THE PLANNING ACT 2008

M4 (JUNCTIONS 3 TO 12) (SMART MOTORWAY) DEVELOPMENT CONSENT ORDER APPLICATION

TR010019

Issue Specific Hearing - Road Safety

Appendix D - 2001 Report 'Safe Haven Layby Frequency and Specification'

Deadline IV - 26 November 2015

SAFE HAVEN LAYBY FREQUENCY AND SPECIFICATION

DECEMBER 2001

Prepared by: ....
Nigel Wilson
Associate Director

Approved by: ....
Alison Cox
Principal Consultant

Reviewed by: ....
Alison Cox
Principal Consultant

Rev No	Comments	Approved / Reviewed (OFT only)	Date
1	Revision to Table 3		26th July 2001
2	Appendix A		20th September 2001
3	Appendix B		December 2001

Job No: Y17184
Reference: Safe Haven Report
Date created: 21/9/01

Telephone: +44 (0) 1904 694400
Fax: +44 (0) 1904 694499
Website: http://www.oscarfaber.com

St Christopher House
George Cayley Drive
York YO30 4XE

CONTENTS

EXECUTIVE SUMMARY

Statistics from a literature review into Safe Havens have been used to determine a methodology for estimating the number of carriageway blockages that are likely to occur within an Active Traffic Management scheme. This is where the hard shoulder is being used for traffic and emergency breakdown provision is provided by laybys introduced at fixed intervals along the carriageway.

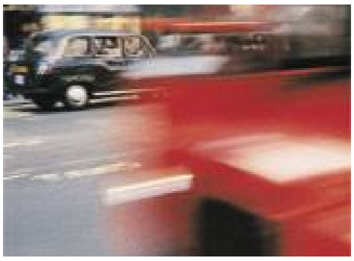
The methodology has been used to determine the number of blockages that will occur for a range of layby intervals.

The results indicate that for a layby length of 300 metres and a range of layby spacings between 1,000 and 2,500 metres the number of breakdowns that will block the carriageway per peak period, per kilometer, per month are between 5 and 10.

A layby design has been proposed that provides a full vehicle width of hardstanding for the whole layby length including entry and exit tapers in order to maximize the effective access length of the layby.

An outline specification has been proposed that identifies the key elements of the safe haven layby design.

1 INTRODUCTION



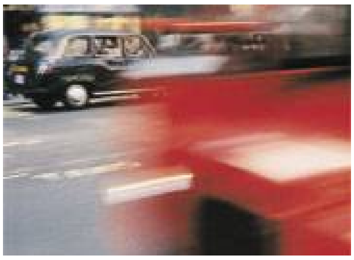
1 INTRODUCTION

This report has been produced for the Highways Agency by Oscar Faber as part of the Outward Facing Research sub-project SP5.4 on Active Traffic Management (ATM).

The objectives of the report are:

- to detail a methodology to determine the frequency and layout of emergency layby facilities that may be provided on a motorway to accommodate breakdowns when the existing hardshoulder is being used to carry traffic within an Active Traffic Management (ATM) scheme;
- to identify a relationship between the frequency of laybys and the number of breakdowns that will block the carriageway; and,
- to provide an outline specification for the key features of laybys provided to accommodate breakdowns in ATM schemes.

2 BACKGROUND



2 BACKGROUND

The occurrence of a breakdown on a motorway without a hardshoulder will cause disruption to traffic flow particularly in peak flow periods. Providing laybys as 'safe havens' will provide a facility where a proportion of breaking down vehicles will be able to enter thereby preventing traffic disruption. However, a proportion of breakdowns will not be able to enter laybys which will result in traffic disruption.

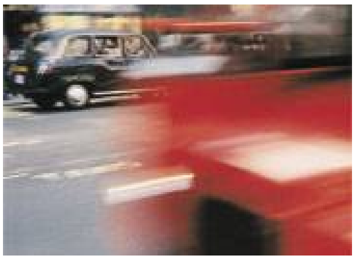
Determining a relationship between layby provision and the number of breakdowns that will cause disruption to traffic will provide blockage rate factors that will allow designers to evaluate the impact of ATM schemes in terms of disruption caused by blockages. This should form part of the overall assessment of the benefits of ATM schemes which are beyond the scope of this report.

