negotiating a bend when an accident occurred; this suggests that excessive speed and loss of control are factors in their accidents.

The problems experienced by different vehicle types clearly vary according to location (Table 4.17). Two-wheeled vehicles (pedal cycles and two-wheeled motor vehicles) are at greater risk than other types of vehicle when they are negotiating a roundabout or traversing the entry or exit slips at grade separated slip road junctions. Nearly a quarter of pedal cycle accidents occurred at slip roads (Table 4.17).

Goods vehicles (both light and heavy goods) had proportionally more of their accidents at private accesses compared to all other vehicle types together. The proportion of 3.8 per cent, compared to 1.4 per cent for all other vehicle groups, may reflect different usage patterns for the private accesses opening on to the dual carriageways being examined. However, it may also be that the standard of access is inadequate for the vehicle mix using them – making their safe negotiation by goods vehicles more difficult.

Table 4.17 Location by vehicle type

Location	Pedal cycle (col %)	TWMV (col %)	Car (col %)	Light goods (col %)	Heavy goods (col %)	Other (col %)	Total
Link	48.9	52.6	63.2	61.2	67.1	54.7	**2732**
Roundabout	8.5	7.5	3.8	3.7	4.3	4.7	**175**
T- junction - no gap	10.6	11.3	7.6	9.4	9.7	10.5	**356**
T junction with gap or staggered	6.4	11.3	14.7	12.2	9.2	12.8	**589**
Grade separated slip road	23.4	15.0	9.4	9.4	6.1	14.0	**406**
Private access	2.1	2.3	1.3	4.1	3.6	3.5	**81**
Total number of vehicles	**47**	**133**	**3221**	**245**	**607**	**86**	**4339**

Accident types, drivers and vehicles involved

The three-way interaction which emerged between manoeuvre, driver gender and accident location is summarised in Table 4.18. For each location, only the significant manoeuvre-gender association is presented. All other manoeuvres for each location are collapsed into the 'other' category.

On the links, the significant association emerges when the 'parked' manoeuvre is compared for gender, against 'other' manoeuvres. The proportion of male drivers in parked vehicles (4.2 per cent) is three times that of female drivers. This difference is partly, but not completely, accounted for by the fact that goods vehicles are mostly driven by males, and are more likely to be parked at the time of their accident than other vehicles.

At roundabouts, the significant association is between gender and the proportion of vehicles waiting or stopping (Table 4.18). Over 60 per cent of the female drivers involved at accidents at roundabouts were undertaking these manoeuvres compared to just a third of male drivers. This association is correlated with, but not completely explained by, females mainly driving cars, with cars being more likely to be waiting or stopping at the time of their accident than other vehicles.

At T or staggered junctions served by a gap in the central reservation, the significant association is between gender and the turning right manoeuvre. The proportion of female drivers who were turning right at the time of an accident at these locations (28.4 per cent) is much greater than that of male drivers (16.5 per cent). Female drivers are clearly experiencing difficulty in crossing the two lanes of a dual carriageway when undertaking a right turn manoeuvre.

Table 4.18 Manoeuvre by gender by location

Manoeuvre on links	Male Count	Male column %	Female Count	Female column %	Total Count	Total column %
Parked	91	4.2	8	1.4	**99**	***3.6***
Other	2058	95.8	575	98.6	**2633**	***96.4***
Total	**2149**		**583**		**2732**	

Manoeuvre at roundabouts	Male Count	Male column %	Female Count	Female column %	Total Count	Total column %
Waiting	28	19.9	12	35.3	**40**	***22.9***
Stopping	19	13.5	9	26.5	**28**	***16.0***
Other	94	66.7	13	38.2	**107**	***61.2***
Total	**141**		**34**		**175**	

Manoeuvre at T junction with gap or staggered	Male Count	Male column %	Female Count	Female column %	Total Count	Total column %
Turning right	75	16.5	38	28.4	**113**	***19.2***
Other	380	83.5	96	71.6	**476**	***80.8***
Total	**455**		**134**		**589**	

4.6 Summary

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

- 4546 vehicles were involved in the 2166 accidents studied; 30% of the accidents involved only a single vehicle.
- There is a higher representation of heavy goods vehicles in dual carriageway accidents than in single carriageway accidents, but they also form a higher proportion of the traffic flow.
- Single vehicle accidents are most likely to involve a private car, but two-wheeled motor vehicles and heavy goods vehicles are also well represented. In particular there is a high two-wheeled motor vehicle involvement on the Parkways Group. The representation of vehicles varies between the route groups.
- Two vehicle accidents are most likely to involve two cars, but the other vehicle combinations vary between the three route Groups.
- Seventy eight per cent of drivers involved in accidents on the dual carriageways studied were male; a similar proportion was found for single carriageways. However, the proportions of male and female drivers varied between the dual carriageway route groups, with female representation being highest on the Parkways Group which functions as an urban distributor network.
- Fewer younger (17-29) drivers and more middle aged (30-59) drivers were involved in accidents on dual carriageways than was found for single carriageways. The proportions of elderly (60+) drivers were similar. There was, however, some marked variation between the route groups.
- "Waiting " or "stopping" accidents were more common and turning accidents less common on the dual carriageways studied than was the case for single carriageways. However the more limited junctions and turning opportunities on dual carriageways may account for some of this effect as well as the differences in manoeuvres observed between the dual carriageway groups.
- Associations between driver age and manoeuvre were found. As was found in the single carriageway study, older (60+) drivers are more involved in accidents when turning right or crossing the carriageway (mainly on the evidence of data from the A1 Group). Younger drivers are more likely to be involved in an accident when negotiating a bend. This effect diminishes with increasing age.
- An association between vehicle type and manoeuvre was found. Cars are more likely to be stopping or waiting at the time of their accident than other vehicles, and motor cycles are more likely to be involved in accidents when negotiating a bend. Goods vehicles are more likely than other vehicles to be either parked or changing lanes at the time of their accident.
- An association between vehicle type and accident location was found. Two-wheeled vehicles were disproportionately represented in accidents at roundabouts or passing the merging and diverging lanes at grade separated junctions.
- On links, the proportion of male drivers whose vehicle was parked at the time of the accident was three times as great as that for females.
- At roundabouts, proportionately more female drivers had their accidents whilst waiting or stopping than males.
- At T or staggered junctions with a central reserve gap (mainly on the A1 Group), the proportion of female drivers who were turning right at the time of their accident was almost twice that of males.

Chapter 5 What the drivers said

In the traffic accident report on single carriageway 'A' class roads (Hughes and Amis 1996), the input of drivers was obtained via a postal questionnaire. A similar exercise was carried out for the drivers of vehicles involved in accidents on dual carriageway 'A' class roads in the county. Postal questionnaires were sent to drivers who had been involved in accidents on the eight sections of dual carriageway during 1994 and 1995. The exercise was carried out at the same time of year as the single carriageway survey.

The aims of the driver questionnaire were three-fold:

- To gain some insight into the general driving habits of drivers
- To obtain their opinion of the circumstances surrounding, and the factors which they considered had contributed to, their accident
- To gain a measure of their perception of various driving tasks for comparison with population involvement

The Transport Research Laboratory (TRL) were commissioned to help with devising the questionnaire and with the administration of the survey.

Greater accident numbers were available for the dual carriageway driver survey (545 accidents) compared to the single carriageway survey (217 accidents). A total of 1203 individuals qualified for inclusion in the present survey compared with 495 drivers for the single carriageway survey. Their distribution among the different road users was as follows:

1179	Vehicle Drivers
12	Pedal Cyclists
12	Pedestrians

In all, a total of 1000 drivers were sent a questionnaire.

In order to avoid confusion within the main body of this chapter, the responses to the questionnaire have been placed in Appendix B where the answers received to each question are presented in the sequence in which they appeared in the questionnaire.

5.1 Those sent a questionnaire

Two hundred and three individuals who had accidents during 1994 and 1995 on the dual carriageways being examined were excluded from the survey. As we were primarily interested in the drivers and riders of motorised vehicles, no pedestrians or pedal cyclists were approached. Foreign drivers were also omitted. Other drivers who could not be approached included those who did not stop at the scene of the accident, either as a result of *'hit and run'* or as a *'non-stop vehicle – not hit'*. Others did not pass the criteria set out in the protocols which had been agreed with Cambridgeshire Constabulary – Appendix C. No driver was approached who had been involved in a fatal accident. The 'unavailable files' consisted of those which had not cleared the court system, and those where a criminal act had taken place. Some of this category also consisted of files which had been destroyed before access had been requested.

In all, 17 per cent of the whole sample were not approached (Table 5.1).

Table 5.1
Postal questionnaire: by response

	Frequency	Percentage of all %	Percentage of approached %
Respondents			
Returned	468	38.9	46.8
Sub-total	**468**	**38.9**	**46.8**
Non-respondents			
Not-returned	466	38.7	46.6
No contact	50	4.2	5.0
Refusal	16	1.3	1.6
Sub-total	**532**	**44.2**	**53.2**
Not approached			
Pedestrians	12	1.0	–
Pedal Cyclists	8	0.7	–
Did not stop	37	3.1	–
Drivers in fatal accidents	61	5.1	–
Foreign drivers	13	1.1	–
Files unavailable	72	6.0	–
Sub-total	**203**	**16.9**	–
TOTAL	**1203**	**100.0**	**100.0**

Of the 1000 people who were approached, 47 per cent returned their questionnaire.

Throughout the remainder of this chapter, "drivers" include those individuals riding two-wheeled motor vehicles.

5.2 Returned questionnaires

In order to establish how representative the 468 drivers who returned their questionnaires were of the *'approached'* driver sample (made up of respondents and non-respondents), significance tests were undertaken in order to assess any differences.

5.2.1 Age

A significant difference (at the five per cent level) exists between the age distribution of the 'respondent' driver sample and the age distribution of the 'non-respondent' driver sample. Younger drivers (aged 17 to 29) are under-represented in the respondent sample and older divers (aged 60 or more) over-represented (Table 5.2).

Table 5.2
Postal questionnaire: – response by age

Age	Approached Drivers	
	Respondent (%)	Non-respondent (%)
17–29	24.6	35.3
30–39	21.8	27.8
40–49	23.7	18.7
50–59	17.9	12.5
60 or over	12.0	5.6
TOTAL	**468**	**518**
Age unknown		*14*

5.2.2 Gender

Nearly 29 per cent of the drivers who returned their questionnaires were female – Table 5.3. The overall gender distribution is not significantly different from that of drivers in the 'non-respondent' sample.

Table 5.3
Postal questionnaire: – response by gender

Sex	Approached Drivers	
	Respondent (%)	Non-respondent (%)
Male	71.2	74.8
Female	28.8	25.2
TOTAL	**468**	**523**
Gender unknown		9

5.2.3 Other comparisons

Comparison between the respondent driver sample and the 'non-respondent' driver sample was also made for vehicle type and accident location. Significant differences emerged between the three driver samples when compared with type of vehicle being driven or ridden. Car drivers are over-represented in the 'respondent' driver sample at the expense of heavy goods and light goods vehicle drivers. No significant differences emerged between the three driver samples when compared for location.

A complete response from all the drivers involved in an accident was only received for 98 accidents (18 per cent) – Table 5.4.

Table 5.4
Completeness of driver responses for accidents

Response	**Number**	**Percentage**
Complete	98	18.0
Partially complete	217	39.8
No response	230	42.2
Accident total	**545**	**100.0**

5.3 Personal Details

Questions 52 to 55

5.3.1 Marital and family status

Just under 63 per cent of the drivers who responded to the questionnaire stated that they were married, with a further four per cent living as married. Twenty one per cent of the drivers were single. All these figures differ significantly from the marital status profile which emerged for the drivers involved in single carriageway accidents (Hughes and Amis 1996). The corresponding figures were 55 per cent, eight per cent and 29 per cent respectively. A child was present in 34 per cent of households. The highest proportion of children was found in the households of married drivers (47 per cent).

5.3.2 Profession

The majority of drivers (29 per cent) were employed in the 'junior managerial, administrative, or professional; supervisory and clerical' employment group – Table 5.5. The combined employment groups of 'professional' and 'senior managerial' accounted for a further 21 per cent of drivers. Twelve per cent of the driver sample were retired. *No direct comparison was made with the single carriageway sample, as the question had been changed for the dual carriageway study.*

Table 5.5 Employment groups of drivers

Employment Group	Percentage	Number
Professional	2.3	10
Senior managerial/administrative	18.9	83
Junior managerial, administrative, or professional; supervisory and clerical	29.5	130
Skilled manual	22.3	98
Semi-skilled or unskilled manual	8.0	35
Student, looking after home/family, unemployed	6.8	30
Retired	12.2	54
Total	**100.0**	**440**

Question not completed by 23 drivers

5.4 Driving habits and experience

In the sub-sections which follow, the driving habits and experience of the individuals who returned their questionnaires are examined by vehicle type, age and gender of drivers *(Questions 38 to 49)*. A comparison is also made with the single carriageway study. Due to the limited number of individuals involved, vehicle types are collapsed into cars, heavy goods vehicles and others (inclusive of motor cycles, buses, light goods vehicles and "other" motor vehicles).

From the summary table which follows, it is clear that females were predominantly car drivers. Only one female was driving a heavy goods vehicle, and only two were driving other vehicles (Table 5.6). Comparisons between male and female drivers in the following sections are restricted to cars. Heavy goods vehicle, light goods vehicle and "other" vehicle drivers are compared against car drivers for males only. It can be seen that heavy goods vehicle drivers are strongly biased towards the 30 to 59 age group (Table 5.7).

Table 5.6 Vehicle driven in accident by gender

Vehicle type	Gender		Total
	Male (row %)	Female (row %)	
Cars	65.6	34.4	384
Heavy Goods	97.8	2.2	45
Other	94.9	5.1	39
Column Total	**333**	**135**	**468**

Table 5.7 Vehicle driven in accident by age – male drivers only

Vehicle type	Driver age			Total
	17–29 (row %)	30–59 (row %)	60 + (row %)	
Cars	19.8	62.7	17.5	252
Heavy Goods	15.9	79.5	4.5	44
Other	35.1	62.2	2.7	37
Column Total	**70**	**216**	**47**	**333**

What the drivers said

5.4.1 Driving history

Only three of the drivers who returned their questionnaire (one per cent) did not hold a full driving licence when their accident occurred *(Question 39)*. The remaining drivers had held their full licences for a range of years: 95 per cent had held their licences for longer than two years while more than half had held their licences for longer than 16 years *(Question 40)*.

When the period for which driving licences had been held is considered alongside the fact that 99 per cent drove on a daily, or near daily basis, it is clear that most of the drivers were very experienced *(Question 42)*. These observations are similar to those found for the drivers involved in single carriageway accidents (Hughes and Amis, 1996).

Most frequent trip lengths

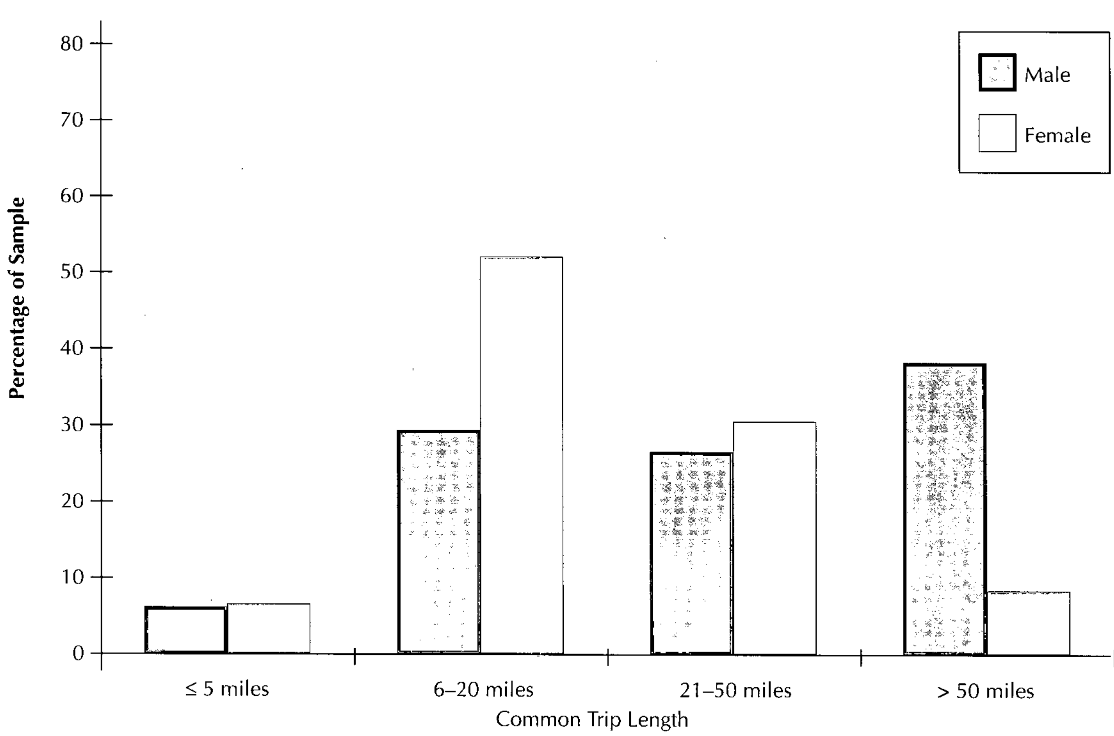
For 94 per cent of drivers, their most frequent trip length was in excess of five miles.

The distribution of most frequent trip length varied between the route groups. Drivers who had accidents on the Parkways Group of routes tended, on average, to have shorter common journey lengths than those whose accidents occurred on the other routes. Respondents having accidents on the A1 comprised the highest proportion of drivers stating that their most common length of journey was in excess of 50 miles (38% compared with 29% on the A14 and 11% on the Parkways).

Table 5.8 Most frequent trip length by route on which accident happened

Group	Most frequent trip length (miles) ≤5 (row %)	6–20 (row %)	21–50 (row %)	>50 (row %)
Parkways	9	54	26	11
A1	8	32	23	38
A14	5	35	31	29
Total	7	37	28	29

Figure 5.1 Most frequent trip lengths in cars by gender



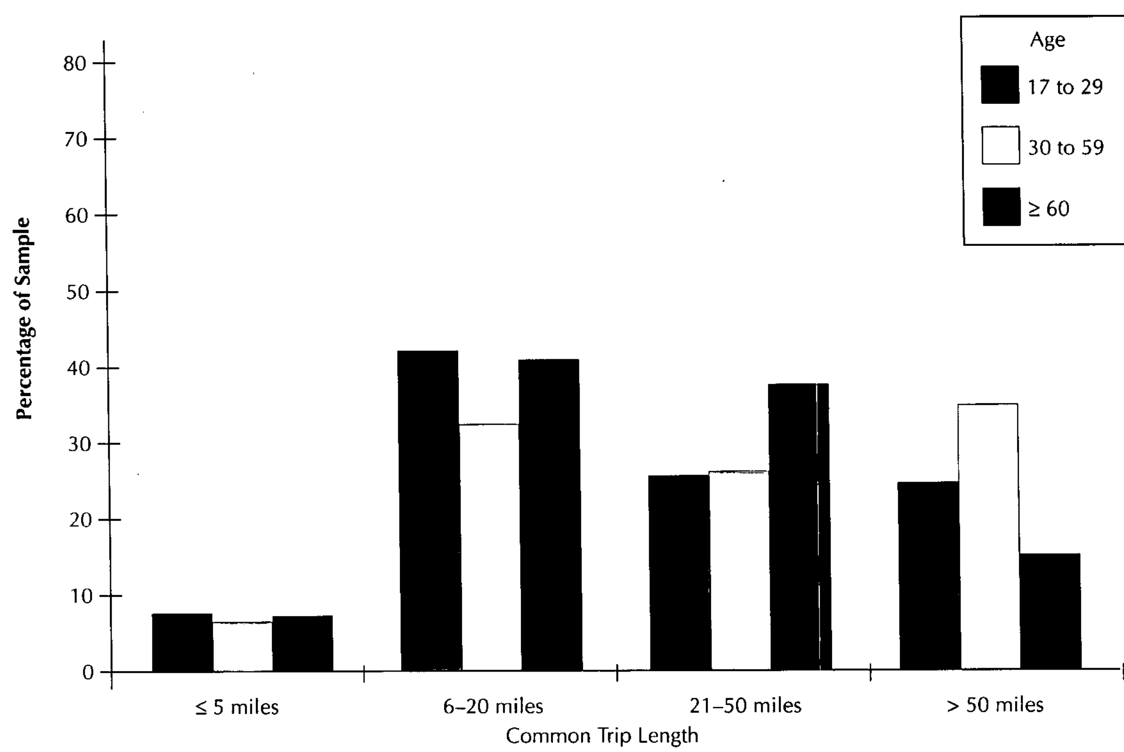
Clear differences emerge when the most frequent trip lengths of car drivers are compared for age and gender *(Question 43)*. Females generally drove shorter trip lengths than males (Figure 5.1). Over half the journeys made by females were between six and 20 miles – this compares with 30 per cent for males. Over a third of journeys made by males were in excess of 50 miles, compared to 10 per cent for females.

Comparing the most frequent trip lengths made by male drivers in the three vehicle groups reveals a significant difference between heavy goods vehicles and the two other groups (Table 5.9). The most common trip length of male car and "other" vehicle drivers is between 21 and 50 miles, whereas 98 per cent of male heavy goods vehicle drivers commonly travelled in excess of 50 miles on each trip (Table 5.9).

Table 5.9 Most frequent trip lengths for male drivers – by vehicle type

Vehicle type	Most frequent trip length				Total
	≤5 miles (row %)	6–20 miles (row %)	21–50 miles (row %)	>50 miles (row %)	
Car	7.7	34.4	32.0	25.9	247
Heavy goods	–	2.3	–	97.7	43
Other	5.7	31.4	20.0	42.9	121
Column Total	21	97	86	121	325

Figure 5.2 Most frequent trip lengths in cars by age



Less than 15 per cent of drivers aged 60 or more commonly made trips in excess of 50 miles; 78 per cent of their trips were between six and 50 miles in length. For drivers in the intermediate age group, more than a third of journeys were in excess of 50 miles.

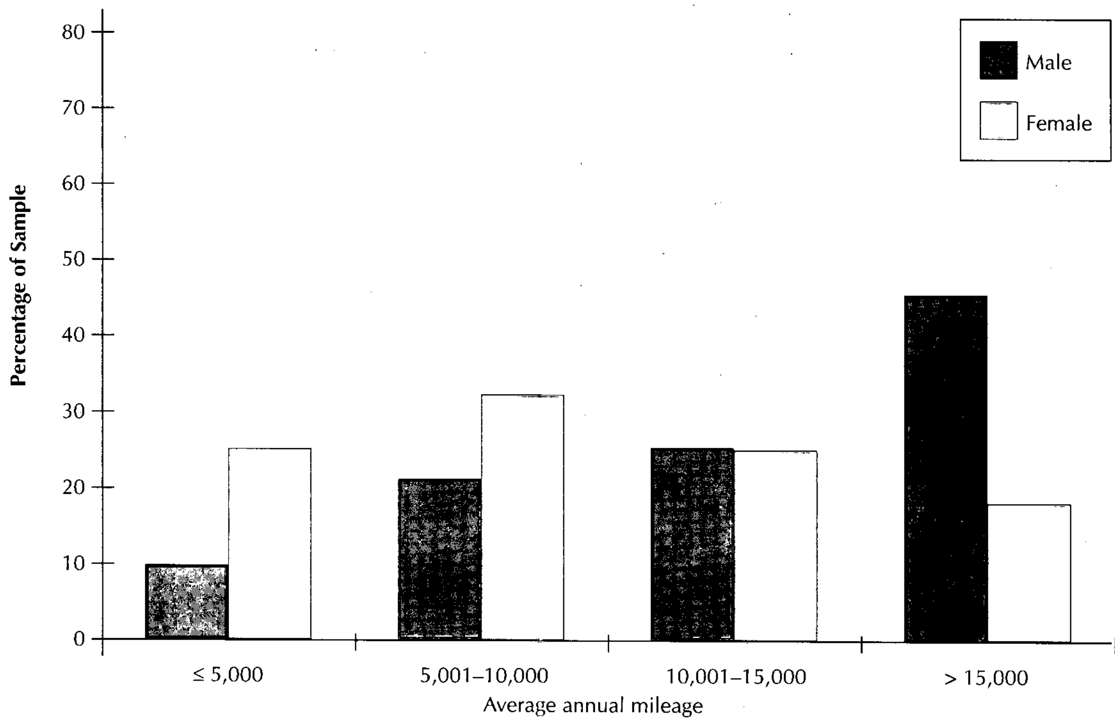
Average annual mileage

The notion that the drivers involved in the accidents were experienced is further supported when their stated annual average mileage is examined *(Question 41)*. Eighty five per cent recorded annual mileage in excess of 5,000 miles, while 41 per cent of the sample drove in excess of 15,000 miles annually.

