Traffic conditions at potential Active Traffic Management sites

by T Rees, A Flint, P Turner, R Smith and T Sutch

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TRAFFIC CONDITIONS AT POTENTIAL ACTIVE TRAFFIC MANAGEMENT SITES

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by T Rees, A Flint, P Turner, R Smith and T Sutch

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CONTENTS

ANNEXES

TRAFFIC CONDITIONS AT POTENTIAL ACTIVE TRAFFIC MANAGEMENT SITES

EXECUTIVE SUMMARY

Over the next ten years, the Highways Agency will be making increasing use of new technology to provide more reliable journey times, improve safety and control traffic flows. This will allow smarter network management and operation. One of the schemes to be employed is Active Traffic Management (ATM), which will use real-time traffic data to control traffic by means of signs and messages on gantries. A programme of trials to test the concept of ATM is planned to take place by 2004.

An ATM scheme is based on similar principles to a Controlled Motorway environment. The purpose of the Controlled Motorway environment is to smooth vehicle flow in heavy traffic conditions with mandatory variable speed limits coupled with enforcement cameras. This has the potential to reduce driver stress, achieve better lane utilisation, improve safety and enhance road capacity. The infrastructure consists of gantry-mounted variable mandatory speed limit signs and traffic control measures backed by a high level of enforcement.

ATM will also allow the Highways Agency to manage the available road space to make best use of the motorway network. ATM can be used to manage the effects of incidents, by using electronic signs to change speed limits and close lanes. In future, it may be possible to permit the controlled use of the hard shoulder during incidents and other periods of congestion.

The Highways Agency has identified a number of potential pilot locations for ATM. This report assesses recent traffic conditions at these locations, to enable the Highways Agency to determine the most suitable pilot locations. The benefits to be obtained from the introduction of ATM will depend on the traffic flow levels, the amount of current congestion and the road layout at each of the locations.

The Highways Agency originally identified four potential pilot locations for ATM, all of which were long sections of motorway (at least 24km in length). Subsequently, the Highways Agency obtained funding from the Capital Modernisation Fund (CMF) to investigate the effectiveness of ATM over shorter sections. As a result, the Highways Agency identified four short sections of motorway (between 13km and 16km in length) as potential ATM pilot locations.

The main advantages and disadvantages of traffic conditions at each location are listed in Tables E1 and E2, to show how suitable each location would be as an ATM pilot site. Table E1 summarises the general traffic conditions at the original (longer) locations. Table E2 describes the shorter CMF locations, and also lists the main Performance Indicators for each CMF location, broken down by direction (clockwise/anticlockwise for the M25 locations, northbound/ southbound for the M42 location).

Location	Advantages	Disadvantages
M6 J2-5	The flows between Junctions 4 and 5 are high, and could benefit from ATM.	Low flows between Junctions 2 and 4, and no congestion.
M25 J16-28	High to medium flows, with regular congestion.	1) Roadworks during 2000/2001 may compromise the “before” data. 2) The new road layout may cause difficulties in assessing the effect of ATM.
M60 J10-18	There is one link where flow breakdown originates, causing regular congestion. ATM could delay the onset of flow breakdown. High flows.	The close proximity of the junctions and the varying number of lanes may cause difficulties in assessing the effect of ATM.
M4,M5 etc (Bristol)	There is some congestion on Sundays.	There are low weekday flows, and no projected signal activity.

Table E1 – Summary of traffic conditions at longer ATM pilot locations

Location	Length of section	Advantages	Disadvantages	Average weekday flow (vehicles/ weekday)	Maximum hourly flow (vehicles/ hour)	Average 85th percentile flow (vehicles/ hour)	Average amount of signal activity (hours/ weekday)	Average amount of flow breakdown (hours/ weekday)
M25 J16-19	16km	High flows and regular congestion.	1) Roadworks during 2000/2001 may compromise the "before" data. 2) The new road layout may cause difficulties in assessing the effect of ATM.	C/W: 75900 A/C: 73200	C/W: 7140 A/C: 5700	C/W: 5060 A/C: 4860	C/W: 11 A/C: 8.5	C/W: 1.7 A/C: 2.2
M25 J23-25	13km	High flows and regular congestion.	None.	C/W: 69500 A/C: 68300	C/W: 6960 A/C: 5570	C/W: 5070 A/C: 4480	C/W: 9 A/C: 5	C/W: 2.2 A/C: 0.4
M25 J27-28	13km	Medium level flows with regular congestion.	1) There may not be spare capacity downstream of this location. 2) There is only one link, so would not be typical of other locations	C/W: 65200 A/C: 63600	C/W: 4980 A/C: 5690	C/W: 4380 A/C: 4280	C/W: 4.5 A/C: 4	C/W: 1.3 A/C: 0.6
M42 J3A-7	16km	1) The medium level flows and the projected signal activity are distributed evenly between the mornings and evenings. 2) There are no major changes between the links.	None.	N/B: 66700 S/B: 69700	N/B: 5670 S/B: 5700	N/B: 4490 S/B: 4580	N/B: 7 S/B: 8	N/B: 0.8 S/B: 0.5

Table E2 – Summary of traffic conditions at shorter ATM pilot locations (CMF locations)

Of the longer lengths of motorway under consideration as ATM pilots:

- The M25 J16-28 has traffic conditions most suitable for the introduction of ATM, but the presence of roadworks and changes to the road layout on parts of this section may cause difficulties in assessing the effects of ATM.
- Traffic conditions on the M60 J10-18 are also suitable, but the road layout at this location is not typical of the rest of the motorway network, which may cause difficulties in assessing the effects of ATM.
- Traffic flows on most of the M6 J2-5 and on the M4/M5 near Bristol are currently too low for traffic responsive signals to operate. There may be benefits for ATM at the M6 and M4/M5 locations in future, due to the general year-to-year increase in traffic flows. There may also be benefits at the M4/M5 during the Summer months due to the increase in holiday traffic.

Of the shorter lengths of motorway under consideration as ATM pilots:

- All of the locations have traffic conditions suitable for the introduction of ATM.
- The M25 J16-19 is likely to gain the greatest benefit from the introduction of ATM, as it is the most congested location. However, the presence of roadworks and changes to the road layout may cause difficulties in assessing the effects of ATM.
- The M25 J23-25 has the next highest flow and congestion levels, and has no major disadvantages.
- The M42 J3A-7 has medium level flows, and less congestion than the M25 locations. It has no major disadvantages.
- The M25 J27-28 has lower flows than the other sites, and is only one link. Any benefits observed at this location might not be transferable to other locations with more junctions.

This report describes the initial assessment of traffic conditions at the potential ATM pilot locations. As a result of this assessment, some locations may not be deemed suitable for ATM. Further data can be collected from the more suitable locations and a more detailed study could be conducted to investigate the potential benefits to be gained from the introduction of ATM at these locations.

TRAFFIC CONDITIONS AT POTENTIAL ACTIVE TRAFFIC MANAGEMENT SITES

1. INTRODUCTION AND BACKGROUND

Over the next ten years, the Highways Agency will be making increasing use of new technology to provide more reliable journey times, improve safety and control traffic flows. This will allow smarter network management and operation. One of the schemes to be employed is Active Traffic Management (ATM), which will use real-time traffic data to control traffic by means of signs and messages on gantries. A programme of trials to test the concept of ATM is planned to take place by 2004.

An ATM scheme is based on similar principles to a Controlled Motorway environment. The purpose of the Controlled Motorway environment is to smooth vehicle flow in heavy traffic conditions with mandatory variable speed limits coupled with enforcement cameras. This has the potential to reduce driver stress, achieve better lane utilisation, improve safety and enhance road capacity. The infrastructure consists of gantry-mounted variable mandatory speed limit signs and traffic control measures backed by a high level of enforcement.

A Controlled Motorways scheme has been operational on the M25 from Junctions 10 to 15 (a distance of 22km) since August 1995, using traffic flow information from the Motorway Incident Detection and Automatic Signalling (MIDAS) system, based on loops in each lane. TRL has been monitoring the performance of the Controlled Motorways section, examining traffic behaviour and trends and studying the behaviour of the system. The Controlled Motorways system provides a beneficial environment for drivers, which has so far allowed the motorway to sustain the effects of a 2% increase in demand per annum. It has been well received by drivers.

ATM will also allow the Highways Agency to manage the available road space to make best use of the motorway network. ATM can be used to manage the effects of incidents, by using electronic signs to change speed limits and close lanes. In future, it may be possible to permit the controlled use of the hard shoulder during incidents and other periods of congestion.

The Highways Agency has identified a number of potential pilot locations for ATM. This report assesses recent traffic conditions at these locations, to enable the Highways Agency to determine the most suitable pilot locations.

The Highways Agency originally identified four potential pilot locations for ATM, all of which were long sections of motorway (at least 24km in length). Subsequently, the Highways Agency obtained funding from the Capital Modernisation Fund (CMF) to investigate the effectiveness of ATM over shorter sections. As a result, the Highways Agency identified four short sections of motorway (between 13km and 16km in length) as potential ATM pilot locations. This report describes the traffic conditions at the original locations and at the CMF locations.

1.1 POTENTIAL PILOT SITES FOR ATM

The Highways Agency originally identified four possible locations for the installation of ATM:

- M6 Junction 2 to Junction 5 (north of Coventry), a length of 29km.
- M25 Junction 16 to Junction 28 (north of London), a length of 73km.
- M60 Junction 10 to Junction 18, plus M62 Junction 18 to Junction 20 (north of Manchester), a length of 24km.
- M4 Junctions 18 to 23, M5 Junctions 14 to 21, M32 Junctions 1 to 3, M48 and M49 (north of Bristol), a combined length of 91km.

Four locations have been identified as CMF sites for the possible installation of ATM. Three of these are parts of the original proposed location on the M25 north of London:

- M25 Junction 16 to Junction 19 (north of London), a length of 16km.
- M25 Junction 23 to Junction 25 (north of London), a length of 13km.
- M25 Junction 27 to Junction 28 (north of London), a length of 13km.
- M42 Junction 3A to Junction 7 (east of Birmingham), a length of 16km.

At all eight locations, both carriageways are under consideration as pilot sites.

1.2 SUITABLE SITE CHARACTERISTICS FOR ATM

The benefits to be obtained from the introduction of ATM will depend on the traffic flow levels, the amount of current congestion and the road layout at each of the locations.

Suitable locations for ATM will have sufficiently high flows for a control regime to be worthwhile, but not so high that control would have little effect. If there is currently no congestion at a site, then it is unlikely that there would be benefits at that site from the introduction of ATM.

One of the objectives of ATM is to increase traffic flow through sections that are currently heavily congested. If the downstream section of motorway were unable to cope with the increased flow, then a bottleneck would be created at the end of the ATM section. Therefore, it would be an advantage if the downstream non-ATM section of motorway currently has spare capacity. This could occur in two ways:

- The downstream section currently has more lanes available than the potential ATM location.
- The end of the ATM pilot location on each carriageway could coincide with a junction where more vehicles leave the main carriageway than join it. The greatest drop in the number of vehicles on the main carriageway is likely to occur at a motorway-to-motorway interchange.

The benefits over a short ATM section are therefore likely to be site specific, depending on the road layout at the downstream ends of the section. Over longer sections with several junctions, the increased flows as a result of ATM would have a longer distance over which to dissipate.

2. DESCRIPTION OF TRAFFIC DATA

The quality and extent of the traffic data from the potential ATM pilot locations varies considerably. In each case, the most recent and most comprehensive traffic data has been used to determine the traffic conditions. Often, data from a number of sources has been combined to provide a complete data set.

2.1 DATA SOURCES

For each site, traffic flows and speeds, plus an estimate of the percentage of HGVs on the link, have been used to analyse traffic conditions.

Where available, MIDAS data has been used. This provides current traffic data every minute, and is highly detailed. If required, lane-by-lane flows and speeds are available. The MIDAS data also supplies length information, in four bins. This can be used to estimate the number of HGVs throughout the day.

The next best data source is TITAN data. This is also current data, but provides data every 5 minutes. Flows by lane are not available, and speeds are collected in 10mph bins. The TITAN data does not provide any information that can be used to estimate numbers of HGVs.

Where neither of these data sources is available, historical hourly data has been used. In general, this data is available for a 12-month period between January 1999 and December 2000. Where data from 1999/2000 is not available, 1998 data has been used instead. At some sites, less than 12 months of data is available. The historical hourly data does not provide any speed or HGV information.

A further source of information on low speeds is from Traffic*master* sensors. These infrared sensors are placed on overbridges around the motorway network, and provide information on when speeds drop below 30mph. There are sensors over most motorway links. TRL has maintained a database of Traffic*master* speeds since the first sensors were installed during 1991.

There are two further sources of HGV information:

- Manual counts. These provide estimates of the daily HGV flow along each link (both carriageways combined).
- CCTV footage. This can be analysed to obtain HGV percentages on each carriageway for the times of day for which video footage is available.

The definition of an HGV can vary according to the source of the data, so the estimates of HGV percentages have been factored to ensure consistency between sites (see Annex C).

The quality and extent of the traffic data from each of the data sources is summarised in Table 1.

Source of data	Type of data		
	Flows	Speeds	HGV percentage
MIDAS	1-minute totals, by lane	1-minute average values, by lane	Length information, in four bins
TITAN	5-minute totals, across the carriageway	5-minute average values, across the carriageway, in 10mph bins	None
Historical	1-hour totals, across the carriageway	None	None
Traffic*master*	None	Number of minutes that speeds drop below 30mph (in one lane)	None
Manual counts	Estimated daily flows (not used)	None	Estimated daily HGV flow (both carriageways combined)
CCTV	Flows by lane at various times of day (not used)	None	HGV flow at various times of day

Table 1 – Data available from each data source

2.2 DATA AVAILABILITY BY PILOT LOCATION

Table 2 describes the available data sources for each of the potential pilot locations. It also defines the time period that has been used in the analysis of traffic conditions at each location.

Where data is available for a whole year, the detailed analysis of daily flow profiles has been carried out for March and September (of whichever year for which data is available), as these are typical months unaffected by school holidays. (The second week of September 2000 has been excluded from the analysis, as traffic conditions during this week were affected by a national fuel shortage.)

Location	Source of data		
	Flows	Speeds	HGV percentage
M6 J2-5	Historical hourly data for the whole of 2000. MIDAS data is available between J4 and J5.	Traffic*master* sensors, September 2000	1) Manual count at J3-4 during Feb 2001. Assumed to apply for J2-3, and for 2000. 2) MIDAS data at J4-5.
M25 J16-28	Historical hourly data for the whole of 2000 (on some links, the data is from 1999 or 1998)	Traffic*master* sensors, September 2000 and September 1999	DETR Stats TSR2 Division data, 1999. These percentages have been assumed to apply for 2000.
M60 J10-18, M62 J18-20	MIDAS data. Data from Feb/Mar 2001 has been analysed.	Traffic*master* sensors, September 2000	MIDAS data. Data from Feb/Mar 2001 has been analysed.
M4, M5, M32 etc (Bristol)	TITAN data for Feb/Mar 2001. Only available for half of the links.	Traffic*master* sensors, September 2000	DETR Stats TSR2 Division data, 1999. These percentages have been assumed to apply for 2001.
M42 J3A-7	Historical hourly data from Dec 1998 to Nov 1999	Traffic*master* sensors, September 2000	Not currently available. Assumed to be the same as the nearby M6. CCTV footage from Apr 2001 will be used to estimate HGV percentages.

Table 2 – Data sources for each potential pilot location

Notes:

1) CCTV footage from the M42 J3A-7 is currently being analysed to obtain HGV percentages. The results will be included in future versions of this report.

2) There were roadworks on parts of the M25 J16-28 during September 2000. Traffic*master* speed data from September 1999 has been used to verify that the observed congestion at this location is typical, rather than caused by roadworks.

3) At some sites, there is additional information available. For consistency, this data has not been used directly in the analysis, but it has been used to confirm the traffic conditions indicated by the main data sources. The additional data is MIDAS data from the M6 (Junctions 4 to 5 only) and TITAN speed data from sites in the Bristol area.

3. TRAFFIC CONDITIONS AT POTENTIAL PILOT SITES

The flows and speeds for each link have been used to calculate Performance Indicators (PIs) for the link. The PIs are:

- Average daily flow.
- Maximum hourly flow.
- 85th percentile flow.
- Projected signal activity.
- Amount of flow breakdown.

The PIs have been calculated for each carriageway separately, and weekdays, Saturdays and Sundays have separate PIs, as weekend traffic has a different profile to that during the week.

This section describes the PIs and provides a descriptive summary of the traffic conditions at each of the potential ATM pilot locations. The numerical values for each link are listed in Annex A (for weekdays) and Annex B (for weekends).