TA 69/96 The Location and Layout of Laybys provides information to designers on the provision of laybys for both driver amenity, public transport and emergency purposes on all purpose trunk roads. The document advises that the maximum spacing of laybys on dual carriageways should be 2.5 Km.

An example location where laybys have been introduced on a dual carriageway trunk road without a hard shoulder is the A42(T) between M1, Junction 23A and M42, Junction 11. This site is of interest as it links two motorways and as such is heavily trafficked. The scheme consists of amenity laybys provided at a 2.5 Km spacing with shorter emergency laybys located in between making a maximum distance between laybys in the order of 1.3 Km.

Information on the operation of the A42(T) scheme with respect to layby usage, incidents and road safety have been requested from the local agents and results from Appendix A of this report.

3 METHODOLOGY



3 METHODOLOGY

The methodology to determine the probability of breakdowns on the carriageway is based on a specific layout and frequency of layby which allows the factors that effect on carriageway breakdown to be identified. Following this the relationship is expanded to illustrate the probability of on carriageway breakdowns for a range of layby frequencies.

The findings of a literature review previously undertaken by Oscar Faber on safe havens have been used to provide statistics on the occurrence of breakdowns on motorways, and is issued within this document within Appendix B. A statistic that is of particular interest is the number of breakdowns occurring in contra flow systems when the vehicle is being driven in an enforced condition without a hardshoulder. Table 3.1 provides a comparison between breakdowns on motorways with hardshoulders and in motorway/dual carriageway contra flow systems.

The table shows that in the enforced contra-flow condition the number of breakdowns is approximately half that for a motorway with hard shoulder. This suggests that 50% of drivers who have a breakdown in a contra-flow are able to exit the system under their own power before stopping.

This statistic is repeated in other research within the literature review that shows that between 40 and 50% of breakdowns on motorways with hard shoulders travel to within 50 metres of an emergency telephone indicating that up to half of breakdowns are able to travel under their own power for at least one mile.

Taking these two statistics together, if drivers are equally less inclined to stop in an ATM scheme as far a contra-flow, and, up to 50% of drivers in breaking down vehicles can travel under power for at least a mile, then we may assume that 50% of breakdowns will travel to the nearest safe haven or exit in an ATM scheme.

Basing layby designs on Layout A (Modified) of TA 69/96 The Location and Layout of Laybys, with hard standing being provided to the rear of the taper markings, then access to the layby would be provided over a length of approximately 300 metres. A test of un-powered travel from 70mph showed that a car may travel approximately 500m and assuming that 50% vehicles can travel this distance then access to the layby could be gained by vehicles breaking down 250 metres upstream of the layby as shown in Figure 1. Taking account of a minimum likely braking distance of 50 metres then the effective layby access length is shown to be 500 metres.

If laybys are introduced at one per kilometre then breaking down vehicles have a 500/1000 probability (0.5) of being able to enter one.

Taking 100 breaking down vehicles then the following is likely to occur:

From this 25% of breakdowns will occur on carriageway and disrupt traffic flows.

Converting the number of breakdowns per million kilometres into numbers of peak period lane blockages, per kilometre, by direction in a month allows both the mean blockages and 85%ile blockages to be calculated through a Poisson distribution.

The results of this are as follows:

Table 3.1 - Comparisons of Breakdowns On Motorways And Contra Flow Systems

Condition	Breakdown per Million Vehicle Kilometres	
	Light Vehicle	Heavy Vehicle
Motorway with hardshoulder	20	10
Contra-Flow	9	5

Table 3.2 - Predicted Drivers Action On Breakdown In ATM Scheme With Emergency Layby

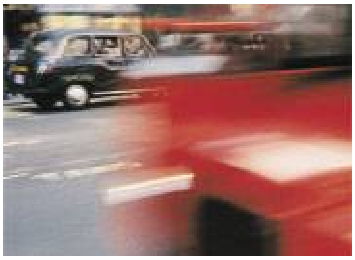
Action on Breakdown	Vehicles
Able to enter layby or exit motorway under own power.	50
Able to enter layby un-powered	25
Unable to enter layby/blocking carriageway	25
Total	**100**

Table 3.3 - Number Of Peak Period Lane Blockages, Per Kilometre, By Direction In A Month

Peak Hour Flow (vph)	Mean Number of Blockages	85th percentile number of blockages
5,000	2.9	4.1
6,000	3.4	4.9
7,000	4.0	5.6
8,000	4.5	6.3

