MyRIAD
Motorway Reliability Incidents And Delays
User Manual
Document Control

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<tbody>
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1. Introduction

Background

1.1. MyRIAD stands for Motorway Reliability Incidents and Delays. It is a software tool which can be used to assess the journey time reliability impacts of interventions or schemes affecting inter-urban motorways.

1.2. Journey time reliability relates to the predictability of travel times. The less variability there is in journey times between an origin and destination, the more predictable or “reliable” the journey time becomes – and vice versa. Apart from the voluntary choice of speed available to the driver, the factors affecting journey time variability are incidents and congestion. MyRIAD can be used to measure the change in journey time variability arising from interventions which affect incident rates and/or congestion.

1.3. The Department for Transport (DfT) sets out the requirements for the appraisal of transport schemes it funds on WebTAG (Web based Transport Analysis Guidance). Unit A1.3 of WebTAG sets out methodologies for assessing the reliability impacts of transport schemes, including the monetisation of those impacts as part of a cost benefit analysis of a proposed scheme.

1.4. Previously, the reliability impacts of inter-urban motorway schemes were quantified and monetised using DfT’s INCA (INcident Cost benefit Analysis) software. INCA was an Excel spreadsheet-based application which implemented the methodology set out in WebTAG A1.3 in relation to assessing the reliability impacts of interventions on motorways.

1.5. INCA was improved incrementally over several releases of the software to incorporate the latest research, to allow for additional effects, and to increase the number of routes and links in the network. The last version of INCA (v4.2) was released in December 2012.

1.6. The maintenance and development of INCA was passed from the DfT to the Highways Agency (HA) from April 2013. The HA has now developed MyRIAD which replaces INCA and should be used in place of INCA as part of all relevant HA scheme appraisals.

1.7. MyRIAD is essentially a revised and renamed version of INCA. The revisions made have been primarily aimed at overcoming some of the limitations associated with the previous version of INCA. In particular, MyRIAD now includes the following improvements:

- increases significantly the maximum number of links and routes;
• disaggregates benefits by trip purpose; and
• reduces input requirements.

1.8. In all other respects, MyRIAD is essentially the same as INCA and will produce the same results. MyRIAD will however continue to be developed, particularly with regard to expanding its applicability to non-motorway standard inter-urban roads.

1.9. An important change to note between INCA and MyRIAD is that the Run MyRIAD macro (Figure 1) must be run following data input (any subsequent changes to data entry will require the macro to be re-run).

![Figure 1 Run MyRIAD Macro Button](image)

1.10. This User Manual explains the types of interventions to which MyRIAD is applicable, the WebTAG methodology as implemented in MyRIAD and how to use MyRIAD.

**Basic Requirements for Running MyRIAD**

1.11. MyRIAD is an Excel 2010 file and can be used on any Windows PC with Excel installed.

1.12. The macro security in Excel should be set to Enable in order to allow all functions of the spreadsheet (from the from Office Button choose Options->Trust Centre Settings->Macro Settings). When MyRIAD is opened the user will see a security warning saying that it contains macros. The user should choose the Enable Macros option otherwise MyRIAD will not work properly.

1.13. As MyRIAD is an Excel spreadsheet, the user should be aware of potential Excel-specific problems when editing data. The user is advised to avoid dragging data between cells as it can corrupt cell references in the MyRIAD calculations. However, copying and pasting of data can be used in the majority of cases.
2. Theory and Applications

Travel Time Variability

2.1. Journey times of individual vehicles fluctuate around an average journey time for a particular time period. This variability in journey times arises primarily from two sources:

(1) Variations in journey time between different time periods and days, caused by different traffic conditions, known and anticipated factors such as long term road-works; and

(2) Variations of travel time at a specific time of day caused by unexpected traffic congestion and unforeseen incidents which reduce capacity, such as weather conditions, accidents and breakdowns.

2.2. Variations in travel time under (1) are predictable and feed into average travel time assessment frameworks such as COBA and TUBA. Variations in travel time as classified under (2) are unpredictable for individual journeys, although their mean and distributions can be predicted. They are not measured in COBA or TUBA economic evaluation, and are the subject of the variability appraisal.

2.3. A journey departing at a particular time and day is considered as having a mean journey time, its variability is then represented by a distribution of times about the mean. This distribution can be characterised by one or more parameters. As discussed in WebTAG A1.3, the preferred measure of variability is the standard deviation of travel times around this mean.

2.4. In the UK, the standard deviation of travel time is used to measure changes in travel time variability. The standard deviation is a measure of how actual travel times (at the same time of day and the same day of the week) are distributed around the average, with increasing standard deviation associated with increasing variability.

\[
\sigma^2 = \frac{1}{n} \sum_{k=1}^{n} (x_k - \bar{x})^2
\]

where \( \sigma \) is the standard deviation of travel time

\( x_k \) is the kth observed travel time

\( \bar{x} \) is the mean travel time

\( n \) is the number of travel time measurements

2.5. The calculation of travel time variability at journey level involves all variability components affecting a journey. These are:
• Incident variability on all links
• Day-to-day variability on all links, i.e. variability not caused by incidents but by fluctuations in demand, weather, etc.

2.6. For each incident type the real-life build-up periods and numbers of lanes closed are distributed around the mean values. In order to calculate TTV, the standard deviation of travel time for whole journeys is established by:

(a) Calculating the variance of travel time for a typical single incident of each type for each individual link for each flow group; and multiplying this by the appropriate probability;
(b) Calculating the variance caused by day to day variability for each link and flow group, as a function of average travel time;
(c) Calculating from (a) and (b) the variance, and hence the standard deviation, of travel times for all routes through the network (as defined by the user).

2.7. Variances may be summed over a series of links and incident types, assuming the probability of incidents on one link/type is independent of the probability on other links/types. Standard deviations may not be summed in that way.

Variability over journeys

2.8. A link improvement which reduces journey time variability is more beneficial the shorter the journey, and is therefore valued higher. This is because any reduction in variability on the scheme link would be a higher proportion of the variability across the entire journey for shorter trips. Separate travellers on the same scheme link will therefore experience different levels of variability benefits from the same improvement.

\[ \sigma^2 = \sum_i \sigma_i^2 + \sigma_s^2 \]

Where \( \sigma^2 \) is the variance of the entire journey
\( \sigma_i^2 \) is the variance on non-scheme links
\( \sigma_s^2 \) is the variance on the scheme link

2.9. The benefits of reductions in variability on scheme links are, therefore, dependent on the variability on non-scheme links. Reliability calculations require a representation of entire journeys. This is achieved by modelling feeder links which represent that part of the journey not taking place on scheme links.

2.10. To calculate total cost TTV (in time units) the standard deviations for each route are multiplied by the route flow. The route flow is one of the user-defined inputs to MyRIAD. It will be reduced for any flow groups where link flows exceed 95% of capacity.
2.11. Further details of the TTV calculations can be found in Appendix B.

Monetising changes in variability

2.12. For the purposes of economic appraisal, it is necessary to apply a monetary value to the standard deviation of travel time. Using the “reliability ratio” it is possible to relate the value of one minute of standard deviation to one minute of average travel time (where the latter is defined by the values of time given in WebTAG data book). For car travel the reliability ratio is 0.8, meaning that one minute of standard deviation has the same value as 0.8 minutes of average travel time. A higher ratio of 1.2 is used for goods vehicle reliability:

\[
\text{Value of Standard Deviation of Travel Time} = \text{Reliability Ratio} \times \text{Value of Average Travel Time}
\]

2.13. The difference between the TTV costs in the Do Minimum and the Do Something produces the TTV benefits.

Incident Delay

2.14. The incident delay methodology is based on deterministic queuing theory which means that the maximum delay for an incident occurs to a vehicle that passes the incident location when the incident is just cleared from the motorway/carriageway, and that the average delay for vehicles passing the incident location is half the maximum delay. This assumes that demand is constant during the incident.

