RELIABILITY OF JOURNEYS ON THE STRATEGIC ROAD NETWORK: THE 'ON TIME' RELIABILITY MEASURE

METHODOLOGY

Summary

- The Department for Transport Business Plan 2011 - 15 sets out a number of impact indicators, designed to help the public judge whether the Department's policies and reforms are working. One of these indicators is the "*Reliability of journeys on Highways Agency's motorway and A road network*".
- The On Time Reliability Measure aims to assess the Department's performance against this impact indicator by monitoring the percentage of 'journeys' on the network that are 'on time'.
- For this measure:
    - A 'journey' represents travel between adjacent junctions on the network.
    - An 'on time journey' is defined as one which is completed within a set reference time, based on historic data on that particular section of road.
- Reference times are adjusted to take into account the expected impact of planned roadworks.
- Reliability performance is monitored for the whole of the Strategic Road Network, 24 hours a day, 365 days a year.

1. Introduction

1.1 This document sets out the methodology used to measure the reliability of journeys on motorways and A roads managed by the Highways Agency, collectively known as the Strategic Road Network (SRN).

1.2 The methodology described here is used to monitor performance against the following impact indicator in the Department for Transport's Business Plan 2011-15:

"Reliability of journeys on Highways Agency's motorway and A road network"

2. Overview of the 'On Time' Reliability Measure

2.1 The On Time Reliability Measure (OTRM) monitors the percentage of 'journeys' on the SRN that are 'on time'.

2.2 For this measure:

- A 'journey' represents travel between adjacent junctions on the network.
- An 'on time journey' is defined as one which is completed within a set reference time.

2.3 Reference times are based on historic data, including a fixed tolerance, and reflect the typical 'journey' time for that time and day, on that part of the network. As a result reference times will not always reflect free-flow conditions as they take into account the expected levels of congestion at different times of the day.

2.4 Reference times for each junction to junction link are updated on an annual basis, at the start of each financial year, in order to reflect the latest conditions experienced on each part of the network.

2.5 An additional allowance is made when planned roadworks are in place by adjusting reference times according to the temporary speed limit in place on that section of road. This allowance is only made for roadworks for which advance notice has been publicly made available on the Highways Agency website.

2.6 There are about 2,500 junction to junction links on the SRN. On motorways a link is the stretch of road between motorway junctions and, on trunk A roads, a link is the stretch of road between other A road or motorway junctions. A map showing the current extent of the SRN is given at **Annex A**.

2.7 Performance is monitored for all junction to junction links on the SRN, for all 15 minute time periods of the day, for every day of the year. This ensures that the whole SRN is measured 24 hours a day, 365 days a year.

2.8 Aggregated performance is weighted by vehicle miles so that longer and more heavily trafficked links have a proportionate contribution overall.

3. Method for calculating the measure

Data source

3.1 The data used to calculate the OTRM are taken from the Highways Agency Traffic and Information System (HATRIS). This database contains journey time data from a variety of sources including:

- Highways Agency Motorway Incident Detection Automatic Signalling (MIDAS) inductive loops, built into the road surface on approximately 30% of the motorway network.
- National Traffic Control Centre Automatic Number Plate Recognition (ANPR) cameras, spaced approximately 25km apart on all trunk A roads and motorways.
- Trafficmaster ANPR cameras, spaced approximately 4km apart on average on most trunk A roads and some motorways.
- Trafficmaster in-vehicle Global Positioning Systems (GPS), installed in a fleet of around 60,000 probe vehicles.

3.2 HATRIS also contains traffic flow data from Highways Agency automatic traffic counters.

3.3 The traffic flow and journey time data within HATRIS are held as average values for each 15 minute time period throughout the day for each junction to junction link on the network.

3.4 Only the highest quality data from each of these sources with a good geographic match to the Highways Agency network are used to calculate the OTRM for each section of road. Where these high quality data are available from more than one source within HATRIS, the data are weighted according to a factor based on the number of vehicles generating each estimate.

3.5 Where no data of this quality are available for a particular section of road or time period, reliability performance is imputed using the methods outlined later in this document.