Basis of calculation	
Traffic composition	10% heavies
Breakdowns blocking carriageway	25% (from table 3.2)
Time Period	Assume 1 month = 20 days, each day has 2 peak periods for a given direction each lasting 3 hours. Therefore 40 peak periods or 120 hours in a month

4 ASSESSMENT OF LAYBY FREQUENCIES



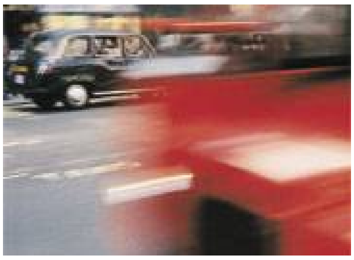
4 ASSESSMENT OF LAYBY FREQUENCIES

Based on the foregoing methodology the number of on carriageway breakdowns in a peak period, per kilometre per month has been calculated for a range of layby frequencies. The results are given in Table 4.1 and are based on the layby layout illustrated in Figure 1. The number of carriageway blockages has been calculated at both a 50% and 85% level of confidence.

Table 4.1 - Number Of Peak Period Lane Blockages, Per Kilometre, By Direction Per Month

Layby Frequency	Number Of Blockages	
	50% Confidence	85% Confidence
1 per 2,500m	7.3	9.6
1 per 2,000m	6.8	9.1
1 per 1,500m	6.1	8.2
1 per 1,000m	4.6	6.3
1 per 500m	0.0	0.0

5 OUTLINE SPECIFICATION FOR SAFE HAVEN LAYBY

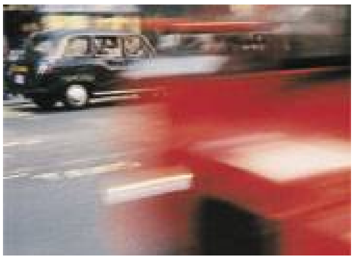


5 OUTLINE SPECIFICATION FOR SAFE HAVEN LAYBY

The following are considered to be key elements in the specification for a safe haven layby for the use with ATM schemes:-

- accommodate 1 x HGV and 1 x recovery vehicle;
- width as per existing hard shoulder;
- accommodate stricken vehicle in centre of flat section;
- entry taper for 70mph;
- exit taper or emergency exit to bridge;
- not for abnormal loads
- not for police use for speeding etc.;
- not for maintenance purposes;
- include telephones;
- no refuge;
- hard standing;
- 45 degree kerbs throughout;
- illuminated;
- signed adequately;
- approximately standard spacing;
- take account of gradient;
- visibility forward etc. conform to DMRB;
- proximity to junctions, crests, structures to be considered; and
- the layby would remain operational outside the hours of operation of the ATM scheme.