What the drivers said

Significant differences emerge when the stated annual mileages are compared for age and gender. It generally followed that males recorded greater average annual mileages than females (Figure 5.3). Forty four per cent of males travelled in excess of 15,000 miles annually; the equivalent proportion for females was 19 per cent. More than half of all the female drivers who responded drove less than 10,000 miles each year.

Figure 5.3 Average annual mileage of car drivers by gender



Among male heavy goods vehicle drivers, more than 90 per cent travelled in excess of 15,000 miles annually (Table 5.10), compared with 44% of car drivers.

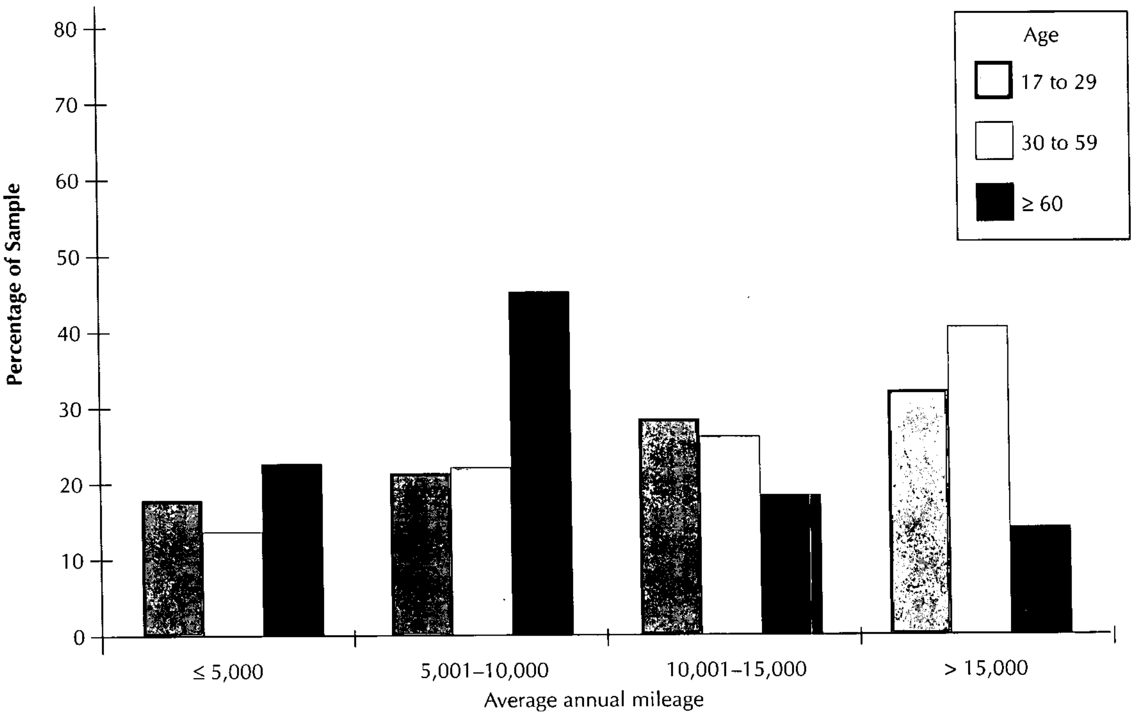
Table 5.10 Average annual mileage among drivers of vehicles – males only

Vehicle type	Average annual mileage ≤5,000 miles (row %)	5,001–10,000 miles (row %)	10,001–15,000 miles (row %)	>15,000 miles (row %)	Total
Car	10.2	21.1	24.8	43.9	246
Heavy goods	4.8	2.4	2.4	90.5	42
Other	22.9	14.3	20.0	42.9	35
Column Total	35	58	69	161	323

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

When annual average mileage was compared for age of car driver it emerged that drivers aged 60 or more drove lower annual mileages than other age groups (Figure 5.4). Two thirds of drivers in this age group travelled less than 10,000 miles in an average year. In the 30 to 59 age group, 95 of the drivers (41 per cent) stated that they travelled in excess of 15,000 miles in an average year. The comparable proportions for drivers aged between 17 and 29, and aged 60 or more, were 32 per cent and 14 per cent respectively.

Figure 5.4 Average annual mileage of car drivers by age



5.4.2 Driving habits

In *Questions 44* and *45* of the questionnaire, drivers were asked to estimate, to the nearest five per cent, the proportion of their average annual driving time they spent driving:

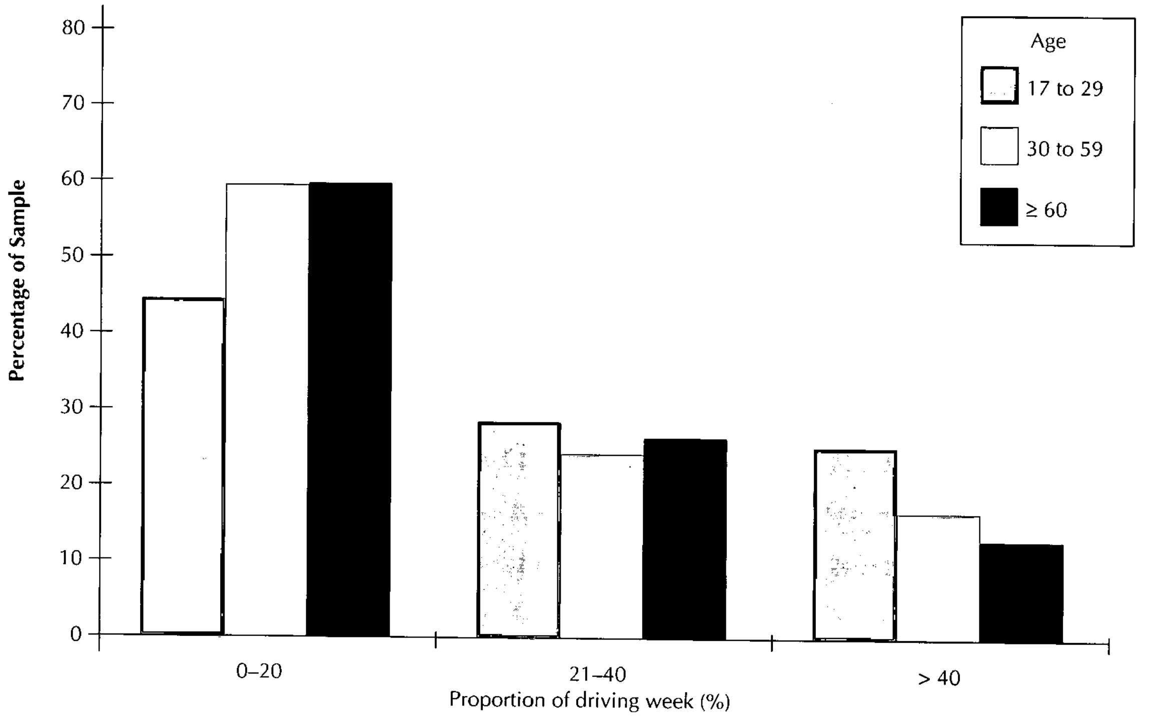
- At weekends
- In darkness
- In the morning and evening peak hours
- On rural roads (speed limit greater than 40 miles/h)

The information provided was collated into one of three groupings: 0 to 20 per cent, 21 to 40 per cent and greater than 41 per cent. The latter category needed to be this large in order to achieve a meaningful cell count for analysis.

At weekends

Only 19 per cent of car drivers stated that they spent more than 40 per cent of their driving time travelling at the weekend. This did not vary significantly by age (Figure 5.5) or gender of car driver. As found in the single carriageway study, drivers aged 60 or more do not restrict their driving to the weekends any more than other age groups.

Figure 5.5
Proportion of driving time spent driving at weekends by age of car drivers



With most heavy goods vehicles being operated on a commercial basis, they mainly work on weekdays when businesses are open for deliveries. It is therefore not surprising that 81 per cent of the male heavy goods vehicle drivers spent less that 20 per cent of their driving time on the roads at weekends (Table 5.11).

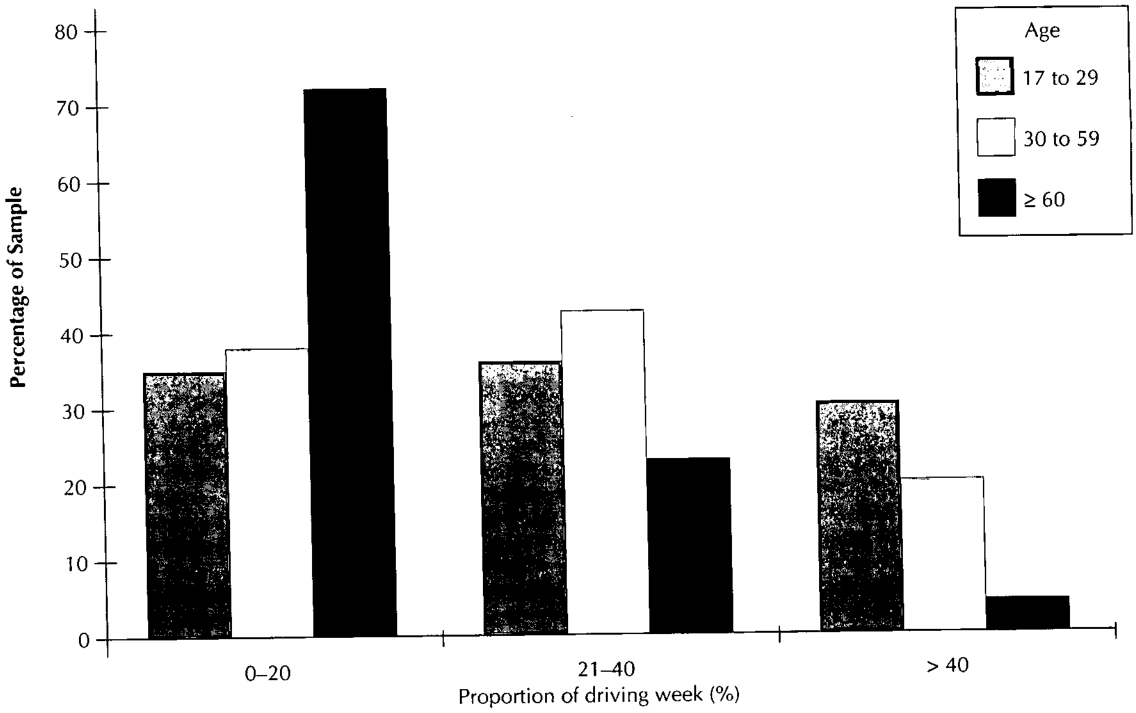
Table 5.11
Proportion of driving week spent driving at weekends – males only

Vehicle type	Proportion of driving time spent driving at weekends			Total
	0–20% (row %)	21–40% (row %)	>40% (row %)	
Car	54.4	26.2	19.4	248
Heavy goods	81.0	16.7	2.4	42
Other	61.1	13.9	25.0	36
Column Total	191	77	58	326

During the hours of darkness

The majority of car drivers (80 per cent) spent less than 41 per cent of their driving time driving during the hours of darkness.

Figure 5.6
Proportion of driving time spent driving in darkness by age



When driving in darkness was examined by age of driver, a significant difference became apparent. Over 73 per cent of car drivers aged 60 or more spent less than 21 per cent of their driving time travelling during the hours of darkness (Figure 5.6). This contrasts with less than 40 per cent in the younger car driver age groups.

No significant difference emerged, between male car, heavy goods and "other" vehicle drivers in the time spent driving during the hours of darkness (Table 5.12).

Table 5.12
Proportion of time spent driving in darkness – males only

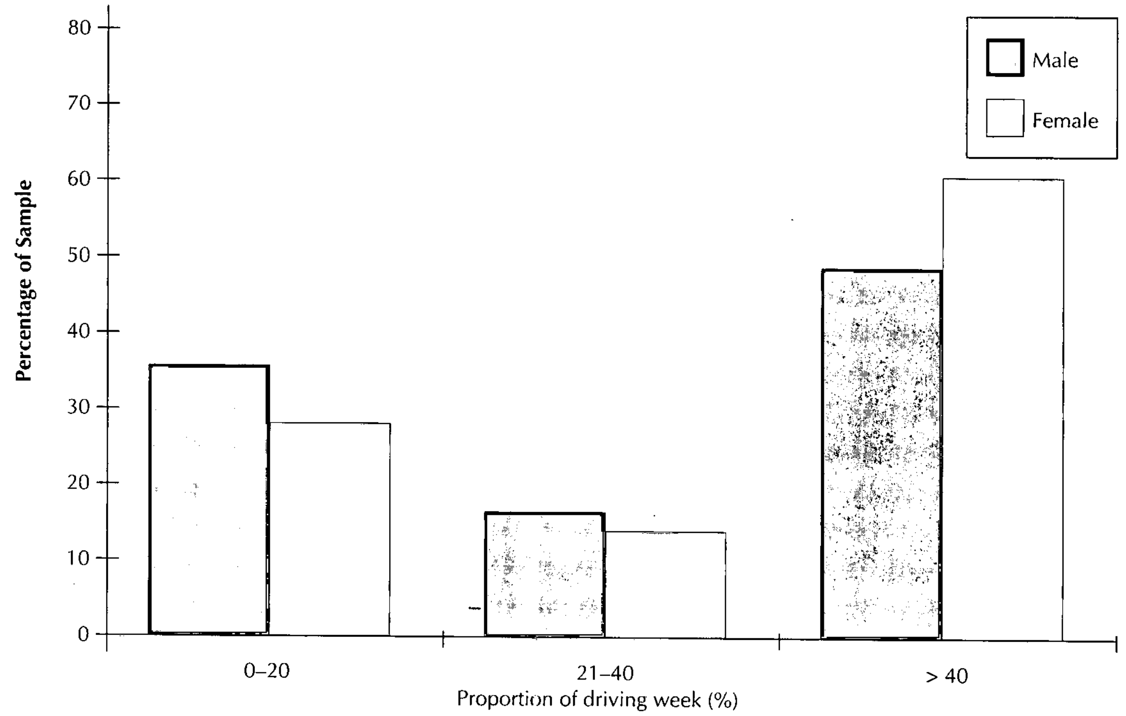
Vehicle type	Proportion of driving time spent driving in darkness			Total
	0–20% (row %)	21–40% (row %)	>40% (row %)	
Car	40.3	41.1	18.5	248
Heavy goods	38.1	35.7	26.2	42
Other	44.4	36.1	19.4	36
Column total	132	130	64	326

During the rush hour period

Just over 50 per cent of car drivers stated that they spent more than 40 per cent of their annual driving time travelling during the morning and evening rush hours.

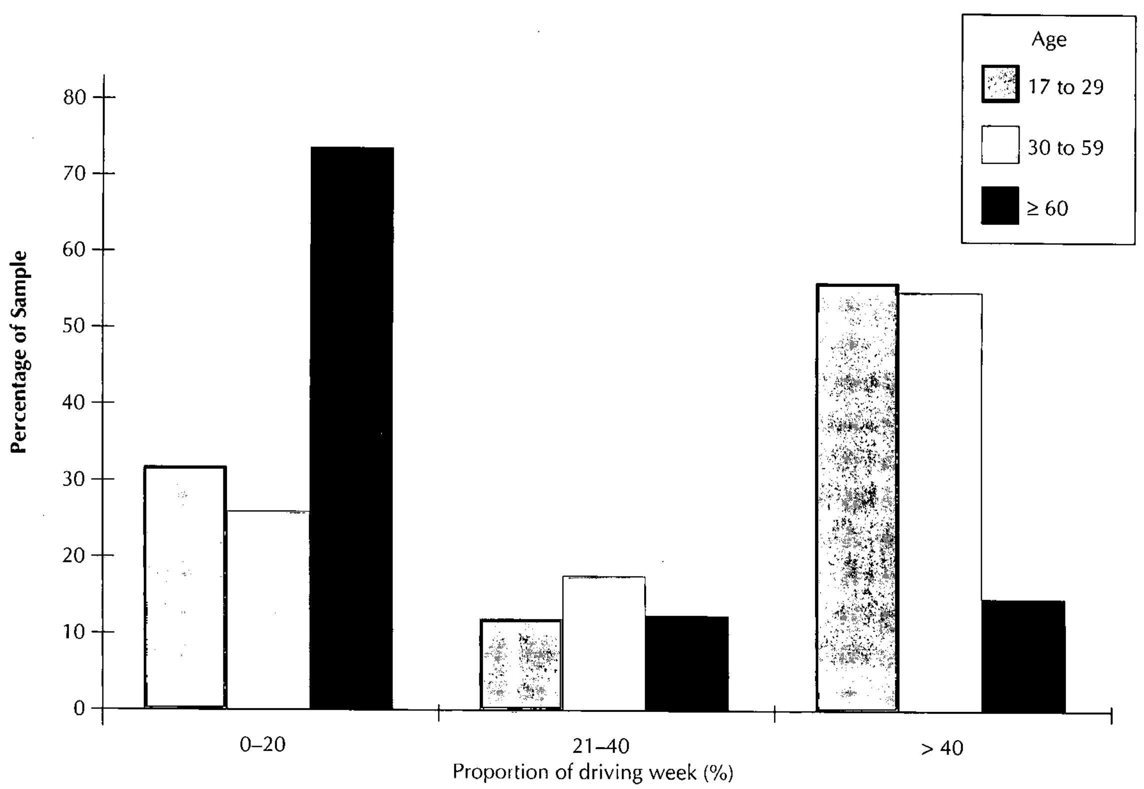
The distribution of time spent driving in peak hours (Figure 5.7) is similar for male and female car drivers.

Figure 5.7 Proportion of driving time spent driving in the peak hours by gender of car driver



The response was found to be significantly dependent on the age of the car driver (Figure 5.8). Nearly 80 per cent of car drivers aged 60 or more spent less than 20 per cent of their driving time travelling during the rush hour periods. This contrasts sharply with drivers aged less than 60, more than half of whom stated that over 40 per cent of their driving time was taken up in the rush hour periods.

Figure 5.8 Proportion of driving time spent driving in the peak hours by age



Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

No significant difference emerged, between male car, heavy goods and other vehicle drivers, in the proportion of driving time spent driving during the peak hours (Table 5.13).

Table 5.13 Proportion of time spent driving in peak hours – males only

Vehicle type	Proportion of driving time spent driving in peak hours			Total
	0–20% (row %)	21–40% (row %)	>40% (row %)	
Car	36.1	15.7	48.2	249
Heavy goods	35.7	28.6	35.7	42
Other	30.6	22.2	47.2	36
Column Total	116	59	152	327

Time spent travelling on rural roads

No significant difference emerged between male and female car drivers when asked to state what proportion of their driving time they spent on rural roads. Nearly 36 per cent stated that they spent more than 40 per cent of their driving time on rural roads, with 76 per cent having a driving exposure in excess of 20 per cent. These drivers were familiar with driving on rural roads.

When compared for age of car driver, no significant difference was apparent.

Previous accidents and offences

Nearly 28 per cent of the drivers had been involved in another accident in the previous five years. Two drivers had been involved in more than three accidents *(Question 46)*.

In terms of motoring offences, 15 per cent of the sample had been prosecuted for 'speeding', with 13 drivers being prosecuted for 'careless or inconsiderate driving' *(Question 48)*. Three had been prosecuted for 'drink driving' offences.

5.4.3 Driving tasks

Question 49 of the questionnaire asked drivers to rate, in terms of difficulty, how they perceived a number of driving tasks. The five point rating scale ranged from "very hard" through to "very easy", with intermediate levels of "hard", "ok" and "easy". As with the single carriageway questionnaire, due to the small numbers who felt that they found tasks either hard or very hard, the data are summarised in terms of the proportion of drivers who rated each task as either easy or very easy.

Simple logistic regression models were used to determine the relationships between age, gender and the proportion of drivers rating a task as either easy or very easy. Drivers who did not answer a question were excluded from the analysis of that question.

What the drivers said

Table 5.14* *Percentage of drivers rating tasks as either 'easy' or 'very easy' – by age (Differences in proportions, between age groups, significant at the five per cent level are in **bold**)

Driving tasks	Dual carriageway				Single
	Age 17–29	Age 30–59	Age 60+	ALL	ALL
General Driving					
Judging speed in darkness	32%	29%	21%	29%	27%
Judging distance in darkness	33%	30%	21%	30%	28%
Darkness driving in general	45%	49%	33%	46%	46%
Judging speed in daylight	61%	62%	62%	62%	64%
Driving on single carriageway roads	**73%**	**61%**	**57%**	64%	*
Judging distance in daylight	67%	67%	57%	66%	70%
Driving on dual carriageway roads	71%	67%	63%	67%	*
Daylight driving in general	**83%**	**76%**	**62%**	76%	76%
Dual Carriageway Driving					
Turning right at junctions	45%	48%	45%	47%	62%
Leaving a lay by	32%	42%	45%	40%	*
Joining main road from slip road	**48%**	**55%**	**37%**	51%	57%
Allowing a vehicle onto main road from a slip road	57%	58%	41%	56%	63%
Overtaking	62%	59%	46%	58%	51%
Negotiating a roundabout	66%	63%	48%	60%	67%
Changing lanes to right	**67%**	**63%**	**47%**	62%	*
Changing lanes to left	**69%**	**64%**	**43%**	63%	*
Entering a lay by	63%	64%	62%	64%	*
Turning left at junctions	75%	72%	65%	72%	70%
Leaving a main road by slip road	78%	73%	65%	73%	*

*No equivalent question
Single carriageway study driving tasks compared with "dual carriageway driving ". "General driving" tasks were not specific to the type of road.

Of all the tasks, judging speed and distance in darkness were, on average, rated as least easy by all age groups (Table 5.14). Turning right at junctions and leaving a lay-by were rated as the least easy dual carriageway driving tasks. It is interesting to note that when dual and single carriageway studies are compared, turning right at junctions was rated as less easy on dual carriageways (62 per cent compared with 47 per cent). Other tasks were rated similarly on dual and single carriageways.

There are significant differences, between age groups, in the rating of driving on single carriageway roads and daylight driving in general. In both cases, the proportion finding the tasks easy or very easy decreases with age. Apart from judging speed in daylight, the other general tasks were all rated as less easy by older drivers, although the differences are not statistically significant.

In terms of significant differences in the rating of specific dual carriageway driving tasks, lane changing and joining the main road from a slip road were all rated as less easy by the 60 plus age group than by younger drivers (Table 5.14).

When considered in terms of a comparison between only two groups – drivers aged under 60 and those aged 60 and over – two further differences are statistically significant, with older drivers finding negotiating a roundabout and allowing a vehicle onto the main road from a slip road less easy than their younger counterparts.