The flows on each link have also been represented graphically, to show the flow profiles during the day and to identify seasonal trends during the year. These graphs are described in Annex D, together with samples of the graphs.

3.1 PERFORMANCE INDICATORS

The PIs provide indications of the traffic conditions on each link. They are based on similar PIs used to monitor the performance of the M25 Controlled Motorways system.

3.1.1 Average daily flow

This PI is a measure of the daily demand flow on each link. The Average Annual Weekday Throughput (AAWT) has been calculated over the whole period for which data is available, for weekdays only. The lower the daily demand flow, the less suitable the link would be for the introduction of ATM. In addition, very high flows might mean that control would have little effect on that link.

The AAWTs for the M25 Controlled Motorways section (J10-15) are higher than on any of the potential ATM pilot sites. On the M25 J13-14 link (a 4-lane section), flows reach 105,000 vehicles per carriageway per day.

The flows per lane at all of the potential CMF locations are lower than on the M25 Controlled Motorways section, where the flow-based signals have been shown to have an effect on traffic (Abou-Rahme and Harbord, 1999). Therefore, the flows at all of the CMF locations should be at a suitable level for control to have an effect.

3.1.2 Maximum hourly flow

This PI is a measure of the maximum throughput on each link. This can be either a measure of the maximum demand flow (if there is no congestion on the link), or an estimate of the capacity of the link (if congestion occurs). The maximum hourly flow has been calculated over the whole period for which data is available, for weekdays and weekends separately.

The capacity of a motorway is approximately 2,000 vehicles per lane per hour, although this can be reduced by many factors, eg weather, road geometry and traffic conditions upstream and downstream. If the maximum hourly flow on a 3-lane section does not exceed 5,000 vehicles, then congestion is unlikely to occur and there are unlikely to be benefits following the introduction of ATM.

For comparison, the maximum hourly flows for the 4-lane M25 Controlled Motorways section vary between 7,000 and 8,000 vehicles.

3.1.3 85th percentile flow

This PI is a measure used by the HETA Division of DETR to provide an indication of the traffic loading on each link. The 85th percentile flow represents a value greater than 85% of all hourly flows. This PI is calculated over the whole period for which data is available, and for weekdays and weekends combined.

3.1.4 Projected signal activity

This PI is calculated from the flow data and provides an indication of the length of time that traffic conditions on each link are congested or nearing congestion. In the M25 Controlled Motorways system, as flows increase, they trigger flow-responsive signals that display 60mph speed limits. The speed limits become more restrictive as the flows increase further. As the flows decrease, the signals revert to 60mph, then are switched off.

The projected signal activity for each link is an estimate of the length of time that flow-responsive signals would be set if a Controlled Motorways system were to be installed on the link, based on the current traffic flows. The signal activity is split into mornings and evenings (before and after 12:00).

The flow threshold used to estimate the signal activity is based on the thresholds used on the M25 Controlled Motorways system. The 60mph On/Off thresholds from the M25 have been averaged, and factored according to the presence of HGVs on the link (see Annex C for a more detailed description of the method). The threshold is expressed as a flow per lane, so the number of lanes on the link has also been included in the calculation. Table A2 in Annex A shows the percentage HGV and the assumed 60mph flow threshold for each link.

In general, the demand at the pilot sites during the evening peak is more spread out than during the morning (see Figures D1 and D2 in Annex D), so there is more projected signal activity during the evenings.

If the signals at any site would be active for less than 3 hours per day, then it is unlikely that there would be benefits at that site from the introduction of ATM under

the current traffic conditions. Since traffic levels are increasing year-to-year, there may be benefits from ATM at these sites in the future.

For comparison, the signals are active on the M25 Controlled Motorways section for approximately 3 hours in the morning and 4 hours in the evening. The signal activity increases during the Summer as the flows vary seasonally (see Annex D).

3.1.5 Flow breakdown

This PI is a measure of the amount of congestion on each link. It is calculated as the number of minutes that traffic speeds drop below 30mph. It is split into mornings and evenings; the morning period is from 06:00 to 12:00 and the evening period is from 15:00 to 21:00.

The flow breakdown on each link lasts for less time than the projected signal activity. The signals would be switched on before congestion occurs, remain on during the period of flow breakdown, then switched off after the congestion has eased.

If there is no flow breakdown at a site, then it is unlikely that there would be benefits at that site from the introduction of ATM under the current traffic conditions. Since traffic levels (and therefore congestion) are increasing year-to-year, there may be benefits from ATM at these sites in the future.

Congestion data is available for most of the links. Where links have no Traffic*master* sensors or MIDAS loops, there is no speed data available and hence no estimates of congestion are possible.

3.2 SUMMARY OF TRAFFIC CONDITIONS

This section summarises the traffic conditions at each of the potential ATM pilot locations. The flows, projected signal activity and current flow breakdown are summarised for each carriageway separately. The data is from weekdays (see Annex A) and weekends (see Annex B).

The PIs for each potential ATM pilot location have been calculated from the data available at that location (see Section 2.2). The effects of seasonal variations in flows and speeds at many of the locations cannot be determined as there is insufficient data available.

This section also includes descriptions of general conditions at the sites (eg road layout, roadworks etc) that may have an impact on the suitability of the locations as ATM pilot sites.

The four original potential ATM pilot locations are described in Sections 3.2.1 to 3.2.4, followed by the four CMF locations in Sections 3.2.5 to 3.2.8. The traffic conditions are summarised in Section 3.2.9.

Long Sections

3.2.1 M6 J2-5

On both carriageways between Junctions 2 and 4, the daily flows on weekdays are below 60,000 vehicles and the maximum hourly flows are less than 5,000 vehicles. There would be approximately 3 hours of signal activity, mostly in the morning on the northbound carriageway and in the evening on the southbound carriageway.

The flows are higher between Junctions 4 and 5 than on the other links at this location. The signal activity on each carriageway would last for approximately 12 hours, including the whole of the evening peak period.

There is currently flow breakdown on the northbound carriageway only between Junctions 4 and 5; this is likely to be a result of congestion tailing back from further downstream.

At weekends, the pattern is similar, with the highest flows being on the southbound carriageway, but the only flow breakdown at weekends is on the northbound carriageway on Saturdays.

3.2.2 M25 J16-28

This section describes the M25 Junction 16 to 28 location in general; more detailed descriptions of the individual CMF locations on the M25 are contained in Sections 3.2.6 to 3.2.8.

The daily flows on weekdays vary from 58,000 to 82,000 vehicles per carriageway, with the highest flows being at the western end (between Junctions 18 and 19). The maximum hourly flows are also highest between Junctions 18 and 19, where the hourly flows reach 7,100 vehicles.

It is projected that there would be up to 13 hours of signal activity at this location, with most of the signal activity being at the western end. In general, there would be more signal activity on the anticlockwise carriageway during the morning and on the clockwise carriageway during the evening, due to the tidal flow nature of the traffic. Overall, there would be most signal activity on the clockwise carriageway.

There is flow breakdown on many of the links. The most severe congestion is on the clockwise carriageway between Junctions 16 and 17 during the evening, and on the anticlockwise carriageway between Junctions 20 and 18 during the morning. The congestion lasts for over 2 hours at each of these sites. There is a separate area of severe congestion on the clockwise carriageway between Junctions 24 and 25 during the evening, also lasting for over 2 hours.

Flows are lower at weekends, but are still high enough between Junctions 16 and 19 for signals to be active and for flow breakdown to occur on both Saturdays and Sundays. There is also severe Sunday congestion on the clockwise carriageway between Junctions 24 and 25, and on the anticlockwise carriageway between Junctions 26 and 25. (The congestion between Junctions 26 and 25 was not present during 1999, so is likely to be a result of roadworks on the section during September 2000.) The maximum hourly flows are higher on Sundays than on Saturdays, resulting

in more signal activity and more congestion. The evening congestion lasts for longer on Sundays than it does on weekdays.

The western end of this location has been affected by roadworks over the last year. There were roadworks near to Junction 18 from June 2000 to December 2000 to install a climbing lane, and there are currently roadworks between Junctions 16 and 17 for the same reason. These roadworks started in February 2001 and will last until June 2001. The roadworks at Junction 18 caused congestion on some days, with queues tailing back beyond Junction 16 into the Controlled Motorways section. However, three lanes were available in each direction through the contraflow, and the overall levels of congestion during September 2000 were similar to those during September 1999, before the roadworks began.

The changes to the road layout at the western end of this location during 2000/2001 may cause difficulties in assessing the effect of ATM, and any conclusions about the benefits/disbenefits of ATM at this location may not be applicable to other more typical motorways.

3.2.3 M60 J10-18 and M62 J18-20

The highest flows in each direction on this section of the M60 are between Junctions 12 and 13, with average weekday flows of 90,000 vehicles per carriageway. The maximum hourly flows on this link are 5,500 vehicles on the clockwise carriageway, and 5,000 vehicles on the anticlockwise carriageway. There are higher hourly flows on other links, but those links have four or five lanes per carriageway. The link between Junctions 12 and 13 has the highest flows per lane.

Flow breakdown originates between Junctions 12 and 13:

- In the morning, the congestion starts between Junctions 13 and 12 on the anticlockwise carriageway. The congestion tails back to Junction 18 and at the most congested point (between Junctions 15 and 14), traffic is slow moving for almost 3 hours on every weekday morning.
- In the evening, the congestion starts between Junctions 12 and 13 on the clockwise carriageway. The congestion tails back beyond Junction 10, and traffic is slow moving for over an hour on every weekday evening.

The projected signal activity would last for approximately 5 hours per weekday on the busiest links, and for approximately 3 hours per weekday at the tails of the congestion. Most of the signal usage would be during the morning on the anticlockwise carriageway, and during the evening on the anticlockwise carriageway.

The patterns of congestion at weekends are similar, with Saturdays being more congested than Sundays.

This section of motorway has junctions at frequent intervals. There are 10 junctions on a 23km length of road (an average of one junction every 2km), with some of the junctions being less than 1km apart. The close proximity of the junctions, in conjunction with the varying number of lanes along the section, means that most of the congestion is junction-related and caused by problems with traffic merging and diverging. For comparison, the M25 Controlled Motorways section has 6 junctions on 22km of road.

Traffic conditions and projected signal activity at this location during 1997 have been studied in greater detail (Rees et al, 2001). That report also describes the traffic conditions during November 2000 after the final section of the M60 orbital road was opened.

3.2.4 M4 J18-23, M5 J14-21, M32 J1-3, M48 and M49

These sites are the least busy of the potential ATM pilot sites. The daily flows on weekdays at all sites are below 50,000 vehicles and the only hourly flows above 5,000 vehicles are on the northbound carriageway of the M5 between Junctions 19 and 18. This is the only site that would have signal activity on weekdays, but the activity would last for less than two hours, and only in the morning peak.

There is flow breakdown on the southbound M32. This motorway leads into the centre of Bristol, and queues tail back from the town centre, especially during the morning peak period. There is also some flow breakdown on the northbound M5, but this was probably due to roadworks on the M5 at that time (September 2000). All other sites are uncongested.

There is little congestion at any of the sites on Saturdays. On Sundays, the northbound M5 is slow moving for up to three hours, and the eastbound M4 is slow moving for approximately two hours. The maximum hourly flows on the eastbound M4 are higher on Sundays than they are during the week.

There is anecdotal evidence that there is more congestion at these sites (especially on the M5) during the Summer months, due to an increase in holiday traffic.

Short Sections (CMF Locations)

3.2.5 M25 J16-19

The daily flows on weekdays vary from 71,000 vehicles per carriageway at the southern end (Junction 16) to 82,000 vehicles on the clockwise carriageway at the northern end (Junction 19). The maximum hourly flows are approximately 7,000 vehicles on the clockwise carriageway, and approximately 5,500 vehicles on the anticlockwise carriageway.

It is projected that there would be between 6 and 13 hours of signal activity at this location. On the Junction 16 to 17 link, there would be more signal activity on the anticlockwise carriageway during the morning and on the clockwise carriageway during the evening, due to the tidal flow nature of the traffic. Between Junctions 17 and 18, the morning and evening flow levels are similar. Between Junctions 18 and 19, most of the signal activity would occur during the evening peak on both carriageways.

There is flow breakdown on all of the links during both peak periods. The most severe congestion is on the clockwise carriageway between Junctions 16 and 17 during the evening, and on the anticlockwise carriageway between Junctions 19 and 18 during the morning. The congestion lasts for over 2 hours at each of these sites.

Flows are lower at weekends, but are still high enough for signals to be active and for flow breakdown to occur on all links on both Saturdays and Sundays. The maximum hourly flows are higher on Sundays than on Saturdays, resulting in more signal activity and more congestion. The evening congestion lasts for longer on Sundays than it does on weekdays.

This location has been affected by roadworks over the last year. There were roadworks near to Junction 18 from June 2000 to December 2000 to install a climbing lane, and there are currently roadworks between Junctions 16 and 17 for the same reason. These roadworks started in February 2001 and will last until June 2001. The roadworks at Junction 18 caused congestion on some days, with queues tailing back beyond Junction 16 into the Controlled Motorways section. However, three lanes were available in each direction through the contraflow, and the overall levels of congestion during September 2000 were similar to those during September 1999, before the roadworks began.

The changes to the road layout at this location during 2000/2001 may cause difficulties in assessing the effect of ATM, and any conclusions about the benefits/disbenefits of ATM at this location may not be applicable to other more typical motorways.

3.2.6 M25 J23-25

The daily flows on weekdays vary from 66,000 to 72,000 vehicles per carriageway. The maximum hourly flows are highest on the clockwise carriageway, where they approach 7,000 vehicles. The maximum hourly flows on the anticlockwise carriageway are approximately 5,500 vehicles.

Most of the projected signal activity would be on the clockwise carriageway, lasting for 3 hours during the morning and up to 6 hours during the evening. On the anticlockwise carriageway, there would be signal activity during the morning (up to 4 hours between Junctions 24 and 23).

The most severe flow breakdown is on the clockwise carriageway between Junctions 24 and 25, where flow breakdown lasts for 50 minutes during the morning and 2.5 hours during the evening.

Flows are lower at weekends, and are higher on Sundays than on Saturdays. On Saturdays, there would be little signal activity, but there is flow breakdown on both carriageways between Junctions 24 and 25. On Sundays, signals would be active on both carriageways, and there is severe flow breakdown between Junctions 24 and 25 on the clockwise carriageway. The congestion at these sites lasts for longer on Sundays than it does on weekday evenings.

3.2.7 M25 J27-28

The daily flows on weekdays are approximately 64,000 vehicles per carriageway. The maximum hourly flows are 5,000 vehicles on the anticlockwise carriageway, and 5,700 vehicles on the anticlockwise carriageway.

The signal activity would last for 3.5 hours during the morning on the anticlockwise carriageway, and for 4 hours during the evening on the clockwise carriageway.

Flow breakdown lasts for approximately 20 minutes on both carriageways during the morning. During the evening, there is flow breakdown on the clockwise carriageway only, lasting for up to 1 hour.

Flows are lower at weekends, with the only projected signal activity being on Saturdays on the clockwise carriageway, and on Sundays on the anticlockwise carriageway. There is 15 minutes of flow breakdown on Sundays on the anticlockwise carriageway.

3.2.8 M42 J3A-7

The flow levels on these links are similar in both directions. The average daily flows on weekdays vary from 65,000 vehicles at the southern end (Junction 3A) to 70,000 vehicles at the northern end (Junction 7). The maximum hourly flows on each of the links are approximately 5,500 vehicles. On average, the signals would be on for 2.5 hours during the morning and 4 hours during the evening, with slightly greater activity at the northern end (Junction 7) where the flows are higher.

There is currently congestion during the morning on the northbound carriageway approaching Junction 4, lasting for up to an hour. There is little flow breakdown beyond this junction, or on the southbound carriageway. During the evening, there is congestion on the northbound carriageway approaching Junction 5 that lasts for up to an hour, plus congestion on the southbound carriageway approaching Junction 4 that lasts for 40 minutes.

At weekends, the flows are lower. On Saturdays, there would be no signal activity, but there is still flow breakdown approaching Junction 4 on the northbound carriageway. On Sundays, there is little congestion, and signals would be set on the southbound carriageway for approximately 3 hours.

3.3 DOWNSTREAM SITE CHARACTERISTICS

At the short CMF locations, suitable sites will have spare capacity on the downstream non-ATM section of motorway, so that the downstream section can cope with increased flows from the ATM section (see Section 1.2). This is less important on the longer sections, as the increased flows would have a longer distance over which to dissipate. This section summarises the site characteristics downstream of each of the short CMF locations.