Reference times

3.6 Reference times are first calculated for each 15 minute time period, for each link on the network and for each of 13 distinct day types, as shown below:

Table 1: Day Types

DAY TYPE	DESCRIPTION	DAY TYPE	DESCRIPTION
0	First working day of normal week	7	First day of week - school holidays, excluding day types 12,13 and 14
1	Normal working Tuesday	9	Middle of week - school holidays, excluding day types 12, 13 and 14
2	Normal working Wednesday	11	Last day of week - school holidays, excluding day types 12, 13 and 14
3	Normal working Thursday	12	Bank Holidays, including Good Friday and excluding day type 14
4	Last working day of normal week	13	Christmas period holidays, days between Christmas Day and New Years Day
5	Saturday	14	Christmas Day/New Years Day
6	Sunday		

3.7 The combination of each of these day types with the 96 individual 15 minute intervals on each day gives rise to 1,248 separate reference times for each link and over 3.1 million references across the network as a whole.

3.8 Each reference is intended to reflect the time it would typically take road users to travel the link on a particular type and time of day. In some cases, particularly during peak hours, it should be noted that this reference time may be significantly longer than during free-flowing driving conditions.

3.9 Within each day type and time period, historic 'journey' time data are extracted from HATRIS for the most recently completed calendar year. Any HATRIS data for links affected by roadworks are removed at this stage so that references reflect typical travel times when works are not in place.

3.10 If sufficient historic data exists within HATRIS for this link, day type and time period, the median (middle) 'journey' time value from these data is calculated. This median value is then capped to the speed limit and a fixed tolerance of three seconds per mile is added. The resulting 'journey' time value is taken as the reference time for the link.

3.11 Where sufficient historic data does not exist in the most recent calendar year for a particular link, day type and time period, alternative methods are used to set the reference time. These begin with the extraction of data from additional calendar years and are outlined in full at **Annex B**.

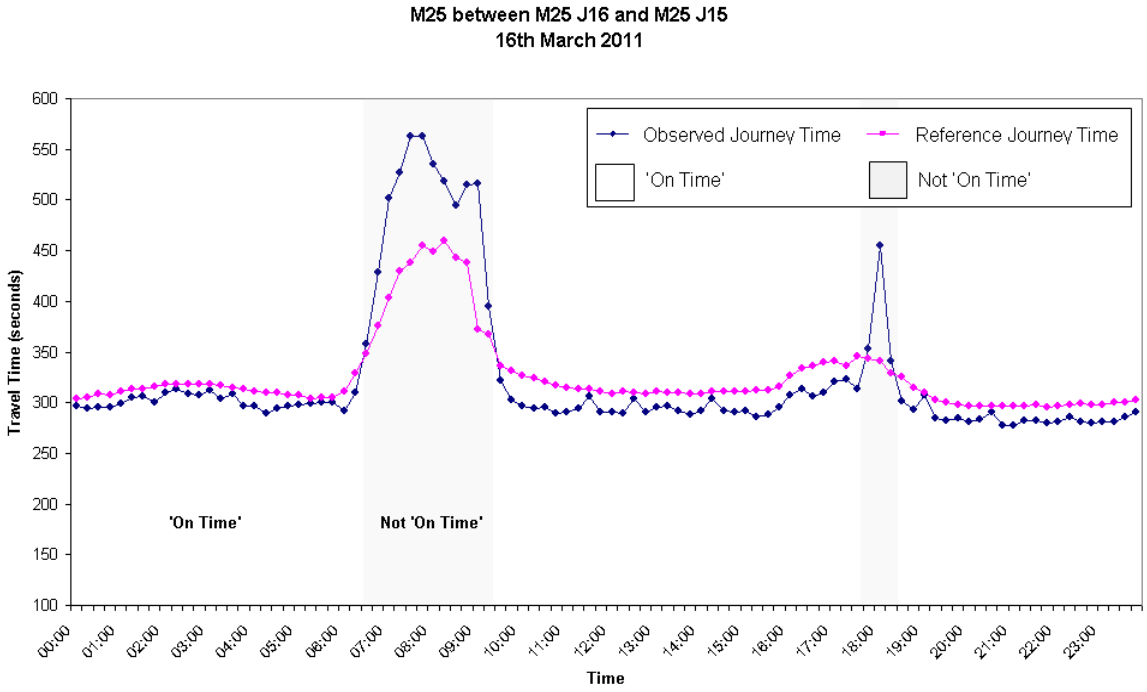
3.12 Reference times are updated at the start of each financial year to ensure that they reflect road users most recent experiences of travelling on the SRN.