Females found driving on dual carriageways and changing lane to the right significantly less easy than males (Table 5.15).

Table 5.15 Percentage of drivers rating tasks as either 'easy' or 'very easy' – by gender (Differences in proportions, between males and females, significant at the five per cent level are in **bold**)

Driving task	Dual carriageway			Single ALL
	Male	Female	ALL	
General Driving				
Judging speed in darkness	30%	26%	29%	27%
Judging distance in darkness	32%	26%	30%	28%
Darkness driving in general	49%	40%	46%	46%
Judging speed in daylight	64%	56%	62%	64%
Driving on single carriageway roads	63%	66%	64%	*
Judging distance in daylight	66%	65%	66%	70%
Driving on dual carriageway roads	**70%**	**60%**	67%	*
Daylight driving in general	77%	75%	76%	76%
Dual Carriageway Driving				
Leaving a lay by	40%	41%	40%	*
Turning right at junctions	46%	49%	47%	62%
Joining main road from slip road	52%	49%	51%	57%
Allowing a vehicle onto main road from a slip road	56%	56%	56%	63%
Overtaking	60%	54%	58%	51%
Negotiating a roundabout	61%	64%	60%	67%
Changing lanes to right	**65%**	**55%**	62%	*
Changing lanes to left	63%	62%	63%	*
Entering a lay by	66%	57%	64%	*
Turning left at junctions	73%	70%	72%	70%
Leaving a main road by slip road	75%	69%	73%	*

*No equivalent question
Single carriageway study driving tasks compared with "dual carriageway driving ". "General driving" tasks were not specific to the type of road.

5.4.4 Relationship between accident involvement and perception

Previous analysis of the accident data in Chapter 4 showed that, on the dual carriageway roads considered, the proportion of drivers aged 60 and over who were turning right at the time of their accident was more than five times as great as for those aged under 60. It is noticeable that there is no difference, between age groups, in the difficulty rating given to the task of turning right at junctions on dual carriageways. As was found in the analysis of accidents on single carriageway roads, the older drivers are, on average, failing to recognise that turning right is more of a problem for them than for other drivers.

In the analysis of the dual carriageway accident data, a trend was also found, with age, in the proportion of drivers negotiating a bend at the time of their accident (ranging from 20 per cent for 17 to 29 year olds to nine per cent for those aged 60 or more). There was no specific question relating to the perceived difficulty of negotiating a bend, so a comparison of the type applied to the turning right manoeuvre cannot be made. However, the fact that there was no significant difference, between age groups, in the rating given to the general questions on judging speed and distance, again suggests a lack of awareness by younger drivers that this could be a particular problem for them.

On average, younger drivers have the highest casualty rates per kilometre travelled. The fact that drivers in this age group do not rate driving tasks as more difficult than their older counterparts also, perhaps, indicates a lack of awareness of their higher risk.

What the drivers said

5.5 The accident

In Section 1 of the postal questionnaire, drivers were asked to recount their whereabouts and movements in the period leading up to their accident, and to recollect their feelings at the time and the factors which, in their opinion, contributed to their accident. The answers to these questions are presented in the following sub-sections.

5.5.1 Vehicle characteristics and familiarity

Most of the respondents were driving a car when they were involved in their accident (80 per cent), followed by heavy goods vehicles (nine per cent) and light goods vehicles (five per cent). Less than three per cent of respondents were riding a two-wheeled motor vehicle *(Question 17).*

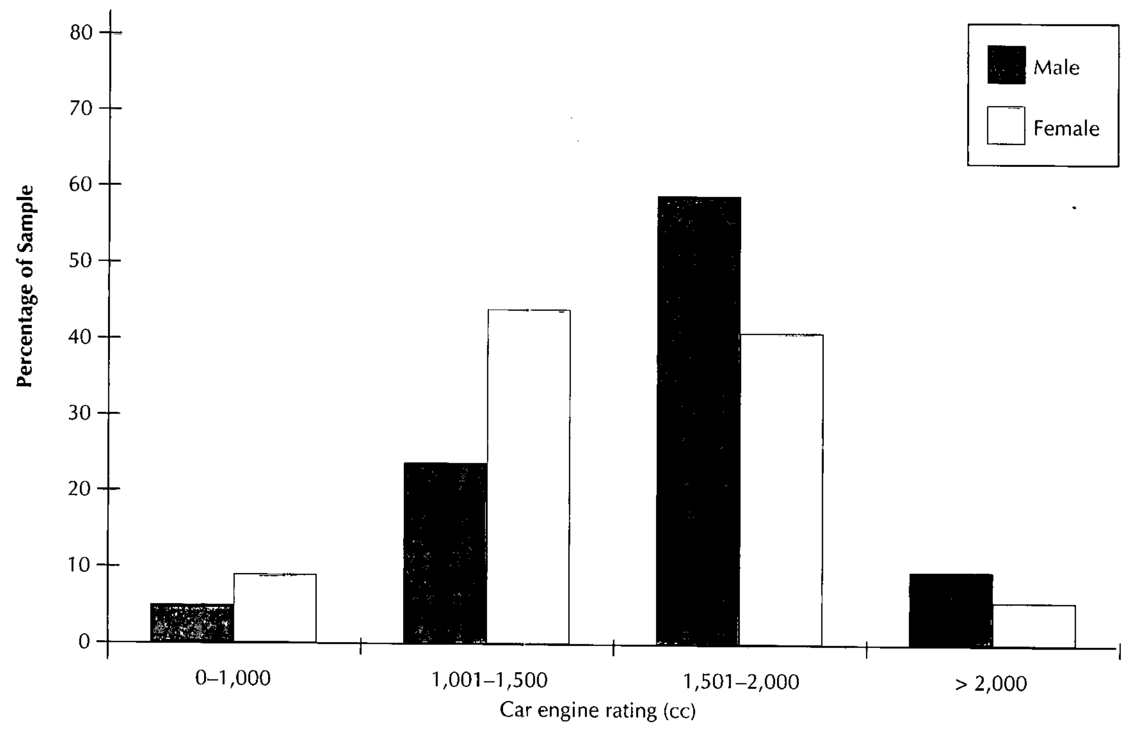
In 91 per cent of cases, the vehicle being driven or ridden on the day of the accident was the vehicle normally driven (Question 12).

Vehicle engine specification

Though engine size varied within each vehicle group, it was only recorded for cars and motor cycles. All the heavy goods vehicles being driven at the time of their accident were powered by engines in excess of 2,000 cubic capacity. Only one of the twelve two-wheeled motor vehicles had an engine greater than 1,000 cubic capacity.

An examination of the relationship between car engine size and gender revealed that females generally drove smaller engined cars than males (Figure 5.9).

Figure 5.9 Engine specification of cars by gender of driver



5.5.2 The journey

Ninety eight per cent of the heavy goods vehicle drivers who responded to the questionnaire were on a journey related to business or job-related work *(Question 6).* This compares with just 41 per cent of car drivers (Table 5.16). Most of the car drivers were on non-business/work related journeys when their accidents occurred.

Table 5.16
Purpose of journey

Journey purpose	Vehicle type			ALL (column %)
	Car (column %)	Heavy Goods (column %)	Other (column %)	
Business or as part of work	15.5	89.1	23.7	25.6
Travelling to / from place of work / study	26.2	8.7	50.0	24.3
Other social/domestic reason / other	28.1	2.2	18.4	22.6
Visiting friends	18.6	–	5.3	15.7
Travelling or going on holiday	7.6	–	–	6.2
Shopping / School-related	3.9	–	2.6	3.5
TOTAL number of drivers	**381**	**46**	**38**	**465**

Over half the respondents stated that they were unaccompanied on their journey *(Question 7– 54* per cent). Where passengers were present, 23 per cent were members of the driver's own family. At least one child was present in 14 per cent of vehicles, and a friend or friends in nine per cent of vehicles. Despite nearly half the journeys being stated as business or work-related, less than five per cent of drivers were accompanied by a work colleague.

The road on which the accident occurred

Only eight per cent of drivers had never travelled the dual carriageway route on which they had their accident before *(Question 3).* Ninety two per cent were familiar with the road. These proportions are similar to those found in the single carriageway study (Table 5.17).

Table 5.17
Familiarity with the route on which the accident occurred

Route - frequency of use	Carriageway type			
	Dual		Single	
	No.	%	No.	%
Daily, or nearly every day	153	33.0	69	33.2
Once a week	75	16.2	39	18.8
Once a month	67	14.4	31	14.9
Less than once a month	137	29.5	53	25.5
Never before	32	7.5	16	7.7
TOTAL	**464**	**100.0**	**208**	**100.0**

5.5.3 Physical and mental state of driver

The proportion of drivers required to wear glasses or contact lenses for driving, and the proportion who were on medication at the time of their accident, was higher among the respondents to the dual carriageway driver questionnaire (41 per cent and nine per cent respectively) compared with the single carriageway study (34 per cent and six per cent respectively). Nevertheless, the majority of drivers in the dual carriageway survey were healthy *(Question 26)* and, of those required to wear glasses or contact lenses, only four drivers (two per cent) were not wearing them at the time of the accident *(Question 25).*

State of mind

A general state of mind which prevailed among drivers at the time of their accident *(Question 28)* was one of feeling happy (23 per cent), relaxed (49 per cent) or contented (50 per cent) – (Table 5.18). Some eight per cent were 'tired, fatigued or bored'. As found in the single carriageway project, few were in a hurry, felt angry or were frustrated, suggesting that 'road rage' was a factor in few accidents.

What the drivers said

Table 5.18
State of mind at time of accident

State of mind	Carriageway type			
	Dual		Single	
	No.	%	No.	%
Relaxed	230	49.1	102	49.0
Contented	236	50.4	101	48.6
Happy	110	23.5	57	27.4
Distracted	33	7.3	11	5.4
Tired/Fatigued	26	5.6	10	4.8
Annoyed/Angry/Frustrated	19	4.1	7	3.4
In a hurry	14	3.0	8	3.8
Bored	17	3.6	5	2.4
Depressed or sad	6	1.3	2	1.0
TOTAL	**464**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive

5.5.4 Driving actions

Vehicle speed into the accident

At the time of their accident *(Question 19)*, only 19 drivers (four per cent) stated that they were travelling at speeds in excess of the national 70 miles/h speed limit for dual carriageway roads. Nearly 45 per cent stated that they were travelling at speeds less than 30 miles/h when their accident happened.

As speed is known to be one of the most important factors in accidents and a determinant of severity, log linear models were used to investigate the relationship between speed, age, gender, severity of injury (to driver) and type of vehicle driven.

The analysis assumes that the drivers' estimates of speed are correct (or at least that the accuracy of response is not correlated with the other variables considered). If, for example, drivers in a particular age group are less likely to admit to breaking the speed limit, the conclusions would not be valid.

It was found that speed was related to driver age, type of vehicle driven and whether or not the driver was injured. The data are summarised in Table 5.19.

A more comprehensive study of any relationship between speed and severity would need to take account of the speeds of other vehicles in the accident. In this context, the results relating to severity are only indicative. Nevertheless, they do show a clear pattern as outlined below.

Despite small numbers in some cells of the table, there is a clear bias towards older drivers travelling more slowly (Table 5.19(1)). This may be due, in part, to the high proportion of elderly drivers turning right, u-turning or turning left crossing the carriageway at the time of their accident.

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Table 5.19 Speed in accident – significant interactions

1. Speed	Age					
	Age 17–29		Age 30–59		Age 60 +	
0–30 mph	45	39%	123	42%	35	66%
31–50 mph	25	22%	70	24%	6	11%
51–70 mph	41	36%	82	28%	12	23%
Over 70 mph	3	3%	16	5%	–	–

2. Speed	Vehicle type			
	Bus or goods vehicle		Other vehicle	
0–30 mph	24	36%	179	46%
31–50 mph	29	44%	72	18%
51–70 mph	13	20%	122	31%
Over 70 mph	–	0%	19	5%

3. Speed	Injury to driver					
	Driver unhurt		Driver slightly injured		Driver seriously injured	
0–30 mph	130	52%	61	36%	12	32%
31–50 mph	55	22%	39	23%	7	19%
51–70 mph	62	25%	59	35%	14	38%
Over 70 mph	4	2%	11	6%	4	11%

The slower speed of buses and goods vehicles is highlighted in the Table 5.19(2).

In terms of the relationship between vehicle speed and injury to drivers, the main difference is between those injured and those not injured, with higher speed related to more injuries (Table 5.19(3)).

Vehicle visibility to other road users

When the accident happened, 45 per cent of the drivers had their vehicle's lights switched on *(Question 20)*. Of these vehicles, 70 per cent were showing dipped headlights, 16 per cent were on side lights, seven per cent were showing full beam and seven per cent had their fog lights on.

Thirty nine per cent of drivers were showing another signal on their vehicles to alert/advise other drivers. Brake lights were the most commonly displayed signal (18 per cent) followed by a right indicator (15 per cent). Six per cent of the signalling vehicles were showing hazard lights. None of the drivers in the single carriageway survey were giving this signal.

5.5.5. Who was to blame?

Having established the circumstances which led up to the accident, each driver was then asked to respond to questions about their own driving when the accident occurred, the condition of their vehicle, the driving of the other driver(s) involved in the accident, and to assess whether some pre-specified factors relating to the road environment and traffic played a part in the accident.

Logistic regression models were used to investigate the relationships between age, gender, severity, number of vehicles in the accident (one or more than one) and the response to each question. *Questions 29, 32, 33* to *35* together, *36* and *37* were considered separately. The response for each question was whether the factor being examined had, or had not, played a part in the accident. In all questions of this type, for the purposes of analysis, drivers who did not answer the question were grouped with those who indicated that none of the factors played a part in the accident.

What was their role in the accident?

When asked to specify if their own driving had, in any way, been a factor in their accident, 28 per cent of the drivers responded that their driving had been a factor *(Question 29)*. This proportion is similar to that found in the single carriageway survey and, as stated then, is a matter for concern. Of the faults which were recognised, 13 per cent of drivers stated that they had misjudged the speed or distance of the other drivers and 13% that they were driving too fast for the conditions or too close to the vehicle in front (Table 5.20).

Table 5.20 Which of the following applied to you?

Own driving	Carriageway type			
	Dual		Single	
	No.	%	No.	%
None of these	339	72.4	156	75.0
Misjudging speed or distance	61	13.0	21	10.1
Driving too fast or too close	59	12.6	11	5.3
Other	29	6.2	24	11.5
TOTAL	**464**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.

Further analysis of this question revealed that in single vehicle accidents (Table 5.21), there is a significant association between age of driver and the proportion of drivers citing some aspect of their own driving as a factor in the accident. This association is not apparent in accidents involving more than one vehicle. Sixty seven per cent of those in the 17-29 age group involved in single vehicle accidents indicated that some aspect of their own driving was a factor in the accident. For drivers aged 30 and over, the comparable figure is 25 per cent.

Table 5.21 Own driving in single vehicle accidents – by age

Own driving	Single vehicle accidents	
	Driver aged 17–29	Driver aged 30+
Own driving a factor	10 (67%)	10 (25%)
Own driving not a factor	5 (33%)	30 (75%)

When asked whether a defect with their own vehicle had been a factor in their accident, only four per cent of drivers stated that this had been the case.

What was the role of the other driver?

Whereas only 28 per cent of drivers felt their own driving was a factor in their accident, 74 per cent found fault with the driving of the other drivers involved in the accident (Table 5.22). The most commonly cited factor *(Question 33)* was that of driving too fast for the conditions or driving too close to the vehicle in front (45 per cent), followed by misjudgement of speed or distance (41 per cent). Improper lane changing and overtaking was considered a factor by 14 per cent of drivers.

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Table 5.22 Which of the following applied to the other driver?

Driving of other driver	Carriageway type			
	Dual		Single	
	No.	%	No.	%
Driving too fast or too close	209	44.7	73	35.1
Misjudging speed or distance	194	41.5	65	31.3
Other	97	20.7	57	27.4
Improper overtaking/lane change	68	14.5	34	16.4
Failure to use mirrors	31	6.6	*	*
None of these	124	26.5	56	26.9
TOTAL	**468**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.
*No equivalent category

Further analysis revealed that the most significant factor associated with the response to this question is whether or not another vehicle was involved in the accident. Eighty three per cent of drivers in an accident in which another vehicle was involved indicated that the driving of the other driver was a factor in the accident (Table 5.23(1)). *(In a few cases, drivers stated that another vehicle was involved in the accident, although this was not reported by the police. This explains the two drivers in single vehicle accidents who cited the driving of the other driver as a factor).*

Table 5.23 Other driver's driving as a factor

1. Other driver's driving	Number of vehicles			
	Single vehicle accident		More than one vehicle	
Driving a factor	2	4%	342	83%
Not a factor	53	96%	71	17%

2. Other driver's driving	Severity Drivers aged 30 to 59			
	Serious accident		Slight accident	
Driving a factor	35	59%	186	78%
Not a factor	24	41%	52	22%

In the 30 to 59 age group, a higher proportion of drivers in slight accidents blamed the driving of the other driver, compared with those involved in serious accidents (Table 5.23(2)). This difference is not apparent in other age groups.

5.5.6 What was to blame?

Was the road layout a factor in the accident?

Road layout *(Question 33)* was considered to have been a factor in the accident by 18 per cent of drivers (Table 5.24). The comparable figure for the single carriageway study was 27 per cent.

What the drivers said

Table 5.24
Road layout as a factor in the accident

Road layout	Carriageway type			
	Dual		Single	
	No.	%	No.	%
None of these	386	82.5	151	72.6
Road layout (right turn facilities, overtaking opportunities, concealed entrances, confusing junction layout, misleading appearance of road ahead and confusing or missing signs or road markings)	82	17.5	57	27.4
TOTAL	**468**	**100.0**	**208**	**100.0**

Was the road pavement a factor in the accident?

Seven per cent thought that poor surface drainage or the presence of mud on the road was a factor in their accident, but for the majority (90 per cent), no aspect of the road pavement *(Question 34)* was cited (Table 5.25). The corresponding proportions were similar in the single carriageway survey.

Table 5.25
Road pavement as a factor in the accident

Road pavement	Carriageway type			
	Dual		Single	
	No.	%	No.	%
None of these	419	89.5	182	87.5
Poor drainage/mud on road	35	7.5	18	8.7
Carriageway factors (raised kerb, soft verge, crumbling verge, pot holes road camber)	17	3.6	13	6.3
TOTAL	**468**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.

Was there anything about the road which restricted visibility and that could have been a factor in the accident?

Nineteen per cent of the drivers considered that an aspect of the road which restricted visibility *(Question 35)* on the dual carriageway had been a factor in their accident (Table 5.26). Five per cent cited poor street lighting or poorly lit road works. These proportions are similar to those found in the single carriageway study.

Table 5.26
Restricted visibility as a factor in the accident

Visibility	Carriageway type			
	Dual		Single	
	No.	%	No.	%
None of these	380	81.2	177	85.1
Restricted visibility (junction, vegetation, road signs, crest of hill or bends)	67	14.3	23	11.1
Poor lighting (street lights or road works)	25	5.3	11	5.3
TOTAL	**468**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.

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In the logistic regression modelling, the responses to *Questions 33* to *35* were considered together so that responses which highlighted an aspect of the road environment as a factor could be distinguished from those which did not. In the pooled data, the "Road was a factor" in the accident according to 165 individuals (35 per cent).

There is a significant association between accident severity and whether or not the driver felt that some aspect of the road was a factor (Table 5.27). Drivers involved in serious accidents were more likely to indicate that the road was a factor in the accident than drivers involved in slight accidents.

Table 5.27 Road as a factor

	Severity			
1. Road	**Serious**		**Slight**	
Road a factor	47	48.5%	118	31.8%
Road not a factor	50	51.5%	253	68.2%

	Severity			
2. Confusing layout	**Serious**		**Slight**	
"confusing layout" a factor	24	25%	37	10%
"confusing layout" not a factor	73	75%	334	90%

The most significant differences are for "misleading appearance of road ahead", "confusing road layout at junctions", "confusing signs or road markings" and "missing signs or road markings". Twenty five per cent of drivers involved in serious accidents ticked at least one of these four boxes in *Question 33*, compared with only 10 per cent of drivers in slight accidents (Table 5.27(2)) .

Was the weather a factor?

Rain was the weather condition most commonly cited *(Question 36)* as contributing to an accident (17 per cent). In all, the prevailing weather was considered a factor by 29 per cent of the drivers. Fog, wind and a glaring sun accounted for, between them, 10 per cent of the stated weather factors (Table 5.28).

Table 5.28 Factors in their accident: weather

Weather	**Carriageway type**			
	Dual		**Single**	
	No.	**%**	**No.**	**%**
None of these	331	70.7	145	69.7
Rain	81	17.3	41	19.7
Other weather (fog, wind or glaring sun)	49	10.5	17	8.2
Ice/Snow	29	6.2	13	6.3
TOTAL	**468**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.

The difference, between age groups, in the proportion of drivers who thought that the weather was a factor in their accident is not quite significant at the five per cent level. It can be seen from Table 5.29 below that the observed difference is mainly due to drivers aged 30-59 being less likely to cite the weather as a factor than younger drivers.

What the drivers said

Table 5.29 Weather as a factor by age of driver

Weather	Driver age					
	Age 17–29		Age 30–59		Age 60 +	
Weather a factor	43	37%	76	26%	18	32%
Weather not a factor	72	63%	221	74%	38	68%

Was the amount or nature of the traffic a factor?

The prevailing traffic conditions *(Question 37)* were considered to have been a factor by 50 per cent of the drivers. This is slightly higher than the proportion found in the single carriageway study. Of the range of scenarios given to each driver, "unexpected slow moving vehicles or queues" were cited by 28 per cent of drivers in the dual carriageway survey as having been a factor in their accident. This proportion is much higher than that found in the single carriageway study (15 per cent). Despite their higher design standards and greater traffic capacity, there is a suggestion that, either there is a flaw in the design or with the maintenance of dual carriageways which is giving rise to stationary traffic, or they are overloaded, or both. Eighteen per cent of drivers indicated that heavy traffic played a part in their accident. Slow moving vehicles (Table 5.30) were considered no more a factor in dual carriageway accidents (10 per cent) than in single carriageway accidents (nine per cent).

Table 5.30 Accident factors: prevailing traffic conditions

Prevailing traffic conditions	Carriageway type			
	Dual		Single	
	No.	%	No.	%
None of these	215	45.9	115	56.7
Unexpected slow moving vehicles or queues	132	28.2	31	15.3
Heavy traffic	86	18.4	30	14.8
Slow moving vehicle (pedal cycle, moped, heavy goods vehicle, bus, farm vehicle, or other slow moving)	46	9.8	18	8.7
Light traffic or no traffic	21	4.5	15	7.4
TOTAL	**468**	**100.0**	**208**	**100.0**

Categories are not mutually exclusive.

In the logistic regression modelling, the statements in *Question 37* were simplified for the analysis. All responses to *Question 37*, other than "little traffic or no traffic" or "none of these", were counted as a "slow or heavy traffic" factor. "Slow or heavy traffic" was stated as being a factor by 232 individuals (50 per cent).

Males were more likely than females to cite slow moving or heavy traffic as being a factor in their accident (Table 5.31(1)), as were drivers aged under 60 compared with those who were older (Table 5.31(2)).