APPENDICES



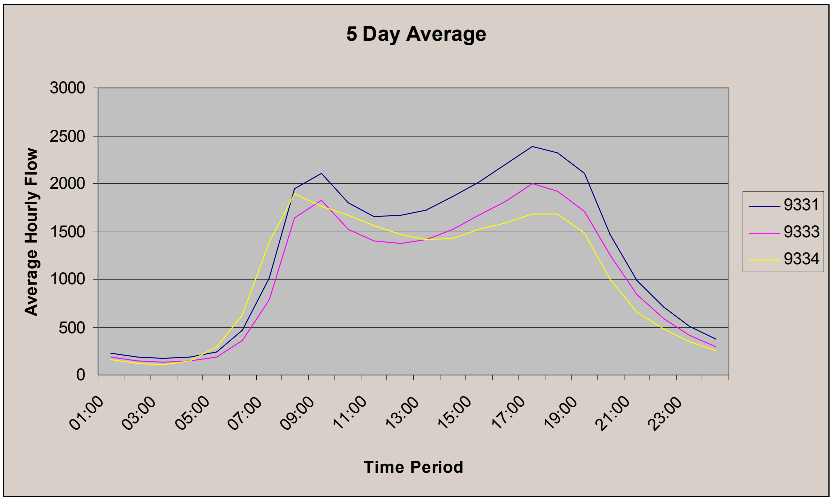
APPENDIX A

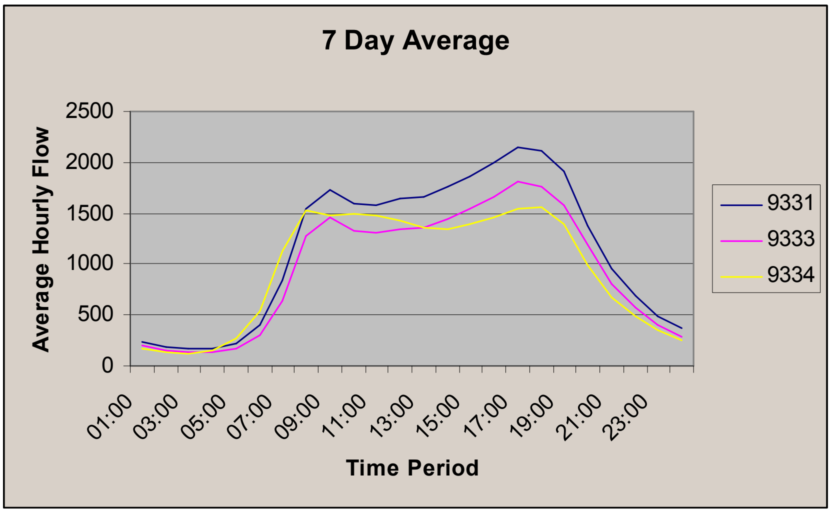
INTRODUCTION
The A42(T) is a four lane dual carriageway with no hard shoulder which traverses the 22 kilometres (14 miles) between M1, Junction 23A and M42, Junction 11. The site is of interest as it links two major motorways and must be considered one of the most direct routes between the north-east and the west midlands.

The cross section of the carriageway does not provide adequate verge widths, allow vehicles to pull off the carriageway, along its entire length.

TRAFFIC FLOWS
Traffic flow information has been obtained from three uni-directional Automatic Traffic Counter (ATC) sites located along the A42(T). The location of the ATC sites are shown on Figure 1.

The count information supplied covered a period between 1st January and 31st December 2000, this has been analysed to provide an average hourly flow for 5 day and 7 day periods. The data seems to indicate that there is a significant directional bias to the traffic count data with the northbound site 9331 indicating the greatest traffic flow throughout the day. The 5 day figures indicate that the northern section of the route has an average two way flow in excess of 3000 vehicles during the normal 12 hour daily period.





(Graphs indicating 5 day and 7 day average hourly traffic flow.)

These traffic levels are likely to cause significant delays upon the occurrence of any incidents likely to restrict flow, therefore a number of emergency laybys have been introduced to compliment places of designated waiting.

LAYBYS

As stated within the body of the report TA69/96 'The location and layout of laybys' provides specific information on the provision and form of laybys on all purpose trunk roads. The document advises a maximum spacing between laybys of 2.5km.

The number of laybys located along the A42(T) is unsurprisingly linked to the levels of traffic flow, with a bias to the southbound direction. The laybys can be divided into two distinct groups, emergency laybys and amenity laybys. The location of the laybys is shown on Figure 2.

Emergency Laybys

The emergency laybys are characterised by their relative short length (30m length at full width with standard entry/exit tapers), traffic regulation order and Emergency Telephone Box (ETB) provision.

During a site visit of four hours duration it was noted that a number of these laybys were occupied by solitary vehicles, some of which were clearly experiencing mechanical difficulties. It was also noted that there was some abuse of the no stopping restrictions with vehicles parked which did not seem to have any legitimate reason to stop at these locations.

The average spacing of the emergency laybys is 2.2km southbound and 2.75km northbound.

Amenity Laybys

The provision of amenity laybys is less than that recommended, given a 2.5km spacing (spacing of 2.75km southbound and 3.6km northbound). The majority of the laybys have been enhanced by the introduction of an ETB, with only three instances where the laybys do not have any such facility.

There are two distinct forms of amenity layby along this stretch, those introduced to the current standards with a splitter island and a more simplified pull-in/out style. The older style pull-in/out laybys are generally located on the southern section, between the A511 and the M42.

Both forms have extensive lengths to accommodate a number of articulated vehicles at any one time. On the day of the site visit these laybys were being used extensively throughout the day and specifically during the lunchtime period.

Overall Provision

The enhancement of the numbers of amenity laybys by the introduction of emergency laybys has resulted in an overall provision significantly better than the prescribed maximum spacing. The southbound direction benefits from an average spacing of 1.2km, less than half the prescribed maximum, whilst the northbound has an average spacing of 1.6km.