2.15. However, flows vary by time-of-day and day-of-week. As incident delay is a function of flow it is necessary to estimate delays for the different flow conditions. To achieve this, flows are classified into flow groups, and the delays arising from typical incidents are calculated for each of these flow groups. MyRIAD models five flow groups (AM and PM Peak, Inter-peak, Off-peak / night-time and weekend).

2.16. To calculate the delays caused by an incident, it is assumed that:

(a) The demand flow is constant for the whole of the build-up and queue decline periods;
(b) The incident delays are measured relative to the time at which a vehicle would have passed the incident location;
(c) The modelled incident delay per vehicle should not exceed a locally determined maximum;
(d) Incidents have no effect beyond the end of the link.

2.17. These assumptions are likely to have more effect for incidents which cause long delays. To limit the effect of assumption (a), demand flow is split into flow groups as already indicated.
2.18. Where they represent relatively short time periods, longer incidents could spill over into an adjacent flow group. Fortunately, for all but the busiest flow groups, spill-over effects between flow groups are likely to have no net effect on the likelihood of any individual vehicle within each flow group being affected by an incident. MyRIAD does not implement a proper spill-over mechanism. To compensate for this all link flows are capped at 95% of capacity to ensure that queues do not grow indefinitely.

2.19. Incident delay in MyRIAD is calculated according to the relationships given in Appendix B. The calculation is over all links, all flow groups, and all incident types. The difference between DM and DS gives the value of the delay benefits from the scheme. This is converted to monetary values by application of WebTAG values of time.

2.20. Further details of the delay calculations can be found in Appendix B.

The effect of diversion on delays

2.21. The delays which occur on road sections are dependent on the proportion of traffic diverting to avoid the incident, which in turn is dependent upon the overall duration of the incident, the length of the backed up queue and the availability of alternative routes and reliable information. Thus the total level of this diversion will depend on:

(a) The availability and attractiveness of alternative routes;
(b) The flow on the main carriageway and the proportion of capacity reduction;
(c) The duration of the incident; and
(d) The average or maximum delay per vehicle caused by the incident.

2.22. The diversion mechanism in MyRIAD is that recommended in TRL (2004). The diversion proportion relationship is given in Appendix B and has been developed from observed data.

2.23. The traffic diverting is capped at 90% of excess demand (i.e. the difference between flow and incident-reduced capacity).

2.24. Very few drivers will divert until the queue has reached a suitable junction. Therefore, the diversion rate is likely to build up gradually as queues lengthen and will subsequently be limited by the capacity of any available diversion route for that or earlier diversion opportunities. The TRL formula increases the diversion proportions for longer queues and is intended to represent the net effect of all the diversion opportunities. It is assumed that diverted traffic experiences the same delay as the traffic that remains on the main carriageway.
2.25. The user can specify the maximum diversion proportion. The default is 1.0, to represent the condition where 100% of traffic will divert if required.

MyRIAD Applications

2.26. There are several types of intervention which can be assessed using MyRIAD. These can have effects which affect all, or just some, of the different components of reliability. For instance, a scheme which affects both the number of accidents and level of congestion will have an impact on all three components of reliability: incident related travel time variability and incident delays (from the change in accidents) and also day-to-day travel time variability (from the change in congestion). Interventions in this category include conventional widening and managed motorway. There are other interventions which will affect only one or two of the components of reliability such as MIDAS, Controlled Motorway and CCTV.

2.27. Table 1 below lists the types of interventions which can be appraised using MyRIAD, together with the typical effects of those schemes that give rise to reliability impacts and the components of reliability that are affected by each.

<table>
<thead>
<tr>
<th>Type of Intervention</th>
<th>Typical Effects</th>
<th>Reliability Impact of Typical Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive CCTV</td>
<td>Reduce incident durations</td>
<td>Reduce incident delays and variability</td>
</tr>
<tr>
<td>MIDAS</td>
<td>Reduce accidents</td>
<td>Reduce incident delays and variability</td>
</tr>
<tr>
<td>Controlled Motorway</td>
<td>Reduce Accidents</td>
<td>Reduce incident delays and variability</td>
</tr>
<tr>
<td></td>
<td>Reduce flow breakdown</td>
<td>Reduce day-to-day variability</td>
</tr>
<tr>
<td>Managed Motorway (ALR)</td>
<td>Permanent Loss of HS</td>
<td>Increase incident delays and variability</td>
</tr>
<tr>
<td>(including Controlled Motorway)</td>
<td>Reduce flow breakdown</td>
<td>Reduce day-to-day variability</td>
</tr>
<tr>
<td></td>
<td>Increase Capacity</td>
<td>Reduce day-to-day variability</td>
</tr>
<tr>
<td>Motorway Widening (including</td>
<td>Reduce Accidents</td>
<td>Reduce incident delays and variability</td>
</tr>
<tr>
<td>Controlled Motorway)</td>
<td>Reduce flow breakdown</td>
<td>Reduce day-to-day variability</td>
</tr>
<tr>
<td></td>
<td>Increase Capacity</td>
<td>Reduce day-to-day variability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 MyRIAD Applications

2.28. The HA uses Interim Advice Notes (IANs) to publish urgent supplementary appraisal guidance on certain subjects. IAN 160 deals with the appraisal of technology schemes and should be referred to when assessing CCTV, MIDAS and Controlled Motorway schemes. In particular, IAN 160 describes the magnitude of the typical effects of CCTV, MIDAS and Controlled Motorway which give rise to reliability impacts, including different combinations of the three types of scheme. It also describes how to assess reliability impacts using MyRIAD.
2.29. IAN 164 is the equivalent document to IAN 160 for MM-ALR. At present, this document refers the reader to the Highways England's TAME Group for advice in relation to using MyRIAD for assessing the reliability impacts described in Table 1. Users of MyRIAD assessing these types of scheme should therefore contact the TAME Group before proceeding with an assessment of MM-ALR.

3. **Using MyRIAD for individual Assessment Years**

3.1. MyRIAD will model the reliability impacts of a proposed intervention for individual assessment years falling within a scheme’s appraisal period eg opening year and 15 years after opening. This allows changes in traffic flows during the appraisal period to be accounted for ie traffic growth. MyRIAD requires a minimum of two assessment years, but can accommodate appraisals with up to six forecast years.

3.2. Each assessment year requires a single year MyRIAD Main workbook to be completed. The results produced by the individual single year workbooks will then be combined to give results for the whole appraisal period by completing the MyRIAD Master workbook (see Chapter 5).

3.3. Five MyRIAD worksheets need to be completed in the single year MyRIAD workbook created for each assessment year:

- Link and Route Information
- Flow Groups
- Incident Parameters
- Values of time
- Speed-flow and DTDV Curves.

3.4. Only traffic flows should change between individual assessment years. These are entered into the Link Information worksheet which should therefore be the only worksheet which needs to be completed for every assessment year. The remaining four worksheets will apply to all assessment years, so it should be possible to complete one single year workbook and copy it for each assessment year, changing only the traffic flows on the Primary Information Sheet worksheet for each year.

**Link and Route Information Worksheet**

3.5. The link information occupies columns A to M of the Link Information worksheet. Each line represents a single link. The number of links in MyRIAD is only limited by the number of
lines in the spreadsheet. In Excel 2010 this is 1,048,576. Realistically, this is unlikely to be exceeded.