Calculating OTRM performance

3.13 The performance of each link is calculated in three separate stages.

i. For all time periods unaffected by roadworks and with high quality data available within HATRIS, performance is calculated by comparing the observed 'journey' time with the related reference time for that link, time period and day type. If the observed time falls within the reference, all 'journeys' within that time period are considered to be 'on time'. If the observed time exceeds the reference, these 'journeys' are considered to be 'not on time'. The following chart provides a graphical illustration of this approach.

Figure 1: 'On time' performance concept



ii. For those time periods affected by roadworks, an adjustment is made to the reference time before the observed 'journey' time comparison is made. This adjustment attempts to take account of the impact of the works by increasing the reference time according to the temporary speed limit in place during that time. A full explanation of the methodology used for this adjustment is given at **Annex C**.

iii. The final calculation stage is used for those time periods without any high quality data available within HATRIS. For these periods, performance is infilled using the national average reliability figure for the month, according to whether the time period being infilled occurred during the day time (06:00-20:00) or during the night (20:00-06:00). A table showing the relatively small amount of performance data infilled using this approach is available here.

Aggregating OTRM performance

3.14 The performance for each time period on each link is aggregated in the Department's statistics both geographically and over time. In these aggregations, individual time period information ('on time' or 'not on time') are weighted by the number of vehicle miles they account for. This is achieved by multiplying the length of the link in question by the traffic flow expected at that time and ensures that longer and/or more heavily trafficked links have a greater contribution to overall performance.

3.15 The final aggregated statistics are presented in terms of the *'percentage of journeys on time'.*

3.16 The following table provides an example of how individual time period data are aggregated through the OTRM:

Table 2: Example of aggregation of performance

M25 Junctions 16 – 18, 08:00 – 09:00, 1st December 2010			
Link / Time	**Vehicle miles total**	**Vehicle miles 'on time'**	**Percentage of 'on time journeys'**
J16 – J17, 08:00 – 08:15	6,337	6,337	100%
J17 – J18, 08:00 – 08:15	1,718	0	0%
J16 – J17, 08:15 – 08:30	6,419	6,419	100%
J17 – J18, 08:15 – 08:30	1,718	0	0%
J16 – J17, 08:30 – 08:45	6,493	6,493	100%
J17 – J18, 08:30 – 08:45	1,718	0	0%
J16 – J17, 08:45 – 09:00	6,475	6,475	100%
J17 – J18, 08:45 – 09:00	1,718	0	0%
Total	**32,596**	**25,724**	**79%**

OTRM performance for individual routes and between junctions

3.17 The OTRM monitors reliability performance for all junction to junction links on the SRN and is aggregated to provide a single overall figure for national reliability across the network.

3.18 However, at present, information about the reliability of journeys on individual routes, or between particular junctions on the network, is not sufficiently robust to be presented as official statistics. This is due to the range of different sources used to calculate journey times across the network.

3.19 Each data source exhibits its own biases which affect the estimates of journey time reliability and, as such, performance cannot be reliably compared between sections of the network monitored through different sources. In addition, where the sources used to monitor a section of the network change over time, it may not be possible to reliably compare estimates of journey time reliability before and after the change.

3.20 The Department are working with the Highways Agency to address these issues of comparability. It is likely that any actions to address these issues will also require some adjustment to the national series although the trends reported in national reliability to date are unlikely to change.

3.21 Until this programme of work is complete, the Highways Agency will publish information about journey time reliability at a sub-national level on their website. This information will be available from the end of November 2011.