There is currently no direct measure of the capacities of the downstream sections. Detailed flow and speed data is required to estimate capacity accurately. From the data currently available, mainline flow levels on the downstream sections have been used to estimate whether spare capacity might be available. If the flows are lower than on the ATM section, then it is likely that there will be spare capacity. In addition, the amount of flow breakdown on the downstream sections provides an indication of whether the capacity of the downstream section has been reached. If there is no flow breakdown, then it is likely that there will be spare capacity.

The downstream characteristics on each carriageway at each location are shown in Table 3.

Location	Clockwise/Northbound		Anticlockwise/Southbound	
	Mainline flows	Flow breakdown	Mainline flows	Flow breakdown
M25 J16-19	There is a drop in daily flow of 11,000 vehicles per day at Junction 19.	None.	The ATM section would lead into a 4-lane section beyond Junction 16.	None.
M25 J23-25	There is a drop in daily flow of 1,500 vehicles per day at Junction 25.	None.	There is a drop in daily flow of 7,000 vehicles per day at Junction 23.	None.
M25 J27-28	There is a drop in daily flow of 3,000 vehicles per day at Junction 28.	1 hour per day	There is a drop in daily flow of 5,000 vehicles per day at Junction 27.	0.5 hour per day
M42 J3A-7	Junction 7 is the junction to the M6. It is likely that there would be a large drop in flows on the M42 after this junction.	No data.	There is a drop in daily flow of 7,000 vehicles per day at Junction 3A.	None.

Table 3 – Downstream site characteristics at CMF potential ATM pilot locations

At three of the sites, there are drops in flow at the downstream sites on both carriageways at all locations, and there is no flow breakdown downstream. Given the available data, it is likely that there would be spare capacity at these downstream sites. There would be most spare capacity at the M25 J16-19 and the M42 J3A-7 locations.

The M25 J27-28 location has downstream flow breakdown on most weekdays. There may not be spare capacity at these downstream sites during the busiest times of day.

3.4 COMPARISON OF POTENTIAL ATM LOCATIONS

Traffic conditions at the potential ATM pilot locations are summarised below. The longer (original) and shorter (CMF) locations are described separately, in approximate order of flow levels at the locations (highest flows first).

3.4.1 Long sections

The highest daily flows are on the M60, where flow breakdown originates on the link between Junction 12 and 13. Congestion occurs on the anticlockwise carriageway during the morning and on the clockwise carriageway during the evening. Because there are often four lanes available, there is less projected signal activity on the M60 than on some of the other locations under consideration. Additionally, the M60 has

junctions at frequent intervals, which, in conjunction with the varying number of lanes along the section, may cause difficulties in assessing the effect of ATM.

The next highest daily flows are on the M25. The daily flows generally become lower as the junction numbers increase around the M25; the highest flows are between Junctions 18 and 19. The level of projected signal activity also drops as the junction numbers increase. The signals would be on for longer (13 hours) between Junctions 18 and 19 than at any other location under consideration. The changes to the road layout between Junctions 16 and 19 during 2000/2001 may cause difficulties in assessing the effect of ATM, and any conclusions about the benefits/disbenefits of ATM at this location may not be applicable to other more typical motorways.

On the M6, there are higher flows between Junctions 4 and 5 than between Junctions 2 and 4. There would be approximately 3 hours of signal activity between Junctions 2 and 4, and approximately 12 hours between Junctions 4 and 5. There is currently little flow breakdown on this section of the M6, apart from congestion tailing back from Junction 6.

The motorways in the Bristol area (M4, M5, M32 etc) have the lowest flows of the motorways under consideration. This is the only location under consideration where Sunday flows are higher than weekday flows. There is little projected signal activity on weekdays, and only a small amount on Sundays.

3.4.2 Short sections (CMF locations)

Of the CMF locations on the M25, the daily flows are highest between Junctions 16 and 19. There would also be the greatest amount of signal activity (up to 13 hours per day) at this location. Between Junctions 23 and 25, the flows are lower, but there is still considerable projected signal activity and current congestion. Between Junctions 27 and 28, the flows are lower again, and there would only be signal activity for one peak period in each direction.

The M42 has the most balanced flows and signal activity of the motorways under consideration. There are no great differences between the mornings and evenings, or any large changes between links. Signals would be on for approximately 6.5 hours in each direction.

The M25 J16-19, M25 J23-25 and M42 locations are likely to have spare capacity downstream of the proposed ATM sections. There would be most spare capacity at the M25 J16-19 and the M42 locations.

The M25 J27-28 location has downstream flow breakdown on most weekdays. There may not be spare capacity at these downstream sites during the busiest times of day.

4. CONCLUSIONS AND FUTURE WORK

4.1 SUMMARY OF FINDINGS

Traffic conditions have been assessed at eight potential ATM pilot locations. Flows, projected signal activity and current levels of flow breakdown have been calculated for each carriageway separately. The main advantages and disadvantages of traffic conditions at each location are listed in Tables 4 and 5, to show how suitable each location would be as an ATM pilot site. Table 4 summarises the general traffic conditions at the original (longer) locations. Table 5 describes the shorter CMF locations, and also lists the main Performance Indicators for each CMF location, broken down by direction (clockwise/anticlockwise for the M25 locations, northbound/ southbound for the M42 location).

Table 4 shows that, of the longer lengths of motorway under consideration as ATM pilots:

- The M25 J16-28 has traffic conditions most suitable for the introduction of ATM, but the presence of roadworks and changes to the road layout on parts of this section may cause difficulties in assessing the effects of ATM.
- Traffic conditions on the M60 J10-18 are also suitable, but the road layout at this location is not typical of the rest of the motorway network, which may cause difficulties in assessing the effects of ATM.
- Traffic flows on most of the M6 J2-5 and on the M4/M5 near Bristol are currently too low for traffic responsive signals to operate.

There may be benefits for ATM at the M6 and M4/M5 locations in future, due to the general year-to-year increase in traffic flows. There may also be benefits at the M4/M5 during the Summer months due to the increase in holiday traffic.

Table 5 shows that, of the shorter lengths of motorway under consideration as ATM pilots:

- All of the locations have traffic conditions suitable for the introduction of ATM.
- The M25 J16-19 is likely to gain the greatest benefit from the introduction of ATM, as it is the most congested location. However, the presence of roadworks and changes to the road layout may cause difficulties in assessing the effects of ATM.
- The M25 J23-25 has the next highest flow and congestion levels, and has no major disadvantages.
- The M42 J3A-7 has medium level flows, and less congestion than the M25 locations. It has no major disadvantages.
- The M25 J27-28 has lower flows than the other sites, and is only one link. Any benefits observed at this location might not be transferable to other locations with more junctions.

Location	Advantages	Disadvantages
M6 J2-5	The flows between Junctions 4 and 5 are high, and could benefit from ATM.	Low flows between Junctions 2 and 4, and no congestion.
M25 J16-28	High to medium flows, with regular congestion.	1) Roadworks during 2000/2001 may compromise the "before" data. 2) The new road layout may cause difficulties in assessing the effect of ATM.
M60 J10-18	There is one link where flow breakdown originates, causing regular congestion. ATM could delay the onset of flow breakdown. High flows.	The close proximity of the junctions and the varying number of lanes may cause difficulties in assessing the effect of ATM.
M4,M5 etc (Bristol)	There is some congestion on Sundays.	There are low weekday flows, and no projected signal activity.

Table 4 – Summary of traffic conditions at original potential ATM pilot locations

Location	Length of section	Advantages	Disadvantages	Average weekday flow (vehicles/ weekday)	Maximum hourly flow (vehicles/ hour)	Average 85th percentile flow (vehicles/ hour)	Average amount of signal activity (hours/ weekday)	Average amount of flow breakdown (hours/ weekday)
M25 J16-19	16km	High flows and regular congestion.	1) Roadworks during 2000/2001 may compromise the "before" data. 2) The new road layout may cause difficulties in assessing the effect of ATM.	C/W: 75900 A/C: 73200	C/W: 7140 A/C: 5700	C/W: 5060 A/C: 4860	C/W: 11 A/C: 8.5	C/W: 1.7 A/C: 2.2
M25 J23-25	13km	High flows and regular congestion.	None.	C/W: 69500 A/C: 68300	C/W: 6960 A/C: 5570	C/W: 5070 A/C: 4480	C/W: 9 A/C: 5	C/W: 2.2 A/C: 0.4
M25 J27-28	13km	Medium level flows with regular congestion.	1) There may not be spare capacity downstream of this location. 2) There is only one link, so would not be typical of other locations	C/W: 65200 A/C: 63600	C/W: 4980 A/C: 5690	C/W: 4380 A/C: 4280	C/W: 4.5 A/C: 4	C/W: 1.3 A/C: 0.6
M42 J3A-7	16km	1) The medium level flows and the projected signal activity are distributed evenly between the mornings and evenings. 2) There are no major changes between the links.	None.	N/B: 66700 S/B: 69700	N/B: 5670 S/B: 5700	N/B: 4490 S/B: 4580	N/B: 7 S/B: 8	N/B: 0.8 S/B: 0.5

Table 5 – Summary of traffic conditions at CMF potential ATM pilot locations

4.2 POSSIBLE FUTURE WORK

This report has summarised an initial investigation into traffic conditions at eight potential ATM pilot locations. There would be benefits in carrying out further work in the following areas:

- The potential benefits to be gained from the introduction of Active Traffic Management could be assessed and a ranking order of locations produced.
- Specific congestion points could be identified and further studies could be carried out to investigate traffic conditions at these points.
- At many of the sites, detailed MIDAS data is not currently available. The assessment of these sites has been based on historical data collected hourly, and consequently the projected signal settings are only estimates. At the locations that are selected as pilot sites, more detailed data should be collected. This data could be 1-minute MIDAS data, or Individual Vehicle Data (IVD). Detailed data should also be collected from links adjacent to the pilot sites, so that any effects on the adjacent links from the introduction of ATM can be assessed.
- When more detailed data becomes available, traffic conditions could be assessed more accurately by calculating the same Performance Indicators described in this report, but using data from the same time of year. Currently, because of the poor data availability, the PIs have often been calculated using data from different months of the year. Seasonal variations in congestion patterns could be assessed. In addition, the effects of incidents, roadworks and bad weather on traffic conditions at the potential ATM pilot locations could be investigated.
- When more detailed data becomes available, an accurate assessment of the projected signal activity under current traffic conditions could be carried out. The effect of seasonal variations in flow could be predicted. The signal settings during future years could also be predicted, using traffic growth rates observed at each location.
- Video data could be collected from the potential ATM pilot locations and correlated with the traffic data to provide a more comprehensive understanding of traffic conditions at each location. The video data could be obtained from existing CCTV cameras or from temporary video cameras.
- A microscopic modelling exercise could be carried out to quantify the likely benefits/disbenefits of ATM at suitable locations. Simulation runs could be performed for weekdays and weekends separately, under a variety of traffic conditions. The effect of ATM on noise and pollution levels could also be modelled.
- The effect of the ATM scheme on flow levels could also be modelled. In congested conditions, the input flow is currently constrained by the capacity of the section. If the capacity is increased (eg by the provision of an extra lane), then the input flow is also likely to increase, up to the level of the underlying demand flow or the new capacity, whichever is lower. When more detailed data becomes available, the underlying demand flow at the potential ATM locations could be estimated. The effect of releasing the higher flows onto the downstream non-ATM section of motorway could also be modelled.

5. REFERENCES

Abou-Rahme, N F and Harbord B J (1999) Speed Control and Incident Detection on the M25 Controlled Motorway (Summary of Results, 1995-1998), *Research Report (128/98 to be published)*, TRL, Crowthorne, UK.

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ANNEX A
TRAFFIC CONDITIONS ON WEEKDAYS

This Annex lists the weekday Performance Indicators (PIs) for each link under consideration as potential ATM pilot sites. The PIs are defined in Section 3.

Table A1 shows the average weekday flow, the maximum hourly flow and the 85th percentile flow for each link. (The 85th percentile flow has been calculated for weekdays and weekends combined.) The number of lanes on each link is also shown.

Table A2 shows the percentage HGV, assumed 60mph flow threshold and projected signal activity for each link. The signal activity is split into mornings and evenings (before and after 12:00).

Table A3 shows the amount of flow breakdown per link, expressed as the number of minutes that traffic speeds drop below 30mph. It is split into morning and evenings; the morning period is from 6:00 to 12:00 and the evening period is from 15:00 to 21:00.

Traffic conditions at weekends are listed in Annex B.

Table A1 - Flows by link and carriageway

Motorway link	Number of lanes	Flows (vehicles)		
		Average weekday flow	Maximum hourly flow (weekdays)	85th percentile flow
M6 J2-3 N	3	58200	4806	3670
M6 J3-2 S	3	58200	4638	3710
M6 J3-4 N	3	55700	4731	3530
M6 J4-3 S	3	55900	4354	3570
M6 J4-5 N	3	77200	5834	4830
M6 J5-4 S	3	79900	5963	5070
M25 J16-17 C/W	3	71900	5622	4820
M25 J17-16 A/C	3	71400	5475	4720
M25 J17-18 C/W	3	73300	6933	4830
M25 J18-17 A/C	3	72400	5697	4810
M25 J18-19 C/W	3	82600	7137	5540
M25 J19-18 A/C	3	75900	5699	5050
M25 J19-20 C/W	3	71300	6146	4780
M25 J20-19 A/C	3	64800	4814	4310
M25 J20-21 C/W	3	69300	5235	4650
M25 J21-20 A/C	3	67200	5114	4400
M25 J21-22 C/W	3	65500	5141	4310
M25 J22-21 A/C	3	63000	4781	4160
M25 J22-23 C/W	3	68100	4924	4570
M25 J23-22 A/C	3	63400	4679	4190
M25 J23-24 C/W	3	72100	6957	5270
M25 J24-23 A/C	3	70400	5565	4620
M25 J24-25 C/W	3	66900	6444	4860
M25 J25-24 A/C	3	66200	5410	4330
M25 J25-26 C/W	3	65400	4794	4260
M25 J26-25 A/C	3	65900	4713	4260
M25 J26-27 C/W	3	58500	4125	3820
M25 J27-26 A/C	3	58200	4742	3830
M25 J27-28 C/W	3	65200	4977	4380
M25 J28-27 A/C	3	63600	5693	4280
M60 J10-11 C/W	3	65600	4735	3984
M60 J11-10 A/C	3	68000	5219	3840
M60 J11-12 C/W	3	66300	4588	3648
M60 J12-11 A/C	3	64400	4212	3648
M60 J12-13 C/W	3	93200	5551	4344
M60 J13-12 A/C	3	89700	4952	4344
M60 J13-14 C/W	3	76900	5510	4428
M60 J14-13 A/C	2	71700	1284	1152
M60 J14-15 C/W	4	No data	2400	1644
M60 J15-14 A/C	4	No data	5989	5616
M60 J15-16 C/W	4	No data	6720	5256
M60 J16-15 A/C	3	No data	5100	4620
M60 J16-17 C/W	4	85600	6477	5088
M60 J17-16 A/C	4	81400	6596	5244
M60 J17-18 C/W	5	80300	6793	5304
M60 J18-17 A/C	4	75400	5990	4776
M62 J18-19 E	3	69600	5593	4584
M62 J19-18 W	3	65200	3755	3000
M62 J19-20 E	3	67700	5453	4416

M62 J20-19 W	3	66700	5340	4392
M4 J18-19 W	3	42100	3529	2868
M4 J19-18 E	3	43100	3965	3263
M4 J19-20 W	3	No data	No data	No data
M4 J20-19 E	3	No data	No data	No data
M4 J20-21 W	3	No data	No data	No data
M4 J21-20 E	3	No data	No data	No data
M4 J21-22 W	3	18500	1990	1361
M4 J22-21 E	3	18500	1990	1361
M4 J22-23 W	3	No data	No data	No data
M4 J23-22 E	3	No data	No data	No data
M5 J14-15 S	3	No data	No data	No data
M5 J15-14 N	3	No data	No data	No data
M5 J15-16 S	3	No data	No data	No data
M5 J16-15 N	3	No data	No data	No data
M5 J16-17 S	3	49100	4159	3316
M5 J17-16 N	3	48800	4181	3510
M5 J17-18 S	3	No data	No data	No data
M5 J18-17 N	3	42300	3844	3386
M5 J18-19 S	3	33300	3601	2165
M5 J19-18 N	3	48100	5268	3385
M5 J19-20 S	3	39200	4218	2536
M5 J20-19 N	3	39300	4193	2656
M5 J20-21 S	3	No data	No data	No data
M5 J21-20 N	3	No data	No data	No data
M32 J1-2 S	3	39900	3231	2743
M32 J2-1 N	3	40400	3755	3000
M32 J2-3 S	3	No data	No data	No data
M32 J3-2 N	3	No data	No data	No data
M48 E	3	No data	No data	No data
M48 W	3	No data	No data	No data
M49 A	3	7200	749	519
M49 B	3	7200	749	519
M42 J3A-4 N	3	64100	5234	4360
M42 J4-3A S	3	67700	5616	4530
M42 J4-5 N	3	68300	5398	4620
M42 J5-4 S	3	72000	5565	4790
M42 J5-6 N	3	66900	5327	4530
M42 J6-5 S	3	68400	5357	4530
M42 J6-7 N	3	67300	5671	4450
M42 J7-6 S	3	70500	5698	4460

Table A1 - Flows by link and carriageway

Note:

At some of the sites, there are faulty loops in one or more lanes, resulting in low counts. These low counts are evident for the M60 J14-13 anticlockwise and J14-15 clockwise.