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Table 5.31
Slow or heavy traffic as a factor

1. Traffic	Gender			
	Male		Female	
Traffic a factor	177	53%	55	41%
Traffic not a factor	156	47%	80	59%

2. Traffic	Age			
	17–59		60+	
Traffic a factor	211	51%	21	38%
Traffic not a factor	201	49%	35	62%

3. Traffic	Number of vehicles			
	Single vehicle		More than one	
Traffic a factor	6	11%	226	55%
Traffic not a factor	49	89%	187	45%

4. Traffic	Severity Accidents involving more than one vehicle			
	Serious		Slight	
Traffic a factor	34	44%	192	57%
Traffic not a factor	44	56%	143	43%

Perhaps not surprisingly, drivers involved in single vehicle accidents found slow moving or heavy traffic less of a problem than those in accidents with more than one vehicle involved (Table 5.31(3)).

For accidents involving more than one vehicle, drivers in slight accidents cited slow moving or heavy traffic more frequently than those in serious accidents (Table 5.31(4)). This is probably related to the type of accident (shunts involving slow moving vehicles are often less serious than accidents of other types such as junction conflicts).

5.6 Summary

The main findings of this chapter are summarised below:

Driver experience

- The individuals involved in the dual carriageway accidents studied were experienced drivers who were familiar with the road on which their accident occurred. More than 95 per cent drove on a near daily basis, and had held a driving licence for more than two years.
- Drivers aged 60 or more, when compared with other drivers, were found to travel lower annual mileages, drove less in darkness and during the rush hour periods, and their most frequent trip length was shorter.
- Female drivers, when compared with males, also drove lower annual mileages and less in darkness. Their most frequent trip lengths were also shorter, but the proportion of time they spent travelling in the rush hour periods was greater.
- Nearly all heavy goods vehicle drivers involved in the accidents were on business or work-related journeys. Among the drivers of cars, more than half the journeys were pleasure or domestic trips.

What the drivers said

Driver perception

- Driving in darkness, judging speed in darkness and judging distance in darkness were the general driving tasks rated as least easy. Turning right at junctions and leaving lay-bys were the dual carriageway driving tasks rated as least easy.
- Drivers aged 60 or more rated driving on single carriageway roads, daylight driving in general, joining a main road from a slip road, changing lanes to the right and changing lanes to the left more difficult than did other age groups.
- Female drivers rated driving on dual carriageways and changing lanes to the right as more difficult than did males.
- Drivers aged 60 or more had a greater relative involvement in accidents involving a right turn manoeuvre, but they did not perceive this task to be any more difficult (or easy) than did other age groups.

The accident

- The majority of individuals did not think that their own driving had contributed to their accident (even in single vehicle accidents). However, the majority found fault with the driving of the other individuals involved in the accident.
- As found in the single carriageway study, relatively few road environment factors were cited as having contributed to accidents. Heavy traffic (18 per cent) and queues (28 per cent) were the most commonly cited factors, but more so by males and drivers aged between 17 and 59.
- Most drivers were relaxed and contented when they had their accident – possibly a sign of complacency.

Chapter 6 Accidents and the road environment

In this chapter, the in-depth profiling of traffic accidents on two lane dual carriageway 'A' class roads is extended to examine what influence, if any, individual or combinations of road environment features have on accident frequency and the type of accident observed on the links and at different public road junction locations. Section 6.1 establishes and compares the environmental characteristics of each of the routes being examined. Section 6.2 outlines the statistical modelling approach adopted in the analysis of interactions between the accident and environment variables. Sections 6.3 and 6.4 summarise these interactions for the inter-junction links and public road junctions respectively.

6.1 Road environment characteristics

Presentation of the road environment characteristics is in two parts. Section 6.1.1 introduces the quantitative features of the road structure and layout. Those features of the road environment which were determined qualitatively are examined in Section 6.1.2.

6.1.1 Quantitative features of road geometry and layout

The road geometry and layout variables introduced in this section are:

- Bendiness
- Carriageway width
- Kerbing
- Forward visibility
- Lane markings
- Nearside and offside hard strips
- Carriageway profile
- Central reservation crash barrier
- Wet skidding resistance

Bendiness

It generally follows that the A14 Group of routes has the smallest bendiness values of all the routes being examined with the exception of the A1b which has a bendiness value of just nine degrees per kilometre. This section of the A1 has few bends as it follows the line of Ermine Street – an old Roman Road. The overall bendiness value of the A1a disguises some severe bends which characterise this section of the A1. Though some have been removed by straightening schemes, Southoe Bends, for example, remains a notorious accident black site. The relatively high bendiness values for the Parkways Group of routes is explained by the need to build these routes through, and around, a densely populated urban environment.

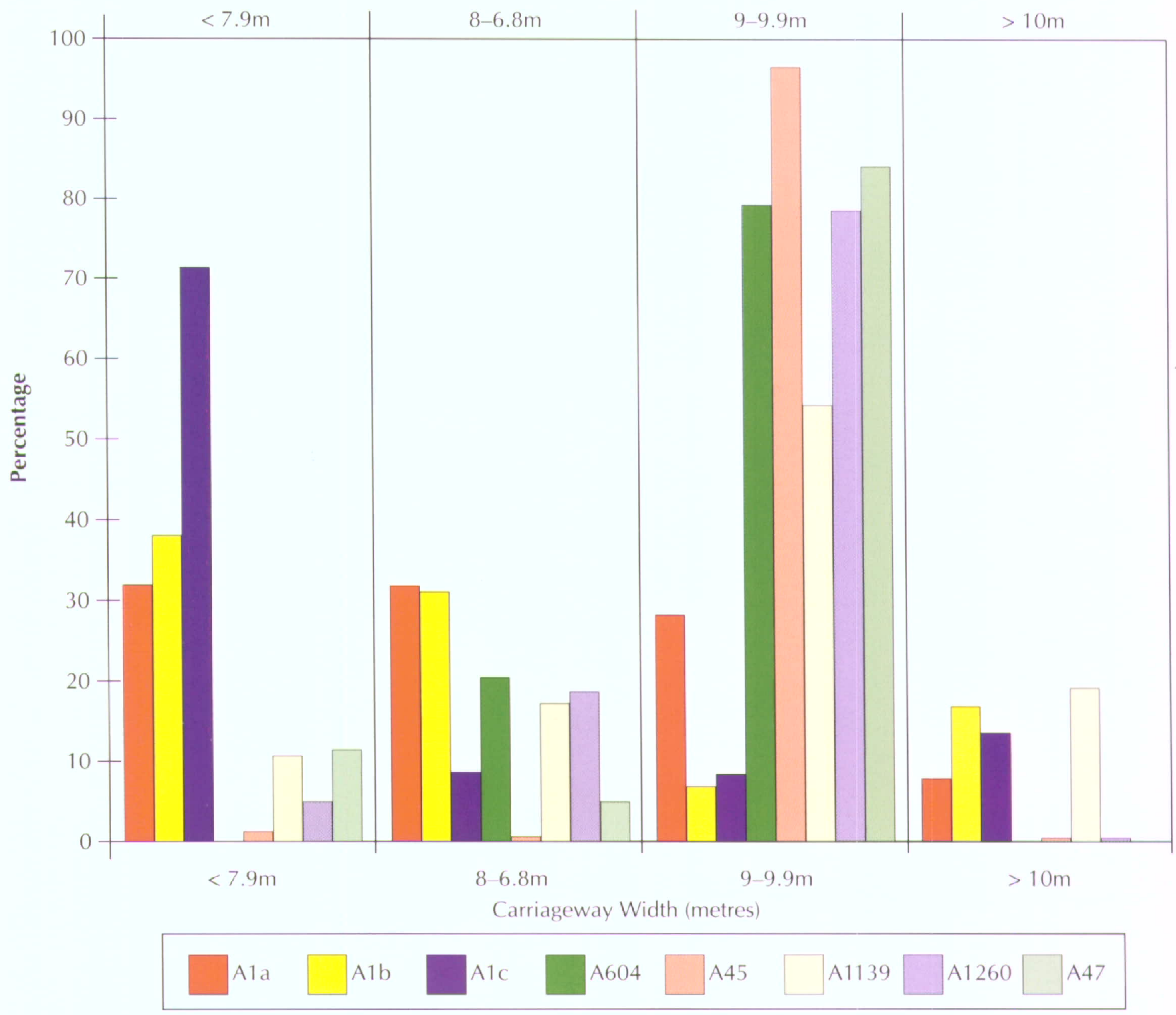
Table 6.1
Bend characteristics

Route Number	Bendiness (Degrees/km)	No. of Bends	Bend Angle Low/High
A1 Group			
A1a	24	25	4°/ 55.5°
A1b	9	19	2.5°/ 33°
A1c	27	49	2°/ 48°
A14 Group			
A604	14	15	2.5°/ 57°
A45	15	6	14.5°/ 74°
Parkways Group			
A1139	29	12	4.5°/ 125°
A1260	27	5	2°/ 48.5°
A47	39	9	2°/ 65°

Carriageway widths

Carriageway width information for each of the routes being examined was supplied by WS Atkins (East Anglia) Ltd. as the average carriageway width per length interval. In the majority of cases, this length interval was 100 metres. However, in the proximity of junctions or lay-bys, the measuring interval could be smaller. Figure 6.1 presents a histogram of the carriageway width distribution of each route.

Figure 6.1 Carriageway width distribution



The large carriageway width variations observed between the A1 Group of routes and the two other groups provides a good example of the evolutionary, but piecemeal improvement of the route. Much of the A1 is less than 8 metres wide. In contrast, the more recent routes show a more uniform carriageway width distribution reflecting improved design of the roads. Though designed to a better standard as a whole, construction of the A1139 took place in five phases, and the width of carriageway changed with each stage.

Roadside kerbing

Kerbing was divided into two categories relating to its presence or absence. No attempt was made to distinguish between different kerb types. The presence of kerbing was noted for both the nearside and offside of the carriageway. The proportional distribution of kerbing along the nearside and offside of each route is shown in Table 6.2.

The Parkways Group of routes is, as mentioned previously, fully kerbed on both sides of the carriageway. Kerbing on the nearside of all the other routes is generally restricted to lay-bys or junctions. Kerbing on the offside of all the other routes is even more limited, being restricted mainly to the proximity of bridge supports in the central reservation. The A1 Group of routes has a slightly higher proportion of offside kerbing along its length compared with the A14 Group of routes. The additional kerbing generally delineates dedicated right turn facilities in the central reservation.

Table 6.2 Roadside kerbing

Route Number	Kerbing nearside (%)	Kerbing offside (%)
A1 Group		
A1a	41	14
A1b	51	6
A1c	43	4
A14 Group		
A604	36	2
A45	45	3
Parkways Group		
A1139	100	98
A1260	100	100
A47	100	98

Forward visibility

Forward visibility was coded to one of two categories based around a critical stopping distance which is associated with roads designed to a maximum speed of 120 kph – ((DMRB) – TD9/93 – Highway Link Design). The critical distance was

- 295 metres sight distance

For simplicity, this value was rounded up to 300 metres. Forward visibility was considered to be **good** when the sight distance was 300 metres or more and **poor** if less than 300 metres. The proportion of each category of forward visibility is based on the sum of forward visibility in both directions.

Table 6.3 Unobstructed forward visibility

Route Number	Good (%)	Poor (%)
A1 Group		
A1a	55	45
A1b	65	35
A1c	24	76
A14 Group		
A604	69	31
A45	95	5
Parkways Group		
A1139	53	47
A1260	66	34
A47	50	50

It is surprising that even on the better designed A14 Group of routes, there can be a high proportion of poor forward visibility. The northern section of the A1 (A1c) is particularly poor, primarily due to the poor horizontal and vertical profile of this road. Forward visibility, of course, assumes an empty carriageway.

Lane markings

Lane markings on the dual carriageways being examined were limited to normal **carriageway demarcation** lines which are the two metre mark separated by a seven metre gap, and **hazard** line markings which are seven metre marks separated by two metre gaps.

Table 6.4
Lane markings

Route Number	Hazard (%)	Demarcation (%)
A1 Group		
A1a	11	89
A1b	12	88
A1c	19	81
A14 Group		
A604	–	100
A45	–	100
Parkways Group		
A1139	2	98
A1260	2	98
A47	3	97

On the A14 Group of routes all the markings are demarcation markings (Table 6.4). The use of hazard markings on the Parkways Group of routes is limited to the proximity of roundabouts which are found at the extreme ends of these routes. The use of hazard line markings are most pervasive on the A1 Group of routes, especially the A1c (19 per cent), but their use is inconsistent. Much of this has arisen due to their non-reinstatement following episodes of road works. The effectiveness of their use is indeed questionable as the distance over which the markings appear is often much less than the minimum stopping distance.

Nearside and offside hard strips

Hard strips were coded to one of four categories relating to width groupings. At areas of the carriageway adjacent to the entry and egress points to and from public road junctions (both nearside and into the central reservation) and adjacent to lay-bys, hard strips were coded as none. Elsewhere, the codes used were less **than 0.5 metres, between 0.5 and 1 metres**, and **greater than 1 metre**. The proportion of each hard strip width on each route is shown in Table 6.5. In the single carriageway report, the type of edge of carriageway markings was also examined. However, for dual carriageways, the marking is consistently a solid white line, some of which has raised ribbing. Unfortunately, the absence of detailed maintenance records meant that the periods over which the ribs were laid could not be determined, but they are known to be a recent addition, and were not present over the whole study period.

Table 6.5
Nearside and offside hard strips

Route Number	Nearside				Offside			
	0 (%)	<0.5m (%)	0.5–1m (%)	>1m (%)	0 (%)	<0.5m (%)	0.5–1m (%)	>1m (%)
A1 Group								
A1a	20	58	22	–	2	78	20	–
A1b	30	64	6	–	4	92	4	–
A1c	26	66	8	–	4	86	10	–
A14 Group								
A604	29	–	**71**	–	1	–	**99**	–
A45	26	–	**74**	–	–	–	**100**	–
Parkways Group								
A1139	20	49	57	21	2	49	49	–
A1260	19	–	**81**	–	–	100	–	–
A47	23	–	77	–	2	96	–	–

Accidents and the road environment

On the A14 Group of routes and most of the Parkways Group, the hard strips bounding the carriageway away from public road junctions and lay-bys are consistently one metre wide. On the other routes, hard strip designation is more varied, and reflects the marking space available on the carriageway. As mentioned previously, the A1139 was established over several construction phases, each with individual design characteristics. A full width hard shoulder bounds the nearside of the carriageway on the length between the A1 interchange and the A1260 Nene Parkway interchange. The A1 is somewhat different in that the upgrade to standard hard strip widths has taken place in a piecemeal manner at times of localised improvements.

Carriageway profile

The profile of the carriageway relative to the surrounding environment was coded as either **at-grade, cutting, embankment**, or **viaduct** (see Table 6.6). The code relates to the nearside of the carriageway. Each carriageway was considered separately. No account has been taken of the effect of carriageways at different levels. As the profile of one carriageway relative to the surrounding environment may differ from the adjacent carriageway, the proportion of each profile has been summed over both directions of travel.

Despite the undulating nature of the A1 Group alignment, especially the middle (A1b) and northern (A1c) sections, much of the carriageway is at-grade. This fact, combined with the poor alignment of the route, goes some way to explaining the high proportion of poor forward visibility on the routes. Among the Standard 2A and 2B designed A14 Group and Parkways Group of carriageways, the use of cuttings and embankments is more pervasive resulting in better aligned roads.

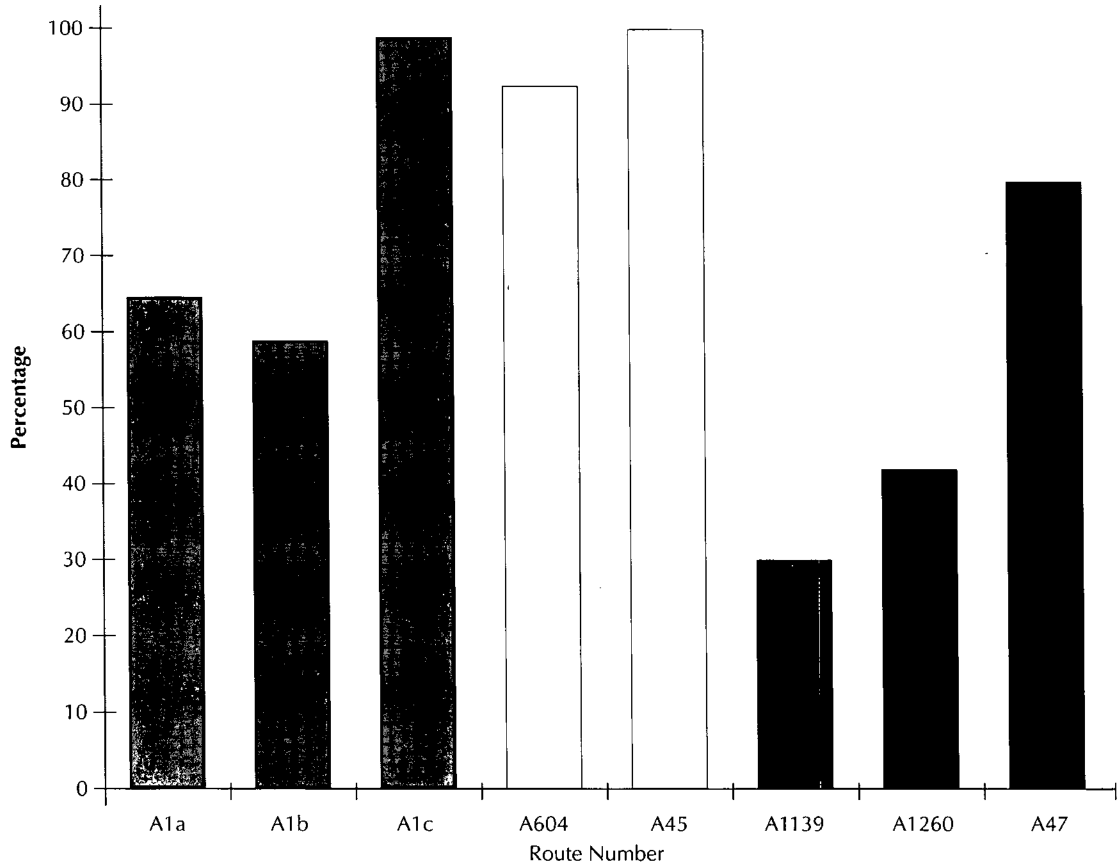
Table 6.6
Carriageway profile

Route Number	At-grade (%)	Cutting (%)	Embankment (%)	Viaduct (%)
A1 Group				
A1a	49	26	23	2
A1b	77	15	8	0
A1c	60	14	24	2
A14 Group				
A604	49	22	26	2
A45	40	41	18	1
Parkways Group				
A1139	9	48	39	4
A1260	14	69	12	6
A47	23	26	49	0

Central reservation crash barrier

The proportion of central reservation crash barrier on each of the dual carriageways being examined is shown in Figure 6.2. The allocation shown in Figure 6.2 is that averaged over the whole study period. This does give a distorted picture of the current situation, in that the A1 Group, and A14 Group of routes now have a 100 per cent central crash barrier allocation.

Figure 6.2
Central reservation crash barrier allocation



The only route which remains to be completely crash barriered is the A1139, but there is an active programme in place for completing this task. Figure 6.2 is not meaningless, as it can be used as a surrogate measure for the proportion of time over which central reservation crash barrier has been in place. For example, the A45 had 100 per cent central crash barrier allocation over the whole eight year period.

Wet skidding resistance

A measure of the wet skidding resistance of each route was obtained from SCRIM data – as described in Section 2.5.2. This information, where available, was collected for each accident that occurred in lane 1 (the lane to which the SCRIM data applied).

As was the case with single carriageways, the wet skidding resistance of the road was considered :

- Poor – skidding resistance below the intervention level
- Adequate – up to 0.05 coefficient above the intervention level
- Good – more than 0.05 coefficient above the intervention level

Using the above categories, the relationship between the incidence of accidents involving skidding on a wet road surface and skidding resistance offered by the road was examined. The results are recorded in Table 6.7.

Table 6.7
Wet skidding – incidence and skidding resistance

	Skidding resistance		
	Poor	Adequate	Good
All accidents on wet roads	6	24	195
Wet skid accidents	2	10	86
% of accidents involving a skidding vehicle	33.3	41.7	44.1

Accidents and the road environment

There is no significant difference between the three road surface categories in terms of the proportion of wet road accidents involving skidding. However, there are a number of shortcomings with the available data. Firstly, the speed at which the SCRIM vehicle collects data (50 kph) is not representative of the normal traffic speeds (typically 100 kph-130 kph). Furthermore, no measurement at all is made in lane 2 where vehicle speeds are often higher than in lane 1. This severely distorts the data. From Table 6.7 above, the proportion of lane 1 accidents involving wet skidding is around 42-44 per cent, whereas from Table 3.9 the proportion of all accidents involving wet skidding is 58 per cent. This points to a need to review how the skid resistance of multi-lane roads is obtained and how the results are used to determine maintenance programmes.

It is certainly the case in Cambridgeshire that greater emphasis and priority was placed on the surface maintenance of these dual carriageways than for "A" class single carriageways with their lower speeds and volumes. This may be reflected in the low numbers of accidents on "poor" or "adequate" surfaces compared to the single carriageways in the earlier study. It is possible that with better skid resistance data a more closely targeted maintenance programme might be obtained.

6.1.2 Qualitative features of the road environment

This section presents those features of the road environment which were determined qualitatively from the video surveys. These features are:

- Hedges and trees
- Verge width
- Aspect

Hedges and trees

Hedges and trees were coded into one of three categories relating to **none, low** or **high**. Low hedges and trees were those which could be overlooked by the driver of a car. The distribution of these categories along each route was obtained by summing over both directions of travel.

Table 6.8 Hedges and trees – by route

Route Number	Nearside			Offside (central reserve)		
	None (%)	Low (%)	High (%)	None (%)	Low (%)	High (%)
A1 Group						
A1a	40	5	55	89	–	11
A1b	18	15	67	63	4	34
A1c	6	5	88	88	–	12
A14 Group						
A604	48	3	49	100	–	–
A45	45	4	52	100	–	–
Parkways Group						
A1139	34	2	65	82	–	18
A1260	42	–	58	100	–	–
A47	29	3	68	100	–	–

Only the A1 Group of routes and the A1139 have trees present on the offside (in the central reservation). For the A1139, the trees are found on the earliest phase of construction between the A1 and the A1260 junctions and were probably planted as part of the scheme. The same is not true for the A1 sections where some of the trees are remnants of the pre-dualling phase of upgrade. On the other routes, the adjacent carriageways are all visible.

On the nearside, high hedges and trees predominate on all the routes. This is probably because trees planted next to the carriageways are normally left to grow unhindered and receive little post-planting maintenance.

Verge width

Verge width was grouped into two categories – **narrow** or **wide**. A wide verge was defined as wide enough for a large vehicle to park off the carriageway. The proportional distribution of verge width for each route was obtained by summing over both directions of travel. The verge width characteristics of each road are shown in Table 6.9.

The offside verge width on most of the routes was narrow due to the narrowness of the central reservation. Though the southern and middle sections of the A1 show more than 20 per cent wide verge, much of this has been reduced to a narrow verge following the provision of central reservation crash barrier.

On the nearside, the highest proportion of wide verge is found on the A1 Group of routes. On the other routes, narrow verges prevail.

Table 6.9
Verge width

Route Number	Nearside		Offside	
	Narrow (%)	Wide (%)	Narrow (%)	Wide (%)
A1 Group				
A1a	42	58	77	23
A1b	44	56	76	24
A1c	44	56	98	2
A14 Group				
A604	89	11	99	1
A45	91	9	100	–
Parkways Group				
A1139	86	14	100	–
A1260	76	24	100	–
A47	82	18	100	–

Aspect

Driver aspect for each carriageway was coded to one of three categories – **open, normal** or **closed**. In general, the presence of high trees and hedges, and cuttings have the effect of creating a closed aspect. Both combinations are present on the A1139 and A1260, which helps to explain the high proportion of closed aspect on them (Table 6.10).

