Transport Research Laboratory
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CLIENT PROJECT REPORT CPR2136

Highways Maintenance Appraisal Tool User Guide

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1 Introduction

1.1 Overview

This document is the User Guide for the Highways Maintenance Appraisal Tool (HMAT) which was developed under a Department for Transport project to model and output the wider impacts of maintenance appraisals for carriageways. This Guide is applicable to the Highways Maintenance Appraisal Tool.

The guide is not a comprehensive report designed to give the user full details on the background of all the functionality within the tool. It is aimed at the user who understands the purpose of the tool and the analyses it can produce, but requires straightforward user guidance to navigate through the tool to undertake one or more analyses. Further background and details on the purpose of the tool are given in the report on model development and demonstration analyses (Buckland et al, 2014)

1.2 The HMAT tool

The tool was developed for use by Central Government and Local Highway Authority asset managers and engineers as a decision support tool and includes the ability to:

- Assess the impacts of different carriageway maintenance funding levels on
    - Impacts of treatments (e.g. delays to users, embodied carbon).
    - Impacts of condition (e.g. vehicle operating costs, journey time costs).
    - Accidents.
    - Job impacts for the road maintenance industry.
- Project condition and predict treatment lengths, as developed in the Highway Maintenance Efficiency Programme (HMEP) Lifecycle Planning Toolkit (HMEP, 2012), such as:
    - Identifying the level of funding required to meet agreed objectives for highway impacts (e.g. condition targets, minimising disruption).
    - Identifying the funding required to minimise impacts across the network.

The tool is designed in a spreadsheet environment for transparency and ease of uptake by new users. The user:

- Enters various data to represent the network under consideration (e.g. length, traffic)
- Confirms or adjusts the value of various default parameters which are used in the analyses (e.g. typical length of carriageway maintenance schemes, CO_2 production by vehicle engines)
- Runs the analysis
- Reviews results of the analysis in various tables and graphs
- Is able to compare the results of different scenarios by opening the separate standalone Aggregated Output Module (AOM) which displays summary data from each separate saved analysis run of the HMAT tool.

The logic of the tool design is displayed in Section 2.3.

1.3 Opening the tool

The following steps are required to open and use the tool in Microsoft Excel:

1. Open the HMAT file using Microsoft Excel 2007 (or later).
2. If prompted, click 'Enable Content' in the Security warning in the yellow strip below the Excel ribbon (see Figure 1).