4. Important notes on the data and the construction of the OTRM

4.1 When looking at the figures and considering the OTRM,, the following important notes should be taken into consideration:

i. The detailed data sources that underpin the measure are in the form of average 'journey' times along each junction to junction link on the network for each 15 minute time period. Information are not held on individual 'journey' times for every vehicle traversing a link. Some of the variability in travel times within a 15 minute time period will therefore not be captured by the data.

ii. For the measure a 'journey' represents travel between adjacent junctions, it does not represent customers' journeys from start to finish (i.e. London to Birmingham).

iii. The measure aims to provide a measure of reliability by comparing observed 'journey' times with reference times. Reference times are based on a historic average for that day and time and do not represent the quickest travel time possible. Therefore, at certain locations and times on the SRN, some 'journeys' at slower speeds may be considered more reliable than other faster 'journeys' on the network.

iv. The measure only monitors whether 'journeys' are 'on time' or 'not on time'. It takes no account of the difference between the observed 'journey' time and the reference. The level of delay remains important however as, the higher the amount of delay generated, the longer it will take for conditions to return to normal and the greater the number of time periods there will be classed as 'not on time'.

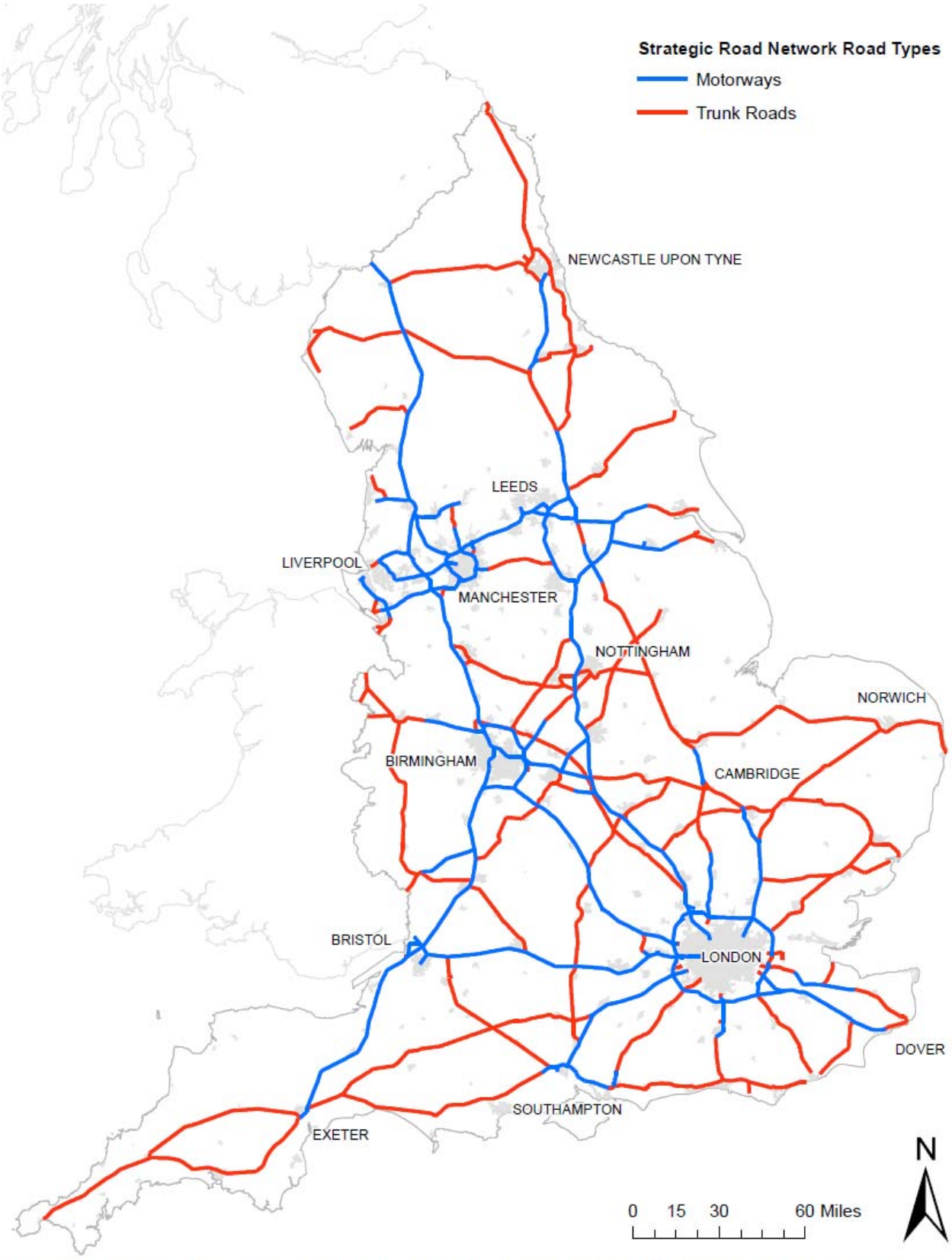
v. Performance is weighted by vehicle miles to ensure that longer and/or more heavily trafficked links are weighted proportionately. This means that a single '*not on time'* period during peak hours may have a higher weighting on the overall measure than multiple *'on time'* periods over night. It also means that some shorter, more heavily trafficked links, will have a greater impact on the measure than some longer links. The same also applies to months that are more heavily trafficked than others.