Table 6.10
Aspect – by route

Route Number	Nearside			Offside		
	Open (%)	Normal (%)	Closed (%)	Open (%)	Normal (%)	Closed (%)
A1 Group						
A1a	33	5	62	38	14	47
A1b	31	5	65	27	19	54
A1c	30	9	61	9	23	68
A14 Group						
A604	38	1	61	36	3	61
A45	47	5	48	2	90	8
Parkways Group						
A1139	6	14	80	3	16	81
A1260	17	14	89	18	31	51
A47	10	26	65	26	16	58

6.2 Statistical modelling

6.2.1 Modelling approach

The aim was to investigate and summarise relationships between a number of "explanatory" variables (measuring traffic volume, road geometry, road environment and STATS19 information) and both accident frequency and accident type.

The following data sets were examined:

- Accident frequencies on the inter-junction links
- Accident types on the inter-junction links
- Accident frequencies at merging slip road junctions (on-slips)
- Accident types at merging slip road junctions (on-slips)
- Accident frequencies at diverging slip road junctions (off-slips)
- Accident types at diverging slip road junctions (off-slips)
- Accident frequencies at T-junctions with and without gaps
- Accident types at T-junctions with and without gaps

A generalised linear modelling approach was adopted, full details of which can be found in a separate technical report.

The models were fitted using the GLIM computer package.

A large number of variables were investigated in an exploratory way during the modelling process. Between about 70 and 100 variables were considered in the analysis of each database. Even if none of the variables was related to accident frequency or accident type, with such large numbers of them "significant" associations may well have occurred due to chance, particularly given that numerous combinations of variables were investigated. This point is important, and means that any results need to be treated with caution and should form the basis of further independent study rather than being interpreted as a set of rules.

An explanatory mechanism can be surmised for most of the associations in the models. Although some of these are fairly obvious, it must be emphasised that an association does not necessarily imply a "cause and effect" relationship.

Confidence intervals, providing estimates of the uncertainty of each significant association, can be found in the technical report. In some cases, the confidence intervals are quite wide indicating a high degree of uncertainty.

For continuous variables, for example traffic flow, significant associations with accident frequency (either at junctions or on the inter-junction links) are summarised in terms of the change in accident frequency associated with a "unit" increase in the variable. As an example, from Section 6.3.1, an increase of 1,000 vehicles per 16 hour day is associated with a 5.1 per cent increase in accident frequency on the inter-junction links. These changes are linear in the sense that, under the model, the figure of 5.1 per cent applies whether the traffic flow changes from 10,000 to 11,000 vehicles or from 25,000 to 26,000. However, the magnitude of the association does not increase linearly as the "unit change" increases. For example, an increase of 5,000 vehicles is not associated with an increase of 25.5 per cent in accident frequency (in this particular example the figure is 28.2 per cent). Further details can be found in the technical report.

The technical report also includes the ranges over which the continuous variables in the models are valid.

6.2.2 Modelling accident types

The modelling of accident types (both at junctions and on the links) explored how the proportion of accidents of a particular type is related to the explanatory variables mentioned above.

The results are summarised in terms of the odds of a particular type of accident (the probability that an accident is of the type of interest divided by the probability that it is of any other type). Modelling the data in this way ensures that the proportion of accidents that are of a particular type is constrained to lie within the range 0 to 1.

It should be emphasised that this approach can only provide estimates of associations between variables and accident type, it does not provide measures of any influence on accident frequency. Only the factors identified in the accident frequency models are associated with a change in the total number of accidents.

The models for different accident types are not independent. The association between a variable and an increase in the odds of one type of accident will invariably be related to an association between that variable and a decrease in the odds of another accident type.

In a similar way to the accident frequency models, significant associations between continuous variables and the odds of a particular type of accident are summarised in terms of the change in the odds of that accident type associated with a "unit" increase in the variable. Again, the magnitude of an association does not increase linearly as the "unit change" increases.

The results of the modelling are outlined in Sections 6.3 and 6.4.

6.3 The inter-junction links

6.3.1 Accident frequency

Methodology

The road network was divided up into a total of 364 (directional) links, ranging between 100 metres and 2.05 kilometres in length. The A1 was divided into 124 separate links; the A14 (formerly A604) into 122 links; the A14 (formerly A45) into 68 links and the Peterborough Parkways into 60 links. All lengths were considered on all the roads, with the exception of a short section of the A1 to the south of Brampton Hut (A1/A14 interchange) for which there was no pre-modification information available. There were 1449 accidents in total, with between 0 and 38 accidents per link.

In dividing each route into separate lengths, no attempt was made to exclude lengths adjacent to junctions from the data set. Accidents occurring within the merging and diverging zones of public road junctions were included in the link data set only if they were considered to have been unrelated to the junction. Junction-related accidents are considered separately in Section 6.4. Similarly, accidents adjacent to private accesses were excluded if they were directly related to the private access, but included if they were unrelated.

The variables considered in the modelling included the eight year average directional vehicle flow (16 hour AAWF equivalent) for each link length. Further flow variables were included to account for the different daily traffic flow levels experienced on each link length. The three additional variables expressed the proportion of time that the hourly flow on each link was at less than 500 vehicles, greater than 1500 vehicles and greater than 2000 vehicles.

Environment variables were included for each category of centreline markings, central crash barrier, aspect, and forward visibility. Hedges, verge, kerbing, and hard strip were included for both the nearside and offside of the carriageway. Offside in all cases was considered to be the central reservation and not the offside of the adjacent dual carriageway. Each category of a variable was expressed as a proportion of total link length. For example, a 500 metre link length with 400 metres of open aspect on the nearside would have had 80 per cent open nearside aspect.

Among the engineering characteristics of each link considered were carriageway vertical and horizontal alignment and carriageway profile relative to the surrounding environment.

Accidents and the road environment

Variables were also included to record the proximity of at-grade roundabouts, number of lay-bys, crests, sags and business private accesses falling on a link.

Where central reservation safety fencing was provided during the study period, or where gap closures were effected, changes were accounted for by averaging the variable over time. For example, a 500 metre length of road with a gap that was open for half the study period would have been coded as having one gap per kilometre. All the variables were averaged over the eight year period of the study.

Periods of road works were excluded from the analysis, and therefore the time period was not the same for each link. (Differing time periods and link lengths were accounted for in the model).

Results

The following variables were found to have a significant association with the occurrence of accidents on the inter-junction links. The influence of each variable is over and above that due to other factors in the model.

- **Major road traffic flow**
  Within the unidirectional major road traffic flow range of 4,900 to 32,200 vehicles (16 hour Average Annual Weekday Flow (AAWF)), an increase of 1,000 vehicles per 16 hour day is associated, on average, with a 5.1 per cent increase in accident frequency.
- **Bendiness [25 to 70 degrees per km]**
  Links with bendiness characteristics falling within the range 25 to 70 degrees per kilometre are associated, on average, with 22 per cent more accidents than those with bendiness characteristics of less than 25 degrees per kilometre.
- **Bendiness [70.1 to 90 degrees per kilometre]**
  Links with bendiness characteristics falling within the range 70.1 to 90 degrees per kilometre are associated, on average, with 260 per cent more accidents than those with bendiness characteristics of less than 25 degrees per kilometre.
- **At-grade roundabout within 500 metres**
  Links falling completely within 500 metres of the approach to an at-grade roundabout are associated, on average, with 160 per cent more accidents than those at other locations.
- **At-grade roundabout between 500 metres and 5 km away**
  Links falling between 500 metres and 5 km of the approach to an at-grade roundabout are associated, on average, with 37 per cent more accidents than those at other locations.
- **Central reservation gaps**
  Links containing gaps in the central reservation are associated with more accidents than those without. An increase of one gap per kilometre is associated, on average, with a 7.8 per cent increase in accidents.
- **Offside aspect**
  Links characterised by 100 per cent open offside aspect are associated, on average, with 35 per cent more accidents than those with no open offside aspect.
- **Central crash barrier**
  The presence of a central crash barrier is associated, on average, with a 31 per cent reduction in accident frequency.
- **Nearside kerbing**
  Links characterised by 100 per cent nearside kerbing are associated, on average, with 29 per cent fewer accidents than those links with no nearside kerbing.

- **Offside kerbing**
  Links characterised by 100 per cent offside kerbing are associated, on average, with 38 per cent fewer accidents than those links with no offside kerbing.
- **Offside hard strip**
  Links characterised by 100 per cent offside hard strip (0.5 metres or wider) are associated, on average, with 21 per cent fewer accidents than those with no offside hard strip.

With these terms in the model, no other factors have a significant association with the total number of accidents on the links. However, this does not mean that other factors have no effect, it might be that a small effect could not be detected with the sample size being considered.

The presence of offside kerbing is highly correlated with the Peterborough Parkways (most of them have it, whereas most of the other roads do not). Also, a wide offside hard strip is highly correlated with the A14. The interpretation of the relationships between these factors and accidents therefore needs to be treated with particular care, as they may be measuring other variables associated with the design of these roads.

6.3.2 Accident types

The accident types investigated are shown in Table 6.11. The more detailed categories outlined in Table 4.9 were grouped in this way in order to provide enough accidents per category to allow meaningful analysis.

There was no need to distinguish between loss of control type accidents occurring on a bend from those loss of control type accidents occurring elsewhere, as a bendiness factor is included in the modelling.

Table 6.11 Number of accidents on the links by accident type

Type	Number of accidents	%
Stacking	617	39
Lane change	188	12
Loss of control	492	31
Vehicle drift	184	12
Other	107	7
Total	**1588**	**100**

Methodology

All the environment variables considered in Section 6.3.1 above were included in the analysis, but this time the actual value of each variable was recorded against each accident location. (The majority of variables were recorded as the average per 100 metre section).

The variables considered in the modelling included a two-way annual average 16 hour weekday flow which was recorded against each accident. Another flow variable recorded an estimate of the hourly traffic flow at the time of the accident. Accidents which occurred in road works were included in the analysis, with a variable recording the presence of, or the approach to, road works.

Results

The following significant associations were found:-

- **Hourly traffic flow**
  An increase in hourly traffic flow of 100 vehicles is associated, on average, with a 10 per cent increase in the odds of a stacking type accident, a six per cent reduction in the

odds of a loss of control type accident, an eight per cent decrease in the odds of a vehicle drift type accident and a five per cent reduction in the odds of a KSI accident.

- **Average Annual Weekday Flow**
  Over and above the relationship with hourly flow, a 1000 vehicle increase in the Average Annual Weekday Flow is associated, on average, with a two per cent increase in the odds of a stacking type accident.
- **Bendiness**
  An increase in link bendiness of 10 degrees per kilometre is associated, on average, with a 10 per cent reduction in the odds of a stacking type accident but a 14 per cent increase in the odds of a loss of control type accident.
- **At-grade roundabout – on the approach**
  The approach to a roundabout is associated with an increase in the odds of a stacking type accident. When compared with locations other than within 1500 metres of a roundabout on the approach, the approach interval falling between 100 metres and 1500 metres is associated, on average, with a 63 per cent increase in the odds of a stacking type accident. The approach interval within 100 metres of a roundabout is associated, on average, with an increase of 479 per cent in the odds of a stacking accident.
- **Distance to the next junction**
  A 1 km increase in the distance to the next junction is associated, on average, with a 22 per cent increase in the odds of a vehicle drift type accident.
- **Object in the carriageway**
  The presence of an object in the carriageway is associated, on average, with a 187 per cent increase in the odds of a stacking type accident but a 75 per cent decrease in the odds of a vehicle drift accident.
- **Road works**
  The presence of road works is also associated with an increase in the odds of a stacking type accident (by 515 per cent on average), but the odds of a loss of control type accident, or a vehicle drift type accident decrease (by 69 per cent and 72 per cent respectively). No association was found between accident type and being within 5 Km of, and on the approach to, road works.
- **Approach to a crest**
  There is, on average, a 32 per cent reduction in the odds of a loss of control type accident when the accident occurs at or within 500 metres of a crest (on the approach).
- **Approach to a lay-by**
  In the 500 metre approach interval to a lay-by, there is, on average, a 51 per cent reduction in the odds of a stacking type accident.
- **Approach to a business access**
  There is, on average, a 116 per cent increase in the odds of a lane change accident when an accident occurs within 500 metres of (on the approach) or at a business access.
- **Nearside aspect**
  Closed nearside aspect is associated, on average, with a 29 per cent reduction in the odds of a loss of control type accident (compared with open or normal nearside aspect).
- **Offside kerb**
  The odds of a vehicle drift type accident are reduced, on average, by 51 per cent when an offside kerb is present.
- **Lane markings**
  Hazard lines are associated, on average, with a 60 per cent reduction in the odds of a vehicle drift type accident (compared with normal demarcation lines).

- **Carriageway gradient**
  A non-level carriageway gradient is associated, on average, with a 34 per cent reduction in the odds of a lane change accident (compared to a level gradient).

- **Offside hard strip**
  The presence of an offside hard strip 0.5 metres wide or less is associated, on average, with a 69 per cent reduction in the odds of a vehicle drift type accident (compared to no offside hard strip); while a 0.5 to one metre hard strip is associated with an 82 per cent reduction in the odds of this accident type. However, the presence of an offside hard strip is associated with a 784 per cent increase in the odds of a lane change accident.

- **Weather conditions**
  Compared to other weather conditions, the odds of a loss of control type accident increase when it is raining (by 80 per cent on average), while the odds of a stacking type accident increase in fog (by 426 per cent). However, when compared with fine weather conditions, the odds of a lane change accident are reduced when it is either foggy (by 85 per cent) or raining (by 59 per cent).

- **Road surface conditions**
  Compared to a dry road surface, the odds of a stacking accident increase, on average, by 36 per cent on a wet road surface, while the odds of a vehicle drift type accident decrease by 35 per cent. Similarly, when compared with a dry road surface, the odds of a vehicle drift type accident are reduced (by 91 per cent on average) when there is snow or ice on the road surface. Compared to all other road surface conditions, the odds of a loss of control type accident are some 281 per cent higher on a snowy or icy road surface. However, the odds of a fatal or serious (KSI) accident are 57 per cent less on snow or ice covered roads.

- **Heavy goods vehicle involved**
  The odds of a fatal or serious accident were found to be 43 per cent higher if a heavy goods vehicle was involved in the accident. Goods vehicles in general (both heavy goods and light goods combined) were associated, on average, with an increase of 41 per cent in the odds of a stacking accident and an increase of 87 per cent in the odds of a lane change accident; they were also associated, on average, with a reduction of 57 per cent in the odds of a loss of control accident and a decrease of 43 per cent in the odds of a vehicle drift accident.

- **Pedestrian involved**
  The involvement of a pedestrian is associated, on average, with an increase of 381 per cent in the odds of a KSI accident.

- **Pedal cycle involved**
  The involvement of a pedal cycle is associated, on average, with an increase of 311 per cent in the odds of a KSI accident, a decrease of 67 per cent in the odds of a loss of control accident and an increase of 333 per cent in the odds of a stacking accident.

- **Two-wheeled motor vehicle involved**
  The involvement of a two-wheeled motor vehicle is associated, on average, with an increase of 79 per cent in the odds of a KSI accident and an increase of 197 per cent in the odds of a loss of control accident. Two-wheeled motor vehicle involvement is also associated with a reduction of 44 per cent in the odds of a stacking accident and a decrease of 76 per cent in the odds of a vehicle drift accident.

- **Accident type and severity**
  Rear end shunt type accidents are associated, on average, with a reduction of 26 per cent in the odds of a KSI accident.

6.4 Public road junctions

The merging elements of grade-separated junctions were modelled separately from the diverging elements. With other junction configurations, it was only possible to separate the merging and diverging elements on the free-flow T-junction configurations. It was not possible to make this distinction on T-junctions with and without a gap in the central reservation. Therefore, in the following sections, grade-separated junctions and free flow T-junctions are considered together while T-junctions with or without a gap in the central reservation, are considered separately. Furthermore, within the grade-separated and free-flow T junctions, the merging and diverging slips are considered separately.

The junction accident data in all the databases only include those accidents occurring within 100 metres of each junction which were, in some way, related to the junction. This method of classification is another departure from the STATS20 definition of a junction accident which states that all accidents occurring within 20 metres of a junction are coded as at the junction irrespective of whether or not they were related to the junction. Non-related accidents occurring adjacent to a junction were considered with accidents on the links as noted in Section 6.3.1.

The accident types considered are listed in Table 6.12.

Table 6.12 Number of accidents at junctions by junction and accident type

Accident type	Junction type				Total
	Off-slip	On-slip	T-gap	T no gap	
Stacking on minor road	10	49	3	2	64
Stacking on main road	12	7	9	3	31
Left turn enter or lane change joining from slip	–	47	14	2	63
Left turn leaving or lane change leaving at slip	16	–	2	2	20
Right turn from minor	–	–	18	1*	19
Right turn from central reservation to minor_	–	–	7	–	7
Right turn from main road	–	–	14	–	14
Right turn from c/r to main road	–	–	19	–	19
U turn from main road	–	1	22	–	23
Lane change to right on main road	5	20	7	1	33
Lane change to left on main road	5	1	–	–	6
Loss of control/vehicle drift	13	4	5	2	24
Other	2	2	2	–	6
Total	63	131	122	13	329

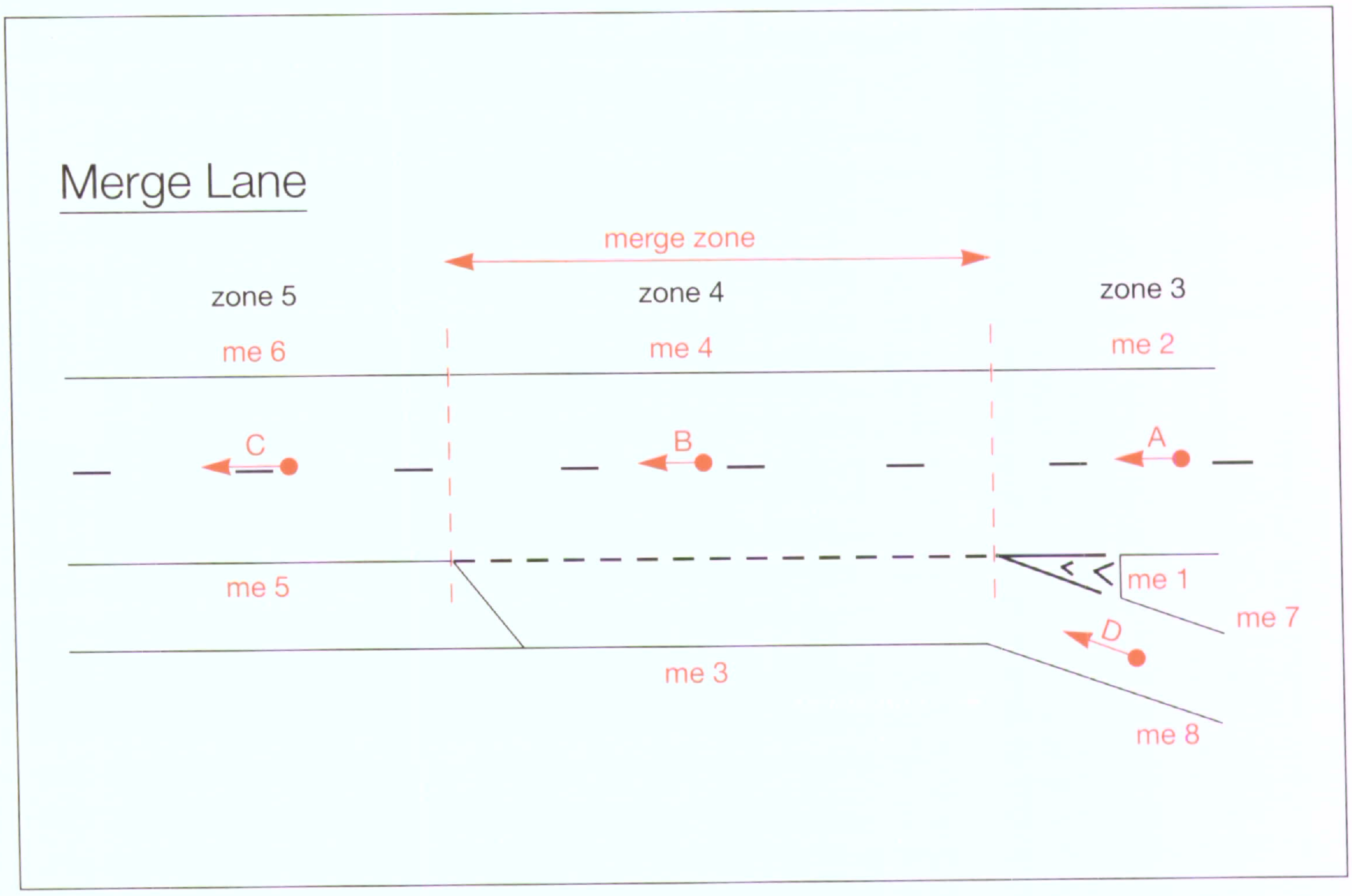
* illegal manoeuvre

6.4.1 Merging slip road junctions (On-slips)

Accident frequency

A comprehensive coverage of all major environmental characteristics which could influence the occurrence of accidents at a merging slip road junction was achieved by collecting the same road environment information at different points about the junction. Hedge, verge, aspect and kerb information were collected at one of eight locations surrounding the junction (me 1 to me 8 – see Figure 6.3), whereas forward visibility was collected at locations on the main and minor roads (A to D) – see Figure 6.3.

Figure 6.3
Environment data collection points for merge lane (on slip)



Among the other variables collected were the vertical alignment of the main and minor road, carriageway and merging lane width, slip road length, merge nosing length (hatched in Figure 6.3) and merging length. Also collected was the distance from the previous junction and the distance to the next junction.

Main road traffic flow was registered as the directional Average Annual Weekday Flow (AAWF) averaged over the period of interest. Minor road traffic flows were based on four hour manual counts which were factored up and averaged over the period of interest. The proportion of heavy goods vehicles was also recorded.

The following variables were found to have a significant association with the occurrence of accidents at merging junctions.

- **Minor road traffic flow**
  A 1,000 vehicle increase in the number of vehicles entering the main road from the minor road is associated, on average, with a 16 per cent increase in accidents.
- **Vertical alignment of on-slip**
  Compared to an on-slip arrangement where the vertical alignment is level, on-slips with positive vertical alignment, and ones with a negative vertical alignment are associated, on average, with increases in accident frequency of 350 per cent and 250 per cent respectively. On-slips with a sag or crest profile are associated with 500 per cent more accidents than those with level alignment.
- **Distance to next junction**
  As the distance to the next junction increases, accident frequency at the preceding junction decreases. A one kilometre increase in inter-junction distance is associated, on average, with a 26 per cent decrease in accident frequency.
- **Verge width on offside of on-slip**
  The presence of a wide verge on the offside of the on-slip (me 7 – Figure 6.3) is associated, on average, with a 90 per cent reduction in accident frequency (compared to a narrow verge).

- **On-slip merging length**
  Accident frequency decreases as the length of the merging lane between the end nosing and the end of the on-slip increases. A 100 metre increase in merging length is associated, on average, with a 26 per cent decrease in accident frequency.

Accident type
The environment variables used in the accident type analysis were the same as those used in the accident frequency analysis above, but, this time, they were coded for each accident rather than for groups of accidents.

The following variables were found to have a significant association with the type of accident occurring at merging slip road junctions:

- **Main road traffic flow**
  An increase in main road traffic flow of 1,000 vehicles per hour is associated, on averaged with an increase of 214 per cent in the odds of an accident involving stacking on the minor road.