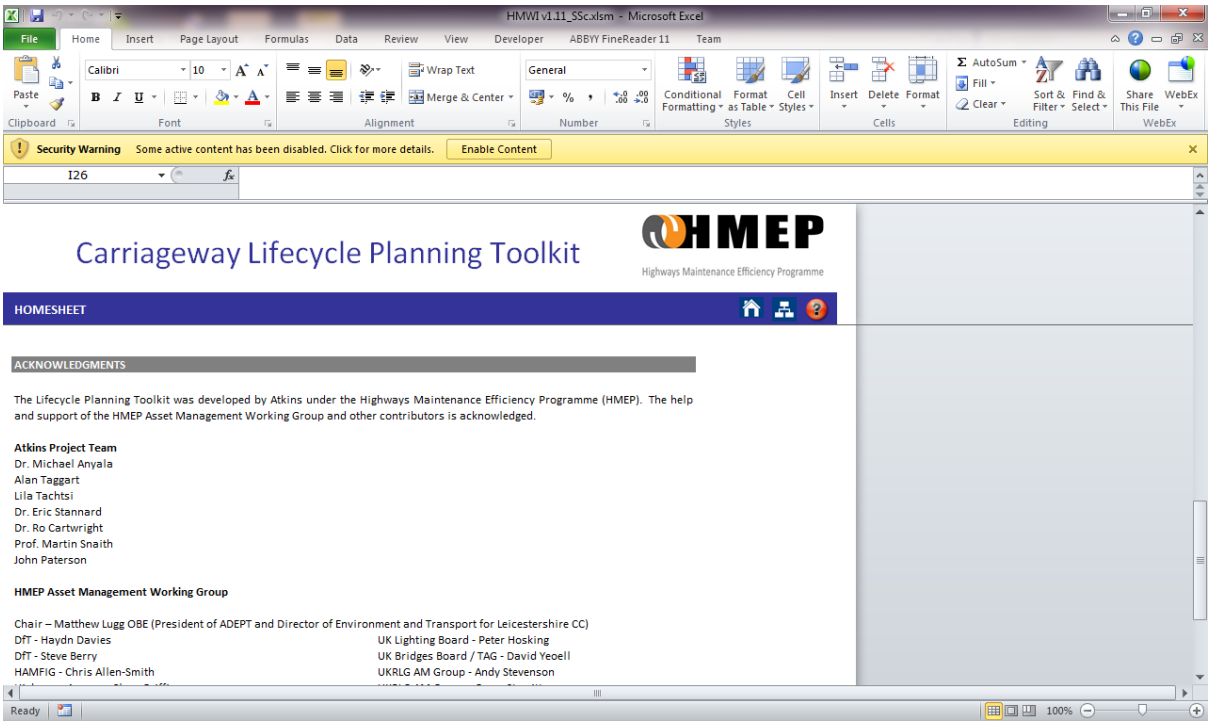


Figure 1: Enabling content in Excel 2007 (or later)

3. This will load the front screen of HMAT (see Figure 2).

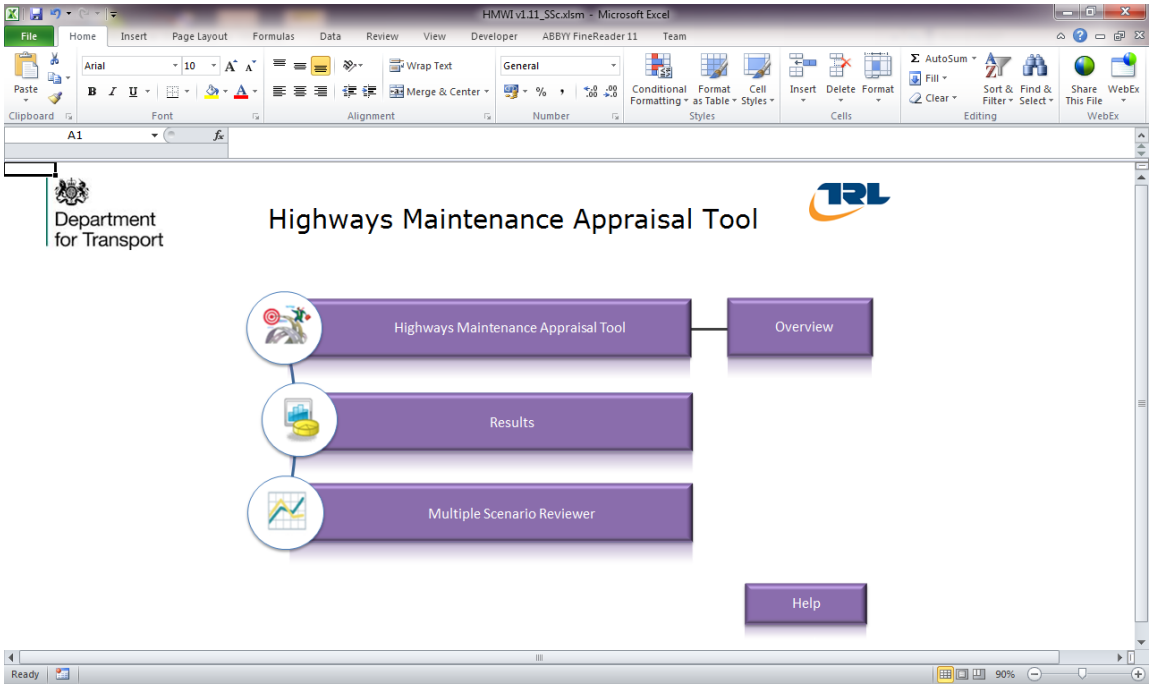


Figure 2: Highways Maintenance Appraisal Tool front screen

1.4 Saving an analysis

The following steps are required to save an analysis undertaken with HMAT:

1. Select 'Save As' from the 'File' menu.
2. In Excel 2007 (or later), in the 'Save as type' options available in the 'Save As' window (see Figure 3) select 'Excel Macro-Enabled Workbook'.