3.6. The following information is required for each motorway link (a link is defined as the length of carriageway from the centre of one junction to the centre of an adjacent junction) in the network:

- Link Name
- Link Type (0 = Feeder, 1 = Network)
- Length (km)
- AADT – Assessment year two-way AADT
- %HGVs (OGV1 + OGV2) for peak- and non-peak time periods
- Number of lanes in DM and DS
- Proportion of traffic generated (Generated traffic is the additional traffic flow on the link in the DS compared with the DM and includes reassigned and additional traffic predicted by the variable demand model. It is relevant for schemes that increase the capacity of the link eg widening or managed motorway. The generated traffic is entered as a proportion of the total DM flow. Generated traffic should only be input for scheme links.)
- Capacity per lane
- Road type in DM and DS (Table 2)

<table>
<thead>
<tr>
<th>Number</th>
<th>Link Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D2M / D3M / D4M Without MIDAS, Without CCTV, Without VMS</td>
</tr>
<tr>
<td>2</td>
<td>D2M / D3M / D4M Without MIDAS, Without CCTV, With VMS</td>
</tr>
<tr>
<td>3</td>
<td>D2M / D3M / D4M Without MIDAS, With CCTV, Without VMS</td>
</tr>
<tr>
<td>4</td>
<td>D2M / D3M / D4M Without MIDAS, With CCTV, With VMS</td>
</tr>
<tr>
<td>5</td>
<td>D2M / D3M / D4M With MIDAS, Without CCTV, With VMS</td>
</tr>
<tr>
<td>6</td>
<td>D2M / D3M / D4M With MIDAS, With CCTV, With VMS</td>
</tr>
<tr>
<td>7</td>
<td>D3CM / D4CM With MIDAS, With CCTV, With VMS</td>
</tr>
<tr>
<td>8</td>
<td>MM-ALR With MIDAS, With CCTV, With VMS</td>
</tr>
<tr>
<td>9</td>
<td>D2AP, Without MIDAS, Without CCTV, Without VMS</td>
</tr>
<tr>
<td>10</td>
<td>D2AP, With MIDAS, Without CCTV, With VMS</td>
</tr>
<tr>
<td>11</td>
<td>User Defined - D2M / D3M / D4M</td>
</tr>
<tr>
<td>12</td>
<td>User Defined - D3CM / D4CM</td>
</tr>
<tr>
<td>13</td>
<td>User Defined - D2AP</td>
</tr>
</tbody>
</table>

Table 2 MyRIAD Road Types

3.7. Network links refer to all real links in the network not identified as feeder links. Feeder links represent notional composite links (in length or capacity) which connect to the network links
and are used to represent the journey lengths of trips which feed into the network links. Each feeder link represents a different journey length so that the different journey lengths of vehicles using the network links are fully represented. Further advice in relation to the construction of a MyRIAD network is contained in Appendix D. Network links and feeder links are treated the same way for the purposes of calculating delays and travel time variability.

Table 3 MyRIAD Link Data Inputs

3.8. For motorway schemes that increase capacity, traffic flows will be forecast flows from a traffic model for each assessment year. Further guidance on network structure and extracting traffic matrices from traffic models is presented in Appendix B.

3.9. For CCTV, MIDAS and Controlled Motorway where models are not used, traffic flows will be observed flows factored to assessment year flows using simple growth factors (see IAN 160).

3.10. Route information is input immediately after the link table (from Column N onwards). Route flows (the number of vehicles traversing the entire route) are specified in Row 15 above each route. These are input as AADT. Route names are specified in Row 16 of the Link Information spreadsheet. The links used by each route are then identified by a ‘1’ in the cell located in the route column and the link’s row. Currently, MyRIAD is limited by the number of columns in Excel; up to 243 routes can be specified when using Excel 2003 and up to 16,371 routes in Excel 2007 onwards. Information on how to construct MyRIAD networks and specify routes is contained in Appendix D.
Table 4 MyRIAD Route Data Inputs

<table>
<thead>
<tr>
<th>Flow Groups</th>
<th>Capacity per Lane (PCU/hr)</th>
<th>Flow type</th>
<th>6:00 - 9:00</th>
<th>9:00 - 12:00</th>
<th>12:00 - 18:00</th>
<th>18:00 - 22:00</th>
<th>22:00 - 24:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM peak</td>
<td></td>
<td></td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>PM peak</td>
<td></td>
<td></td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Inter-peak</td>
<td></td>
<td></td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Off-peak / Night-time</td>
<td></td>
<td></td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Weekend</td>
<td></td>
<td></td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Flow Groups Worksheet

3.11. Reliability impacts will vary throughout the day depending upon the level of traffic flow. The level of daily traffic flow will also vary between weekdays and weekends. It is therefore necessary to use flow groups which combine hours of the year with similar traffic flows. Up to five flow groups can be specified in MyRIAD (these can be used to represent AM peak, PM peak, Inter-peak, Off-peak / Night-time, Weekend). The number of hours per year in each Flow Group is required as well as a Flow Group factor [Flow Group Average Hourly Flow / AADT]. This value is applied to the link AADT to calculate hourly flows for each flow group.

3.12. Local flow group factors should be input and used in preference to the default values. Default factors should only be used where local count data suggests a similar profile to the default values. MyRIAD results can be sensitive to flow profiles and so every effort should be made to calculate local flow group factors. Where local values are used, annual hours should add up to 8760 and the number of days to 365 unless the scheme is only operational part of the time.

3.13. The flow-group specific generated traffic multiplier is multiplied by the link-specific proportion of generated traffic defined in the link information worksheet. A value of 0 implies no generated traffic, regardless of the proportion of traffic generated in the link data. The default value of 1 implies full application of the link specific values in the affected flow group(s). The multiplier enables MyRIAD to identify the volume of generated traffic in each flow group.
3.14. An incident is defined as any event that causes a temporary blockage of the running lanes, and therefore a reduction in capacity: those incidents confined to the hard shoulder do not affect traffic and are not relevant to the reliability assessment. Within MyRIAD, twelve different types of incident are considered:

<table>
<thead>
<tr>
<th>Incident Type</th>
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<tbody>
<tr>
<td>1</td>
</tr>
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</tr>
<tr>
<td>3</td>
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<td>11</td>
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<tr>
<td>12</td>
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</tbody>
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Table 6 MyRIAD Incident Types

3.15. MyRIAD uses the road-type specified in the Link Information worksheet to automatically assign default incident parameters to each link. The parameters are listed in column A of the worksheet and include, inter alia, the rate of occurrence of each of the twelve incident types per million veh/km.
Table 7 MyRIAD Incident Parameters worksheet

3.16. Appendix A lists the default incident parameters provided on the worksheet for the following road types: D2M/D3M/D4M (with and without MIDAS / CCTV), D3CM/D4CM, MM-ALR, and D2AP. User-defined rates can be specified for link types 11-13. Unless there is a change from these defaults, there is no need to modify the worksheet.

Values of Time Worksheet

3.17. This worksheet calculates a local value of travel time and travel time variability for use in the monetisation of the reliability and delay impacts. An average value per vehicle is calculated for each flow group which takes account of the different values of time of different vehicle types and the composition of vehicle types on the network for the flow group. The vehicle types considered are working cars (business), non-working cars (non-business), LGV, OGV and PSV.

3.18. Table E1 contains default parameters for splitting heavy vehicles into OGV/PSV and light vehicles into cars/LGV. These are applied to the proportions of light and heavy vehicles using the network in each flow group to obtain the network wide proportions of four vehicle types in each flow group (cars, LGV, OGV and PSV). The proportion of cars is then split into working and non-working cars by applying the TUBA working time proportions.

3.19. The heavy / light vehicle splits are national averages and should only be changed if there are significantly different values available for the MyRIAD network. It should also be noted that the proportions of light and heavy vehicles using the network in each flow group is derived from the heavy vehicle proportions entered on the Link Information worksheet.

3.20. Table E2 contains the default values of time for the five vehicle types in 2010 market prices and values from WebTAG data book (November 2014). There should be no need to change these values.
3.21. Average values of time are obtained by multiplying the values of time for each vehicle type by the corresponding proportion of that vehicle type on the network in Table E3. Summing the results across all vehicle types gives the average value of time per vehicle in each flow group as shown on the bottom row of Table E4.