ACCIDENT DATA

Unfortunately we have been unable to obtain any incident data relating to stationary vehicles within the carriageway, we have received an accident plot for the three year period between May 1998 and April 2001. The accident plot information is represented on Figures 3 and 4.

The accident plot does again show a marked difference in the total number of Personal Injury (PI) accidents between the northbound and southbound directions, a total of 44 PI accidents recorded in the northbound direction, compared to 28 southbound.

There are a significant number of accidents that seem to involve a stationary vehicles that are not waiting in a queue, 7 northbound and 6 southbound. These accidents result in 4 fatalities, two in either direction. It is not clear from the current information if the vehicles were stopped on the carriageway or in a designated parking place.

CONCLUSION

From the limited data we have received it is difficult to make any substantial conclusions in respect to the operation of the emergency laybys in connection with incidents or accidents on the carriageway. There may ultimately be a statistical correlation between the factors tabulated below, but further study will be required and especially in respect of detailed accident descriptions and incident information (if any were available).

Carriageway	Max Average Hourly Flow (5 day)	Layby Spacing	Recorded PI Accidents
Southbound	1900	1.2	28
Northbound	2389	1.6	44

APPENDIX B – LITERATURE REVIEW

INTRODUCTION
This note summarises the available research on the rates of vehicles stopping on hard shoulders. A range of research has been reviewed covering highways in UK, US and in Europe. The major conclusions are that:

- Breakdowns comprise only a small proportion of hard shoulder stops;
- The trend for breakdowns is a significant reduction over the past 30 years;
- The numbers of stops made by HGVs is greater than that made by cars in proportion to numbers of the road;
- There are very many short stops made on hard shoulders.

For the UK, the only reliable survey data that exists is for motorway standard roads, although it is probable that many of the results could be extrapolated to other carriageway types.

Three major study methods have been used to collect the data:

- Videotaping a short section of road to record stoppages;
- Driving around the motorway network in search of stoppages;
- Analysis of attendance records from police reports.

There are advantages and disadvantages to each method. Videotape has the advantage of collecting all stops, no matter how short. It is however, limited to relatively short sections of motorway and there may be problems in extrapolating the results from a survey site to the wider motorway network. Moreover, it is not always possible to derive the precise purpose for the stop from a videotape record.

Driving around the network and either recording, or stopping and interviewing drivers of stopped vehicles provides a much broader picture of the stopping patterns across large sections of the motorway. This method is, however, biased in favour of longer stops and has been shown to seriously underestimate the numbers of short stops made.

Analysis of police records provides a useful volume of data concerning the cause of stops, however, a very small proportion of stops are attended by the police, and once again this technique underestimates the short term stop.

Of the three, the videotape method is the most successful in providing an overview of the absolute number of stops that might be expected on a section of motorway, and for the purpose of this analysis we have concentrated on the results of videotape analysis.

REASONS FOR STOPPING
Most researchers have grouped vehicle stops in to three main categories:

- Breakdowns – which can either be fixed by the driver or require assistance from recovery vehicles;
- Vehicle checks – which may include the driver leaving the vehicle to check tyres, mirrors, lights or the engine;
- Comfort Stops – which may include stopping to change drivers, to use a mobile phone, to rest or to eat.

Of the three, the latter, which as a reason for stopping is technically illegal on UK motorways, is the most common. Breakdowns, which comprise about 10% of all stops are generally the only stops that remain on the hard shoulder for a significant amount of time.

SUMMARY OF RESULTS

BREAKDOWNS
The best estimate for breakdown rates is:

Light vehicles: 20 per million vehicle kilometres
Heavy vehicles: 10 per million vehicle kilometres

Rates of this order have been consistently observed in a number of recent surveys. These rates have fallen significantly over the past 30 years from levels up to 5 times as high in the early 1970s. There is evidence to suggest that these rates are more universal and would be equally applicable in non-motorway situations.

The video survey reported by Summersgill & al (1998), however, reported much higher rates of around 18 per m v-km for light vehicles and up to 88 per m v-km for heavies. These results were for peak hours only.

They also carried out surveys at a signed vehicle refuge, where once again breakdown rates were much higher than on normal carriageway sections. This led to the assumption that pre-signed refuges would attract drivers of vehicles that were about to break down.