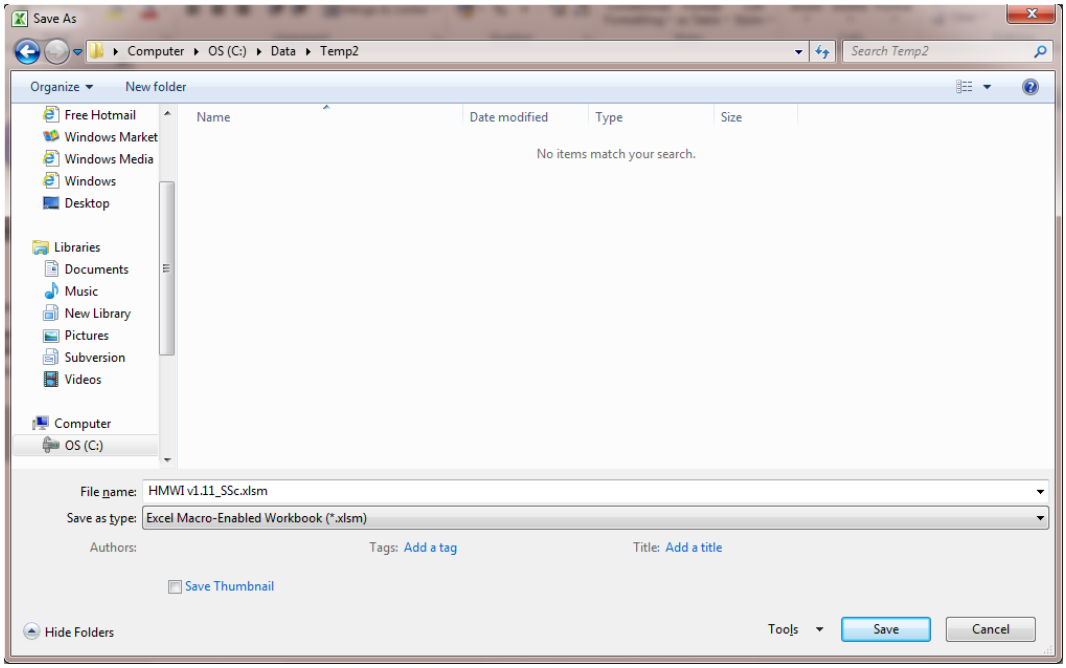


Figure 3: Saving the tool

2 HMAT introduction

All worksheets in the tool are available but some are initially hidden from view. All worksheets are protected and users can only make changes to data entry cells. The tool has been built using the existing HMEP Toolkit (HMEP, 2012) for asset condition projection and maintenance treatment identification. All bounds that have been set in the HMEP Toolkit (e.g. length of analysis period, number of condition bands) have been retained in HMAT to preserve the interaction between the different processes.

This Section describes the following worksheets in the tool:

- HMAT Front: The front screen of HMAT.
- Help: Provides the user with basic help for navigating around the tool
- Overview: a map of the structure and interactions in the tool.

2.1 HMAT Front

The 'HMAT Front' worksheet is the welcome screen that the user sees when opening the tool (see Figure 2). From this worksheet the user can navigate to the start point for:

- An analysis, using the 'Highways Maintenance Appraisal Tool' button.
- Viewing existing results, using the 'Results' button.
- Comparing results from a number of individual HMAT analyses, using the 'Multiple Scenario Viewer' button.
- Viewing a layout of the tool and allowing the user to navigate to any relevant worksheet, using the 'Overview' button.
- Viewing the HMAT user help information, with the 'Help' button.