3.22. The values in Table E5 of the worksheet are equal to the values in Table E4 multiplied by the reliability ratio of 0.8 for non-goods vehicles and 1.2 for goods vehicles. Summing the results across all vehicle types gives the average value of travel time variability per vehicle in each flow group as shown on the bottom row of Table E5.

Table 8 MyRIAD Values of Time worksheet

Speed Flow and DTDV Worksheet

3.23. Managed motorway and widening schemes will increase the capacity of the carriageway. This will change average speeds and journey times which will in turn have an impact on the day-to-day variability component of reliability. The purpose of this worksheet is to define the variables which will be used by MyRIAD to calculate the impact. For interventions which do not increase capacity (CCTV, MIDAS and Controlled Motorway), MyRIAD will not predict any change in day-to-day variability (DTDV).

Speed Flow Curve

3.24. The speed-flow curve is used to determine the average speed on a link with the flows provided on the Primary Information Sheet. This information is required to enable application of the DTDV curve to estimate day-to-day variability.
3.25. The shape of the speed-flow curves is fully compatible with COBA speed-flow curves and take the form shown in Figure 2:

![Indicative speed-flow curve used by MyRIAD](image)

**Figure 2 Indicative speed-flow curve used by MyRIAD**

3.26. The curve is piece-wise linear, with up to five breakpoints. Beyond the last breakpoint the speed flow curve is extrapolated from the last and penultimate breakpoints until it reaches the minimum allowed speed. The same speed-flow curve applies to all vehicles on the link. However, a maximum allowed speed for heavy vehicles is defined. If the speed calculated using the curve exceeds this value, then the heavy vehicle speed is set to the maximum allowed.

3.27. The following data must be defined for each road type:

- Road type name
- Free flow speed for light vehicles in km/h \(V_0\)
- First breakpoint: flow in vehs/hr and speed in km/h \((Q_1, V_1)\)
- Minimum speed in km/h \(V_{\text{min}}\)
- Maximum speed for heavy vehicles in km/h

Up to four additional breakpoints may be defined \([Q_2, V_2] to [Q_5, V_5]\).

Note that flows in this worksheet are defined as one-way vehs/hr and not vehs/lane/hr.

3.28. Default curves are provided in Appendix A for D4M, D3M, D2M and D2AP. The D4M curve should be used for MM-ALR.
3.29. Note that the speed flow curve is used only in the calculation of journey time per km for input to the DTDV function. It has no other uses. In particular, it is not used to calculate benefits due to changes in average travel times – these are Transport Economic Efficiency impacts which are subject to separate assessment.

Day-to-day Variability Curves

3.30. The DTDV coefficients are used in a function of the following form:

Standard deviation of journey time (in seconds per km) = \( a + bx + cx^2 + dx^3 \)

where \( x \) is the mean journey time per km, as calculated from the speed-flow curve.

3.31. Default values for the coefficients are provided in Appendix A for D4M, D4CM, D3M, D3CM, and D2AP / D2M. The coefficients are from Mott MacDonald (2008a, 2008b).

<table>
<thead>
<tr>
<th>Speed Flow Definitions</th>
<th>D4M</th>
<th>D4CM</th>
<th>D3M</th>
<th>D3CM</th>
<th>D2AP</th>
<th>D2M</th>
</tr>
</thead>
<tbody>
<tr>
<td>High flow speed limits (m/s)</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
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<td>Speed limit (m/s)</td>
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<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Speed limit (ft/s)</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
</tr>
<tr>
<td>Speed limit (kph)</td>
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<td>99.5</td>
<td>127.7</td>
<td>99.5</td>
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<td>40</td>
<td>40</td>
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<td>40</td>
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<tr>
<td>Day-to-day variability curves</td>
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<table>
<thead>
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<th>D4CM</th>
<th>D3M</th>
<th>D3CM</th>
<th>D2AP</th>
<th>D2M</th>
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<td>118</td>
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<tr>
<td>Speed limit (m/s)</td>
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<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Speed limit (ft/s)</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
<td>118</td>
</tr>
<tr>
<td>Speed limit (kph)</td>
<td>127.7</td>
<td>99.5</td>
<td>127.7</td>
<td>99.5</td>
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<td>Speed limit (mph)</td>
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<table>
<thead>
<tr>
<th>Speed Flow Definitions</th>
<th>D4M</th>
<th>D4CM</th>
<th>D3M</th>
<th>D3CM</th>
<th>D2AP</th>
<th>D2M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum speed (m/s)</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Minimum speed (kph)</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DTDV Definitions</th>
<th>D4M</th>
<th>D4CM</th>
<th>D3M</th>
<th>D3CM</th>
<th>D2AP</th>
<th>D2M</th>
</tr>
</thead>
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<tr>
<td>Coefficients</td>
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<td>0.920</td>
<td>0.730</td>
<td>0.920</td>
<td>0.730</td>
<td>0.920</td>
</tr>
<tr>
<td>Coefficients</td>
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<td>-0.220E-01</td>
<td>-0.220E-01</td>
<td>-0.220E-01</td>
<td>-0.220E-01</td>
<td>-0.220E-01</td>
</tr>
</tbody>
</table>

| Table 9 MyRIAD Speed-flow and DTDV Curves worksheet |
4. **MyRIAD Results for Individual Assessment Years**

4.1. The results of the reliability assessment for the assessment year are contained in the Model Year Results worksheet. The results include the total reliability benefit for the assessment year and for each of its two components (travel time variability and incident delays). There are also further tables which show:

- Incident Delay and TTV benefits by flow group
- Incident Delay and TTV benefits by type of incident
- Incident Delay and TTV benefits by trip purpose (Business and Commuting/Other)
- Incident delays by type of incident for DM and DS
- Incident related variability by flow group for DM and DS

4.2. TTV benefits include benefits from both incident related and day-to-day variability. However, because of the non-linearities in the calculations, it is not possible to unambiguously split the total variability benefits between each incident type and DTDV so only total variability benefits are shown.

4.3. All monetary values in the results worksheet are presented without application of discounting or value of time growth. This is carried out in the “MyRIAD Master” workbook that calculates benefits over the whole appraisal period.

![MyRIAD Results](image)

Table 10 Single Year Results Worksheet
5. **MyRIAD Results for the Appraisal Period**

5.1. To obtain results for the whole appraisal period, the user should complete the MyRIAD Master workbook to combine the results for individual assessment years. Between two and six forecast years can be combined in the Master workbook.

5.2. Although most Highways Agency road schemes are assessed over 60 years, some schemes, namely CCTV, MIDAS and Controlled Motorway, are assessed over 30 years. MyRIAD allows the user to specify the length of the appraisal period in the Master workbook between 30 and 60 years.

5.3. Results from the single year MyRIAD workbooks are interpolated to obtain results for the years in between assessment years and extrapolated for the years beyond the last assessment year to cover the specified appraisal period. The results for each year are then discounted and added together to provide results for the full appraisal period in 2010 market prices, discounted to 2010.

5.4. The following information is required in the MyRIAD Master workbook:
   - Scenario name
   - Appraisal period (30 to 60 years)
   - Current year – this is the year when the appraisal is being carried out
   - Location of MyRIAD individual assessment year workbooks – these are input by double clicking in the appropriate cell and locating the file in the ‘Save As’ box. The assessment year also needs to be specified.

From these inputs, the MyRIAD Master workbook calculates total benefits which represent the sum of Incident Delay and TTV benefits for the specified appraisal period in 2010 market prices, discounted to 2010. It is worth reiterating that incident delay time saving benefits have the same values of time (VOT) as other travel time savings. Growth in the value of time is also applied in the same manner as for other travel time savings.