- **Darkness**
  Darkness is associated, on average, with an increase of 429 per cent in the odds of an accident involving stacking on the minor road, and a decrease of 63 per cent in the odds of an accident involving a vehicle joining the main road from the slip road. (As outlined in Section 6.2, an increase in the odds of one accident type will inevitably be associated with a reduction in the odds of other types of accident).

- **Main carriageway width**
  An increase of one metre in main carriageway width is associated, on average, with a decrease of 56 per cent in the odds of an accident involving a vehicle joining the main road from a slip road, with a corresponding increase of 234 per cent in the odds of an accident involving stacking on the minor road.

- **Main road bend radius**
  An increase of one km in main road bend is related to an increase of 8 per cent in the odds of an accident involving stacking on the minor road. This can be interpreted in terms of the increased bend radius (less bendy road) being associated with relatively fewer accidents of other types rather than increasing numbers of accidents on the minor road.

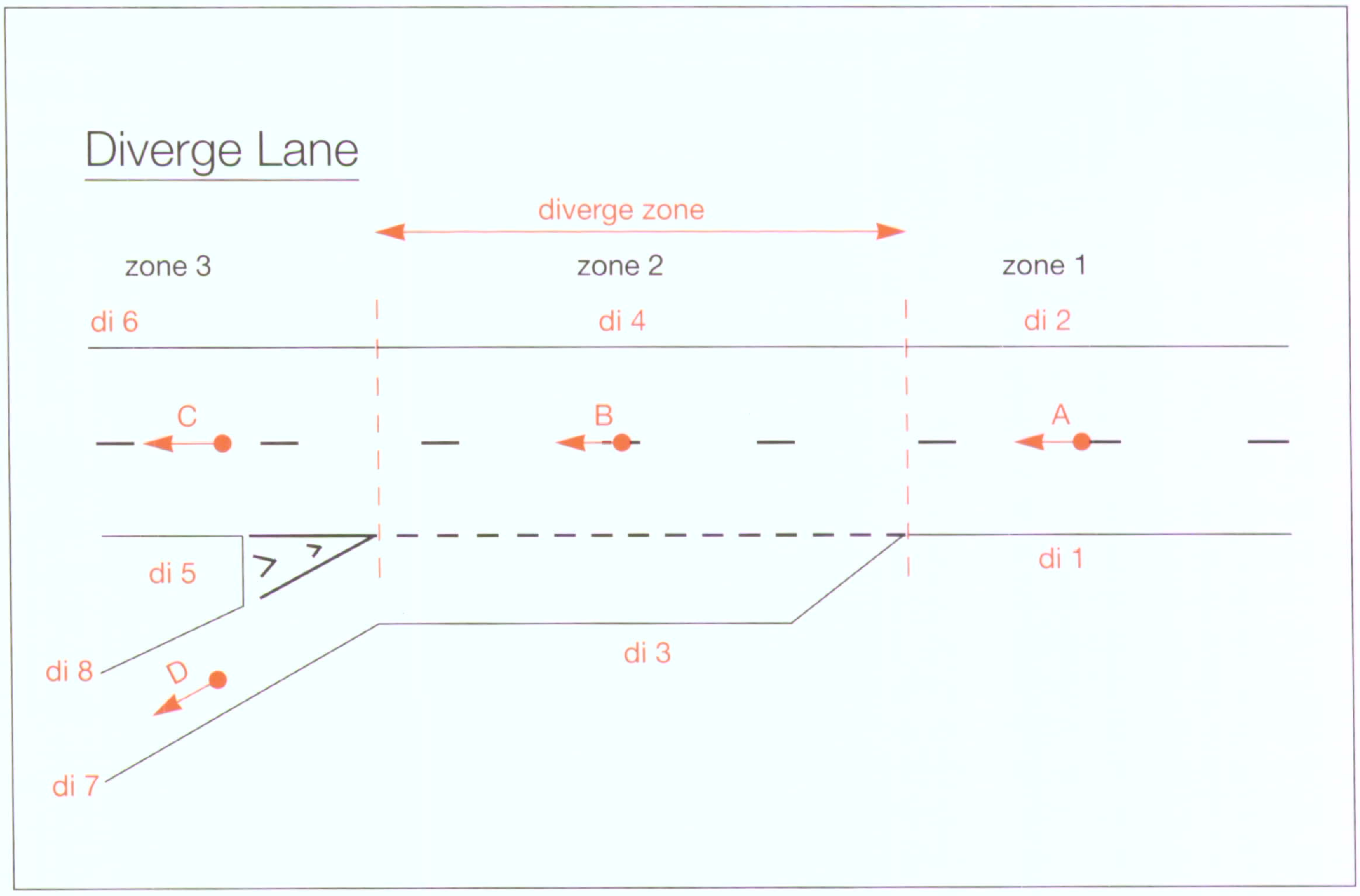
- **Vulnerable user involved**
  The presence of a vulnerable user (pedal cyclist or pedestrian) is associated, on average, with an increase of 257 per cent in the odds of an accident being either fatal or serious. (There was only one pedestrian accident in the sample, so this result is biased towards two-wheeled vehicle accidents).

- **Accident type**
  Stacking on the minor road is associated with a reduction of 93 per cent in the odds of an accident being either fatal or serious.

6.4.2 Diverging slip road junctions (off-slips)

Accident frequency
The environment variables collected for diverging slip roads were the same as those collected for merging slip roads. However, the locations around the junction for the collection of the environment variables were different (di 1- di 8 – Figure 6.4).

***Figure 6.4* Environment data collection points for diverge lane (off slip)**



The following variables were found to have a significant association with the occurrence of accidents at diverging slip road junctions:

- **Exit traffic flow**
  A 1,000 vehicle increase in the number of vehicles leaving the main road onto the minor road is associated, on average, with a 13 per cent increase in accidents.
- **Vertical alignment of off-slip**
  Compared to an off-slip arrangement where the vertical alignment is level or negative, off-slips with positive or crest vertical alignments, are associated, on average, with an increase of 124 per cent in accident frequency.
- **Distance to next junction**
  As the distance to the next junction increases, accident frequency at the preceding junction decreases. A one kilometre increase in inter-junction distance is associated, on average, with a 61 per cent decrease in accident frequency at the off-slip.
- **Verge width on offside of off-slip**
  The presence of a wide verge on the offside of the off-slip (di 8 – Figure 6.4) is associated, on average, with a 79 per cent reduction in accident frequency (compared to a narrow verge).
- **Hedge on nearside of diverging lane**
  The presence of a hedge on the nearside of a diverging lane (di 3 – Figure 6.4) is associated, on average, with a 43 per cent decrease in accidents.

Accident type

The environment variables used in the accident type analysis were the same as those used in the accident frequency analysis above, but, this time, they were coded for each accident rather than for groups of accidents.

The following variables were found to have a significant association with the type of accident occurring at diverging slip road junctions:

- **Vulnerable user involvement**
  The involvement of a vulnerable user (pedal cyclist, motor cyclist or pedestrian) at an off-slip junction is associated, on average, with an estimated increase, by a factor of times 12.9, in the odds of an accident being either fatal or serious (KSI). This figure is biased towards motor cyclists who were involved in 77 per cent of the vulnerable user accidents.
- **Street lighting**
  The presence of street lighting is associated, on average, with a reduction of 82 per cent in the odds of a KSI accident.

6.4.3 T-junctions with and without gaps

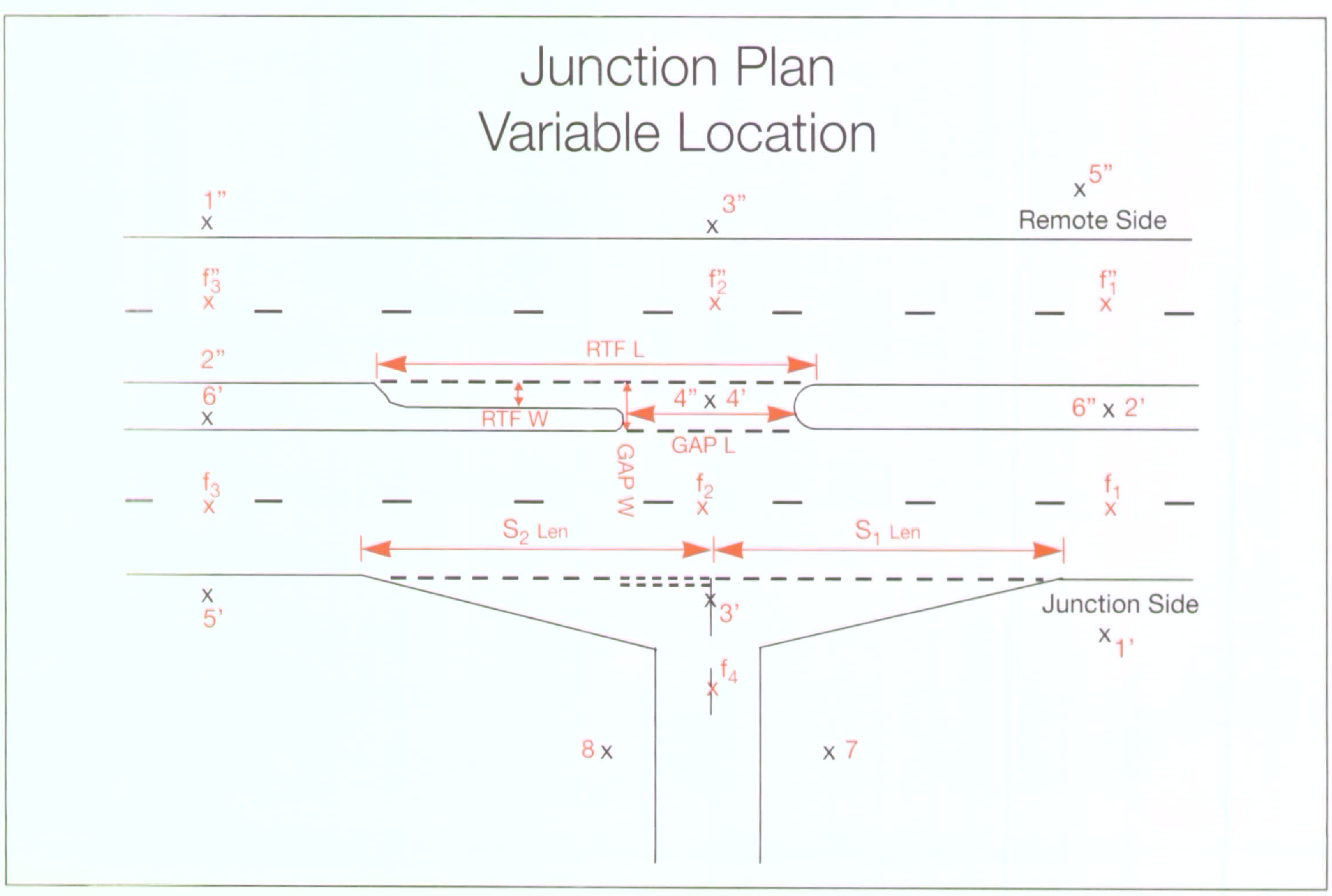
Accident frequency
T-junctions with and without gaps were the only junction configurations where the exit and entry points were not considered separately. It follows that the methodology for data collection also differed – see Figure 6.5.

For T junctions without a gap, environment information was collected at one of eight locations around the junction (1′ to 6′ in Figure 6.5 and locations 7 and 8). Forward visibility was coded at one of four locations (f1 to f4 in Figure 6.5). In addition, the lengths of the off-lane (S_1 Len) and on-lane (S_2 Len) were also documented.

For T-junctions served by a gap, all the above variables were recorded and, in addition, the same variables were recorded for the 'remote side' lane of the dual carriageway. Environment information was recorded at a further six locations (1″ to 6″ in Figure 6.5), and forward visibility at a further three locations (f''_1 to f''_3). This was necessary to account for accidents which may have occurred at the junction, but on the remote side carriageway. Further variables were recorded relating to the dimensions of the gap in the central reservation. The length (RTF L) and width (RTF W) of all dedicated right turn facilities were recorded, along with the length (GAP L) and width (GAP W) of the gap (Figure 6.4).

Main road traffic flow was registered as the directional Average Annual Weekday Flow (AAWF) averaged over the period of interest. As most junctions with a gap were on the A1, turning counts were determined from historical junction surveys, and were factored up to the relevant levels.

Figure 6.5 Environment data collection points for T-junctions with and without gaps



The following factors were found to have a significant association with accident frequency at T-junctions:

- **Minor road traffic flow**
  An increase of 1,000 vehicles per 16 hour Average Annual Weekday Flow (AAWF) entering the dual carriageways from the minor road is associated, on average, with an increase of 120 per cent in accidents at the junction.
- **Gap in central reservation**
  T-junctions served by a gap in the central reservation are associated, on average, with 270 per cent more accidents than T-junctions having no gap.
- **Traffic using gap in central reservation**
  A 10 per cent increase in the proportion of minor road traffic flow using a gap in the central reservation is associated, on average, with a nine per cent increase in accidents at the junction.

Accident type
The modelling in this section focused only on those T-junctions with a gap. While the dimensions of the gap and dedicated right turn facilities were coded for each accident, the environment information used for each accident depended on whether the accident had occurred on the junction side or remote side of the carriageway.

The following factors were found to have a significant association with the type of accident occurring at T-junctions with gaps:

- **Minor road traffic using gap**
  An increase of one per cent in the proportion of minor road traffic using the central reserve gap is associated, on average, with an increase of 3.5 per cent in the odds of an accident involving a right turn either from the minor road or from the central.
- **Gap width**
  An increase of one metre in the width of the central reserve gap is associated, on average, with a reduction of 15 per cent in the odds of an accident involving a right turn either from the minor road or from the central reserve.
- **Dedicated right turn lane**
  The presence of a dedicated right turn lane is associated, on average, with a reduction of 89 per cent in the odds of an accident involving a right turn from the main road. The presence of a dedicated right turn lane is also associated with an average reduction of 79 per cent in the odds of an accident being either fatal or serious.

6.5 Summary

- From the available data, the majority of wet skid accidents took place despite a "good" SCRIM value for the road surface. However, there are doubts as to validity of the standard method of obtaining SCRIM data for dual carriageways and the findings are further skewed by the impact of policies and priorities for maintenance of such roads.
- Factors associated with an increase in accident frequency on the inter-junction links:
  - Major road traffic flow
  - Bendiness
  - Approach to a roundabout
  - Central reservation gap
  - Open offside aspect

Accidents and the road environment

- Factors associated with a decrease in accident frequency on the inter-junction links:
  - Central reserve crash barrier
  - Nearside and offside kerbing
  - Offside hard strip
- Factors associated with an increase in accident frequency at junctions:
  - Increasing number of vehicles entering main road at on-slips
  - Increasing numbers of vehicles leaving main road at off-slips
  - Traffic flow from minor road at T-junctions
  - Non-level vertical alignment of on-slips
  - Positive vertical alignment of main carriageway at off-slips
  - Presence of gaps in the central reserve
  - Increasing proportion of traffic using a gap in the central reserve
- Factors associated with a decrease in accident frequency at junctions:
  - Increasing distance to next junction
  - Wide verge on offside of slips
  - Increasing on-slip merging length
  - Hedge on nearside of off-slip diverging lane

A number of other factors are associated with accident type and severity, although those listed above are the only ones to be associated with a change in accident frequency.

Chapter 7 What are the main conclusions?

This chapter brings together and discusses the main findings of the study. The implications of the findings and their possible practical application are also discussed.

The three groups of dual carriageways studied were of very different character and these differences emerged frequently during the study of the accidents on them. The three groups of routes studied were:

- A purpose built route **(A14 Group)** for long distance traffic, which was unlit, with very few central reserve gaps or private accesses and mainly well spaced grade separated junctions.
- A purpose built high speed urban distributor road **(Parkways Group)**, streetlit, with no private accesses or open central reserve gaps and relatively closely spaced grade separated junctions.
- A long haul route **(A1 Group)** which has been upgraded in a piecemeal fashion from an earlier single carriageway road with a mix of junction types including gaps in the central reserve and is unlit apart from at-grade roundabouts.

Comparisons with the earlier study of single carriageway 'A' class roads have been possible and the differences and similarities highlighted.

7.1 Main findings

Traffic volume

All the chosen routes were busy and some sections exceeded their design capacity by a substantial margin. Traffic volume alone could not account for the differences in accident numbers or characteristics between the groups. Clearly other factors, such as layout, are at work and influence the nature and number of the accidents.

It emerged that increasing traffic volume is associated with an increase in the odds of stacking accidents, both on the main carriageway and in the side roads where they join. Increasing side road traffic volume is associated with an increase in junction accidents, especially where there is a gap in the central reserve.

There were proportionately more accidents involving a heavy goods vehicle on dual carriageways compared to single carriageways. However, this is partly explained by greater numbers of heavy goods vehicles on the dual carriageways studied.

Junctions

At-grade roundabouts (which were only examined on the A1) were found to have the highest accident rates. This did not accord with the findings for single carriageways. Accidents at roundabouts tended to be less severe than elsewhere, but two-wheeled vehicles (powered or unpowered) were particularly at risk. The effect on accidents extended up to 5 km away on the approaches to roundabouts, with significant increases in accident frequency and increases in the odds of a stacking type accident. It is emphasised that the roundabouts studied are well separated. The findings might not apply to the same extent where roundabouts are very frequent on a rural (> 40 miles/h) dual carriageway network as is found in some "new town" layouts.

Generally speaking, the simpler the junction layout the better it performed in safety terms. Junctions with central reserve gaps had poor safety records, but accident severity was improved and the proportion of accidents involving right turning vehicles leaving the main road was less if a right turn lane was present. Accidents involving right turning or crossing the main carriageway at such locations were associated with older drivers and female drivers.

Grade separated junctions had the lowest accident rates but only the main carriageway and the joining lanes were examined. The other elements of the junction (i.e. the associated grade separated roundabout or priority junctions with the minor road) were not included and, taken overall, may present a different picture.

The design of slip roads was found to be an important factor with longer merges performing better. Also found to be significant were the alignment of the joining lane (preferably flat), a wide offside verge and a hedge on the nearside of the diverging lane. Two-wheeled vehicles are vulnerable where slip roads enter or leave the main carriageway.

The distance to the next junction (which in many cases was part of the same interchange) was found to be important. There was an increasing accident frequency observed as the distance fell. This has particular relevance to dual carriageways in an urban context, where distances between junctions are generally shorter.

Links

Increasing bendiness was found to be associated with an increase in the odds of loss of control accidents. The odds of a two-wheeled motor vehicle accident increases at bends, and the odds of any driver having an accident at a bend decreases with increasing age.

The presence of central reserve safety fencing, a non-open offside aspect, kerbing, or offside hard strips were found to be associated with a reduction in accident frequency.

The odds of a stacking accident were increased in road works (but, perhaps surprisingly, no similar association was found on the approach to the road works).

Fog or wet roads are associated with an increase in the odds of stacking accidents. Icy, frost or snow covered roads are associated with an increase in the odds of loss of control accidents.

The majority of wet skidding accidents took place on roads where the skidding resistance was "good", but this may be due to the high priority placed on the maintenance of dual carriageways.

However, the findings cast some doubt on the usefulness of the standard method of measuring skid resistance when applied to high speed dual carriageways. It is suggested that the method might be reviewed to obtain data about both lanes and is carried out at more representative speeds of dual carriageway travel.

Drivers

Proportionately fewer younger drivers were involved in accidents than was found for the single carriageway study. Younger drivers (17-29) were more likely to accept that an aspect of their own driving was to blame in single vehicle accidents than older drivers (30+), but, taken overall, the vast majority of drivers did not feel that their own driving contributed to their accidents. A minority of drivers identified road, weather or traffic conditions as a possible factor.

At the time of their accident most drivers were happy/contented/relaxed. Very few recalled being angry frustrated or tired. Generally speaking, female drivers found dual carriageway driving more difficult than did male drivers. However, the majority of responding drivers rated most of the tasks as "easy" or "very easy".

Older drivers were identified as having greater involvement in right turning or crossing the main carriageway accidents. However, there was no evidence of this task being rated as more difficult with increasing age. This was also observed in the previous single carriageway study. Similarly, younger drivers were identified as being more likely to have a loss of control accident at a bend. Although there was no specific question to cover this situation, the respondents' perception of the difficulty of judging distance and speed did not change with age.

Severity

Taken overall, accidents on dual carriageways have lower severity than on single carriageways. However, due to their greater numbers the cost is higher. Accidents on the routes studied cost nearly £22 million per annum (£190,000 per km per annum). Accidents occurring in darkness tend to have greater severity.

On the links, the involvement of a heavy goods vehicle (possibly due to their greater weight and therefore impact energy), or a two-wheeled vehicle or pedestrian (less / no protection from vehicle structure) is associated with an increase in accident severity. The odds of stacking accidents are increased if a heavy goods vehicle or bicycle are involved in the accident, and the odds of an accident involving loss of control are increased if a two-wheeled motor vehicle is involved. Stacking accidents tend to have lower severity, and the odds of this type of accident occurring increases with increasing traffic volume.

Speed

Despite attempting, via several means, to examine the role of speed in dual carriageway accidents, definite relationships remain elusive. The main difficulty is determining the speed of individual vehicles prior to their accidents. However, some tentative pointers can be drawn. The high incidence of loss of control and stacking accidents suggests that drivers tend to drive too fast, although those responding to questionnaires did not admit to it.

The commonly observed flow breakdown at high traffic volumes was examined. However, apart from the connection between increasing stacking accidents and increasing hourly flow, no clear relationships could be found. Indeed, the incidence of flow breakdown seems to be related not only to absolute main carriageway volume but also to whether that volume is increasing or decreasing at the next junction.

7.2 Discussion

The contrasting characters of the three groups of routes studied provided much evidence of the importance, from a safety point of view, of the good engineering design of dual carriageway roads. Junction type, design and layout, treatment of road edges and the use of central reserve safety fencing are all important determinants of a road's subsequent safety record. However, much of this engineering effort is directed at motor vehicles. It must not be forgotten that dual carriageways are all purpose roads and the more vulnerable users are very poorly catered for. That they are present in only very small numbers is indicative of the unattractiveness of such roads. Where they are present they face significant risks in several situations. Of particular concern is the vulnerability of two-wheeled vehicle users at slip roads and roundabouts. That accidents involving such vehicles tend to be more severe than average only increases the importance of devising new ways of protecting those involved.

7.2.1 The road

One unexpected finding relating to design was the association between a closed offside aspect and lower accident frequency. This may be due to drivers' attention being better focused on the road ahead or there may be other explanations. Whatever the underlying reason, it is a finding which may be a useful "mass action" in some circumstances. It may also present an opportunity for new planting in verges or central reserves.

The study has confirmed the value of closing central reserve gaps and having fewer, well spaced junctions. However, whilst diverging lanes are well signed (usually for directional purposes) and the manoeuvres executed at them generally don't conflict with the main carriageway flow, merging lanes, which have a higher accident frequency and represent potential conflict with the main carriageway flow, are unsigned. This effect is heightened in that the distance between off and on slip can be quite long or there may be no off slip at all in the case of limited access junctions. Better warning by means of signs or road marking may be an appropriate response. Longer merging lengths also seem to be associated with fewer accidents.

Given the general upward trends, over time, in traffic volume, we can expect increasing accident numbers, especially of the stacking type, unless fundamental changes in driver behaviour occur. The accident costs involved (calculated at £190,000 per km per annum at existing accident levels in the study) are sufficiently high to warrant considerable investment with a potentially excellent return.

7.2.2 The driver

As was found with the single carriageway study, a substantial proportion of the accidents is attributable to driver attitude, judgement and attention. Primarily the drivers' reluctance to accept that their driving is at fault (even when they were the only vehicle involved!) is a major concern. The study's findings (Chapter 5) paint a picture whereby drivers are quite happy / contented / relaxed prior to their accident. Aggressive driving does not appear to be a major factor. This points to complacency or inattention being a significant element.