2.2 Help

The 'Help' worksheet provides basic information for using the tool (see Figure 4):

- Explanation of buttons on the worksheets in the tool.
- Explanation of the different colours used for the worksheet tabs in the tool.
- Explanation of the different cell colours used on the worksheets in the tool.
- Allowing the user to unhide (or hide) the default look-up data worksheets

2.2.1 Worksheet specific help

Each worksheet contains a 'Help'  button on the title header. When this button is clicked it displays specific help information for the current worksheet.

Throughout the tool the cells are coloured according to the action needed:

Data input cells (data entered by the user or selected from drop-down menus)

Default data that can be changed

Optional data

Header (descriptive) text

Outputs from the analysis

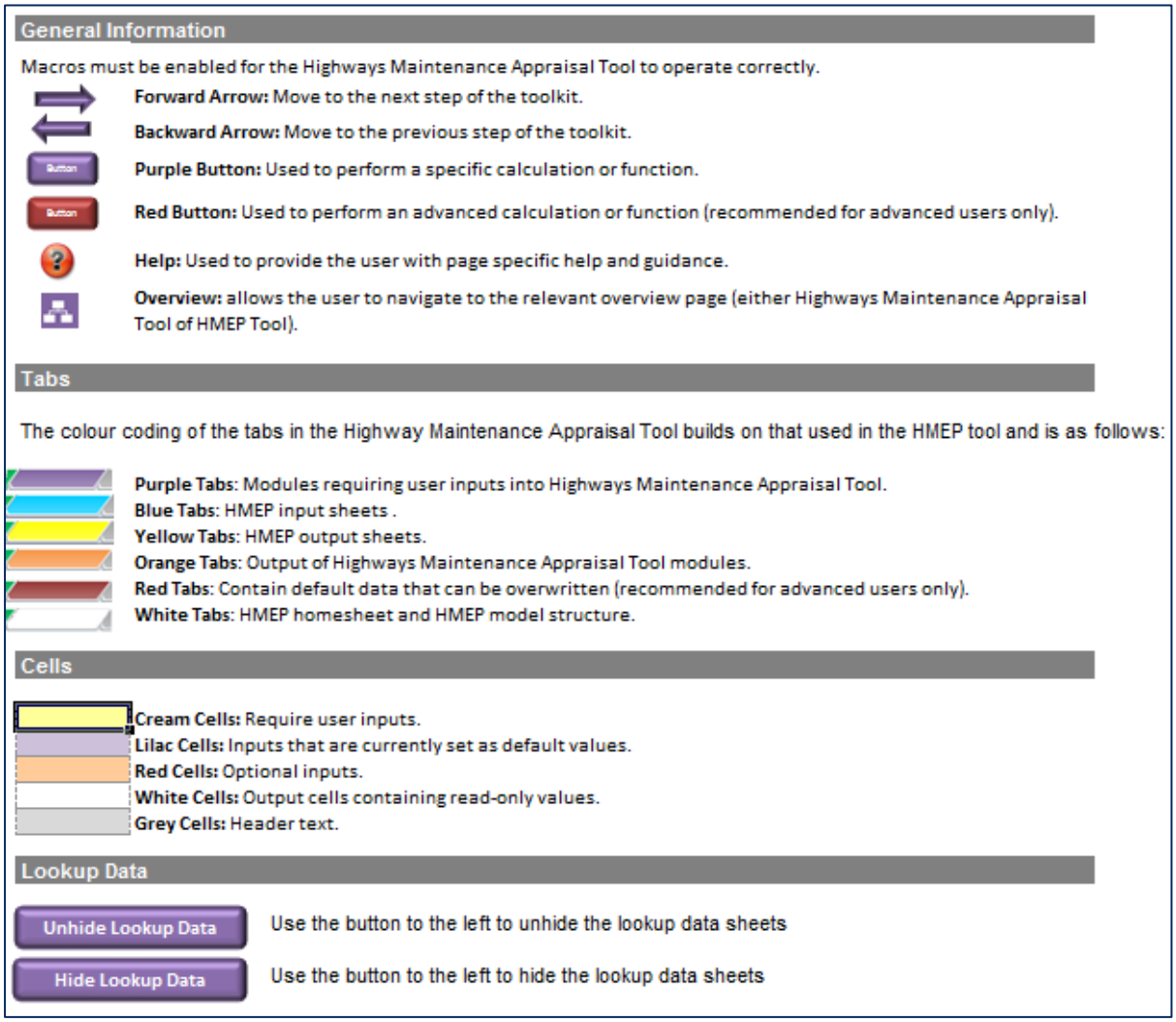


Figure 4: Help worksheet information

The 'Help' worksheet also contains the version history for the tool.

2.2.2 Updating default look-up data

If the user requires the default look-up data to be updated within the tool (e.g. if there is a new version of WebTAG with updated look-up values) then the buttons on the 'Help' worksheet can be used to unhide the required worksheets.

The user is able to update the values within the look-up data worksheets using the structure and format that already exists.

2.3 Overview

The 'Overview' worksheet shows the layout of the tool and how the worksheets interact (see Figure 5). The colours used represent the same role as the tab colours given in Figure 4. The worksheets in the tool are ordered in a logical sequential order for undertaking an analysis.

The colours of the 'buttons' on each of the worksheets align with the colours of the tabs (as shown on the 'Help' worksheet in Figure 4.) and users can navigate to any of the shown worksheets by selecting the button.

A user can return to the 'Overview' worksheet from anywhere in the tool by selecting the 'Overview'  button found on the title header of each worksheet.

If the user selects the Overview button on any of the purple or red HMAT tabs it will direct them to the HMAT Overview. If the Overview button on the blue HMEP tab is pressed it will direct them to the HMEP overview tab '0b – Model Structure'.