The MyRIAD Master workbook also contains a summary of benefits with tables showing:
   - Incident Delay and TTV benefits by flow group
   - Incident Delay by type of incident
   - Incident Delay and TTV benefits by trip purpose (Business and Commuting/Other)
- Incident Delay and TTV benefits by flow group in each assessment year

### Table 11 MyRIAD Master Outputs

5.5. It should be noted that, according to WebTAG, monetised reliability impacts are not to be included in the Analysis of Monetised Costs and Benefits table which is used to calculate a scheme’s Benefit-Cost Ratio (BCR). They should however be included in the Appraisal Summary Table disaggregated between business and commuter / other users.
6. **Enquiries**

6.1. If you have any questions or comments, find that something is not working the way it should, or require additional functionality, please contact:

TAMESoftware@mottmac.com
References

INCA Manual Version 1.1 (DTLR / Mott McDonald, 2002)

Published Research Report 030 Updating and validating parameters for incident appraisal model INCA (TRL, 2004)

Estimation of DTDV functions for motorways (Mott McDonald, 2008a)

Estimation of variability functions for additional inter-urban road types (Mott McDonald, 2008b)

INCA User Manual Version 4.1 (DfT / Mott McDonald, 2009)

INCA Software Version 4.1 (DfT / Mott McDonald, 2009)
Appendix A – Incident Parameters

A.1. The Incident Parameters worksheet defines incident parameters for each of the twelve incident types. The defaults are shown in tables A1 to A3 below.

A.2. Table A1 includes different incident rates for D2M/D3M/D4M, D3CM/D4CM and MM-ALR road types. These road types are then sub-divided by different combinations of technology provision, namely VMS, CCTV and MIDAS. All three are integral components of D3CM/D4CM and MM-ALR. For D2M/D3M/D4M, there can be more variation in technology provision. Only VMS for instance is an integral part of the MIDAS system: CCTV may or may not be present.

A.3. Incident rates relating to HGVs assume the COBA motorway percentage of HGV (12.6%). If the percentage of HGVs on scheme links is significantly different, the HGV incident rates in this table should be factored accordingly.

<table>
<thead>
<tr>
<th>Incident Type</th>
<th>Incident Rates (incidents per million veh kms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D2M/D3M/D4M</td>
</tr>
<tr>
<td></td>
<td>Without MIDAS</td>
</tr>
<tr>
<td>Single lane accident</td>
<td>0.1348</td>
</tr>
<tr>
<td>Multi-lane accident</td>
<td>0.0307</td>
</tr>
<tr>
<td>Non-HGV breakdown</td>
<td>0.1047</td>
</tr>
<tr>
<td>HGV breakdown *</td>
<td>0.0304</td>
</tr>
<tr>
<td>Minor Debris</td>
<td>0.1928</td>
</tr>
<tr>
<td>Non-HGV Fire</td>
<td>0.0084</td>
</tr>
<tr>
<td>HGV Fire *</td>
<td>0.0014</td>
</tr>
<tr>
<td>Load shedding</td>
<td>0.0025</td>
</tr>
<tr>
<td>Spillage</td>
<td>0.0022</td>
</tr>
<tr>
<td>SL emergency r'works</td>
<td>0.0410</td>
</tr>
<tr>
<td>ML emergency r'works *</td>
<td>0.0118</td>
</tr>
<tr>
<td>Animal</td>
<td>0.0032</td>
</tr>
</tbody>
</table>

*Accident rates for MM-ALR should be agreed with TAME on a case-by-case basis. They will always be the same or less than the rates for D2M / D3M / D4M with MIDAS.

# For two-lane roads, multi-lane roadworks are assumed to be very infrequent since implementing them would require closing the road completely. MyRIAD will apply this automatically if two-lanes are specified and motorway road-type is selected.

Table A1 MyRIAD Incident Rates
A.4. It is not usual practice to adjust the default accident rates in MyRIAD to match observed levels, mainly because the MyRIAD rates include damage-only accidents for which robust local data is unlikely to be available. However, it may be advisable to make some adjustment if local injury accident rates are significantly different from the national average for motorways (upon which MyRIAD is based). In these cases the following procedure should be followed:

(a) Calculate the local accident rate (PIAs per million vehicle kms). Call this A1.
(b) Calculate the national average accident rate for motorways (this can be obtained from the COBA manual, allowing for any predicted change over time). Call this A2.
(c) On the Incident Parameters Worksheet of MyRIAD, multiply the incident rates for ‘Single lane accident’ and ‘Multi-lane accident’ by the local accident adjustment factor (A1/A2). This should be done for both the Do Minimum and Do Something road types.

Do not adjust the rates for any other incidents.

<table>
<thead>
<tr>
<th>Incident Category</th>
<th>Mean Incident (Build-up) Duration (mins)</th>
<th>RMS Duration Weighting</th>
<th>Variance Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without CCTV</td>
<td>With CCTV</td>
<td></td>
</tr>
<tr>
<td>Single lane accident</td>
<td>24.6</td>
<td>24.1</td>
<td>0.99</td>
</tr>
<tr>
<td>Multi-lane accident</td>
<td>86.4</td>
<td>84.7</td>
<td>0.71</td>
</tr>
<tr>
<td>Non-HGV breakdown</td>
<td>16.8</td>
<td>16.8</td>
<td>1.04</td>
</tr>
<tr>
<td>HGV breakdown</td>
<td>51.6</td>
<td>51.6</td>
<td>0.76</td>
</tr>
<tr>
<td>Debris</td>
<td>19.6</td>
<td>19.6</td>
<td>1.04</td>
</tr>
<tr>
<td>Non-HGV Fire</td>
<td>39.4</td>
<td>34.4</td>
<td>0.96</td>
</tr>
<tr>
<td>HGV fire</td>
<td>138.8</td>
<td>133.8</td>
<td>0.80</td>
</tr>
<tr>
<td>Load shedding</td>
<td>17.6</td>
<td>12.6</td>
<td>0.99</td>
</tr>
<tr>
<td>Spillage</td>
<td>46.5</td>
<td>41.5</td>
<td>0.95</td>
</tr>
<tr>
<td>SL emergency Roadworks</td>
<td>241.9</td>
<td>241.9</td>
<td>1.20</td>
</tr>
<tr>
<td>ML emergency Roadworks</td>
<td>29.5</td>
<td>29.5</td>
<td>1.10</td>
</tr>
<tr>
<td>Animal</td>
<td>27.0</td>
<td>27.0</td>
<td>1.22</td>
</tr>
</tbody>
</table>

*Table A2 MyRIAD Incident Durations and Variance Weightings*
<table>
<thead>
<tr>
<th>Incident Category</th>
<th>All Road Types (Two lanes)</th>
<th>All Road Types (Three lanes or more)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single lane accident</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Multi-lane accident</td>
<td>1.99*</td>
<td>2.22</td>
</tr>
<tr>
<td>Non-HGV breakdown</td>
<td>1.26</td>
<td>1.26</td>
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<tr>
<td>HGV breakdown</td>
<td>1.04</td>
<td>1.04</td>
</tr>
<tr>
<td>Debris</td>
<td>1.43</td>
<td>1.43</td>
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<tr>
<td>Non-HGV Fire</td>
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<td>1.22</td>
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<tr>
<td>HGV fire</td>
<td>1.36</td>
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<tr>
<td>Load shedding</td>
<td>1.22</td>
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<tr>
<td>Spillage</td>
<td>1.25</td>
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<tr>
<td>SL emergency Roadworks</td>
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<td>1.00</td>
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<tr>
<td>ML emergency Roadworks</td>
<td>1.82</td>
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</tr>
<tr>
<td>Animal</td>
<td>1.52</td>
<td>1.52</td>
</tr>
</tbody>
</table>

*For two-lane road-types, the number of lanes blocked is limited to two. However, to avoid division by 0 in the delay calculations, this is set to 1.99 in the incident parameters.