vi. Part and full road closures are measured in different ways:

- It is expected that the quality of 'journey' time data during part road closures (where lane availability has been reduced but the road remains open) will in most areas remain at a level considered suitable for inclusion in the measure.
- Where full closures are enforced, no 'journey' time data will be available and, as a result, performance for those time periods will be infilled with the national average. However, it should be noted that full road closures will almost certainly have an impact on the performance of adjacent links and any diversion routes on the network.

vii. If the length and/or speed limit of a link changes during the measured period then performance for that link will be infilled with the national average for the remainder of the financial year. Historic data for the link captured prior to the change will not be used when setting reference times.

Annex A: Map of the Strategic Road Network



Annex B: Calculation of reference times

Introduction

This annex explains the full methodology used to calculate reference times for each link, day type and time period. This methodology produces over three million reference times, represented by:

(around) 2500 links x 13 day types x 96 time periods

Calculating the reference time

Reference times are calculated in six stages. Only the highest quality HATRIS 'journey' time data are used to calculate the reference at each stage. Any 'journey' time data affected by roadworks are also removed prior to calculating the references. Any data collected prior to a change in the speed limit or length of a link are also removed at this stage.

Stage 1

- For each link, day type, and 15 minute time period, historic 'journey' time data are taken from the most recently completed calendar year.
- If there are **at least four instances** over the year where data were available for this 15 minute interval, then the median (middle value) of these 'journey' time data is calculated.
- If there are **fewer than four instances** over the year where data were available for this time period, then historic data are taken from the two most recently completed calendar years and, again, the data are examined for at least four separate instances of data.
- This process is repeated for all calendar years back to and including 2007.

Stage 2

- For any 15 minute time periods for which a reference could not be calculated under stage 1, vertical infilling is applied so that any references that have been set within 30 minutes of the missing time period are used to estimate the median. Within this process, priority is initially given to references that fall within 15 minutes of the missing time period.
- For example:

Time Period	Example 1	Example 2	Example 3	Example 4
08:00 - 08:15	10	10	10	10
08:15 - 08:30	20			
08:30 - 08:45	Infilled as average of 20 & 30	Infilled to 30	Infilled as average of 10 & 40	Infilled to 10
08:45 -09:00	30	30		
09:00 - 09:15	40	40	40	

NOTE – The infill process does not wrap around midnight.

Stage 3

- For any 15 minute time periods for which a reference could not be calculated under stages 1 or 2 and that fall during the night (20:00-00:00 & 00:00-06:00), the median of all 'journey' times on the link during these night time periods are used to estimate the reference.

- A minimum of 20 instances of night-time data must be available for a link for the reference to be set and, as with the first stage, the process begins with the most recently completed calendar year and then expands this to the two most recently completed years and so on back to 2007.

Stage 4

- For any 15 minute time periods for which a reference could not be calculated under the first 3 stages, the median 'journey' time on the link for this time period on similar day types are used to estimate the reference.