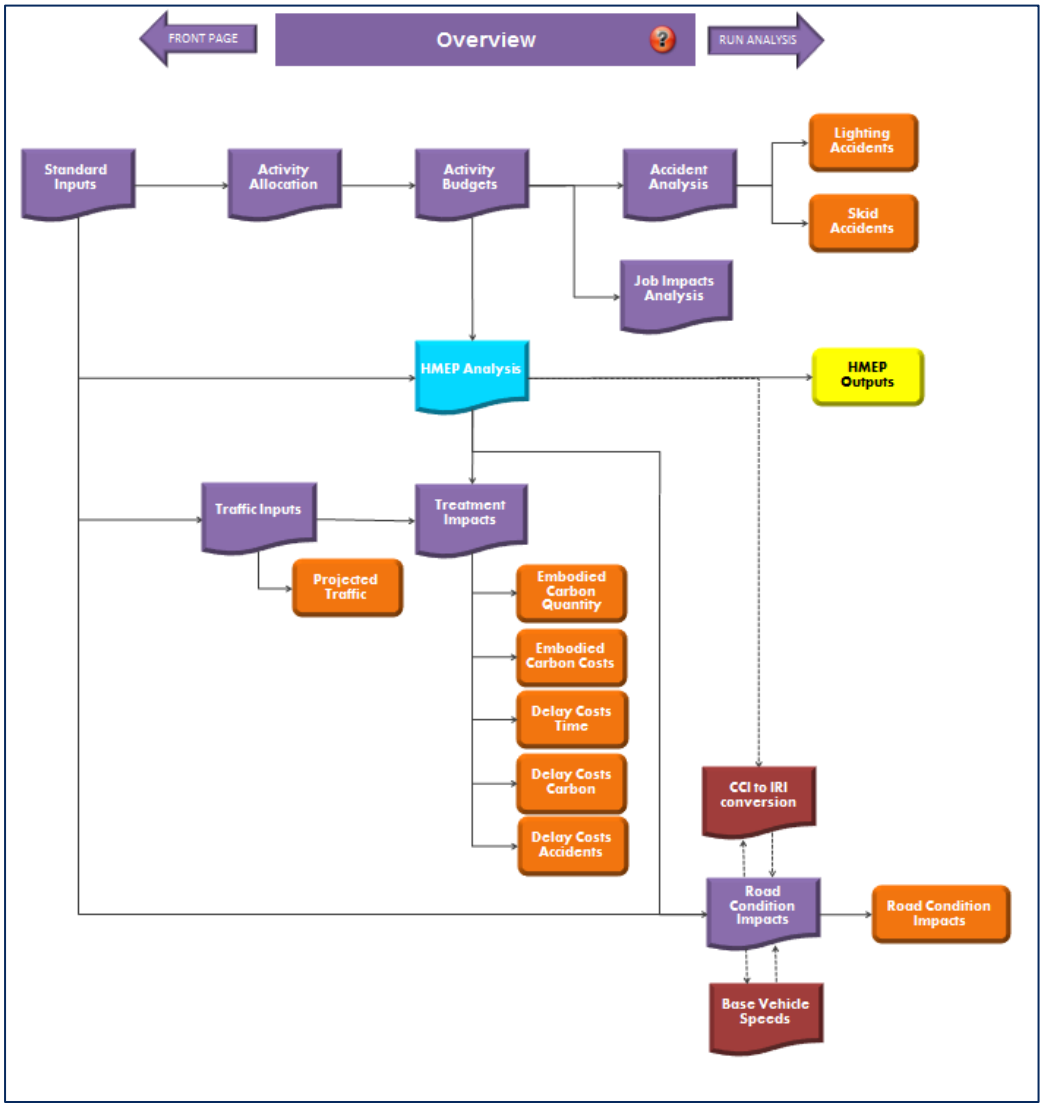


Figure 5: 'Overview' worksheet

3 Data population

The supplied tool has example data entered and where this can be changed is described in this Guide. Example analyses, representing analyses of the national network are available and can be used as the basis for further analyses. Data needed for an analysis is entered in the following worksheets:

- Standard Inputs
- Activity Allocation
- Activity Budgets
- HMEP Toolkit
    - 1 – Homogenous Asset Groups
    - 2 – Transition Matrices
    - 3 – Treatment Effects & Costs
    - 4 – Treatment Strategies
    - 5 – Budgets
    - 6 – Performance Targets