Table A2 – Projected signal activity by link, carriageway and time of day

Motorway link	Number of lanes	%HGV	60mph flow threshold	Projected signal activity (hh:mm)	
				AM	PM
M6 J2-3 N	3	No data	4064	2:00	1:45
M6 J3-2 S	3	No data	4064	2:00	3:00
M6 J3-4 N	3	21	4064	2:00	0
M6 J4-3 S	3	21	4064	1:30	2:00
M6 J4-5 N	3	21	4064	3:30	8:00
M6 J5-4 S	3	21	4064	4:00	8:30
M25 J16-17 C/W	3	11	4430	3:00	5:30
M25 J17-16 A/C	3	11	4430	4:00	2:15
M25 J17-18 C/W	3	10	4470	6:00	6:00
M25 J18-17 A/C	3	10	4470	4:15	3:00
M25 J18-19 C/W	3	11	4430	4:30	8:30
M25 J19-18 A/C	3	11	4430	5:00	7:00
M25 J19-20 C/W	3	11	4430	3:15	6:00
M25 J20-19 A/C	3	11	4430	0:45	3:00
M25 J20-21 C/W	3	12	4390	2:00	3:45
M25 J21-20 A/C	3	12	4390	0:30	4:00
M25 J21-22 C/W	3	15	4276	2:00	2:00
M25 J22-21 A/C	3	15	4276	2:00	0
M25 J22-23 C/W	3	15	4276	2:00	6:00
M25 J23-22 A/C	3	15	4276	1:30	0
M25 J23-24 C/W	3	17	4203	3:30	6:00
M25 J24-23 A/C	3	17	4203	4:00	2:00
M25 J24-25 C/W	3	17	4203	3:00	5:30
M25 J25-24 A/C	3	17	4203	3:30	0
M25 J25-26 C/W	3	16	4239	1:00	3:15
M25 J26-25 A/C	3	16	4239	2:15	0
M25 J26-27 C/W	3	16	4239	0	0
M25 J27-26 A/C	3	16	4239	1:45	0
M25 J27-28 C/W	3	17	4203	0	4:15
M25 J28-27 A/C	3	17	4203	3:30	0:30
M60 J10-11 C/W	3	19	4132	1:00	2:00
M60 J11-10 A/C	3	19	4132	0	2:15
M60 J11-12 C/W	3	19	4132	0	1:45
M60 J12-11 A/C	3	19	4132	0	0:15
M60 J12-13 C/W	3	19	4132	0:45	4:00
M60 J13-12 A/C	3	19	4132	1:45	2:45
M60 J13-14 C/W	3	19	4132	0:45	4:15
M60 J14-13 A/C	2	19	2755	0	0
M60 J14-15 C/W	4	19	5509	0	0
M60 J15-14 A/C	4	19	5509	2:30	1:00
M60 J15-16 C/W	4	19	5509	0	3:00
M60 J16-15 A/C	3	19	4132	4:45	6:15
M60 J16-17 C/W	4	20	5464	0	2:30
M60 J17-16 A/C	4	20	5464	0:15	2:30
M60 J17-18 C/W	5	20	6830	0	0
M60 J18-17 A/C	4	20	5464	0	1:45
M62 J18-19 E	3	21	4064	0:30	5:45
M62 J19-18 W	3	21	4064	0	0
M62 J19-20 E	3	21	4064	0	5:00
M62 J20-19 W	3	21	4064	1:30	4:30

M4 J18-19 W	3	11	4430	0	0
M4 J19-18 E	3	11	4430	0	0
M4 J19-20 W	3	15	4276	No data	No data
M4 J20-19 E	3	15	4276	No data	No data
M4 J20-21 W	3	14	4313	No data	No data
M4 J21-20 E	3	14	4313	No data	No data
M4 J21-22 W	3	No data	4313	0	0
M4 J22-21 E	3	No data	4313	0	0
M4 J22-23 W	3	No data	4313	No data	No data
M4 J23-22 E	3	No data	4313	No data	No data
M5 J14-15 S	3	14	4313	No data	No data
M5 J15-14 N	3	14	4313	No data	No data
M5 J15-16 S	3	14	4313	No data	No data
M5 J16-15 N	3	14	4313	No data	No data
M5 J16-17 S	3	14	4313	0	0
M5 J17-16 N	3	14	4313	0	0
M5 J17-18 S	3	13	4351	No data	No data
M5 J18-17 N	3	13	4351	0	0
M5 J18-19 S	3	13	4351	0	0
M5 J19-18 N	3	13	4351	1:45	0
M5 J19-20 S	3	11	4430	0	0
M5 J20-19 N	3	11	4430	0	0
M5 J20-21 S	3	10	4470	No data	No data
M5 J21-20 N	3	10	4470	No data	No data
M32 J1-2 S	3	5	4683	0	0
M32 J2-1 N	3	5	4683	0	0
M32 J2-3 S	3	5	4683	No data	No data
M32 J3-2 N	3	5	4683	No data	No data
M48 E	3	No data	4470	No data	No data
M48 W	3	No data	4470	No data	No data
M49 A	3	No data	4470	0	0
M49 B	3	No data	4470	0	0
M42 J3A-4 N	3	21	4064	2:30	3:15
M42 J4-3A S	3	21	4064	2:30	4:30
M42 J4-5 N	3	21	4064	3:00	5:15
M42 J5-4 S	3	21	4064	3:00	5:30
M42 J5-6 N	3	21	4064	2:45	4:00
M42 J6-5 S	3	21	4064	2:30	5:00
M42 J6-7 N	3	21	4064	1:30	5:30
M42 J7-6 S	3	21	4064	4:30	3:45

Table A2 – Projected signal activity by link, carriageway and time of day

Note:

The flow thresholds are expressed as vehicles per hour across the carriageway. The thresholds are dependent on the HGV percentage (see Annex C), and are proportional to the number of lanes at the site.

Table A3 – Flow breakdown by link, carriageway and time of day

Motorway link	Number of minutes per weekday period that speeds drop below 30mph	
	AM	PM
M6 J2-3 N	6	3
M6 J3-2 S	0	0
M6 J3-4 N	1	0
M6 J4-3 S	0	0
M6 J4-5 N	52	16
M6 J5-4 S	0	0
M25 J16-17 C/W	27	142
M25 J17-16 A/C	38	22
M25 J17-18 C/W	No data	No data
M25 J18-17 A/C	No data	No data
M25 J18-19 C/W	5	28
M25 J19-18 A/C	143	66
M25 J19-20 C/W	2	3
M25 J20-19 A/C	170	51
M25 J20-21 C/W	2	6
M25 J21-20 A/C	85	19
M25 J21-22 C/W	4	22
M25 J22-21 A/C	29	21
M25 J22-23 C/W	1	22
M25 J23-22 A/C	4	8
M25 J23-24 C/W	5	43
M25 J24-23 A/C	10	15
M25 J24-25 C/W	49	162
M25 J25-24 A/C	8	11
M25 J25-26 C/W	0	7
M25 J26-25 A/C	36	7
M25 J26-27 C/W	9	43
M25 J27-26 A/C	34	1
M25 J27-28 C/W	21	55
M25 J28-27 A/C	25	13
M60 J10-11 C/W	2	72
M60 J11-10 A/C	19	20
M60 J11-12 C/W	No data	No data
M60 J12-11 A/C	No data	No data
M60 J12-13 C/W	1	67
M60 J13-12 A/C	1	2
M60 J13-14 C/W	0	0
M60 J14-13 A/C	0	0
M60 J14-15 C/W	11	7
M60 J15-14 A/C	165	10
M60 J15-16 C/W	21	35
M60 J16-15 A/C	91	1
M60 J16-17 C/W	No data	No data
M60 J17-16 A/C	No data	No data
M60 J17-18 C/W	No data	No data
M60 J18-17 A/C	No data	No data
M62 J18-19 E	17	2
M62 J19-18 W	45	5
M62 J19-20 E	No data	No data

M62 J20-19 W	No data	No data
M4 J18-19 W	9	2
M4 J19-18 E	2	1
M4 J19-20 W	7	9
M4 J20-19 E	17	0
M4 J20-21 W	No data	No data
M4 J21-20 E	No data	No data
M4 J21-22 W	No data	No data
M4 J22-21 E	No data	No data
M4 J22-23 W	No data	No data
M4 J23-22 E	No data	No data
M5 J14-15 S	14	14
M5 J15-14 N	1	31
M5 J15-16 S	No data	No data
M5 J16-15 N	No data	No data
M5 J16-17 S	0	3
M5 J17-16 N	1	11
M5 J17-18 S	0	18
M5 J18-17 N	0	2
M5 J18-19 S	0	0
M5 J19-18 N	34	22
M5 J19-20 S	1	5
M5 J20-19 N	27	16
M5 J20-21 S	0	0
M5 J21-20 N	0	0
M32 J1-2 S	18	3
M32 J2-1 N	0	1
M32 J2-3 S	78	36
M32 J3-2 N	0	1
M48 E	3	0
M48 W	0	0
M49 A	No data	No data
M49 B	No data	No data
M42 J3A-4 N	56	61
M42 J4-3A S	1	5
M42 J4-5 N	4	43
M42 J5-4 S	7	39
M42 J5-6 N	0	16
M42 J6-5 S	3	38
M42 J6-7 N	1	0
M42 J7-6 S	2	35

Table A3 – Flow breakdown by link, carriageway and time of day

ANNEX B

TRAFFIC CONDITIONS AT WEEKENDS

This Annex lists the weekend PIs for each link under consideration as potential ATM pilot sites, in a similar format to the weekday data listed in Annex A. The PIs are defined in Section 3.

Table B1 shows the maximum hourly flows for Saturdays and Sundays. (No 85th percentile flows are shown as these have been calculated for weekdays and weekends combined and listed in Annex A.)

Table B2 shows the projected signal activity on each link for Saturdays and Sundays. The assumed 60mph flow threshold is the same as for weekdays (see Annex A). HGV percentages at weekends are not available for most of the locations.

Table B3 shows the amount of flow breakdown per link for Saturdays and Sundays.

Table B1 – Maximum hourly flows by link and carriageway at weekends

Motorway link	Number of lanes	Maximum hourly flows (vehicles)	
		Saturday	Sunday
M6 J2-3 N	3	3163	2820
M6 J3-2 S	3	2783	3559
M6 J3-4 N	3	3012	2590
M6 J4-3 S	3	2660	3473
M6 J4-5 N	3	4109	3747
M6 J5-4 S	3	4367	4662
M25 J16-17 C/W	3	4537	4938
M25 J17-16 A/C	3	4537	4605
M25 J17-18 C/W	3	4714	6312
M25 J18-17 A/C	3	4600	4856
M25 J18-19 C/W	3	4916	5276
M25 J19-18 A/C	3	4817	5114
M25 J19-20 C/W	3	4235	4628
M25 J20-19 A/C	3	4491	4361
M25 J20-21 C/W	3	4200	4550
M25 J21-20 A/C	3	4404	4575
M25 J21-22 C/W	3	3700	4040
M25 J22-21 A/C	3	3781	4263
M25 J22-23 C/W	3	3979	4279
M25 J23-22 A/C	3	3831	4291
M25 J23-24 C/W	3	4578	4853
M25 J24-23 A/C	3	3919	4530
M25 J24-25 C/W	3	4166	4520
M25 J25-24 A/C	3	3683	4350
M25 J25-26 C/W	3	4075	3992
M25 J26-25 A/C	3	3934	4290
M25 J26-27 C/W	3	3881	3669
M25 J27-26 A/C	3	3334	4350
M25 J27-28 C/W	3	4421	4198
M25 J28-27 A/C	3	3657	4758
M60 J10-11 C/W	3	4799	4353
M60 J11-10 A/C	3	4837	4934
M60 J11-12 C/W	3	4136	3472
M60 J12-11 A/C	3	4475	4306
M60 J12-13 C/W	3	4723	4371
M60 J13-12 A/C	3	5972	5630
M60 J13-14 C/W	3	4797	4487
M60 J14-13 A/C	2	2772	2378
M60 J14-15 C/W	4	1604	1441
M60 J15-14 A/C	4	1140	5766
M60 J15-16 C/W	4	5216	4830
M60 J16-15 A/C	3	7177	6261
M60 J16-17 C/W	4	4106	4564
M60 J17-16 A/C	4	5128	4926
M60 J17-18 C/W	5	7827	8307
M60 J18-17 A/C	4	4277	4040
M62 J18-19 E	3	4798	5328
M62 J19-18 W	3	4070	3627
M62 J19-20 E	3	4525	5193
M62 J20-19 W	3	4948	4662

M4 J18-19 W	3	3193	3230
M4 J19-18 E	3	2838	4696
M4 J19-20 W	3	No data	No data
M4 J20-19 E	3	No data	No data
M4 J20-21 W	3	No data	No data
M4 J21-20 E	3	No data	No data
M4 J21-22 W	3	1424	2540
M4 J22-21 E	3	1424	2540
M4 J22-23 W	3	No data	No data
M4 J23-22 E	3	No data	No data
M5 J14-15 S	3	No data	No data
M5 J15-14 N	3	No data	No data
M5 J15-16 S	3	No data	No data
M5 J16-15 N	3	No data	No data
M5 J16-17 S	3	4593	3966
M5 J17-16 N	3	3082	4424
M5 J17-18 S	3	No data	No data
M5 J18-17 N	3	3286	3882
M5 J18-19 S	3	3205	2629
M5 J19-18 N	3	3160	3647
M5 J19-20 S	3	3625	2970
M5 J20-19 N	3	2682	3301
M5 J20-21 S	3	No data	No data
M5 J21-20 N	3	No data	No data
M32 J1-2 S	3	2802	2346
M32 J2-1 N	3	2803	2626
M32 J2-3 S	3	No data	No data
M32 J3-2 N	3	No data	No data
M48 E	3	No data	No data
M48 W	3	No data	No data
M49 A	3	402	460
M49 B	3	402	460
M42 J3A-4 N	3	3582	3830
M42 J4-3A S	3	3842	4313
M42 J4-5 N	3	3876	3982
M42 J5-4 S	3	3767	3688
M42 J5-6 N	3	3817	3744
M42 J6-5 S	3	3640	3458
M42 J6-7 N	3	3560	4275
M42 J7-6 S	3	3683	4335

Table B1 – Maximum hourly flows by link and carriageway at weekends

Note:

At some of the sites, there are faulty loops in one or more lanes, resulting in low counts. These low counts are evident for both carriageways on the M60 J14-15.