This view is perhaps heightened by the fact that the drivers were, on the whole, experienced and familiar with the route. Perhaps highway and car design have created the situation whereby drivers are no longer required to pay their full attention to the task and are tending to drive "passively " instead of "actively" and only respond to situations rather than anticipating them. Of course, for the vast majority of drivers accidents are a very rare event; nonetheless, those involved in accidents have clearly failed to respond appropriately, or in time to the situation that arose.

Despite the lack of firm evidence, inappropriate speed is still thought to be a factor underlying a substantial proportion of dual carriageway accidents. On first sight this might be thought contradictory to the view set out in the previous paragraph. However, it may be the case that the general inattention to the task in hand extends to consideration of the appropriate speed for the various driving situations encountered. This is an important area which requires research that is beyond the scope of this study.

Changing the "culture" of a nation of drivers is a very major undertaking. It is recognised that any change will be in the long term. If significant reduction in the human and financial cost of road accidents is to be achieved this issue must be successfully addressed. The main messages seem to be :

- That accidents can be avoided by appropriate driving style and anticipation of potential conflicts (there is some evidence from other work that adopting "defensive driving" techniques reduces the chances of being involved in an accident).
- That the judgement necessary to safely execute right turning manoeuvres deteriorates with age.

What are the main conclusions?

7.3 Conclusions

This study is the conclusion of a four year programme which has latterly focused on the factors behind road accidents on the "A" class road network. That these roads are experiencing traffic growth is a pointer towards increasing accident numbers unless interventions are made.

The importance of good road design has been highlighted (perhaps more so than in the single carriageway road case where less major re-engineering of routes has taken place). There will always be opportunities for road modification with the aim of improving safety, and excellent local returns can be shown from such investment. It is the view of the researchers, based on two studies of rural 'A' class roads, that a significant impact on total accident numbers could additionally be achieved through a shift in driver attitudes. Drivers frequently represent the weak link in the system. It is recognised that this is a major undertaking that will not happen in a short time scale, but the issue needs to be faced.

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The views expressed are those of the authors and not necessarily those of Cambridgeshire County Council or the AA Foundation for Road Safety Research.

Appendix A Road environment parameters

The following parameters were collected for the general accident database, and for the accident frequency and accident types databases. The latter databases were split between links and junctions.

STATS19 databases

Data for the general accident database were derived from the Police completed STATS19 forms. An example of such a form is enclosed (Table A1). The following data supplied on the STATS19 forms were modified:

- 'Going ahead left bend' and 'going ahead right bend' were changed to 'going ahead on a bend'.
- 'Overtaking a moving vehicle on the offside' was re-coded to either 'going ahead – other', 'changing lane to left' or 'changing lane to right'.
- Vehicle manoeuvres involving entering or leaving a dual carriageway at a grade separated junction, or free-flow T-junction configuration were changed from 'turning left' to 'changing lane to right' or 'changing lane to left'. 'Turning left' was only retained for simple T-junctions or staggered T-junctions.
- 'Turning right' was only permitted at junctions served by a gap.

The following variables were added to the database in order to increase the scope of the analyses:

- A variable called 'turning left crossing carriageway' was introduced for those vehicles using a gap at a staggered T-junction.
- New accident locations were introduced for 'T-junctions not served by a gap', 'T-junctions served by a gap', 'Staggered or cross roads' and 'Free-flow T-junctions'.
- A variable called 'Lane' was introduced which gave the location on the dual carriageways of each vehicle involved in the accident. The categories were 'Minor road', 'Lane 1 (nearside)', 'Lane 2 (offside)', 'Gap in central reservation', 'In lay-by' or 'On hard shoulder'.
- Accident type codes were introduced to describe the different types of accidents. A full listing can be found in Appendix D. The general categories were 'Loss of control', 'Turning related', 'Lane change', 'Stacking', 'Vehicle drift' and 'Other'.

Environment Databases

In addition to all the above variables, the location specific databases contained environment information. The following variables were common to all the databases, though the way they were collected varied. The reader is referred to the relevant diagrams and descriptions in Chapter 6 for further information on collection methodology.

The variables collected included:

- **Hedges and trees** categorised as 'none', low' or high'.
- **Aspect** categorised as 'closed', 'normal' or 'open'.
- **Kerbing** categorised as 'present' or 'not present'.
- **Verge** categorised as 'narrow' or 'wide'.

- **Forward visibility** categorised as 'good' or 'poor'.
- **Centreline** categorised as 'demarcation' or 'hazard'.
- **Hardstrip** categorised as 'none', 'less than 0.5 metre wide', '0.5 to 1 metre wide' or 'greater than 1 metre'.
- **Vertical alignment** categorised as 'level', 'positive' or 'negative'.
- **Bendiness.**
- **Carriageway profile** categorised as 'at-grade', 'cutting', 'embankment' or 'viaduct'.
- **Carriageway width** measured in metres.
- **Directional traffic flow** measured as 16 hour AAWF.

Aspect, hedges and trees, kerbing hardstrip and verge width were measured for both the nearside and offside (central reservation) of the carriageway.

Accident frequency – links database

In addition to the variables listed above, the following were also collected for the accident frequency links database. The road network was divided into 364 (directional) links.

- **Link length** measured in metres.
- **Accidents in section** excluding those which occurred in road works.
- **Number of 'on' junctions** on a given section length.
- **Number of 'off' junctions** on a given section length.
- **Number of Service Stations** on a given section length.
- **Number of lay-bys** on a given section length.
- **Number of gaps in the central reservation** on a given section length.
- **Central reservation crash barrier.**
- **Proximity to roundabout** categorised as 'within 100 metres', 'between 101 and 500 metres', 'between 501 metres and 1500 metres' 'between 1501 metres and 5000 metres' or 'greater than 5000 metres'.
- **Hourly flow** categorised as 'number of hours with less than 500 vehicles', 'number of hours with more than 1500 vehicles' or 'number of hours with more than 2000 vehicles'.
- **Wearing course material** categorised as 'concrete' or 'other'.

Changes which had taken place in the road environment were accommodated by averaging over time. Each category of a variable was expressed as a proportion of total link length.

Accident types – links database

The variables collected for the accident types database were virtually the same as those collected for the accident frequency database, but the way they were collected was different. Instead of each category of each variable being expressed as a proportion of total link length, the actual variable category was recorded for each accident location.

- **Service Stations** on a given section length.
- **Lay-bys** on a given section length.
- **Central reservation crash barrier.**

Road environment parameters

- **Proximity to roundabout** categorised as 'within 100 metres', 'between 101 and 500 metres', 'between 501 metres and 1500 metres' 'between 1501 metres and 5000 metres' or 'greater than 5000 metres'.
- **Hourly flow** at time of accident.
- **Wearing course material** categorised as 'concrete' or 'other'.
- **Road works** categorised as 'in works', 'within 5 km of works' or 'beyond 5 km of works'.
- **Crest or Sag**.
- **Distance to next junction** in metres.
- **Distance from previous junction** in metres.

Services, crests, sags and lay-bys were coded as 'within 100 metre of feature', '101 to 200 metres from feature', '201 to 300 metres from feature', '301 to 400 metres from feature' '401 to 500 metres from feature' or 'more than 500 metres from feature'.

Accident frequency and accident types – merging and diverging lane databases

The reader is referred to Figures 6.3 and 6.4 for reference on how the environment variables were collected for these databases. In addition to those environment variables outlined earlier, the following were also collected for these databases.

- **Merging lane** was categorised as 'present' or 'not present'.
- **Diverging lane** was categorised as 'present' or 'not present'.
- **Merging lane length** was measured in metres.
- **Diverging lane length** was measured in metres.
- **Street lighting** was categorised as 'present' or 'not present'.
- **Merging lane and diverging lane width** measured in metres.
- **Vertical alignment of merging lane or diverging lane** categorised as 'level', 'positive', 'negative', 'crest' or 'sag'.
- **Distance to next junction** measured in metres.
- **Distance from previous junction** measured in metres.
- **Length of merging lane and diverging lane nosing** measured in metres.
- **Internal bend angle on merging and diverging lane** measured in degrees.
- **16 hour AAWF traffic flow** on merging lane.
- **16 hour AAWF traffic flow** on diverging lane.

Accident frequency and accident types – T junctions served by, and not served by gaps.

The reader is referred to Figure 6.5 for reference on how the environment variables were collected for these databases. No distinction is made within the following list between those variables relating to T-junctions served by a gap and those T-junctions without a gap. The following additional variables were collected..

- **Off-lane length** measured in metres.
- **On-lane length** measured in metres.
- **Length of junction** measured from addition of off-lane length and on-lane length.
- **Street lighting** was categorised as 'present' or 'not present'.

Road environment parameters

- **Minor road width** measured in metres.
- **Vertical alignment of minor road** categorised as 'level', 'positive', 'negative', 'crest' or 'sag'.
- **Distance to next junction** measured in metres.
- **Distance from previous junction** measured in metres.
- **Internal bend angle on merging and diverging lane** measured in degrees.
- **Minor road traffic flow** (combined direction).
- **Minor road traffic flow using gap in central reservation.**
- **Heavy goods vehicle proportion using gap in central reservation.**
- **Gap in central reservation** categorised as 'present' or 'not present'.
- **Gap length** in metres.
- **Gap width** in metres.
- **Dedicated right turn lane in central reservation** categorised as 'present' or 'not present'.
- **Length of dedicated right turn lane** in metres.
- **Width of dedicated right turn lane** in metres.

Table A1 STATS19 form

CAMBRIDGESHIRE CONSTABULARY — ROAD ACCIDENT STATS19

ATTENDANT CIRCUMSTANCES

PNC CODE FOR SUBDIVISION WHERE ACCIDENT OCCURRED [3][5][ ][ ]

PNC / DVLC CODE FOR BASE OF OFFICER DEALING [3][5][ ][ ]

1.03 ACCIDENT REFERENCE NUMBER
To be completed by AEU

1.04 SEVERITY OF ACCIDENT 1 Fatal 2 Serious 3 Slight

1.07 DATE Day Month Year

1.08 DAY OF WEEK 1 Sunday 2 Monday 3 Tuesday 4 Wednesday 5 Thursday 6 Friday 7 Saturday

1.09 TIME (24 HOUR CLOCK) Hours. Mins

1.11 LOCATION Ordnance Survey Grid Reference
→ Easting → [5] ↑ Northing ↑ [3/2]

1.12 MAIN ROAD CLASS
1 M 3 A 4 B 5 C 6 Unclassified

1.13 MAIN ROAD NUMBER

1.14 CARRIAGEWAY TYPE OR MARKINGS
1 Roundabout
2 One way street
3 Dual carriageway-2 lanes each way
4 Dual carriageway-3 or more lanes
5 Single carriageway-single track
6 Single carriageway-2 lanes
7 Single carriageway-3 lanes
8 Single carriageway-4 lanes
9 Other or unknown

1.15 SPEED LIMIT (m.p.h)

1.16 JUNCTION DETAIL
0 Not at or within 20m of junction
1 Roundabout
2 Mini roundabout
3 'T' or staggered junction
4 'Y' junction
5 Slip road
6 Crossroads
7 Multiple junction
8 Private drive IN USE
9 Other junction

1.20 PEDESTRIAN CROSSING FACILITIES
0 None within 50 metres
1 Zebra
2 Zebra with school crossing patrol
3 Zebra with other authorized person
4 Pelican (or puffin)
5 Other light controlled crossing
6 Other site with school crossing patrol
7 Other site with other authorised person
8 Central refuge alone
9 Footbridge or subway

1.21 LIGHT CONDITIONS
Day
1 Street lights present
2 No street lights
3 Presence of street lights unknown
Dark
4 Street lights lit
5 Street lights present but unlit
6 No street lighting
7 Unknown street lighting

1.22 WEATHER
1 Fine (without high winds)
2 Raining (without high winds)
3 Snowing (without high winds)
4 Fine and windy
5 Raining and windy
6 Snowing and windy
7 Fog (or mist if a hazard)
8 Other
9 Unknown

1.23 SURFACE CONDITION
1 Dry 2 Wet/damp 3 Snow 4 Frost/Ice 5 Flood (> 3cm)

1.24 SPECIAL CONDITIONS AT SITE
0 None
1 Automatic traffic signal out
2 Automatic traffic signal partially defective
3 Permanent road sign defective or obscured
4 Road works present
5 Road surface defective

1.25 CARRIAGEWAY HAZARDS
0 None
1 Dislodged vehicle load in carriageway
2 Other object in carriageway
3 Involvement in previous accident
4 Dog in carriageway
5 Other animal in carriageway
6 Uninjured pedestrian in carriageway

1.17, 1.18 & 1.19 - COMPLETE FOR JUNCTION ACCIDENTS ONLY

1.17 JUNCTION CONTROL
1 Authorised person
2 Automatic traffic signal
3 Stop sign
4 Give way sign or markings
5 Uncontrolled

1.18 MINOR ROAD CLASS
1 M 3 A 4 B 5 C 6 Unclassified

1.19 MINOR ROAD NUMBER

DIAGRAM OF MOVEMENTS ○ Show north using a map

Please show location, road numbers or names and movements of vehicles and pedestrians numbered as in this report - to show what actually happened in the accident

1.28 PARISH NAME

PARISH NUMBER (to be completed at HQ)

1.31 EXACT LOCATION

1.99 CONTRIBUTORY FACTORS
Please refer to list of factors
First Second Third Fourth Fifth Sixth

1.33 DESCRIPTION OF ACCIDENT

FORM 624 (Rev. 01/94)

	VEHICLE DETAILS	**1.05**	**TOTAL NUMBER OF VEHICLES**	
2.99	Please enter the reference number of the vehicle which you think was mainly at fault. If blame was equally shared or cannot be attributed please enter **00**. If a pedestrian was mainly at fault please enter **PP**			

2.04	**VEHICLE REFERENCE NUMBER**			
4.01	**REGISTRATION NUMBER** Please enter the registration number of all motor vehicles except those with foreign, military or trade plates. PLEASE DO NOT LEAVE SPACES			
2.05	**TYPE OF VEHICLE** **01** Pedal cycle **02** Moped **03** Motor Scooter **04** Motor cycle **05** Combimation **06** Invalid tricycle **07** Other three wheeled car **08** Taxi **09** Car (four wheeled) **10** Minibus **11** Bus or coach **12** Goods not over 3.5 tonnes MGVW **13** Goods over 3.5 tonnes MGVW **16** Milk float **17** Ambulance **18** Fire tender **19** Agricultural tractor **20** Other slow plant **21** Motor caravan **22** Horse **14** Other motor vehicle **15** Other non - motor vehicle			
2.06	**TOWING & ARTICULATION** **0** None **1** Articulated **2** Double or multiple trailer **3** Caravan **4** Single trailer **5** Other tow			
2.07	**MANOEUVRES** **01** Reversing **02** Parked **03** Waiting to go but held up **04** Stopping **05** Starting **06** Making U-turn **07** Turning left **08** Waiting to turn left **09** Turning right **10** Waiting to turn right **11** Changing lane to left **12** Changing lane to right **13** Overtaking moving veh on o'side **14** Overtaking stationary vehicle on its offside **15** Overtaking on nearside **16** Going ahead left bend **17** Going ahead right bend **18** Going ahead other			
2.08	**VEHICLE MOVEMENT** **1** N **2** NE **3** E **4** SE **5** S **6** SW **7** W **8** NW **0** In 'To' box - parked at kerb **0** In BOTH boxes - parked but not at kerb	From To	From To	From To
2.09	**LOCATION AT TIME OF ACCIDENT** **01** Leaving main road **02** Entering main road **03** On main road **04** On minor road **05** On service road **06** On lay-by or hard shoulder **07** Entering lay-by or hard shoulder **08** Leaving lay-by or hard shoulder **09** On cycleway **10** Not on carriageway			
2.10	**LOCATION IN JUNCTION ON IMPACT** **0** Not at or within 20 m of junction **1** Approaching junction or parked on junction approach **2** Vehicle in middle of junction **3** Cleared junction or parked on junction exit **4** At junction, but no impact			
2.11	**SKIDDING** **0** No skidding, jack-knifing or overturning **1** skidded **2** Skidded and overturned **3** Jack-knifed **4** Jack-knifed & overturned **5** Overturned			
2.12	**HIT OBJECT IN CARRIAGEWAY** **00** None **01** Previous accident **02** Road works **03** Parked vehicle - lit **04** Parked vehicle - unlit **05** Bridge (roof) **06** Bridge (side) **07** Bollard / refuge **08** Open door of vehicle **09** Roundabout central island **10** Kerb **11** Other object			
2.13	**VEHICLE LEAVING CARRIAGEWAY** **0** Did not leave carriageway **1** Left carriageway nearside **2** Left c/w nearside & rebounded **3** Left c/w straight on at junction **4** Left c/w offside onto central reserve **5** Left offside onto central reserve & rebounded **6** Left c/w offside & crossed central reserve **7** Left carriageway offside **8** Left carriageway offside & rebounded			
2.14	**HIT OBJECT OFF CARRIAGEWAY** **00** None **01** Road sign or traffic signal **02** Lamp post **03** Telegraph or electricity pole **04** Tree **05** Bus stop or shelter **06** Central crash barrier **07** Nearside or offside crash barrier **08** Completely submerged in water **09** Entered ditch **10** Other permanent object			
2.16	**FIRST POINT OF IMPACT** **0** Did not impact **1** Front **2** Back **3** Offside **4** Nearside			
2.17	**OTHER VEHICLE HIT / HIT BY** **00** If no impact with another vehicle Otherwise enter the reference number of the first vehicle which hit or was hit by this veh.			
2.18	**PARTS DAMAGED** Complete from left leaving blanks to right if necessary **0** None **1** Front **2** Back **3** Offside **4** Nearside **5** Roof **6** Underside **7** All four sides	1st 2nd 3rd	1st 2nd 3rd	1st 2nd 3rd
2.25	**SPECIAL PROJECTS** Pedal cycle or other non-motorised vehicle - **Leave Blank** **1** Motorised vehicle without bull bars **2** Motorised vehicle with bull bars			

PERSON DETAILS

TOTAL NUMBER OF CASUALTIES ☐☐

VEHICLE DRIVERS AND RIDERS

Please enter details of **ALL** drivers and riders, whether or not they were injured

3.04	**VEHICLE REFERENCE NUMBER** Reference number of vehicle which the person was driving or riding	☐☐	☐☐	☐☐
3.06	**PERSON TYPE** 1 Driver or rider	1	1	1
3.07	**SEX** 1 Male 2 Female 3 Unknown	☐	☐	☐
3.08	**AGE** Enter age in years. 00 Babies under 1 year old Blank Unknown age	☐☐	☐☐	☐☐
2.23	**BREATH TEST** 0 Not applicable 1 Positive 2 Negative 3 Not requested 4 Failed to provide 5 Driver not contacted at time 6 Doctor refused permission	☐	☐	☐
2.24	**NON-STOP DRIVER** 0 Driver stopped 1 Hit and run 2 Non-stop vehicle, not hit	☐	☐	☐
2.25	**MOTOR CYCLE RIDER'S LICENCE** 0 Not known 1 Provisional licence holder 2 Full licence holder Blank For drivers of vehicles other than mopeds, motor cycles, motor scooters or motor cycle combinations	☐	☐	☐
3.05	**CASUALTY REFERENCE NUMBER (If driver or rider was injured)** Enter casualty number as in HO/RT 7	☐☐	☐☐	☐☐
3.09	**CASUALTY SEVERITY** 1 Fatal 2 Serious 3 Slight	☐	☐	☐
3.13	**SCHOOL PUPIL** 1 School pupil on journey to or from school only 0 All other casualties	☐	☐	☐
3.99	**CYCLE HELMET USAGE** Only complete for pedal cyclists 0 Not wearing cycle helmet 1 Wearing cycle helmet Blank Not pedal cyclist	☐	☐	☐

Please complete for ALL drivers and riders (3.04–2.25)

Please complete only if driver or rider was INJURED (3.05–3.99)

INJURED PASSENGERS

Please enter details of all INJURED passengers

3.04	**VEHICLE REFERENCE NUMBER** Please enter reference number of the vehicle in which the person was travelling	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
3.05	**CASUALTY REFERENCE NUMBER** Enter casualty number as in HO/RT 7	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
3.06	**PERSON TYPE** 2 Passenger	2	2	2	2	2	2	2	2
3.07	**SEX** 1 Male 2 Female 3 unknown	☐	☐	☐	☐	☐	☐	☐	☐
3.08	**AGE** Enter age in years. 00 Babies under 1 year old. Blank unknown age	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
3.09	**CASUALTY SEVERITY** 1 Fatal 2 Serious 3 Slight	☐	☐	☐	☐	☐	☐	☐	☐
3.15	**CAR PASSENGER** 0 Not a car passenger 1 Front seat passenger 2 Rear seat passenger	☐	☐	☐	☐	☐	☐	☐	☐
3.16	**BUS OR COACH PASSENGER** 0 Not a bus or coach passenger 1 Boarding 2 Alighting 3 Standing passenger 4 Seated passenger	☐	☐	☐	☐	☐	☐	☐	☐
3.13	**SCHOOL PUPIL** 1 School pupil on journey to or from school 0 All other casualties	☐	☐	☐	☐	☐	☐	☐	☐

INJURED PEDESTRIANS

Please enter details of all INJURED pedestrians

3.04	**VEHICLE REFERENCE NUMBER** **Reference number of vehicle which HIT the pedestrian**	☐☐	☐☐	☐☐	☐☐
3.06	**PERSON TYPE** 3 Pedestrian	3	3	3	3
3.07	**SEX** 1 Male 2 Female 3 Unknown	☐	☐	☐	☐
3.08	**AGE** Enter age in years. 00 Babies under 1 year old. **Blank** Unknown age	☐☐	☐☐	☐☐	☐☐
3.10	**PEDESTRIAN LOCATION** 01 In carriageway, crossing on pedestrian crossing 02 In carriageway, crossing within zig-zag at crossing approach 03 In carriageway, crossing within zig-zag at crossing exit 04 In carriageway, crossing elsewhere within 50m of pedestrian crossing, 05 In carriageway, crossing elsewhere 06 On footway or verge 07 On refuge, central island or central reservation 08 In centre of carriageway, not on refuge, central island or central reservation 09 In carriageway not crossing 10 Unknown location	☐☐	☐☐	☐☐	☐☐
3.11	**PEDESTRIAN MOVEMENT** 01 Crossing from driver's nearside 02 Crossing from driver's nearside, masked by parked or stationary vehicle 03 Crossing from driver's offside 04 Crossing from driver's offside, masked by parked or stationary vehicle 05 In carriageway, stationary -not crossing (standing or playing) 06 In carriageway, stationary -not crossing, masked by parked or stationary vehicle 07 Walking along in carriageway - facing traffic 08 Walking along in carriageway - back to trafic 09 Unknown movement	☐☐	☐☐	☐☐	☐☐
3.12	**PEDESTRIAN MOVING TOWARDS** 0 Standing still 1 N 3 E 5 S 7 W 2 NE 4 SE 6 SW 8 NW	☐	☐	☐	☐
3.05	**CASUALTY REFERENCE NUMBER** **Enter casualty number as in HO/RT 7**	☐☐	☐☐	☐☐	☐☐
3.09	**CASUALTY SEVERITY** 1 Fatal 2 Serious 3 Slight	☐	☐	☐	☐
3.13	**SCHOOL PUPIL** 1 School pupil on journey to or from school 0 All other casualties	☐	☐	☐	☐

SCHOOL ATTENDED

Please complete a separate block for each casualty (rider, passenger or pedestrian) who is a school pupil

FIRST SCHOOL PUPIL - CASUALTY REFERENCE NO. **(See 3.05 - Rider, Passenger or Pedestrian)** ☐☐ **3.19 SCHOOL ATTENDED** ______	**THIRD SCHOOL PUPIL - CASUALTY REFERENCE NO.** **(See 3.05 - Rider, Passenger or Pedestrian)** ☐☐ **3.19 SCHOOL ATTENDED** ______
SECOND SCHOOL PUPIL - CASUALTY REFERENCE NO. **(See 3.05 - Rider, Passenger or Pedestrian)** ☐☐ **3.19 SCHOOL ATTENDED** ______	**FOURTH SCHOOL PUPIL - CASUALTY REFERENCE NO.** **(See 3.05 - Rider, Passenger or Pedestrian)** ☐☐ **3.19 SCHOOL ATTENDED** ______

Appendix B Rural road accident survey - responses

Please answer all questions in this questionnaire by either ticking the appropriate box(es) or writing in the required detail. Any information that you give will of course be treated in the strictest confidence.