    - 7 – Scenario
- Traffic
- Treatment Impacts
- Road Condition Impacts
- Accidents Analysis
- Job Impacts

There are two worksheets for which data entry is optional:

- Condition Bands to IRI conversion
- Base Vehicle Speeds

3.1 Standard Inputs

'Standard Inputs' are used for the general initialisation of the tool and requires information for:

- Base analysis data
- Road types
- Condition bands
- Treatment types.

3.1.1 Base analysis data

The following information is required (see Figure 6):

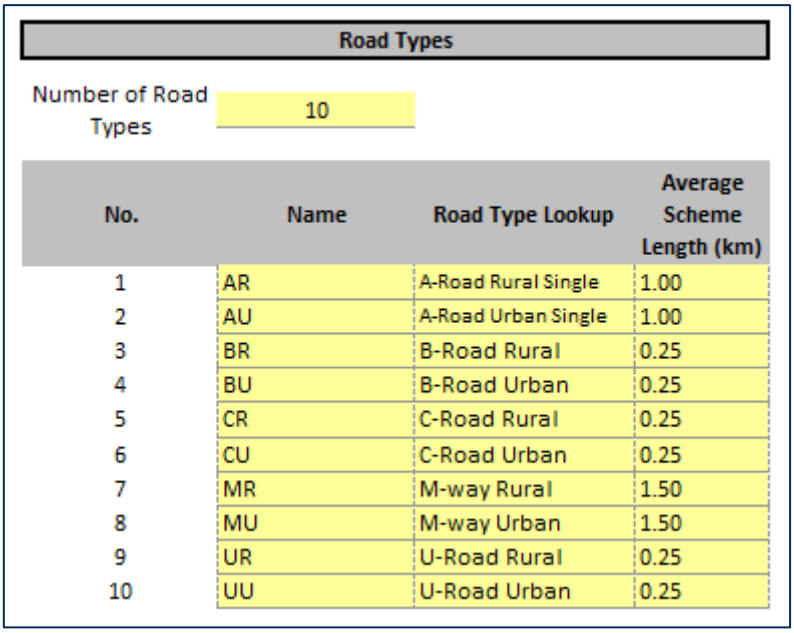
1. Start year of the analysis in the range 1900 to 2200.
2. Length of analysis period in the range 10 to 60 years.