Table B2 – Projected signal activity by link and carriageway at weekends

Motorway link	Number of lanes	Projected signal activity (hh:mm)	
		Saturday	Sunday
M6 J2-3 N	3	0	0
M6 J3-2 S	3	0	0
M6 J3-4 N	3	0	0
M6 J4-3 S	3	0	0
M6 J4-5 N	3	1:00	0
M6 J5-4 S	3	2:00	4:00
M25 J16-17 C/W	3	1:00	3:45
M25 J17-16 A/C	3	1:15	1:30
M25 J17-18 C/W	3	0:45	2:15
M25 J18-17 A/C	3	1:15	2:30
M25 J18-19 C/W	3	3:15	6:00
M25 J19-18 A/C	3	2:00	3:45
M25 J19-20 C/W	3	0	1:30
M25 J20-19 A/C	3	0:30	0
M25 J20-21 C/W	3	0	2:00
M25 J21-20 A/C	3	0:45	1:45
M25 J21-22 C/W	3	0	0
M25 J22-21 A/C	3	0	0
M25 J22-23 C/W	3	0	0
M25 J23-22 A/C	3	0	0:30
M25 J23-24 C/W	3	2:00	3:15
M25 J24-23 A/C	3	0	3:00
M25 J24-25 C/W	3	0	2:30
M25 J25-24 A/C	3	0	1:45
M25 J25-26 C/W	3	0	0
M25 J26-25 A/C	3	0	0:45
M25 J26-27 C/W	3	0	0
M25 J27-26 A/C	3	0	0:30
M25 J27-28 C/W	3	2:30	0
M25 J28-27 A/C	3	0	2:15
M60 J10-11 C/W	3	2:00	0:15
M60 J11-10 A/C	3	4:00	4:30
M60 J11-12 C/W	3	0	0
M60 J12-11 A/C	3	0:45	0:15
M60 J12-13 C/W	3	3:00	0:45
M60 J13-12 A/C	3	4:15	5:00
M60 J13-14 C/W	3	3:30	1:15
M60 J14-13 A/C	2	0	0
M60 J14-15 C/W	4	0	0
M60 J15-14 A/C	4	0:30	0:15
M60 J15-16 C/W	4	0	0
M60 J16-15 A/C	3	7:00	6:45
M60 J16-17 C/W	4	0	0
M60 J17-16 A/C	4	0	0
M60 J17-18 C/W	5	6:15	5:30
M60 J18-17 A/C	4	0	0
M62 J18-19 E	3	2:30	4:30
M62 J19-18 W	3	0	0
M62 J19-20 E	3	1:30	3:45
M62 J20-19 W	3	3:15	1:30

M4 J18-19 W	3	0	0
M4 J19-18 E	3	0	1:45
M4 J19-20 W	3	No data	No data
M4 J20-19 E	3	No data	No data
M4 J20-21 W	3	No data	No data
M4 J21-20 E	3	No data	No data
M4 J21-22 W	3	0	0
M4 J22-21 E	3	0	0
M4 J22-23 W	3	No data	No data
M4 J23-22 E	3	No data	No data
M5 J14-15 S	3	No data	No data
M5 J15-14 N	3	No data	No data
M5 J15-16 S	3	No data	No data
M5 J16-15 N	3	No data	No data
M5 J16-17 S	3	1:30	0
M5 J17-16 N	3	0	1:00
M5 J17-18 S	3	No data	No data
M5 J18-17 N	3	0	0
M5 J18-19 S	3	0	0
M5 J19-18 N	3	0	0
M5 J19-20 S	3	0	0
M5 J20-19 N	3	0	0
M5 J20-21 S	3	No data	No data
M5 J21-20 N	3	No data	No data
M32 J1-2 S	3	0	0
M32 J2-1 N	3	0	0
M32 J2-3 S	3	No data	No data
M32 J3-2 N	3	No data	No data
M48 E	3	No data	No data
M48 W	3	No data	No data
M49 A	3	0	0
M49 B	3	0	0
M42 J3A-4 N	3	0	0
M42 J4-3A S	3	0	2:00
M42 J4-5 N	3	0	0
M42 J5-4 S	3	0	3:30
M42 J5-6 N	3	0	0
M42 J6-5 S	3	0	3:15
M42 J6-7 N	3	0	1:15
M42 J7-6 S	3	0	2:00

Table B2 – Projected signal activity by link and carriageway at weekends

Table B3 – Flow breakdown by link and carriageway at weekends

Motorway link	Number of minutes per weekend day that speeds drop below 30mph	
	Saturday	Sunday
M6 J2-3 N	0	0
M6 J3-2 S	0	0
M6 J3-4 N	0	2
M6 J4-3 S	0	0
M6 J4-5 N	34	0
M6 J5-4 S	0	0
M25 J16-17 C/W	2	151
M25 J17-16 A/C	32	64
M25 J17-18 C/W	No data	No data
M25 J18-17 A/C	No data	No data
M25 J18-19 C/W	26	5
M25 J19-18 A/C	70	104
M25 J19-20 C/W	0	0
M25 J20-19 A/C	83	165
M25 J20-21 C/W	0	1
M25 J21-20 A/C	21	54
M25 J21-22 C/W	2	3
M25 J22-21 A/C	0	2
M25 J22-23 C/W	68	0
M25 J23-22 A/C	91	0
M25 J23-24 C/W	0	0
M25 J24-23 A/C	9	0
M25 J24-25 C/W	36	153
M25 J25-24 A/C	36	16
M25 J25-26 C/W	2	0
M25 J26-25 A/C	8	128 (*)
M25 J26-27 C/W	3	12
M25 J27-26 A/C	0	30
M25 J27-28 C/W	0	2
M25 J28-27 A/C	2	16
M60 J10-11 C/W	30	0
M60 J11-10 A/C	0	0
M60 J11-12 C/W	No data	No data
M60 J12-11 A/C	No data	No data
M60 J12-13 C/W	0	4
M60 J13-12 A/C	4	6
M60 J13-14 C/W	0	0
M60 J14-13 A/C	0	0
M60 J14-15 C/W	32	14
M60 J15-14 A/C	68	55
M60 J15-16 C/W	35	2
M60 J16-15 A/C	11	0
M60 J16-17 C/W	No data	No data
M60 J17-16 A/C	No data	No data
M60 J17-18 C/W	No data	No data
M60 J18-17 A/C	No data	No data
M62 J18-19 E	0	2
M62 J19-18 W	67	5
M62 J19-20 E	No data	No data

M62 J20-19 W	No data	No data
M4 J18-19 W	4	3
M4 J19-18 E	10	105
M4 J19-20 W	9	0
M4 J20-19 E	2	119
M4 J20-21 W	No data	No data
M4 J21-20 E	No data	No data
M4 J21-22 W	No data	No data
M4 J22-21 E	No data	No data
M4 J22-23 W	No data	No data
M4 J23-22 E	No data	No data
M5 J14-15 S	8	15
M5 J15-14 N	6	128
M5 J15-16 S	No data	No data
M5 J16-15 N	No data	No data
M5 J16-17 S	5	50
M5 J17-16 N	2	172
M5 J17-18 S	23	0
M5 J18-17 N	2	111
M5 J18-19 S	0	0
M5 J19-18 N	0	30
M5 J19-20 S	2	0
M5 J20-19 N	0	12
M5 J20-21 S	0	0
M5 J21-20 N	0	0
M32 J1-2 S	2	0
M32 J2-1 N	0	0
M32 J2-3 S	0	0
M32 J3-2 N	1	0
M48 E	2	4
M48 W	0	0
M49 A	No data	No data
M49 B	No data	No data
M42 J3A-4 N	44	0
M42 J4-3A S	0	0
M42 J4-5 N	0	2
M42 J5-4 S	0	0
M42 J5-6 N	0	2
M42 J6-5 S	0	8
M42 J6-7 N	0	0
M42 J7-6 S	0	3

Table B3 – Flow breakdown by link and carriageway at weekends

(*) The Sunday congestion on the M25 J26-25 anticlockwise carriageway was not present during 1999, so is likely to be a result of roadworks on the section during September 2000.

Figures B1 and B2 show examples of daily flow profiles at weekends (see Annex D for examples of weekday flow profiles). These graphs show how the hourly flows vary during the day, and where the peak flows occur. On most links, the flow patterns are the same on both carriageways. On Saturdays, the highest flows tend to occur around noon, but they often do not reach the 60mph flow threshold. On Sundays, the highest flows are during the evening, and these flows are usually higher than the peak Saturday flows.

Figure B1
M42 J6-J7 Northbound
Average Hourly Flow (Weekends during March 1999)

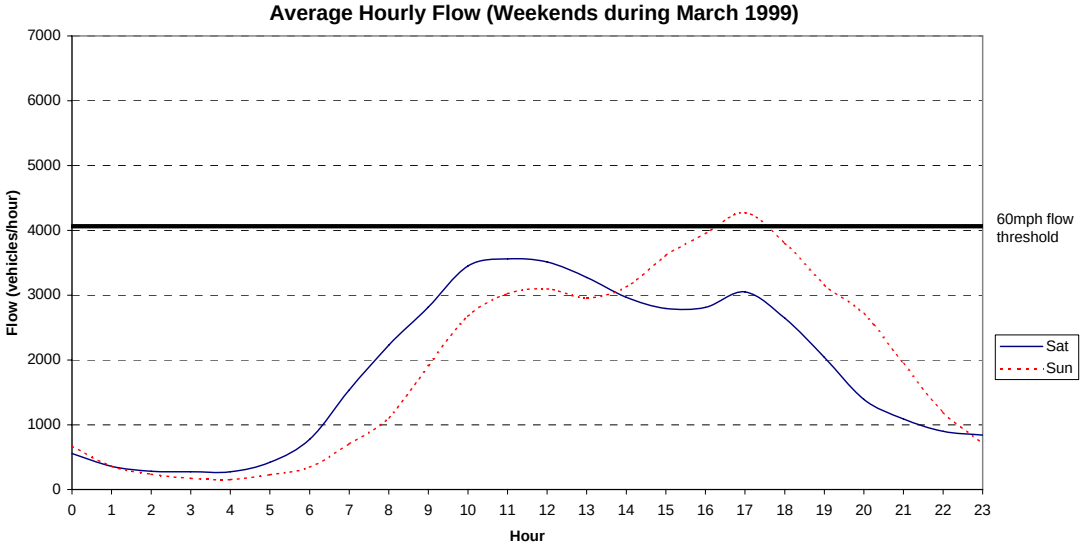
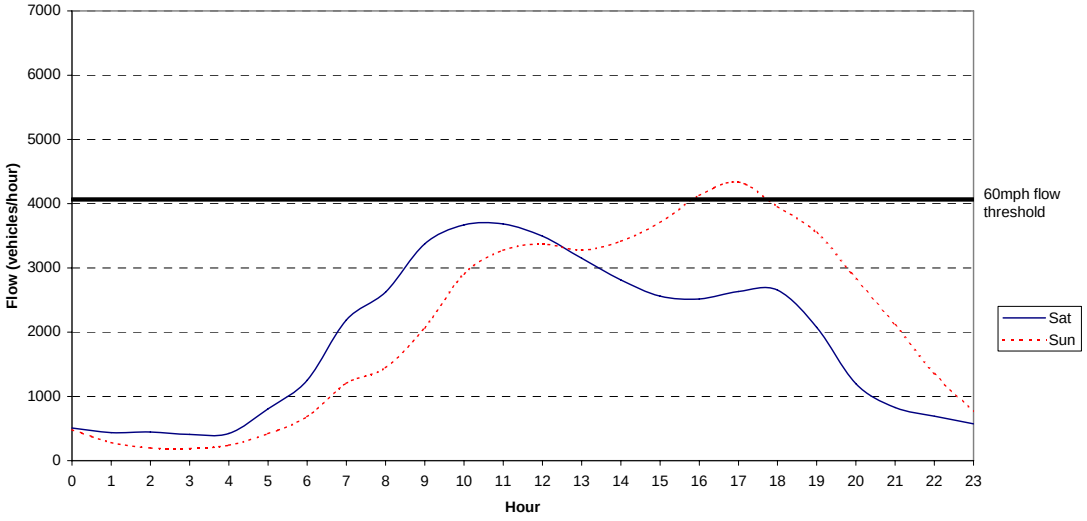


Figure B2
M42 J7-J6 Southbound
Average Hourly Flow (Weekends during March 1999)



ANNEX C

HGV PERCENTAGES AND ESTIMATION OF FLOW THRESHOLDS

The Controlled Motorways system on the M25 sets flow-based speed limits based on the number of vehicles using the motorway each minute. The flow thresholds have been tuned so that the signals come on as the traffic density approaches a critical level. These thresholds are specific to the M25. A Controlled Motorway system has not yet been installed on any other motorway, so suitable flow thresholds for other motorways have not yet been determined.

Thresholds for other motorways have been estimated by assuming that the signals should switch on when the traffic density reaches the same level as for the M25 signals. To estimate this threshold correctly, it is important to know the percentage of HGVs using the motorway at the time, since this affects the traffic density.

MIDAS does not measure the HGV percentage, and flows are all measured in numbers of vehicles, whatever their type. The HGV percentage on the M25 J10-15 was found to be consistent from day to day and was allowed for in the original calculation of the flow thresholds.

In this report, flow thresholds for each of the potential ATM pilot sites have been factored to allow for the different HGV percentages on other motorways. The M25 thresholds have been converted to Passenger Car Units (PCUs), with cars being 1 PCU and HGVs being 2 PCUs. For example, the M25 J10-15 has 10% HGVs each day, and a flow threshold of 4470 vehicles/hour (equivalent to 4917 PCUs). The flow threshold for each other site is assumed to be 4917 PCUs, and the HGV percentage at each site is used to convert this PCU threshold into a flow in vehicles per hour. For example, the M60 J16-17 site has 20% HGVs each day, so the flow threshold for this site is reduced to 4098 vehicles/hour. This should result in the signals switching on at similar levels of congestion as they do on the M25.

The flow thresholds are dependent on the number of lanes at the site. The thresholds above have been calculated assuming three lanes per carriageway. Where there are different numbers of lanes, the flow thresholds have been adjusted proportionally. This only applies to the M60, where the number of lanes per carriageway varies between two and five.

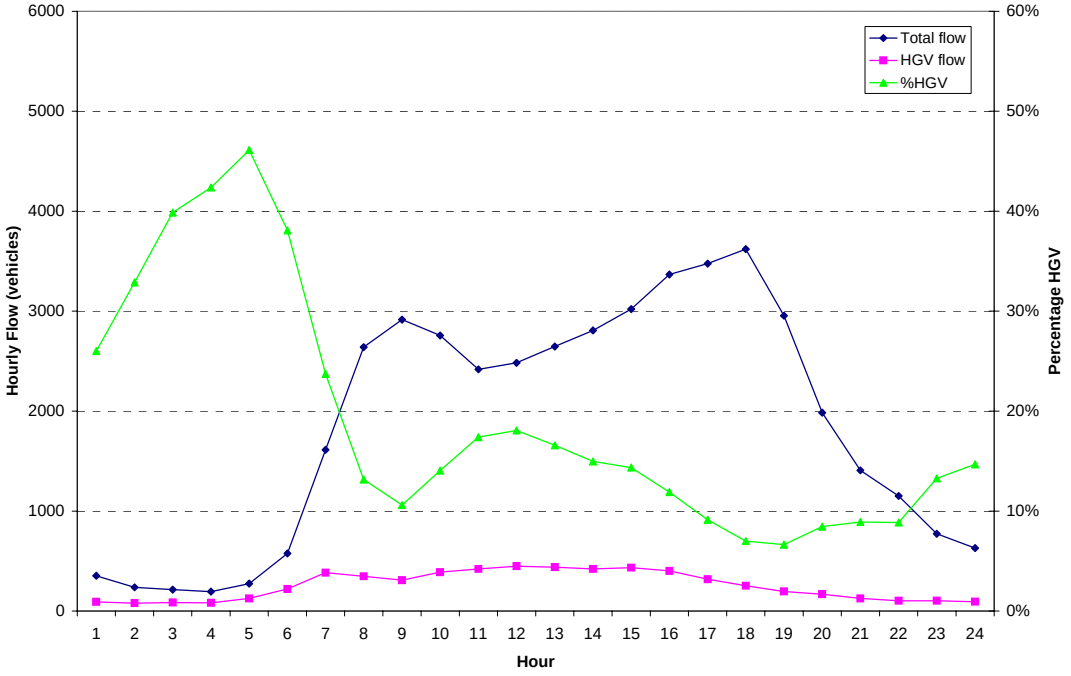
The flow thresholds have been used to estimate the signal activity that would occur if a Controlled Motorways system were installed at the potential pilot locations.

The HGV percentages at the pilot locations have been estimated using one of three methods:

- Manual observations. These provide daily averages for both carriageways combined. This data is provided by DETR Stats TSR2 Division, and is available for Southern England (the M25 and Bristol ATM pilot locations), plus one site on the M6.
- CCTV footage. This provides HGV percentages on each carriageway for the times of day for which video footage is available. This data is available for the M42 sites, and also for the M25 J18-19.

- Length data from MIDAS. This provides continuous data for each carriageway. This data is available for the M60 sites and the M6 J4-5. Figure C1 shows an example of the HGV information available from MIDAS. The number of HGVs remains relatively constant throughout the day; the change in HGV percentage during the day is a result of greater numbers of cars during the peak periods.