% may not equal 100 due to rounding

Section 1: Your accident

Q1 On the day of your accident, where were you travelling from?

______________________________ (Town / City)

Q2a How far into your journey were you at the time of the accident?

PLEASE WRITE IN ________________ miles

2**b** How much further had you left to go?

PLEASE WRITE IN ________________ miles

Q3 On average, how often did you travel along the road on which you had your accident?
Tick One Box

		%
Daily or nearly every day	153	33.0
Once a week	75	16.2
Once a month	67	14.4
Less than once a month	137	29.5
Never before	32	7.5
Valid cases – 464		

Q4 Up to the moment of the accident, had you driven continuously since the time you started the journey?
Tick One Box

		%
No	114	24.7
Yes	347	75.3
Valid cases – 461		

Q5 How long had you been driving since your *last* break? If you had not stopped, how long was it since you started your journey?
Tick One Box

	%	
Less than half an hour	201	43.9
Between half an hour and 1 hour	108	23.6
1–2 hours	101	22.1
2–4 hours	40	8.7
4–8 hours	3	0.7
Over 8 hours	5	1.1
Valid cases – 458		

Q6 What was the main purpose of your journey?
Tick One Box

		%
Travelling to / from place of work / study	113	24.3
Business or as part of your job	119	25.6
Visiting friends	73	15.7
Travelling or going on holiday	29	6.2
Shopping	12	2.6
Taking children to / from school	4	0.9
Other social / domestic reason	105	22.6
Other reason	10	2.2
Please specify		

Valid cases – 465

Q7 Who accompanied you on the journey?
Tick All That Apply

		%
Nobody	252	53.8
Parent(s)	13	2.8
Child / children	67	14.3
Other members of your family	107	22.9
Friend(s)	44	9.4
Work colleague(s)	21	4.5
Hitchhiker(s)	1	0.2
Family pet(s)	11	2.4
Someone else	10	2.1

Categories are not mutually exclusive

Q8 What type of vehicle were you driving / riding when the accident happened?
Tick One Box

		%
Motorcycle, moped or motor scooter	12	2.6
Car	371	79.8
Light goods vehicle	22	4.7
Heavy goods vehicle	42	9.0
Bus or minibus	6	1.3
Other type of vehicle	12	2.6
Please specify		

Valid cases – 465

If you were a MOTORCYCLIST, go to Question 9. Otherwise go to Question 10

Q9 Were you wearing any clothing which would help other road users see you?
Tick Box And Give Details

		%
No	10	71.4
Yes	4	28.6
Please specify		

Valid cases – 14

Q10 Were you towing anything behind your vehicle?
Tick One Box

			%
No	**Go to Question 11**	419	92.3
Yes		35	7.7
Valid cases – 454			

If yes, what were you towing?
Tick One Box

		%
Caravan	4	11.1
Trailer	30	83.3
Horsebox		
Other	2	5.6
Please specify		
Valid cases – 36		

Q11 What was the make, model and engine size of the vehicle?

Make (eg Ford) ______________________

Model (eg Escort) ______________________

Engine size ______________________ cc

	Engine Size		%
< 1000 cc		48	11.7
1001–1500 cc		114	27.8
1501–2000 cc		207	50.5
> 2000 cc		41	10.0
Valid cases 411			

Q12 Is this the vehicle you normally drove?
Tick One Box

		%
Yes	417	90.8
No	42	9.2
Valid cases – 459		

Q13 How often had you driven this vehicle?
Tick One Box

		%
Daily or nearly every day	415	90.6
Once a week	21	4.6
Once a month	5	1.1
Less than once a month	10	2.2
Never before	7	1.5
Valid cases – 458		

Q14 Please describe briefly how the accident happened.

____

____

____

Accidents on Rural Roads: Dual Carriageway 'A' Class Roads

Q15 In which lane of the dual carriageway were you travelling when the accident occurred?
Tick One Box

		%
Nearside (inside lane)	148	32.2
Offside (outside lane)	244	53.2
Slip road off to the left	6	1.3
Slip road on from the left	20	4.4
Dedicated right hand turn lane	6	1.3
Changing lanes from inside to outside	13	2.8
Changing lanes from outside to inside	10	2.2
On hard shoulder or lay-by	7	1.5
Crossing dual carriageway	3	0.6
On minor road	2	0.4

Valid cases – 459

Q16 When the accident happened, were you:
Tick One Box

		%
Stationary (parked)	16	3.5
Stationary (waiting to go ahead)	89	19.4
Going ahead round a bend	22	4.8
Entering from left or waiting to enter from left	15	3.3
Leaving main road to left or waiting to leave to left	9	2.0
Turning right, crossing main road or u-turning using a gap in the central reserve (or waiting to do any of these)	19	4.1
Changing lane	27	5.9
Overtaking	73	15.9
Going ahead	151	33.0
Stopping or slowing down	37	8.1
Please specify		

Valid cases – 458

If you were ENTERING OR LEAVING THE MAIN ROAD, USING A GAP ON THE CENTRAL RESERVE OR CHANGING LANE go to question 17.

If you were OVERTAKING, go to Question 18.
Otherwise, go to Question 19.

Q17 What type of vehicle did you turn in front of?
Tick One Box

		%
None	10	34.5
Pedal cycle	-	-
Motorcycle, moped or motor scooter	1	3.4
Car	12	41.4
Light goods vehicle	1	3.4
Heavy goods vehicle	4	13.8
Bus or minibus	-	-
Other type of vehicle	-	-
Please specify		

Valid cases – 29

Please go to Question 19

Q18 What type of vehicle were you passing?
Tick One Box

		%
Pedal cycle		
Motorcycle, moped or motor scooter		
Car	31	43.7
Light goods vehicle	9	12.7
Heavy goods vehicle	26	36.6
Bus or minibus	1	1.4
Other type of vehicle	4	5.6
Please specify		

Valid cases – 71

Q19 Just before the accident happened, how fast were you travelling?
Tick One Box

		%
Not moving	103	22.5
Up to 30 mph	100	21.8
31–50 mph	101	22.1
51–70 mph	135	29.5
71–80 mph	14	3.1
Over 80 mph	5	1.1

Valid cases – 458

Q20 When the accident happened, were your vehicle's lights on?
Tick One Box

		%
Yes	204	45.0
No	249	55.0

Valid cases – 453

If YES, go to Question 21
If NO, go to Question 22

Q21 Which vehicle lights were on?
Tick All That Apply

		%
Side lights	32	16.4
Dipped headlights	136	69.7
Main beam headlights	14	7.2
Fog lights	13	6.7

Valid cases – 195

Q22 Were you giving other road users any signal at the time of the accident?
Tick One Box

	%	
Yes	184	41.2
No	263	58.8

Valid cases – 447

If YES, go to Question 23
If NO, go to Question 24

Q23 What signal(s) were you giving?
Tick All That Apply

		%
Indicating right	68	14.4
Indicating left	21	4.5
Brake lights	82	17.5
Flashing headlights	-	-
Hazard warning lights	28	6.0
Other signal	7	1.5
Please specify:		

Categories are not mutually exclusive

Q24 Do you normally wear glasses or contact lenses for driving?
Tick One Box

		%
Yes	189	41.0
No	272	59.0

Valid cases – 461

If YES, go to Question 25
If NO, go to Question 26

Q25 Were you wearing your glasses or contact lenses when the accident occurred?
Tick One Box

		%
Yes	185	97.9
No	4	2.1

Valid cases – 189

Q26 Were you taking any medicine for treatment of a medical condition?
Tick One Box

		%
Yes	41	9.0
No	416	91.0

Valid cases – 457

If YES, go to Question 27
If NO, go to Question 28

Q27 What medicine(s) were you taking?
Tick All That Apply

		%
Antibiotics	1	0.2
Tranquillisers	-	-
Anti-depressants	2	0.4
Anti-histamine	2	0.4
Other	35	7.5

Categories are not mutually exclusive

Rural road accident survey – responses

Q28 What were your feelings just before the accident happened?
Tick All That Apply

		%
Depressed / sad	6	1.3
Angry / annoyed	7	1.5
Frustrated	12	2.6
Tired / fatigued	26	5.6
Happy	110	23.5
Contented	236	50.4
Relaxed	230	49.1
Bored	17	3.6
In a hurry	14	3.0
Distracted by thoughts / problems on your mind	18	3.8
Distracted by something inside the vehicle	2	0.4
Distracted by something outside the vehicle	15	3.2

Categories are not mutually exclusive

In the following questions, we want your opinion of the factors which you think played a part in the accident.

Q29 Which of the following applied to you just before the accident occurred?
Tick All That Apply

		%
Driving too fast for the conditions	25	5.3
Driving too close to vehicle in front	40	8.5
Misjudging speed or distance of other road users / objects	61	13.0
Improper overtaking on the inside	2	0.4
Improper overtaking on the outside	2	0.4
Improper lane change	6	1.3
Failing to give way at a junction	1	0.2
Failing to use mirrors	2	0.4
Other Please specify	17	3.6
None of these	339	72.4

Categories are not mutually exclusive

Q30 Which of the following applied to **your vehicle** just before the accident occurred?
Tick All That Apply

		%
Poorly secured load	-	-
Defective vehicle brakes	2	0.4
Defective vehicle light(s)	-	-
Defective vehicle tyre(s)	7	1.5
Other vehicle defect Please specify	10	2.1
None of these	449	95.9

Categories are not mutually exclusive

Q31 Were any other vehicles involved in the accident?
Tick One Box

		%
Yes	392	86.0
No	64	14.0
Valid cases – 456		

If YES, go to Question 32
If NO, go to Question 33

Q32 In your opinion, which of the following statements applied to the **other driver(s) / rider(s)** involved in the accident?
Tick All That Apply

		%
Driving too fast for the conditions	145	31.0
Driving too close to the vehicle in front	141	30.1
Misjudging speed or distance of other road users or objects	194	41.5
Improper overtaking on the inside	6	1.3
Improper overtaking on the outside	29	6.2
Improper lane change	55	11.8
Failing to give way at a junction	20	4.3
Failing to use mirrors	31	6.6
Other	81	17.3
Please specify		
None of these	124	26.5
Categories are not mutually exclusive		

Q33 Was there anything about the **road layout** which may have been a factor in the accident?
Tick All That Apply

		%
Lack of right turn facility	6	1.3
Lack of overtaking opportunities	13	2.8
Confusing signs or road markings	22	4.7
Missing signs or road markings	10	2.1
Unsigned entrances / concealed entrances	14	3.0
Confusing road layout at junctions	14	3.0
Misleading appearance of road ahead	33	7.1
None of these	359	76.7
Categories are not mutually exclusive		

Q34 Was there anything about the **road itself** which could have been a factor in the accident?
Tick All That Apply

		%
Raised kerb	2	0.4
Soft verge	4	0.9
Crumbling road verge / poorly defined road edges	5	1.1
Excessive surface water / poor drainage	27	5.8
Mud on the road	8	1.7
Potholes	2	0.4
Poor road camber	6	1.3
None of these	419	89.5
Categories are not mutually exclusive		

Q35 Was there anything about the road **that restricted visibility** which could have been a factor in the accident?
Tick All That Apply

		%
Restricted sight distance at junction	9	1.9
Restricted visibility due to vegetation	7	1.5
Restricted visibility due to road signs	5	1.1
Restricted visibility due to crest of hill or bend	53	11.3
Poor street lighting	18	3.8
Poorly signed / lit roadworks	7	1.5
None of these	380	81.2

Categories are not mutually exclusive

Q36 Was there anything about the **weather** that could have been a factor in the accident?
Tick All That Apply

		%
Rain	81	17.3
Ice / snow	29	6.2
Fog	20	4.3
High winds	7	1.5
Glare from the sun	22	4.7
None of these	331	70.7

Categories are not mutually exclusive

Q37 Was there anything about the **amount or nature of the traffic** that could have been a factor in the accident?
Tick All That Apply

		%
Slow moving pedal cycle	3	0.6
Slow moving moped / motor scooter	1	0.2
Slow moving heavy goods vehicle	23	4.9
Slow moving bus	1	0.2
Slow moving farm vehicle	4	0.9
Other slow moving vehicle	20	4.3
Heavy traffic	86	18.4
Restricted visibility due to other vehicle	28	6.0
Unexpected slow moving traffic or queue(s)	132	28.2
Little traffic or no traffic	21	4.5
None of these	236	50.4

Categories are not mutually exclusive

Section 2: Driving habits

In this section we are interested in your driving habits.

Q38 At the time of the accident, did you hold the appropriate licence for the vehicle you were driving?
Tick One Box

		%
Yes	460	99.6
No	2	0.4

Valid cases – 462

If YES, go to Question 39
If NO, go to Question 41

Q39 Was the licence:
Tick One Box

		%
Full	453	99.3
Provisional	3	0.7
Valid cases – 456		

Q40 How long had you held this licence?
Tick One Box

		%
Less than six months	5	1.1
Six months to one year	7	1.5
1 to 2 years	9	2.0
2 to 4 years	21	4.6
4 to 8 years	73	15.9
8 to 16 years	82	17.9
16 to 32 years	176	38.4
More than 32 years	86	18.2
Valid cases – 458		

Q41 What was your annual average mileage?
(It may help to think of the number of miles you drove in a typical week, multiply this number by 50, and add the mileage of any extra journeys, eg driving on holiday.)
Tick One Box

		%
Up to 5,000 miles	67	14.7
5,001–10,000 miles	99	21.8
10,001–15,000 miles	102	22.4
15,001–20,000 miles	48	10.5
Over 20,000 miles	139	30.5

Q42 On average, how often did you drive?
Tick One Box

		%
Daily or nearly every day	455	98.7
Once a week	4	0.9
Once every two weeks	1	0.2
Once a month	1	0.2
Less than once a month	-	-
Valid cases – 461		

Q43 What was the most common length of your journeys when you drove your motor vehicle?
Tick One Box

		%
Under 5 miles	30	6.4
6–20 miles	168	36.7
21–50 miles	126	27.5
51–100 miles	51	11.1
Over 100 miles	83	18.1
Valid cases – 458		

Rural road accident survey – responses

Q44 What percentage of your annual driving time was spent driving:
(Write in percentage to nearest 5%)

On Saturdays and Sundays

		%
0–20 per cent	267	58.4
21–40 per cent	110	24.1
41–60 per cent	58	12.7
61–80 per cent	20	4.4
81–100 per cent	2	0.4
Valid cases – 457		

In the hours of darkness

		%
0–20 per cent	191	41.8
21–40 per cent	171	37.4
41–60 per cent	77	16.8
61–80 per cent	14	3.1
81–100 per cent	4	0.9
Valid cases – 457		

During the morning and evening rush hour peaks

		%
0–20 per cent	152	33.2
21–40 per cent	76	16.6
41–60 per cent	97	21.2
61–80 per cent	95	20.7
81–100 per cent	38	8.3
Valid cases – 458		

Q45 What percentage of your annual driving time was spent driving:
(Write in percentage to nearest 5%)

On non-motorway roads with speed limits of 40 miles/h or less

		%
0–20 per cent	188	41.0
21–40 per cent	156	34.1
41–60 per cent	78	17.0
61–80 per cent	31	6.8
81–100 per cent	5	1.1
Valid cases – 458		

On non-motorway roads with speed limits of over 40 miles/h

		%
0–20 per cent	103	22.5
21–40 per cent	195	42.7
41–60 per cent	98	21.4
61–80 per cent	50	10.9
81–100 per cent	11	2.4
Valid cases – 457		

On motorways

		%
0–20 per cent	249	54.5
21–40 per cent	118	25.8
41–60 per cent	57	12.5
61–80 per cent	27	5.9
81–100 per cent	6	1.3

Valid cases – 457

Q46 In the last five years, how many other road accidents have you been involved in as a driver or rider?
Tick One Box

		%
None	332	72.2
One	96	20.9
Two	26	5.7
Three	4	0.9
Four	1	0.2
More than four	1	0.2

Valid cases – 460

Q47 How many of these accidents resulted in injury to anyone involved?
Please write in number: ______________________

Q48 In the last five years, have you ever had any of the following motoring offences against your name?
Tick One Box

		%
Drink driving	3	0.6
Speeding	70	15.0
Careless or inconsiderate driving	13	2.8
Dangerous driving	2	0.4
Accident related	5	1.1
Vehicle defect related	3	0.6
Other	8	1.7
Please specify		

Categories not mutually exclusive

Q49 Please indicate, by ticking the appropriate box, how you rate the following tasks:

Task	Very Hard	Hard	OK	Easy	Very Easy	Valid Cases
General driving						
Judging speed in daylight	-	7	168	170	113	458
Judging speed in darkness	11	85	229	101	32	458
Judging distance in daylight	-	8	148	173	129	458
Judging distance in darkness	16	88	217	110	27	456
Daylight driving in general	-	3	106	177	172	458
Darkness driving in general	1	37	207	159	52	456
Driving on single carriageway roads	-	2	164	177	114	457
Driving on dual carriageway roads	-	6	144	169	139	458
Dual carriageway driving						
Turning right at junctions	12	58	172	137	77	455
Turning left at junctions	-	1	126	186	143	456
Joining main road from slip road	-	38	185	153	78	454
Changing lanes to left	-	6	162	190	94	452
Changing lanes to right	-	10	161	190	93	454
Entering a lay-by	-	14	152	171	118	455
Leaving a lay-by	9	84	178	103	79	453
Leaving main road by slip road	-	-	122	190	145	457
Allowing a vehicle onto main road from a slip road	-	17	184	157	96	454
Negotiating a roundabout	-	8	165	174	109	468
Overtaking	2	13	176	164	102	457

Q50 What is your date of birth?
(Please write in numerical format – DD/MM/YY)

____/____/____

Q51 Are you male or female?
Tick One Box

		%
Male	330	71.3
Female	133	28.7

Valid cases – 463

Q52 What was your marital status at the time of the accident?
Tick One Box

		%
Single	96	20.8
Married	290	62.8
Living as married	18	3.9
Divorced / separated	39	8.4
Widowed	19	4.1

Valid cases – 462

Q53 How many children under 16 were living in your household at the time of the accident?
Tick One Box

		%
None	302	65.5
One	72	15.6
Two	66	14.3
Three	17	3.7
Four or more	4	0.9

Valid cases – 461

Q54 Which most closely describes your work situation at the time of the accident?
Tick One Box

		%
In full or part time employment	365	78.8
In full or part time education	13	2.8
On a youth or employment training scheme	1	0.2
Looking after home / family	10	2.2
Unemployed and looking for work	6	1.3
Retired	54	11.7
Other	14	3.0
Please specify		

Valid cases – 463

Q55 What was your occupation?
If you were retired or not working at the time of the accident, please give your previous occupation. If you had never worked, go to Question 56.

____

What was your grade or position?

____

What qualifications did you hold?

____

Q56 Would you be willing to help the Transport Research Laboratory with any further research into road safety?
Tick One Box

		%
Yes	389	86.1
No	63	13.9

Valid cases – 452

Appendix C Questionnaire protocols

The study proceeded with the co-operation of the Police, but was nevertheless independent. Certain protocols were applied throughout the study, in order to clarify the relative interests of the parties concerned, and to provide assurances about the confidential nature of the information obtained. The protocols were as follows:

1. No information on extra data obtained or the conclusions reached as to contributory factors on particular accidents would be passed to the police or to anyone else in any circumstance.
2. An interview would only be attempted after the Police had taken any statements they required from an accident participant.
3. Names and addresses of participants in an accident, and the registration numbers of the vehicles involved, would not be recorded on the computer files of accident data, and would not be divulged to third parties.
4. Checks would be made to ensure that no contact was attempted with anyone involved in a fatal accident.
5. Information about individual accidents contributed by the co-operating organisations was regarded as the copyright of those organisations. Copies of any reports would be returned to them or, with their approval, destroyed at the conclusion of the study.
6. The sole right of the copyright in the results of the research, including any report made, and any data or other information collected specifically for the programme of research, vests (insofar as it is not already the copyright of any third party) in the AA Foundation for Road Safety Research.

Appendix D Accident types by vehicle manoeuvres

Accident types by vehicle manoeuvres

1. <u>Stacking Accidents</u>

Rear end shunt on minor
Evasion offside – minor
Evasion nearside – minor

Shunt
Shunt – vehicle left nearside
Shunt – vehicle left offside
Shunt – parked vehicle

Evasion – nearside
Evasion – offside

2. <u>Loss of Control</u>

Loss of control
Loss of control – nearside
Loss of control – offside
Loss of control – crossed central reserve

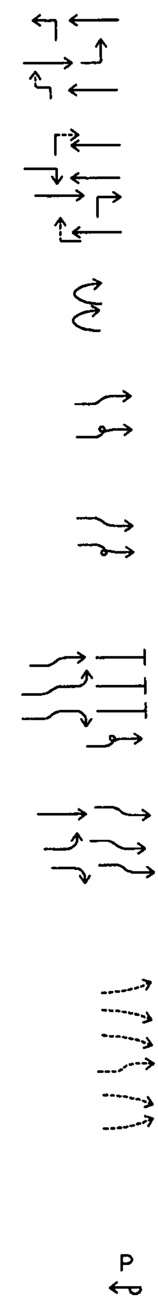
Loss of control on left bend
Loss of control on left bend – nearside
Loss of control on left bend – offside
Loss of control on left bend – crossed central reserve

Loss of control on right bend
Loss of control on right bend – nearside
Loss of control on right bend – offside
Loss of control on right bend – crossed central reserve

3. <u>Lane change accidents</u>

LANE CHANGE TO RIGHT
- shunt
- evasion nearside
- evasion offside
- loss of control
- loss of control – nearside
- loss of control – offside
- loss of control – crossed central res.

LANE CHANGE TO LEFT
- shunt
- evasion nearside
- evasion offside
- loss of control
- loss of control – nearside
- loss of control – offside



4. Turning accidents

Left turn entering
Left turn leaving
Left turn crossing carriageway

Right turn from minor
Right turn from central reserve – leaving
Right turn from central reserve – joining
Right turn from main

U–turn on main
U–turn on minor

LEAVING AT JUNCTION
Changing lane to left
Changing lane to left + LOC

JOINING AT JUNCTION
Changing lane to right
Changing lane to right + LOC

LAY–BY
Changing lane to left
- shunt
- evasion nearside
- evasion offside
- loss of control

Changing lane to right
- shunt
- evasion nearside
- evasion offside

5. Leaving carriageway – not at junction

Left carriageway nearside – no LOC
Left carriageway offside – no LOC
Left carriageway xcl – no LOC
Left carriageway nearside – lay–by
Lane 1 to Lane 2
Lane 2 to Lane 1

6. Miscellaneous

Pedestrian Accidents
- In carriageway
- Crossing from offside
- Crossing from nearside

£20.00

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