3. The analysis name. This field is optional but it is recommended to be populated because the name is used in the Aggregate Outputs Module to identify the analysis when comparing multiple analyses. This is free text (up to 25 characters)

Figure 6: Base analysis data

3.1.2 Road types

Road types split the network into representative groups for modelling (see Figure 7).



No.	Name	Road Type Lookup	Average Scheme Length (km)
1	AR	A-Road Rural Single	1.00
2	AU	A-Road Urban Single	1.00
3	BR	B-Road Rural	0.25
4	BU	B-Road Urban	0.25
5	CR	C-Road Rural	0.25
6	CU	C-Road Urban	0.25
7	MR	M-way Rural	1.50
8	MU	M-way Urban	1.50
9	UR	U-Road Rural	0.25
10	UU	U-Road Urban	0.25

Figure 7: Road type information

Road types can be added or removed from the list.

3.1.2.1 Adding road types

To add one or more new road types use the following steps (see Figure 8):

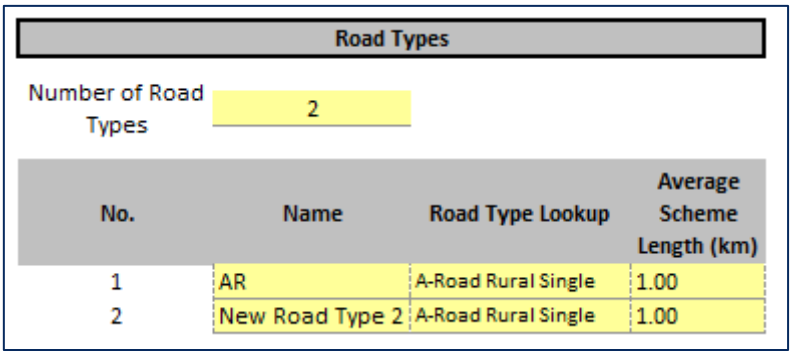
1. Enter the number of road types to be used in the analysis in the range 1 to 100. Other data is needed for a new road type and other worksheets are automatically updated to show the need for data for the new road type.

2. Enter the names for the new road type(s) below the current last record with the following data:

a. 'Name' (replaces 'New Road Type x', where x is the number of the road type record).

b. 'Road Type Look-up' is initially shown to be the same as the first record and should be amended by selecting from the drop-down list.

c. 'Average Scheme Length (km)'. This is the typical maintenance scheme length that will be used to represent maintenance works on this road type and is initially shown to be the same as the first road type record.



Road Types

Number of Road Types: 2

No.	Name	Road Type Lookup	Average Scheme Length (km)
1	AR	A-Road Rural Single	1.00
2	New Road Type 2	A-Road Rural Single	1.00

Figure 8: Example of adding a second road type

Selection of the Road Type Look-up automatically links data for the road type for Road Class (for traffic data), VOC Look-up Group (for vehicle operating cost data) and Delay Look-up (for Delay costs data) (see Table 1).