Figure C1
Weekday flows at 9245a (M60 J14)



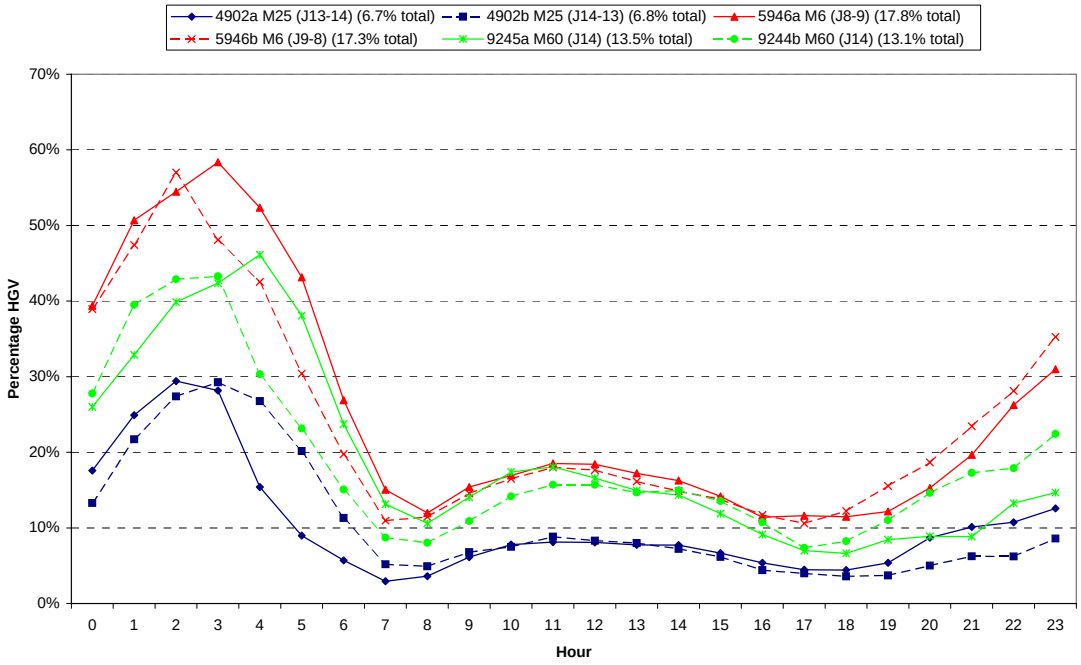
The three methods use different assumptions about HGVs, so they are not directly comparable. However, manual observations and length data are available for the M25 Controlled Motorways section, and manual observations and CCTV footage are available for the M25 J18-19. From these pairings, the methods can been compared to ensure consistency.

Manual observations from the M25 J10-15 indicate that there are on average 10% HGVs during the day. The length data suggests that there are on average 7% HGVs. Therefore, HGV percentages derived from length data have been factored up so that both methods provide the same results.

The CCTV footage is currently being processed. When the analysis is complete, a conversion factor will be set up to ensure consistency between counts from CCTV footage and manual observations.

Figure C2 shows how the HGV percentages vary during the day on the three motorways for which comprehensive MIDAS data is available. The projected signal activity would be during the peak periods, when the HGV percentages are lower than at other times of day. Figure C2 shows that the trends in HGV percentage during the day are similar on all three motorways, so comparing percentages in peak periods is equivalent to comparing daily HGV percentages. Therefore, for simplicity, the overall daily percentages (factored where necessary to allow for the different methods of data collection) have been used to estimate the flow thresholds.

Figure C2
HGV traffic as a percentage of average weekday flow



ANNEX D
GRAPHICAL REPRESENTATION OF FLOWS

For each link under consideration as a proposed ATM pilot site, graphs of daily flow profiles, seasonal trends in daily flows and cumulative frequencies of hourly flows have been produced. This Annex contains examples of each type of plot from one link of each of the potential CMF sites (M42, M25 J16-19, M25 J23-25, M25 J27-28); similar plots are available for all links under consideration as potential ATM pilot sites.

Figures D1 to D6 are described below; these plots are from the M42 J6-7 (each carriageway separately). Figures D7 to D12 are from the M25 J16-17, Figures D13 to D18 are from the M25 J24-25 and Figures D19 to D24 are from the M25 J27-28.

Figures D1 and D2 show daily flow profiles. These graphs show how the hourly flows vary during the day, and show whether the morning or evening peak period is the busiest. On most links, the flow is tidal: if one carriageway is busy during the morning, then the opposite carriageway is busy during the evening as the same traffic makes its return journey. The highest flows over the whole day tend to occur during the morning peak periods, as the demand is concentrated over a shorter period than during the evening. The evening peak period often lasts longer than the morning peak period.

The 60mph flow threshold is shown on these graphs; whenever the flow is above this threshold, it is projected that Controlled Motorway signals would be set. Each flow threshold has been calculated to take account of the HGV percentage using the link (see Annex C).

Figures D3 and D4 show seasonal trends in the Average Annual Weekday Throughput (AAWT) during the year. At the CMF sites, data is available for a whole year (with some gaps in the data). Figures D3 and D4 show that the flow levels rise from the start of the year, peak during the Summer, and drop off during the Autumn. The seasonal trends are the same on both carriageways. These trends in flow have been found to occur on all of the motorways for which data is currently available.

Figures D5 and D6 show cumulative frequencies of the hourly flows for a whole year, for weekdays and weekends combined. The 85th percentile flow level is shown on the graphs (85% of all the hourly flows are below this level). The cumulative frequency graphs for most of the sites under consideration have the same general shape as in Figures D5 and D6. (Cumulative frequency graphs usually have the frequency as the y-axis; these hourly flow frequency graphs have been drawn as defined by the HETA Division of DETR.)

Figure D1
M42 J6-J7 Northbound
Average Hourly Flow (Week beginning Monday 8th Nov 1999)

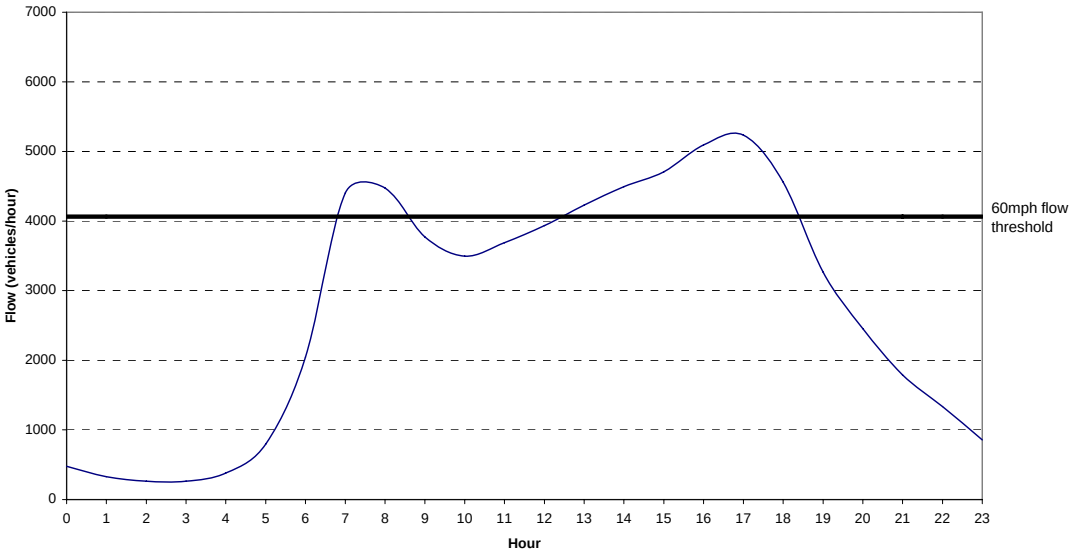


Figure D2
M42 J7-J6 Southbound
Average Hourly Flow (Week beginning Monday 8th Nov 1999)

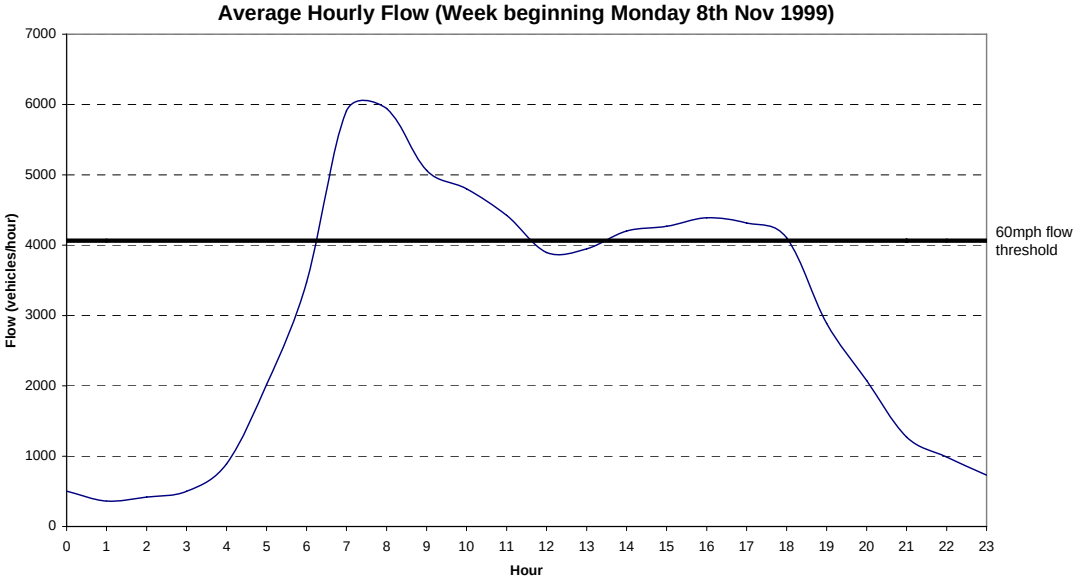


Figure D3
M42 J6-J7 Northbound
Average Daily Flow (Mon-Fri) during 1999

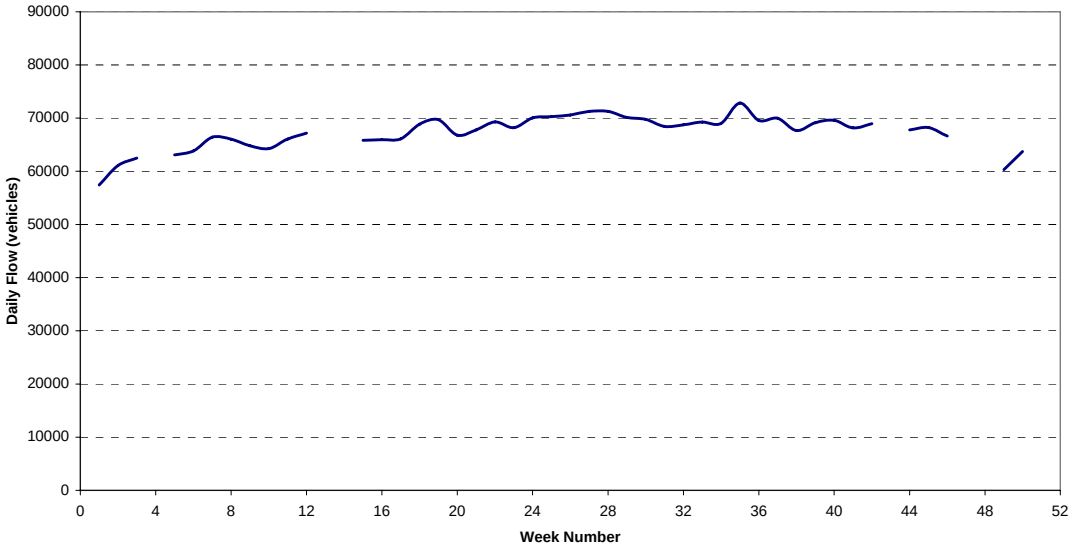


Figure D4
M42 J7-J6 Southbound
Average Daily Flow (Mon-Fri) during 1999

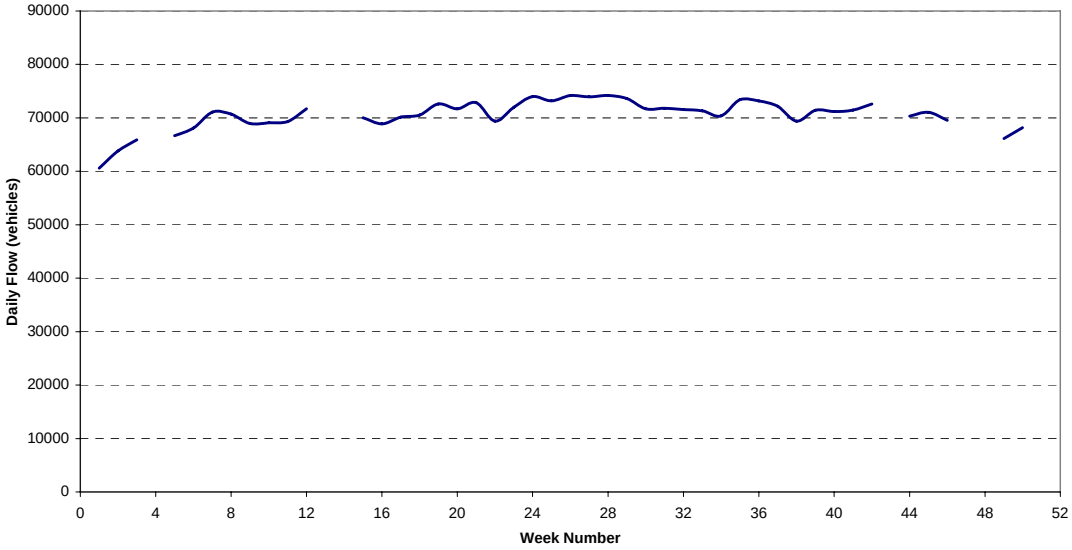


Figure D5
M42 J6-J7 Northbound
Cumulative frequency of hourly flows during 1999

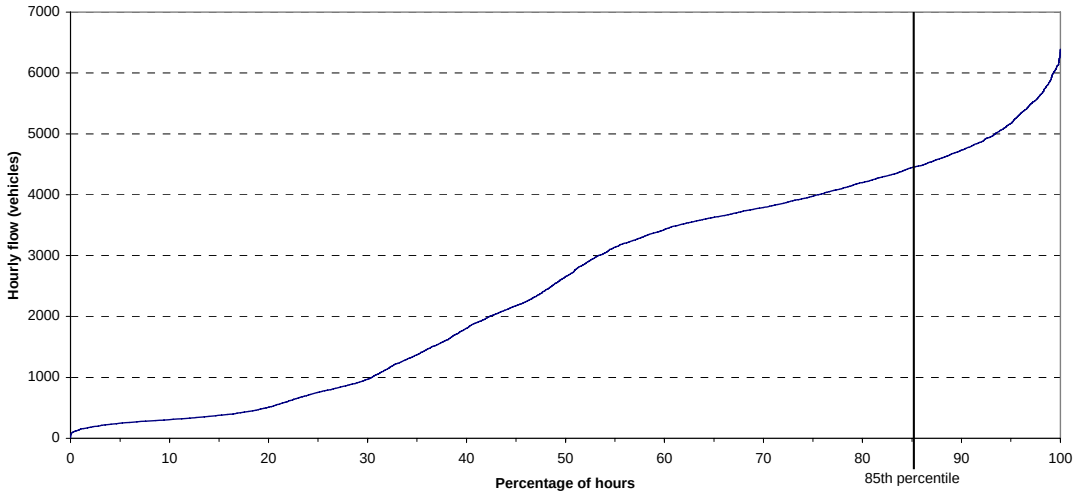


Figure D6
M42 J7-J6 Southbound
Cumulative frequency of hourly flows during 1999

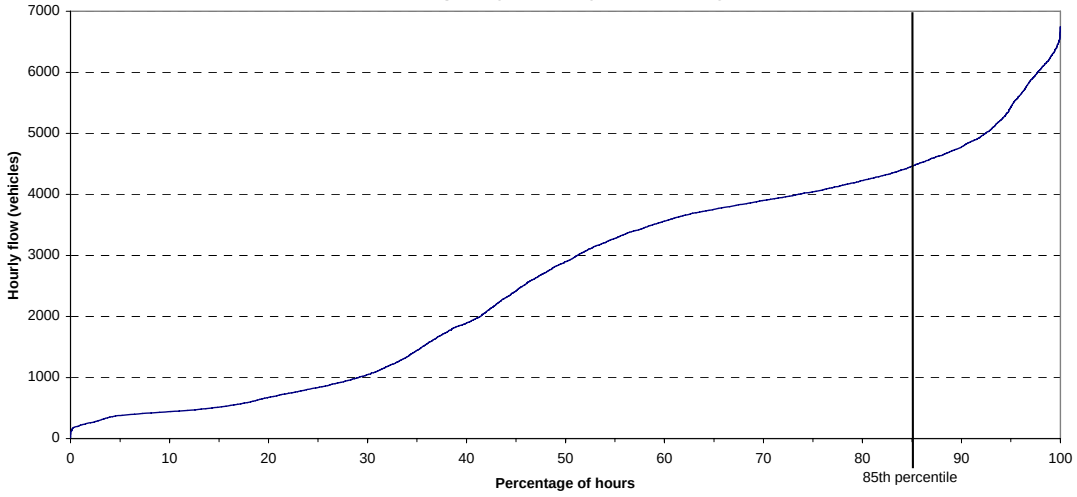


Figure D7
M25 J16-J17 Clockwise
Average hourly flow (Week beginning 30 Oct 2000)