**Table A3 MyRIAD Average number of lanes closed**
Appendix B – Speed-flow curves and DTDV Curve Parameters

B.1. Speed-flow curves are based on COBA curves with zero hilliness and bendiness. The parameters will need to be adjusted if either of these is significant.

B.2. The D3M and D4M speed-flow curves are also assumed to apply to D3CM and D4CM respectively (three and four lane controlled motorways). MM-ALR assessments should use the D4M curve.

B.3. Certain rules apply to the definition of breakpoints for speed flow curves:

- At least one breakpoint must be defined;
- For each breakpoint speed and flow must both be defined, or both left blank;
- The flow at each breakpoint must be greater than that at the previous breakpoint;
- The speed at each breakpoint must be less than or equal to that at the previous breakpoint.

<table>
<thead>
<tr>
<th>Breakpoint Parameter</th>
<th>D4M / D4CM</th>
<th>D3M / D3CM</th>
<th>D2AP</th>
<th>D2M</th>
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</thead>
<tbody>
<tr>
<td>Free flow speed (lights) (km/h) (VL0)</td>
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<td>118</td>
<td>108</td>
<td>118</td>
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<tr>
<td>Breakpoint 1</td>
<td>Flow (total vehs/hr) (Q1)</td>
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<td>3600</td>
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<td></td>
<td>Speed (km/h) (V1)</td>
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<td>110.8</td>
<td>101.52</td>
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<td>5586</td>
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<td>Speed (km/h) (V2)</td>
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<td></td>
<td>Speed (km/h) (V3)</td>
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<td></td>
<td>Speed (km/h) (V4)</td>
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<td>Breakpoint 5</td>
<td>Flow (total vehs/hr) (Q5)</td>
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<td></td>
<td>Speed (km/h) (V5)</td>
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<td>Minimum speed (km/h)</td>
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<td>45</td>
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<td>Maximum speed heavies (km/h)</td>
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<td>93</td>
<td>86</td>
<td>93</td>
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</tbody>
</table>

Table B1 Default speed-flow curves in MyRIAD

B.4. The estimation of DTDV Curves is explained in the Mott Macdonald reports *Estimation of DTDV functions for motorways* (January 2008) and *Estimation of variability functions for additional inter-urban road types* (November 2008).
B.5. DTDV curves were estimated from observed data and are only valid over the range of journey times for which there were observations. These ranges are as follows:

- D3M: journey times up to 130 sec/km (=28 km/h)
- D4M: journey times up to 130 sec/km (=28 km/h)
- D4CM: journey times up to 80 sec/km (=45km/h)
- D3CM: journey times up to 80 sec/km (=45km/h)
- D2AP: journey times up to 80 sec/km (=45km/h)

B.6. The default speed-flow curves all have a minimum speed of 45km/h, or 80 seconds per km. This means that they will always return journey times within the observed range for D3M, D4M, D3CM, D4CM, and D2AP.

B.7. D2M links are assumed to have the same DTDV curves as D2AP with metre-strips.

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>D4M</th>
<th>D3M</th>
<th>D4CM</th>
<th>D3CM</th>
<th>D2AP</th>
<th>D2M</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-coefficient</td>
<td>-48.498</td>
<td>-58.682</td>
<td>68.455</td>
<td>54.046</td>
<td>31.179</td>
<td>31.179</td>
</tr>
<tr>
<td>b-coefficient</td>
<td>1.738</td>
<td>2.201</td>
<td>-5.524</td>
<td>-4.048</td>
<td>-1.990</td>
<td>-1.990</td>
</tr>
<tr>
<td>c-coefficient</td>
<td>-8.739 x 10^{-3}</td>
<td>-1.446 x 10^{-2}</td>
<td>1.381 x 10^{-1}</td>
<td>9.362 x 10^{-2}</td>
<td>3.715 x 10^{2}</td>
<td>3.715 x 10^{2}</td>
</tr>
<tr>
<td>d-coefficient</td>
<td>9.411 x 10^{-6}</td>
<td>3.638 x 10^{-5}</td>
<td>-9.909 x 10^{-4}</td>
<td>-5.976 x 10^{-4}</td>
<td>-1.312 x 10^{-4}</td>
<td>-1.312 x 10^{-4}</td>
</tr>
</tbody>
</table>

*Table B2 Default DTDV coefficients in MyRIAD*

B.8. As a consequence of the cubic function used to calculate DTDV, the resulting curves can be hump-shaped i.e variability increases with journey time, reaches a maximum value, then decreases. This decrease tends to happen beyond the observed range of the data. As a safeguard, the calculated variability in this ‘decreasing’ region is replaced with the maximum value. This is shown in Figure B1. The dotted line shows the standard deviation in the decreasing region, as calculated by the cubic function. The solid line shows the standard deviation that is actually used in MyRIAD.
Figure B1 Preventing decreasing variability with increasing journey time
Appendix C – Software Specification

MyRIAD uses a series of VBA Macros to calculate DM and DS incident delays and journey time variability. These Macros are hidden from the user and are run in sequence when MyRIAD is run for a single year assessment. This section provides an overview of the calculations performed by MyRIAD. The figure below summarises the process for the do-minimum and do-something scenarios.

1. Produce pro-forma incident parameter and results tables
2. Populate tables with incident parameters from Incident Parameters Worksheet
3. Calculate link capacities during normal operation
4. Calculate link capacities during each incident type
5. Calculate link delays and variances by incident type
6. Combine link variances and delays for each incident type to calculate the total delay and variance for the link
7. Combine link variances across routes
8. Apply monetary values to changes in variability and delay
I. **Prepare Results Table** – Generates two tables with fields ready for inputting (a) incident parameters and (b) subsequent calculations with the 12 different incident types across the top and incident parameters along the side.

II. **Get Incident Parameters** – Populates the incident parameters table produced above with values from INCA’s Secondary Input Sheet.

Incident-related delays and variability on a link is calculated using the module GenericIncident. This includes the Main sub-routine that, when run, calls (runs) the following sub-routines:

I. **Normal Operation Link Capacity** – Calculates link capacity during normal operation.

II. **With Incident** – Is called for each incident type and calculates the variance and delay by incident type for a link.

III. **Total Variability and Delay** – Combines the link variances and delays for each incident type to calculate the total delay and variance for the link.

These sub-routines record the values calculated for various parameters and used in subsequent calculations in an Excel spreadsheet. These calculations are explained in more detail below.

I. **Normal Operation Link Capacity Sub-routine** (link capacity during normal operation)

Hourly capacity per lane is calculated using the formula:

\[
Lane \, Capacity \,(Vehicles) = \frac{Lane \, Capacity \,(PCUs)}{(1-%HGV) + (2\times%HGV)}
\]

Where **Lane Capacity (Vehicles)** is the hourly one-way capacity per lane in vehicles

**Lane Capacity (PCUs)** is the default hourly capacity per lane in pcus. This is 2300 in INCA but can be changed by the user

%HGV is the percentage of HGVs on the link

Hourly capacity per one-way link is calculated using the formula:

\[
Capacity \, Link \,(Veh/\,Hour) = NLANE \times LaneCapacity
\]

Where **Capacity Link (Veh/Hour)** is the hourly one-way capacity per link in vehicles

**NLANE** is the number of lanes in each direction
Capacity per hour is converted into capacity per minutes by dividing by 60.

\[
Capacity\ Link\ (C)\ (\text{Veh/Min}) = \frac{Capacity\ Link\ (\text{Hour})}{60}
\]

Where \textbf{Capacity Link, C, (Veh/Min)} is the one-way capacity per minute per link in vehicles.

Link flow (demand) is calculated using the formula

\[
Demand\ (\text{Veh/Hour}) = \frac{AADT \times Traffic\ Growth \times AADT\ _Factor\ Hour}{2}
\]

Where \textbf{Demand (Veh/Hour)} is the hourly one-way demand per link in vehicles in the assessment year.