- Similar day types are defined as:

Day Type	Description	Similar Day Types
0	Any - First Working day of normal week	0, 7
1	Tuesday - Normal working Tuesday	1, 2, 3, 9
2	Wednesday - Normal working Wednesday	1, 2, 3, 9
3	Thursday - Normal working Thursday	1, 2, 3, 9
4	Any - Last Working day of normal week	4, 11
5	Saturday - Saturday	5, 6, 12, 13
6	Sunday - Sunday	5, 6, 12, 13
7	Any - First day of week - School holidays	0, 7
9	Any - Middle of week - School holidays	1, 2, 3, 9
11	Any - Last day of week - school holidays	4, 11
12	Any - Bank Holidays	5, 6, 12, 13
13	Any - Christmas period holidays	5, 6, 12, 13
14	Any - Christmas day/new years day	14

- As with the first stage, a minimum of four instances of 'journey' time data are required from similar day types to calculate the median and the process iterates through completed calendar years, starting with the most recent and extending back to 2007.

Stage 5

- For any 15 minute time periods for which a reference could not be calculated under the first four stages, the median of all available 'journey' time data – across all day types, time periods and calendar years – are used to estimate the reference for the link.

- Again, a minimum of four instances of 'journey' time data are required to set the reference under this stage.

Stage 6

- For any 15 minute time periods for which a reference could not be set under any of the first five stages, the free flow 'journey' time for the link is used to set the reference.

- Free flow speeds are defined as below (all in **mph**):

Speed Limit	Trunk 'A' Road, single carriageway	Trunk 'A' Road, dual carriageway	Motorway
30	22	25	-
40	32	30	-
50	40	37	50
60	45	57	60
70	-	62	67

Capping to the speed limit

Once all the above stages have been completed, any calculated 'journey' times that exceed the speed limit on a link are capped to the speed limit.

Adding the tolerance

Finally, reference times are derived by adding a fixed tolerance of three seconds per mile to each of the calculated 'journey' times.

Results and uses

References are updated at the start of each financial year so:

- References set using 2007-9 data are used to calculate performance during 2010/11.
- References set using 2007-10 data are used to calculate performance during 2011/12.

The following table shows the percentage of references set at each stage in each reference year.

Stage set	2007-9	2007-10
1	92.7	94.6
2	1.7	1.5
3	2.7	2.1
4	0.8	0.4
5	2.1	1.4
6	0.0	0.0
Total number of references	3,116,256	3,108,768

Annex C: Allowance for planned roadworks

The OTRM includes an allowance for planned roadworks with temporary speed limits in place. It is assumed that in these circumstances 'journey' times will be different from normal operation.

An allowance is only made for works that are recorded within the Highways Agency's Scheduled Roadworks database as ongoing or have been completed and are of the following types:

Barriers - Permanent	*Construction-Bridge/Structure*	*Inspection/Survey*	*Structure Inspections*
Barriers - Temporary	*Construction-Bypass/New*	*Litter clearance*	*Structure Repairs*
Carriageway ResurfacingOverlay	*Construction-Improvement/Upgrading*	*Other*	*Structure-Maintenance*
Carriageway-Anti-skid	*Diversion Route*	*Safety Barrier/fence repairs*	*SU Works*
Carriagway-Reconstruction/Repair	*Drainage*	*Signs-Erection*	*Sweeping of carriageway*
Central Reserve Works	*Electrical Works*	*Signs-Maintenance*	*Tunnel Maintenance*
Communications	*Horticulture (cutting & planting)*	*Structure - New/Reconstruction*	*Verge/Off-Road Works*
White lining/road markings			

And <u>not</u> of the following types:

Closed on Police Instruction	*Event*	*Emergency Work - Unspecified*	*Emergency Work-Unspecified*
Police Reconstruction	*Road Traffic Collision*	*Training*	

The allowance for these planned roadworks is applied proportionately based on the difference between the standard and temporary speed limit.

Specifically, the pre-tolerance adjusted reference time is calculated using the following formula:

- **ART = RT * (PSL / TSL)**

Where:

ART = Adjusted reference time (pre tolerance)

RT = Reference time (pre tolerance)

PSL = Permanent Speed Limit

TSL = Temporary Speed Limit

For example, for a 5 mile motorway link (70mph) affected by roadworks (50mph) and with an original reference time (before the tolerance was added) of 100 seconds, the pre-tolerance adjusted reference would be calculated as follows:

Adjusted reference time (pre tolerance)	= 100 * (70/50)
	= 100 * 1.4
	= 140 seconds

A tolerance of 15 seconds (three seconds per mile) would then be added to calculate the final adjusted reference time for that link.