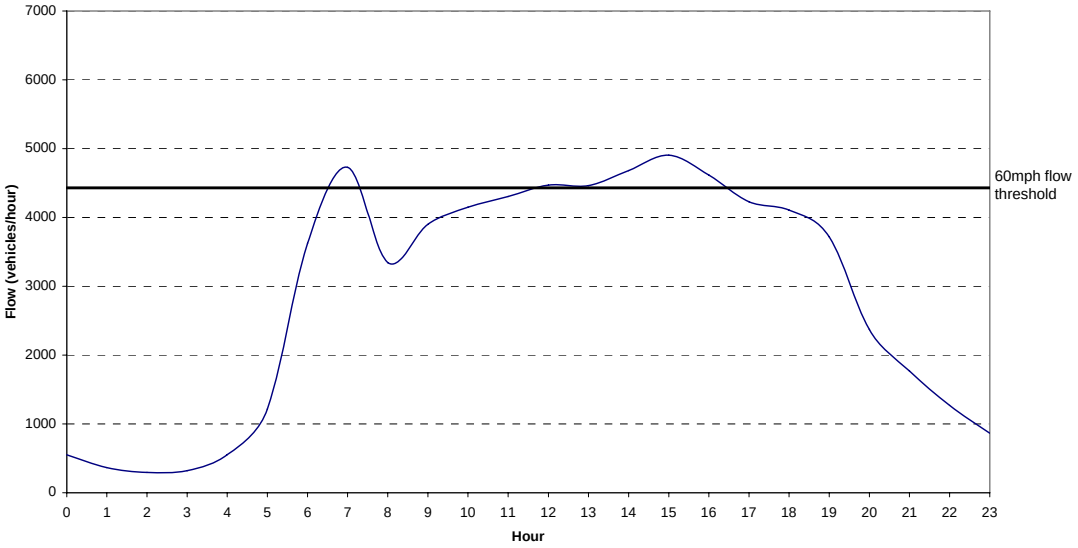


Figure D8
M25 J17-J16 Anticlockwise
Average hourly flow (Week beginning 30 Oct 2000)

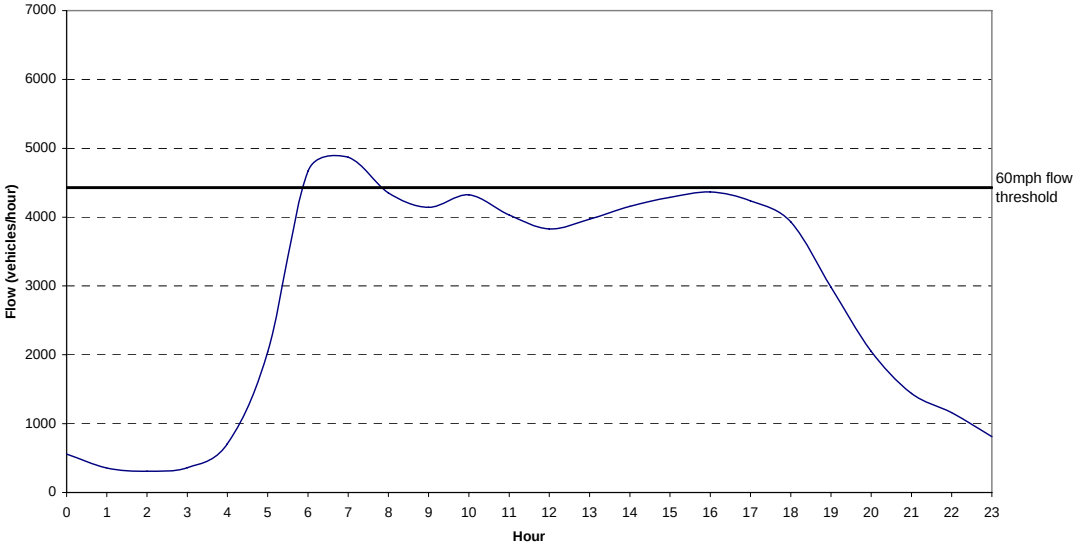


Figure D9
M25 J16-J17 Clockwise
Average Daily Flow (Mon-Fri) during 2000

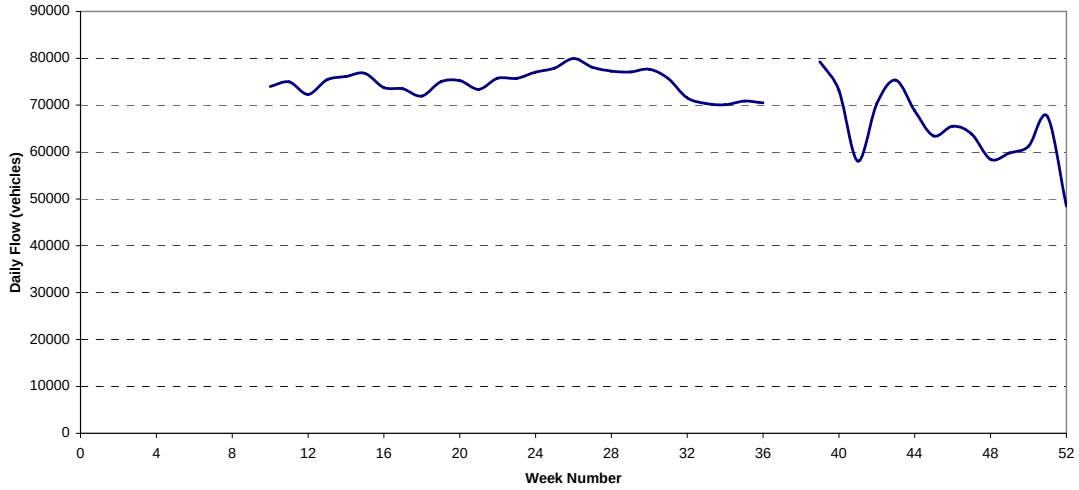


Figure D10
M25 J17-J16 Anticlockwise
Average Daily Flow (Mon-Fri) during 2000

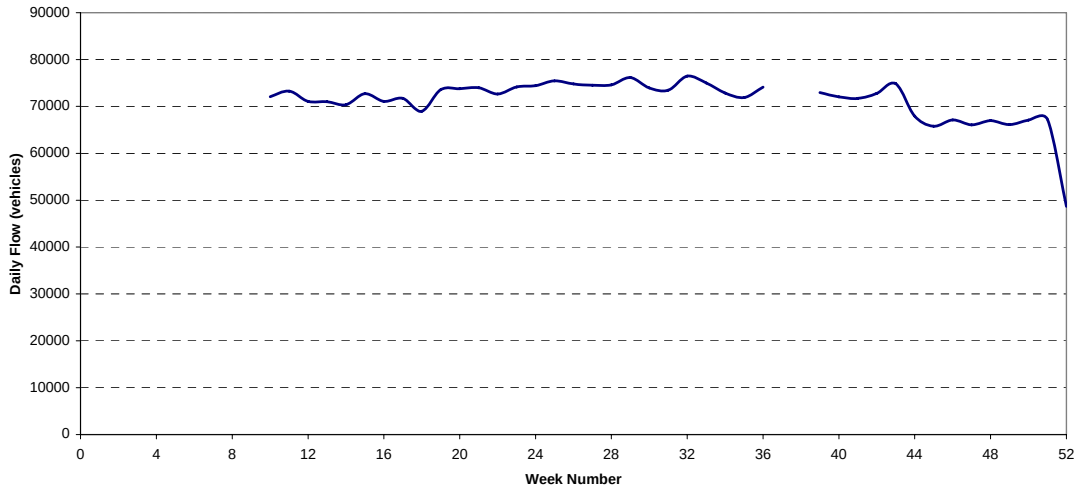


Figure D11
M25 J16-J17 Clockwise
Cumulative frequency of hourly flows during 2000

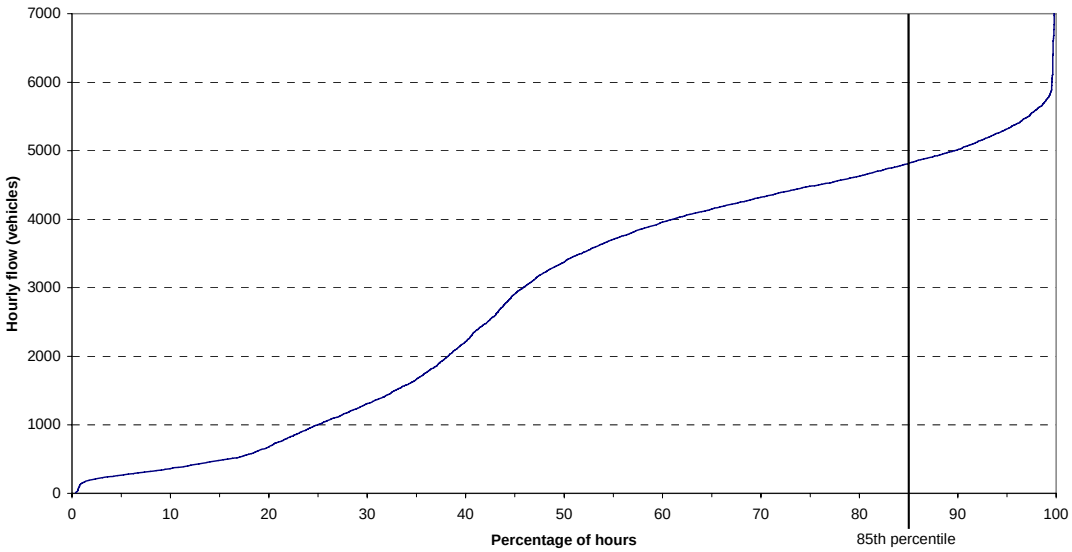


Figure D12
M25 J17-J16 Anticlockwise
Cumulative frequency of hourly flows during 2000

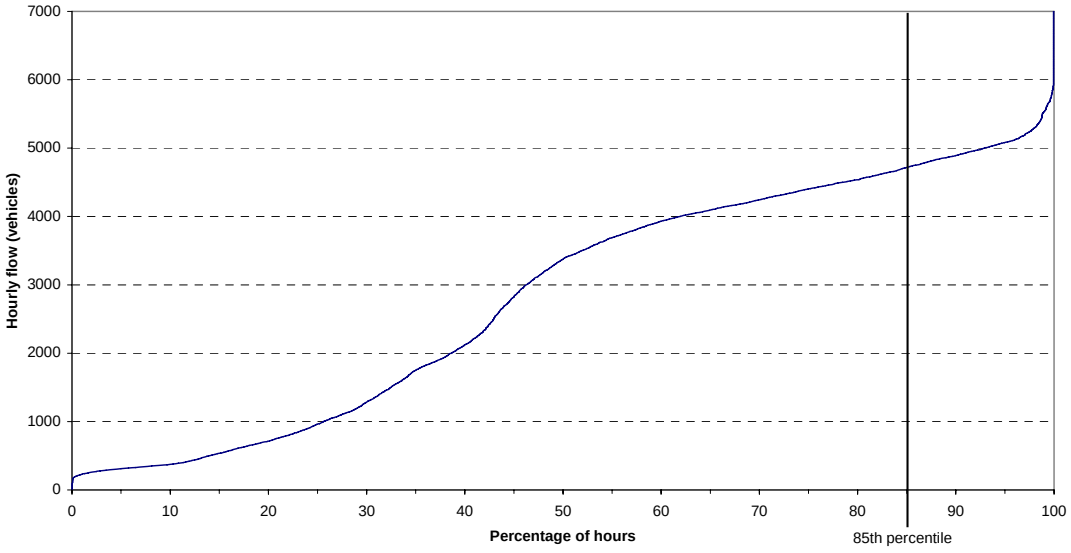


Figure D13
M25 J23-J24 Clockwise
Average hourly flow (Week beginning 1 Nov 1999)

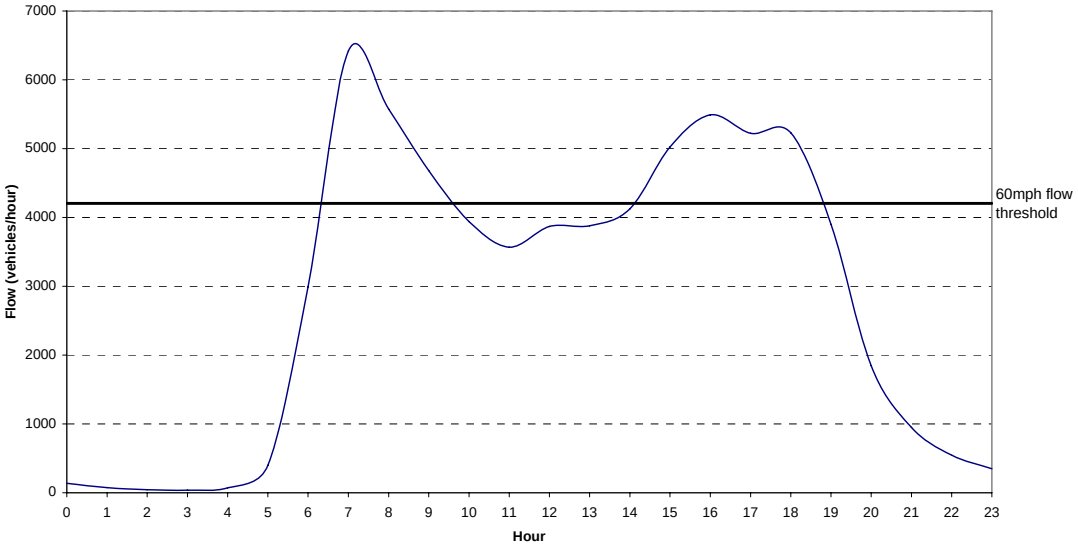


Figure D14
M25 J24-J23 Anticlockwise
Average hourly flow (Week beginning 30 Oct 2000)