Recent studies at contraflow roadworks and some motorways have produced much lower rates of 9 per million veh km for lights and 5 per million veh km for HGVs. This enforces the conclusion that at locations where breakdowns would cause congestion or otherwise lead to a dangerous situation arising, the observed rates are lower, implying the driver does in some cases have a choice of whether or not to stop.

Location
There is a evidence that the driver has limited influence in where these stops occur, as they tend to cluster around emergency telephones. Summersgill & al (1998) identified that the proportion of breakdowns stopping within 50 metres of an emergency telephone was between 40% and 50%, as opposed to the 10% that might be expected by chance. This indicates that around 1/3 of drivers have some prior indication that a breakdown is about to occur, and are able to travel for up to a mile before needing to stop. This travel is, however, sometimes made on the hard shoulder, and at low speed. In recent years, such surveys have been distorted by the numbers of drivers using mobile telephones, thus avoiding the necessity to stop near an emergency telephone.

VEHICLE CHECKS
The best estimate for vehicle check rates is:

Light vehicles: 2 – 17 per million vehicle kilometres
Heavy vehicles: 6 – 89 per million vehicle kilometres

There is clearly a wide range in these rates. This is due to the fact that one of the surveys producing these results included on and off-slips as survey locations. It was demonstrated that stopping rates on on-slips were much greater than rates on the motorway carriageway itself. It is natural to suppose that a greater number of vehicle checks would be made on the on slip as drivers prepare themselves for driving on the motorway.

COMFORT
The best estimate for comfort stops is:

Light vehicles: 50 – 90 per million vehicle kilometres
Heavy vehicles: 70 – 170 per million vehicle kilometres

This shows that comfort stops account for by far the greatest proportion of motorway stops. Typically of the order of 60% and up to 87% in one survey. Some research suggests that the numbers of comfort stops on motorway hard shoulders would be far greater than on hard shoulders on non-motorway routes, since off the motorway there are considerably more opportunities to leave the main road completely to make these stops, ie on side roads or on garage forecourts.

CONCLUSION
A literature review has been carried out to identify previous research into stopping rates on hard shoulders.

Although a considerable amount of research has been carried out during the last forty years, only recent data is particularly relevant. All the surveys show a decreasing trend in the number of breakdown stops over time matching the increased reliability of vehicles.

The review has identified several relevant reports produced on stopping rates in the last ten years.

Owing partly to the differing survey methods, and partly to the infrequent occurrence and random nature of motorway breakdowns, the stopping rates observed in these surveys display a very wide range.

The table below uses the most pessimistic rates from the ranges identified to determine the number of vehicles stopping on a single kilometre section of hard shoulder for given levels of traffic flow.

It is based on:

Breakdowns: 20 per m v-km (light)
10 per m v-km (heavy)
Vehicle checks: 17 per m v-km (light)
89 per m v-km (heavy)
Comfort: 90 per m v-km (light)
170 per m v-km (heavy)

NUMBER OF STOPS PER KILOMETRE OF HARD SHOULDER BY AADT (ONE WAY).

AADT (000s) (One Way)	Breakdowns	Vehicle Checks	Comfort Stops	Total
40	0.8	1.0	3.9	5.6
50	1.0	1.2	4.9	7.1
60	1.1	1.5	5.9	8.5
70	1.3	1.7	6.9	9.9
80	1.5	1.9	7.8	11.3
90	1.7	2.2	8.8	12.7

For comparison, typical one way AADTs on UK motorways in 1998 have been extracted from the DETR Transport Statistics Bulletin (1999). The 1997 National Road Traffic Forecasts provide a central estimate for growth in rural motorway traffic. Between 1998 and 2006, motorway traffic is expected to grow by 26%. Current, and 2006 forecast traffic volumes on selected motorway locations are given below:

Motorway Section	AADT (000s) (One Way)	
	1998	2006
M1 north of M6 junction	46	58
M1 south of M6 junction	47	59
M6 south of M62	48	60
M25 –eastern links from A1(m) to M23	59	74
M25 –western links from A1(M) to M23	67	84
M62 – west of Pennines	41	52

For a carriageway without hard shoulders the numbers of vehicle check stops and comfort stops would be much lower, close to zero. The breakdown rates could also be reduced.

There is also evidence to suggest that weekend rates are significantly higher than weekday rates.

DURATION OF STOPPAGES

Limited evidence is available with regard to the duration of stoppages, in particular for vehicle checks and comfort stops.