- \textit{AADT} is the Average Annual Daily Traffic (Two-way).
- \textit{Traffic Growth} is the forecast growth between the base year and the assessment year.
- \textit{AADT\ _Factor\ Hour} is the factor applied to the AADT to calculate the hourly flow.

Flow per hour is converted into flow per minute by dividing by 60.

\[
Demand\ (D)\ (\text{Veh/Min}) = \frac{Demand\ (\text{Veh/Hour})}{60}
\]

Where \textbf{Demand, D, (Veh/Min)} is the flow per minute.

The ratio of flow to capacity on the link is calculated using the formula

\[
RFC = \frac{Demand}{Capacity}
\]

Where \textbf{RFC} is the ratio of flow to capacity.

RFC in INCA is limited to 0.95. If RFC is greater than 0.95, D is capped to 0.95 RFC.

\[
Demand\ (D)\ (\text{Veh/Min}) = RFC \times C
\]

\textbf{II. With\_Incident\ Sub-routine} (calculates variance and delay by incident type)

\textbf{a. Link Capacity}

The link capacity with an incident is calculated using the formula

\[
Incident\ Capacity\ (C') = (NLANE - ALC) \times C \left( \frac{BLCF}{NLANE} \right)
\]

Where \textbf{Incident Capacity, C', (Veh/Min)} is the link capacity per minute with the incident.

\textbf{ALC} is the average lanes closed during the incident.
**BLCF** is the Build-up lane capacity factor and specifies what proportion of the normal lane capacity is available during the build-up phase of the queue during an incident. This reflects the fact that even when a lane is fully open, it will not usually be operating at full capacity during the incident.

# indicates an incident-related parameter for which INCA defaults are normally used

**b. Proportion of Traffic Diverting**

The delays which occur on the sections affected by an incident are dependent on the proportion of traffic diverting to avoid the incident. The proportion of traffic diverting is calculated according to the formula

\[
\text{Diversion Proportion} (\text{DP}) = 0.004168 \times \left( B \times \frac{(D-C)}{D} \right)
\]

Where **Diversion Proportion, DP**, is the proportion of traffic diverted (Diverted traffic is capped at 90% of excess demand)

**B** is the build-up duration of the incident in minutes

If RFC is greater than 0.95 with the incident, then capped demand on the affected link (less diverted traffic) is

\[
\text{Capped Demand with Diversion} (D') = D \times (1 - DP)
\]

Where **Capped Demand with Diversion (Veh/min), D'**, is the demand on the affected link less diverted traffic

Otherwise, capped demand becomes

\[
\text{Capped Demand with Diversion} (D) = 0.95 \times D \times (1 - DP)
\]

**c. Duration of Incident**

Incident durations are calculated using INCA incident parameters

\[
\text{Weighted Incident Duration} (B) = \text{Build–up Duration} \times \text{RMS Duration Weighting}
\]

Where **Weighted Incident Duration (mins), B**, is calculated from the mean incident duration and the duration weighting

**Build-up Duration** is the average duration of an incident in minutes. It is the time between the occurrence of an incident, and the time when all obstructions are removed.

**RMS Duration Weighting** is applied so that average delay of an incident is closer to the average delay from all incidents in the class.

\[
\text{Transition Period} (T) (\text{Mins}) = \frac{B \times (D' - C)}{C}
\]
Where **Transition Period, T**, is the time between the incident being cleared and the time that the last vehicle which joined the queue prior to the incident being cleared would have passed the point where the incident occurred if the first in first out principle (FIFO) had been observed

\[
\text{Discharge Duration (} D \text{)} = B \times \left( \frac{(D-C)}{(C-D')} \right)
\]

Where **Discharge Duration, D**, is the time between the end of the transition period and the time when the queue would be cleared

\[
\text{Total Duration (Mins)} = B + D
\]

\[
\text{Capacity Shortfall (} k \text{)} = \frac{(D-C)}{C}
\]

d. Delay

\[
\text{Total Delay (Mins)} = \left( \frac{B^2 \times C + B \times T \times C}{\left( \left( \frac{1}{k} \right) + 1 \right) + T \times D \times C} \right) \times \left( \frac{1}{1 - DP} \right)
\]

Where **Total Delay** is the total delay to all vehicles affected by the incident

\[
\text{Vehicles Delayed} = B \times C + D \times C \times \left( \frac{1}{1 - DP} \right)
\]

Where **Vehicles Delayed** is the number of vehicles delayed by the incident

\[
\text{Average Delay (Mins)} = \frac{\text{Total Delay}}{\text{Vehicles Delayed}}
\]

Where **Average Delay (Mins), A^0**, is the average delay per vehicle

In order to prevent unrealistic queuing and delays, if average delay per vehicle exceeds a user defined maximum threshold, a capping formula is applied.

\[
A^1 = A^f \times (1 - f) + A^0 \times f \quad \text{where: } A^0 > A^1; \quad \text{Otherwise } A^1 = A^0
\]

Where **A^f** is the average delay with threshold reduction applied

**A^f** is the average delay threshold (INCA default is 30 minutes)

**f** is the average delay threshold factor (INCA default is 0)
Total Delay\(^{1}\) (Mins) = \(A^{1} \times \text{Vehicles Delayed}\)

Total Delay\(^{1}\) is therefore the delay associated with each occurrence of a particular incident type. In order to calculate the total delay per annum associated with each incident, the Distance Travelled is first calculated.

\[
\text{Distance Travelled (Annual \(\text{km}\))} = \left(\frac{\text{Link Length} \times (D \times 60) \times \text{Annualisation Factor}}{1000000}\right)
\]

Where \(\text{mvkm}\) is million vehicle kilometres

- **Link Length (km)** is the length of the link being assessed in kilometres
- **Annualisation Factor** is the number of hours within a specific flow group

This is combined with the incident rate to produce the number of incidents.

\[
\text{Number of Incidents} = \text{Incident Rate} \times \text{Distance Travelled}
\]

Finally, the annual delay associated with each incident type is calculated by combining the number of incidents with the total delay associated each incident

\[
\text{Annual Delay (Minutes)} = \text{Number of Incidents} \times \text{Total Delay}^{1}
\]

e. Variance

The travel time variance associated with each incident is calculated using the maximum delay per vehicle. According to deterministic queuing theory, this is twice the average delay per vehicle.

\[
\text{Maximum Delay per vehicle (Mins)} = 2A^{1}
\]

\[
\sigma^{2} = \left(\frac{\text{Maximum Delay per Vehicle}^{2}}{3}\right) \times \text{Variance Weighting}
\]

Where \(\sigma^{2}\) (minutes per vehicle) is the travel time variance caused by each incident type

- **Variance Weighting**\(^{a}\) takes into account the distribution of incident durations within an incident type

**III. Total Variability and Delay Sub-routine** (Calculates total delays and variance)

a. Total Delay

The total delay on a link across all incident types is calculated by summing the total delay for all incidents.
Total Delay = \sum_{i=1}^{12} Total Delay^i \text{ where } i=1 \text{ is incident type 1}

Where \textbf{Total Delay} is the delay per vehicle in the flow group across all incidents.

\textbf{b. Total Variability}

The total variability on a link is calculated using the probability of an incident in each flow group.

\[
\text{Probability of Incident } (P) = \text{Number of Incidents} \times \left( \frac{\text{Total Duration}}{\text{Annualisation Factor} \times 60} \right)
\]

Where \textbf{Probability of Incident, } P, \text{ is the probability of a particular incident in a flow group}

The product of the probability and variance for each incident type is then summed to calculate the total variance on a link.

\[
\text{Total Variance} = \sum_{i=1}^{12} P \sigma^2 \text{ where } i=1 \text{ is incident type 1}
\]

Where \textbf{Total Variance} is the variance per vehicle in the flow group across all incidents.
Appendix D – Network Definition Guidance

This guidance has been developed to improve and standardise the process of preparing MyRIAD input data and constructing MyRIAD networks.