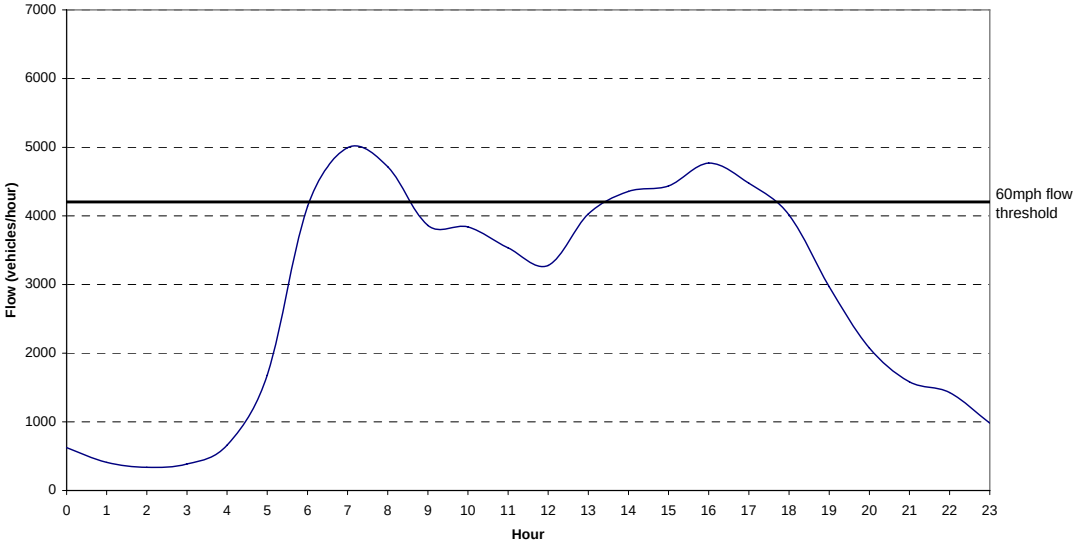


Figure D15
M25 J23-J24 Clockwise
Average Daily Flow (Mon-Fri) during 1999

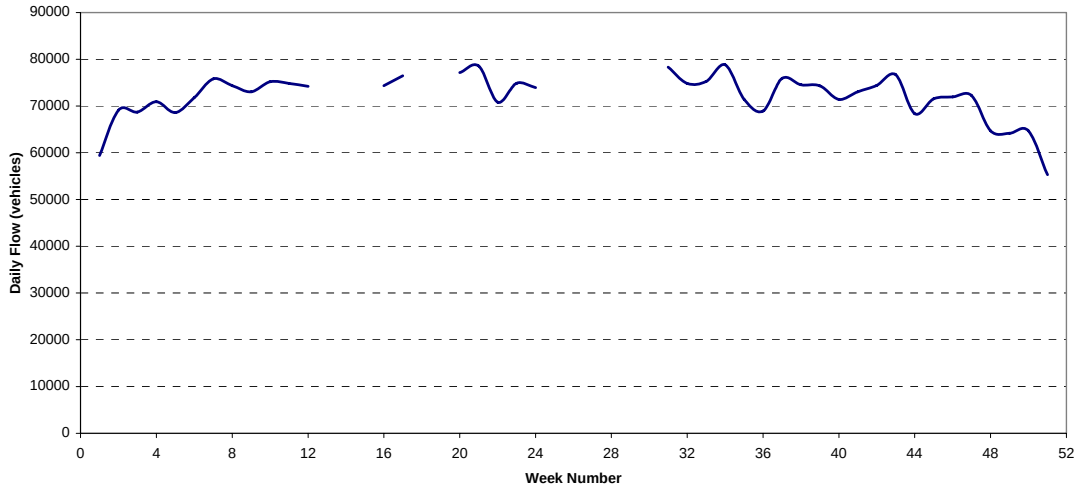


Figure D16
M25 J24-J23 Anticlockwise
Average Daily Flow (Mon-Fri) during 2000

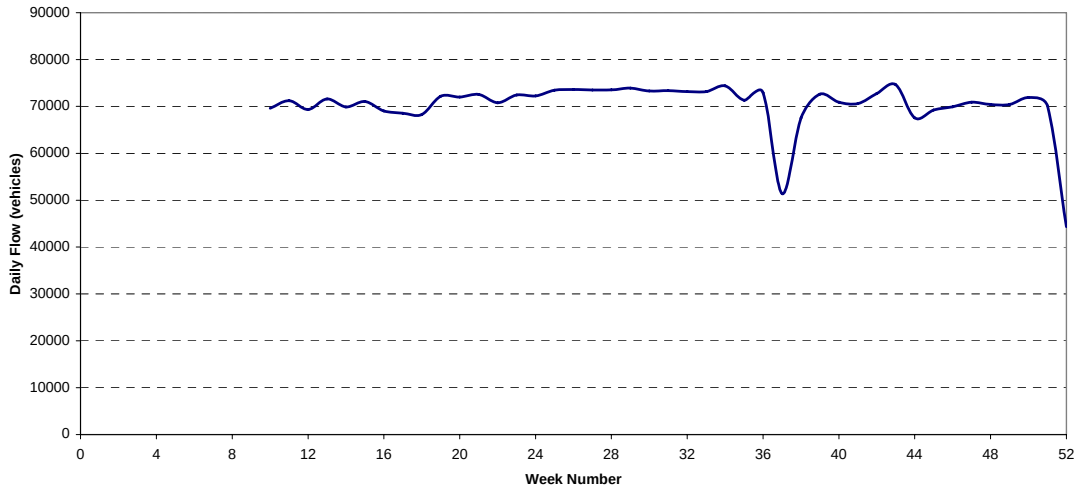


Figure D17
M25 J23-J24 Clockwise
Cumulative frequency of hourly flows during 1999

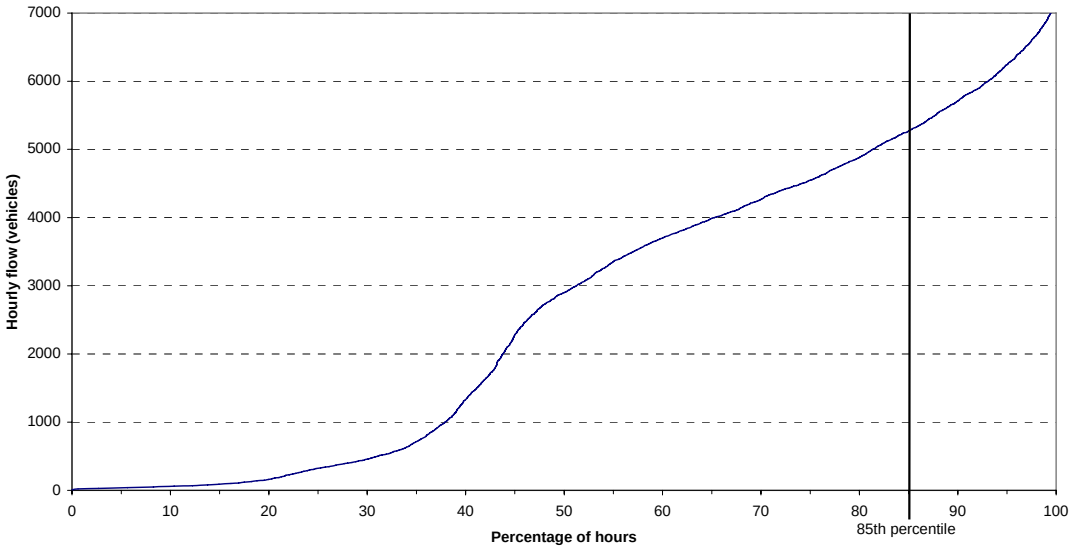


Figure D18
M25 J24-J23 Anticlockwise
Cumulative frequency of hourly flows during 2000

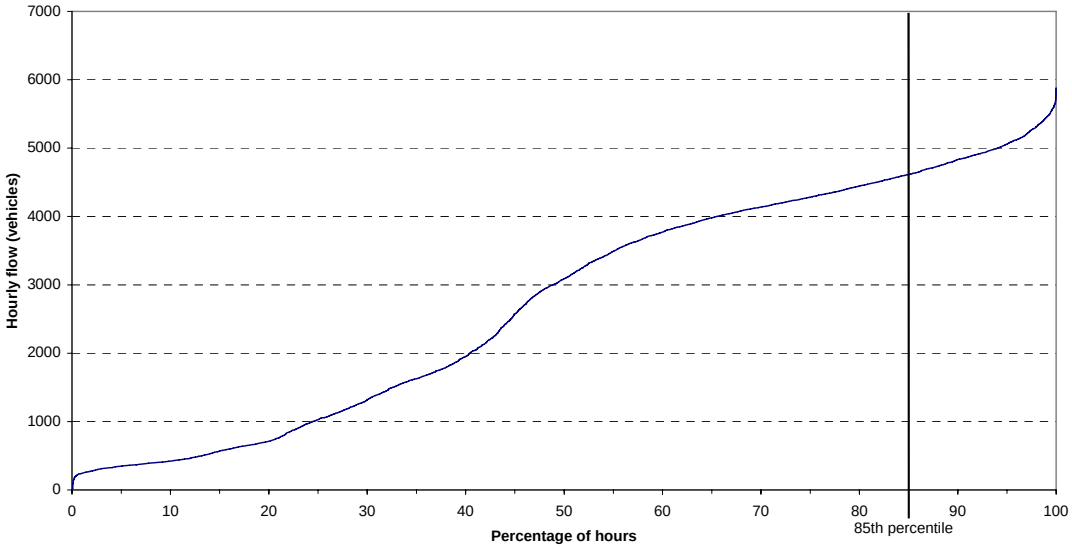


Figure D19
M25 J27-J28 Clockwise
Average hourly flow (Week beginning 30 Oct 2000)

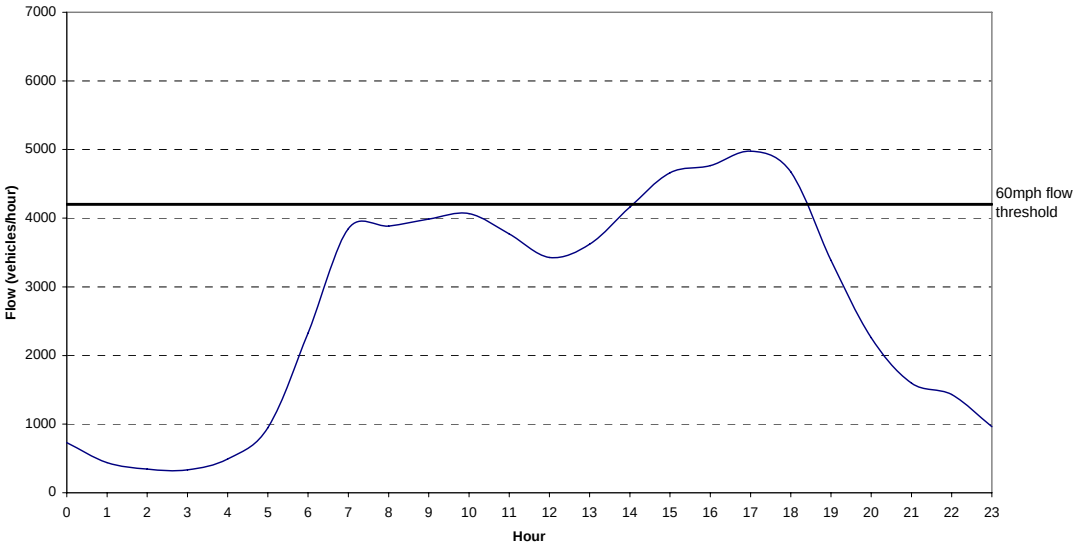


Figure D20
M25 J28-J27 Anticlockwise
Average hourly flow (Week beginning 30 Oct 2000)

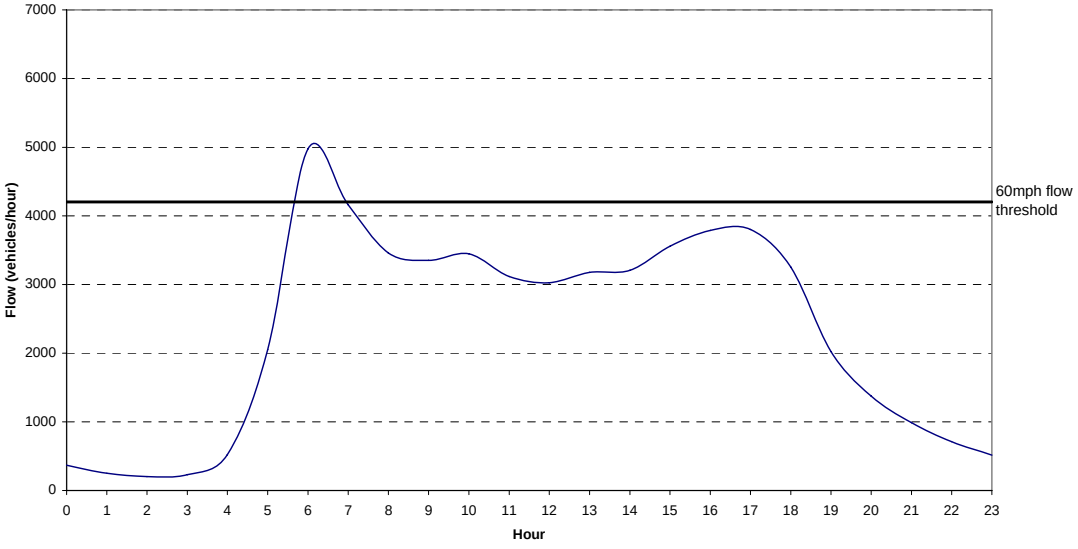


Figure D21
M25 J27-J28 Clockwise
Average Daily Flow (Mon-Fri) during 2000

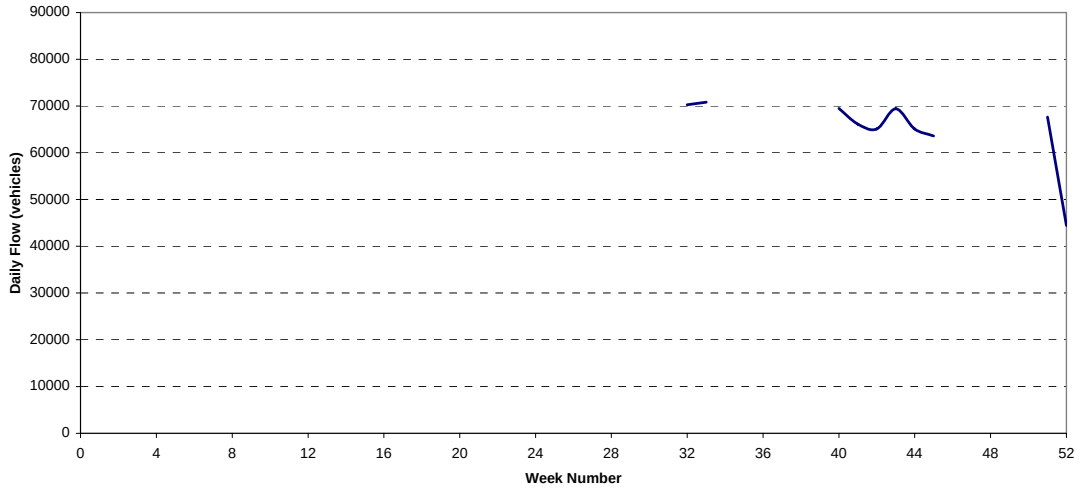


Figure D22
M25 J28-J27 Anticlockwise
Average Daily Flow (Mon-Fri) during 2000

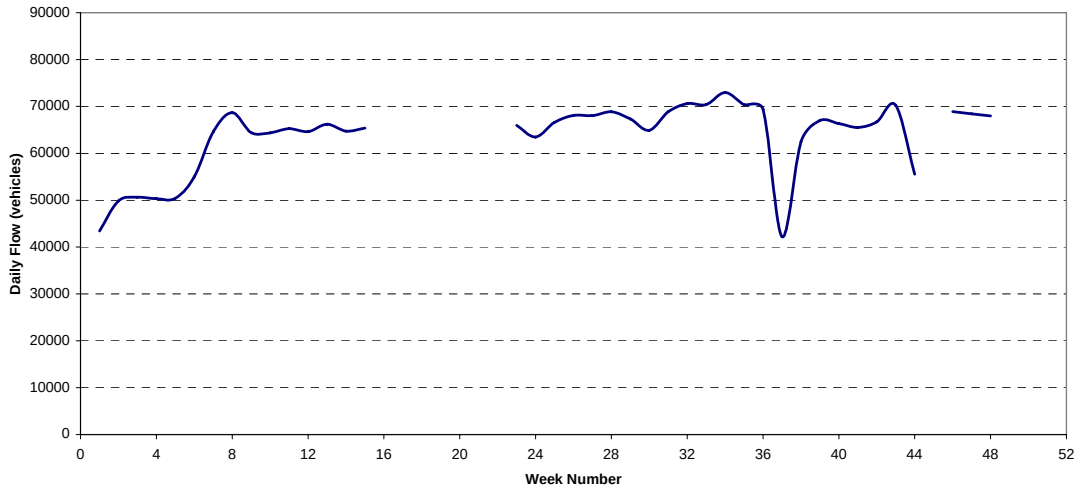


Figure D23
M25 J27-J28 Clockwise
Cumulative frequency of hourly flows during 2000

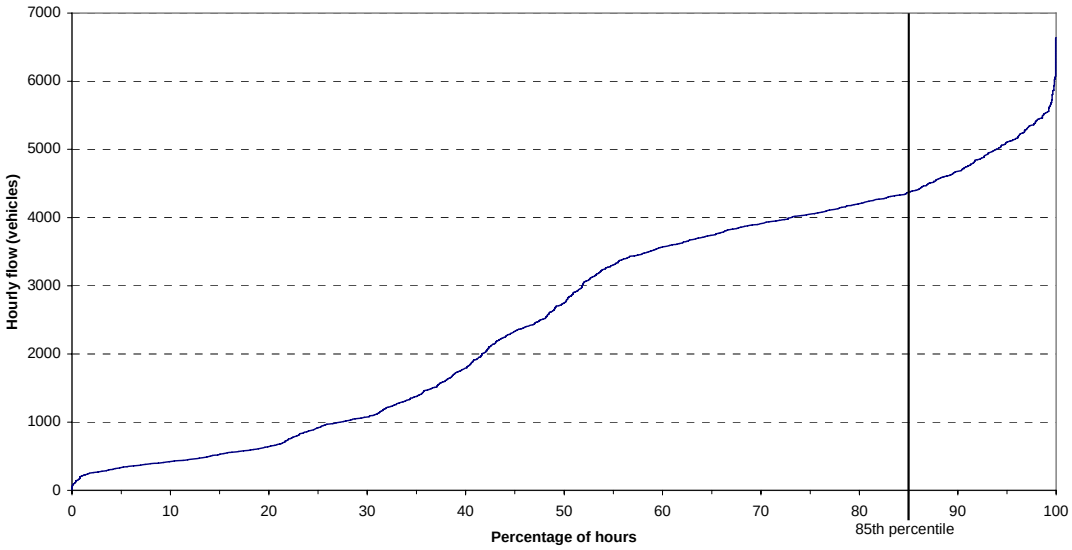


Figure D24
M25 J28-J27 Anticlockwise
Cumulative frequency of hourly flows during 2000