Recent analysis of video surveys (Summersgill & al, 1998) produced the following estimates:

Breakdowns:

45 minutes (Light)	75 minutes (Heavy)
Vehicle checks:	4 minutes (All)
Comfort stops:	4 minutes (All)

Using these values, the amount of time for which a given kilometre of hard shoulder would be occupied by stopped vehicles during an average 24 hour day would be:

AADT (000s) One Way	Minutes	
	5.1.1 ALL STOPS	5.1.2 BREAKDOWNS ONLY
40	56	37
50	70	46
60	84	55
70	98	64
80	112	73
90	126	82

Further Work

The review of existing data has demonstrated that the estimates of motorway stops fall within a very wide range, in particular since trends over time are towards a reduction in the numbers of stops, particularly breakdowns. Consequently older data tends to distort the observations.

Further, most video studies, which provide the most detailed data, have been conducted on relatively short sections of motorway, and at single or a small number of separate sites. It is not always clear how typical of the overall network these sections are, and consequently how these results may be generalised over a wider area.

For this reason, it is difficult to draw up a realistic confidence interval for the results reported. Therefore, although the results tabulated above may represent the best estimate of stopping rates in recent years, it is difficult to extract from these any indication of the range of results that might be expected, which would be important in designing the size and frequency of refuge points along a motorway.

In recent years CCTV coverage of motorways has been substantially increased. This now presents opportunities for more comprehensive surveys of longer sections of motorways than were available to earlier researchers. Carrying out further studies at this time would enable a much larger database, covering current conditions, to be developed.

If these surveys were to cover longer sections of motorways, for example the ring around Manchester, and for a reasonable length of time, it would be possible to derive up to date estimates of stopping rates, and more importantly, to calculate confidence intervals across a number of sites from which more robust estimates of the frequency and duration of stops may be obtained.

Summary of available research into stoppage rates
The main source for these values was Summersgill & Holroyd (1992) and Summersgill, Fletcher and Sharples(1997) , the latter gives a full bibliography.

Summersgill and Holroyd (1992) conclude that a realistic breakdown rate would be 20 per million veh-km for cars and 10 per million veh km for HGVs.

Portigo (1976)	
Road Type:	Rural freeway (US)
Date:	1976

Rates
526 emergency stops per million veh-km
1670 convenience/leisure stops per million veh-km.
(ie 23% emergency stops)

Agent and Pigman (1990)	
Road Type:	interstates and parkways (US)
Date:	1990

Rates
With shoulder:
53 emergency stops per million veh-km 300 leisure/convenience stops per million veh-km
(ie 4% emergency stops)

Without shoulder:
47 emergency stops per million veh-km
0 leisure stops

Reasons:
Emergency
37%
Leisure
49%
Work
14%

Duration:
Under 20 min
19%
20 – 60 min
28%
over 60 min
525%

Billion (1959)	
Road Type:	US
Date:	1959

Rates
52 emergency stops per million veh-km
222 leisure stops (>5 min) per million veh-km

SUMMARY OF EARLY US RESEARCH
Stopping rates on roads without shoulders similar to emergency stop rate on roads with shoulders.

Emergency rates between 50 and 100 stops per million veh-km
Leisure rates – variable but > than emergency rates.

Breakdown in Tunnels, PIARC,1986	
Road Type:	Road Tunnels (France)
Date:	1983 - 1985

Rates
Breakdowns 10 per million veh-km

This is an average over a number of tunnels, individual rates vary between 2.3 and 16.0 per million veh-km.

Breakdown in Tunnels, PIARC,1986	
Road Type:	Road Tunnels (Germany)
Date:	1975 - 1985

Rates
Breakdowns 12 per million veh-km.

No time trend apparent between 1975 and 1985

Individual rates vary between 7.6 and 19.6.

Evidence that tunnels without shoulders have lower rates than those with shoulders.

Breakdown in Tunnels, PIARC,1986	
Road Type:	Road Tunnels (UK)
Date:	1975 - 1985

Rates
1975 35 per million veh-km
1985 24 per million veh-km

UK rates much higher than France/Germany, but the nature of UK tunnels was different in that they all had steep upgrades to the exit so that vehicles could not 'limp through' if experiencing difficulties.