This guidance is developed based on a traffic model developed using the SATURN traffic modelling software suite. Hence for simplicity, some of the methods for deriving data from the model are described by the use of SATURN related processes. However, data can be equally derived using other traffic modelling software.

Trip Matrix Development

The following methodology is suggested for developing the trip matrices for input into MyRIAD. Figure D1 shows a schematic diagram for a typical MyRIAD network, which has been simplified to three scheme links (SL1, SL2, SL3), three junctions (A, B, C, D) and five feeder links (FL1 to FL5). The purpose of the feeder links is to model routes for the trips on the scheme links.

![Figure D1 Indicative MyRIAD diagram](image)

To obtain the trip matrices for the Do-Minimum scenario (for the network shown in Figure D1), the following method is suggested (for each modelled time period and forecast year):

- Generate trip matrices for all movements on the scheme links (in both directions). In this case, flows on the scheme links can be summarised as a matrix of movements (numbers indicate direction of travel):

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

- For each of these trip matrices, obtain the corresponding trip lengths from the Do-Minimum traffic model.
• Remove the scheme link lengths from the trip lengths, as the scheme lengths will be included within the MyRIAD network structure for scheme links.

• Round the remaining trip lengths to the nearest 5km (for ease of data analysis) or to another suitable frequency.

• Convert the modelled flows (AM, IP and PM) to AADT, using the available observed traffic data. AADTs should be calculated separately for Light and Heavy vehicles as MyRIAD requires the percentage HGV by link.

• Combine the AADT trips to obtain trip matrices for each feeder link.

• Calculate the trip length for each feeder link weighted by the trips.

**Volume to Capacity (V/C) Ratio calculations**

The V/C ratio for feeder links should be calculated using the traffic model. The suggested methodology for the calculations is:

• Step 1 – Identify a list of model links along which vehicles travel to arrive at or depart from the scheme links in both directions, which are within the SATURN simulation network;

• Step 2 – Identify the corresponding V/C and link lengths for the links identified in Step 1 within the SATURN simulation network area, for each time period (AM, IP and PM);

• Step 3 – Calculate the average V/C weighted by link length and link flow (ignoring link flows less than 50 pcu) for the links identified in Step 1, for each time period;

• Step 4 – Select the highest time period V/C for each year calculated in Step 3.

• Step 5 – Calculate the feeder link flows using the maximum V/Cs from Step 4.

A suggested formula for calculating the V/C is given below:

\[
\text{Feeder Link V/C} = \frac{\sum (\text{LinkLength} \times \text{Flow} \times \text{Capacity})}{\sum (\text{LinkLength} \times \text{Flow} \div \text{Flow}_f)}
\]

Where

- LinkLength\(_S\), Flows\(_S\), Capacity\(_S\) correspond to links that have traffic leading to the scheme link (Step 1 in above methodology),
- Flow\(_f\) corresponds to the flow on the scheme links.

**Assessing Parallel Routes**

When a scheme is built it is likely to attract traffic from alternative routes. While the traffic on the scheme links is likely to increase with the introduction of the scheme, the traffic on parallel routes is likely to decrease. To capture the benefits of a reduction in traffic on parallel routes, it is suggested that a separate MyRIAD run be carried out for affected parallel routes, then the benefits combined with the scheme link MyRIAD benefits. It is assumed that the traffic on the scheme and on the parallel routes are independent for this assessment and that the scheme does not result in traffic diverting to use just part of the scheme.
For assessing parallel routes, the following methodology for developing scheme link assessments should be used.

Parallel routes can initially be identified by comparing the differences in modelled traffic flows between Do-Something and Do-Minimum scenarios for future forecast years. If this is the case, the SATRAP facility in SATURN can be used to quantify the use of parallel routes.

For this, a select link trip matrix for the scheme links in Do-Something scenario is required. Using SATRAP, assign this matrix on to the model which has the Do-Something matrix assigned onto the Do-Minimum network, to identify the parallel routes – that is the routes likely to be followed by traffic which would use the scheme links post-implementation but which do not do so pre-implementation because of capacity constraints. Parallel routes should only be considered if an alternative route contributes over 250 vehicles in any peak-hour.

**Combining diversion links**

QDIV (QUADRO DIVersion) is part of QUADRO software, which calculates the combined speed/flow relationship for a number of links, either in series or in parallel. Please refer to Volume 14 Section 1, Part 7 QDIV of DMRB manual for further information on QDIV.

As a parallel route might consist of links with different carriageway characteristics the use of QDIV is suggested to identify a single speed-flow curve that is relevant to the entire parallel route(s), or for parts of the parallel route forming a single modelled link within MyRIAD.

QDIV requires the following data:

- 16 hour flows (one-way)
- Number of lanes
- Link Length
- Carriageway width
- HGV % and
- Maximum link speed.

Most of this data can be obtained directly from information held within the SATURN traffic model, although it will usually be necessary to derive the 16 hour flows from the individual time period results, and look up the number of lanes from link speed-flow curve data. Aerial photographs, available on the internet, can be used to confirm the number of lanes and speed limits. Care should be taken, though, in using internet resources as the images viewed may not be up-to-date. A maximum of 10 links can be combined into a single speed-flow curve with QDIV.
Once produced using QDIV, the speed flow curve should be coded in MyRIAD in the ‘SpeedFlow and DTDV’ worksheet. Only a maximum of four user-derived speed flow curves can be specified.

**MyRIAD assessment for parallel routes**

The input for the MyRIAD assessment of parallel routes should be carried out in a similar way to scheme links, however the following points should be considered:

- The link type should be coded as 1;
- The link will be the overall length of the diversion routes, or part of it if the route is specified as more than one link;
- The proportion of traffic generated should be specified as a negative value, as the parallel route is likely to experience a reduction in traffic;
- The road type for parallel routes should match the corresponding bespoke speed-flow curves developed using either QDIV or a similar method. The road type should be the same for both Do-Minimum and Do-Something scenarios.
- The incident parameters for both Do-Minimum and Do-Something scenarios should be the same;
- If the parallel route is not a D3M route, the incident rates for dual-carriageways should be obtained from TAME.
- The calculated speed flow curves for parallel routes should be specified.
Appendix E - Reporting Guidance

A MyRIAD assessment should be reported with the following information in the Economic Assessment Report:

1. The year and source of all base year AADTs used for each scheme-specific MyRIAD or in the look-up tables should be stated.

2. The DM and DS road types specified in MyRIAD for the scheme links should be stated.

3. The MyRIAD network diagram should be included. The following data should be shown:
   - Node/junction names
   - Link lengths
   - AADTs (base year, two-way)
   - Flow to capacity ratios on the feeder links should be shown for the busiest flow group.

4. If it has been necessary to combine two or more real links into a single MyRIAD network then details should be included of the calculation of the combined AADT (should be a distance-weighted average).

5. Traffic growth factors from base year to opening year and any other modelled years and the source of those traffic growth factors used in MyRIAD should be stated.

6. The trip matrix used in MyRIAD should be included. The source of this, and the implied trip length distribution, should be described.

7. MyRIAD impacts should be reported and summarised in a table of the following format:

<table>
<thead>
<tr>
<th>Incident and Day-to-day Variability</th>
<th>(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident delays</td>
<td>(b)</td>
</tr>
<tr>
<td><strong>Total impacts</strong></td>
<td>(a) + (b)</td>
</tr>
</tbody>
</table>

8. MyRIAD impacts are reported in the scheme Appraisal Summary Table under Economy: Reliability impact on Business users and Social: Reliability impact on Commuting and Other users. These are output directly from the MyRIAD Master spreadsheet.