Breakdowns on Open Road, PIARC	
Road Type:	Motorway (Germany)
Date:	unknown

Rates
88 stops per million veh-km, but only 10% of drivers called for assistance
Stop durations:
Less than 2 min 45%
2 – 10 min 35%
Over 10 min 20%

UK Studies	
Road Type:	Motorway (within roadworks) (UK)
Date:	1978

RATES
Breakdowns
Cars 30 per million veh-km
Lorries 100 per million veh-km
Road Type:
Motorway (UK)
Date:
Unknown
Rate – estimate from motoring organisations (1984)
Cars 39 per million veh-km
Buses 100 per million veh-km
Lorries 100 per million veh-km
Road Type:
Motorway (UK) – Restricted sites (roadworks, bridges, tunnels)
Date:
1984

Frank Graham Study
Car breakdown rates: 30 per million veh-km
Lorry rates: 60 per million veh-km

On unrestricted sites the overall stoppage rate was higher, but the level of breakdowns was unaffected.

Coe and Evans (1992)
Breakdowns at contraflow road works;

Late 1970s: (light / heavy)	30 / 100 per million veh km
Early 1980s:	30 / 60 per million veh-km
Late 1980s:	25 / 25 per million veh-km
Early 1990s:	9 / 5 per million veh km

Rates
88 stops per million veh-km, but only 10% of drivers called for assistance
Stop durations:

Less than 2 min	45%
2 – 10 min	35%
Over 10 min	20%

Rutley (1987)	
Road Type:	Open motorways (UK)
Date:	1987

Rates – All Stops
From a video survey of ½ mile of carriageway
Cars 140 per million veh km
Lorries 420 per million veh-km

Of these, 75% were for 10 minutes or less.

From driving around the network:

Reasons for stopping:

Breakdowns	56%
Tyre failure	17%
Out of fuel	4%
Vehicle checks	14%
Tiredness	2%
Illness	1%
Other	6%

(ie 75% breakdowns)
Average duration of stop 70 minutes

Stop duration much longer, due to survey method – longer stops more likely to be identified.

Roberts, Webb, Coe (1994)
TPK, cit Summersgill & al (1998)

Video survey:

Comfort breaks	65%
Breakdowns	11%
Unofficial hard shoulder travel	8%
Official hard shoulder travel	7%
Other	9%

Overall weighted mean:

Incident rate	11.5 per million veh-km
Breakdowns	9.1 per million veh-km
Unrecorded stops	76.2 per million veh-km

Summersgill & al (1998)
Further analysis of part of above data collected in Manchester (M) & Warwick (W)

Rate (peak only):
Lights

Total	84.6 / m v-km (W) 88.6 / m v-km (M)
Breakdown (21%,23%)	17.7 / m v-km (W) 20.4 / m v-km (M)
Check (9%,19%)	7.6 / m v-km (W) 16.8 / m v-km (M)
Comfort (70%,58%)	59.4 / m v-km (W) 51.5 / m v-km (M)

Heavies

Total	393.5 / m v-km (W) 379.5 / m v-km (M)
Breakdown	38.8 / m v-km (W) 88.5 / m v-km (M)
Check	144.1 / m v-km (W) 82.2 / m v-km (M)
Comfort	221.7 / m v-km (W) 208.7 / m v-km (M)

This analysis included junctions and slip roads, on motorway links only the rates for total stops were:

106 / m v-km (W) 87.8 / m v-km (M)93.6 / m v-km (both)

Summersgill & al (1999)
Video survey M25

Rate:
All stops

Lights:	79.5 / m v-km
Heavies:	135.9 / m v-km
All:	86.6 / m-v-km

Breakdowns	8.8 / 4.8 / 8.3 (light/heavy/all)	m v-km
Checks	2.3 / 6.4 / 2.8	m v-km
Comfort	68.5 / 124.7 / 75.5	m v-km

split

breakdown 10%;
veh check 3%;
comfort 87%

MAIN REFERENCES

Summersgill I and A Holroyd (1992) Effects of road margins on safety and capacity of rural motorways and dual carriageways. Working Paper WP/TS/73. TRL.

Summersgill I, JP Fletcher and JM Sharples (1997) Monitoring the Safety and Performance of Widened Motorways. Unpublished Project Report PR/TT/118/97. TRL

Summersgill I & al (1999) Safety on hard shoulders on the M25. Unpublished Project Report PR/TT/072/99. TRL.