Table 1: Road type look-up associations

Road Type Look-up	Road Class	VOC Look-up Group	Delay Look-up
A-Road Rural Single	Non Built-up Principal	A-Road	A-Road Rural Single
A-Road Urban Single	Built-up Principal	A-Road	A-Road Urban Single
A-Road Rural Dual	Non Built-up Principal	A-Road	A-Road Rural Dual
A-Road Urban Dual	Built-up Principal	A-Road	A-Road Urban Dual
B-Road Rural	Other	B-Road	B-Road Rural
B-Road Urban	Other	B-Road	B-Road Urban
C-Road Rural	Other	C-Road	C-Road Rural
C-Road Urban	Other	C-Road	C-Road Urban
M-way Rural	Motorway	M-way	M-way Rural
M-way Urban	Motorway	M-way	M-way Urban
U-Road Rural	Other	U-Road	U-Road Rural
U-Road Urban	Other	U-Road	U-Road Urban

HMAT automatically amends all associated data worksheets and tables to enable data to be added (on other screens) for the additional road type(s) and the road type(s) to be included in the analysis results.

3.1.2.2 Deleting road types

Road types can only be removed from the bottom of the list of road types. To remove one or more road types use the following steps:

1. Enter the number of road types to be used in the analysis in the range 1 to 100

   Two messages will appear asking for confirmation to proceed.

2. Choose 'Yes' for both messages and the appropriate number of road types will be deleted from the bottom of the list.

Note, if a road type in the middle of the current list is to be removed, then that road type and the road types below that road type must be removed first and the road types originally below the road type to be removed must be re-entered.

3.1.3 Condition bands

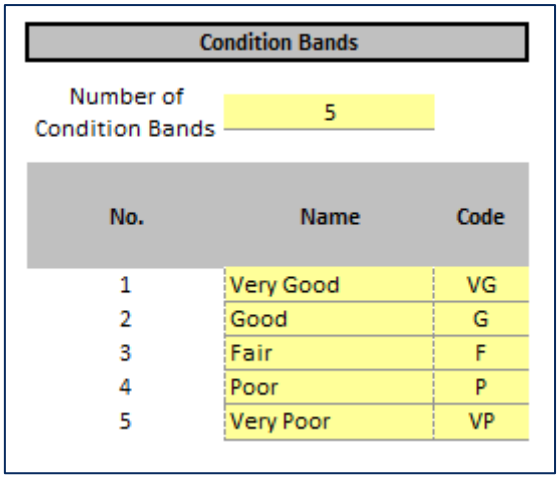
Condition bands split each road type into a representative distribution of condition. When supplied, HMAT uses the five condition bands adopted generally to describe the condition of local roads in England (see Figure 9). It is recommended that initial runs of the tool continue to use this number of bands until more experience is gained about the interaction of the different analysis modules.

3.1.3.1 Adding condition bands

To add one or more new condition bands the same approach is used as for adding road types (see Section 3.1.2.1):

1. Enter the number of condition bands to be used in the analysis. The number of condition bands in an analysis can be in the range 3 to 10.
2. Enter the information for the condition band(s) below the current last record with the following data:
   a. 'Name' (replaces 'New Condition Band x', where x is the number of the condition band record). This is free text.
   b. 'Code' (replaces 'CB#x', where x is the number of the condition band record). The code is free text.

   The tool automatically amends all associated data worksheets and tables to represent the additional condition band(s).



Condition Bands

Number of Condition Bands: 5

No.	Name	Code
1	Very Good	VG
2	Good	G
3	Fair	F
4	Poor	P
5	Very Poor	VP

Figure 9: Condition band information

3.1.3.2 Deleting condition bands

Condition bands can be removed from the bottom of the list (in the same way as for road types – see Section 3.1.2.2). To remove one or more condition bands use the following steps:

1. Enter the number of condition bands to be used in the analysis in the range 3 to 10.

   Two messages will appear asking for confirmation to proceed.

2. Choose 'Yes' for both messages and the appropriate number of condition bands will be deleted from the bottom of the list.

Note, if a condition band in the middle of the current list is to be removed, then that condition band and the condition bands below that condition band must be removed first and the condition bands originally below the condition band to be removed must be re-entered.

The tool automatically amends all associated data worksheets and tables to represent the deletion of the condition band(s).

3.1.4 Carriageway treatment types

Treatment types determine the maintenance treatments to apply to the network. When supplied, HMAT uses six treatment types but more can be added or some can be removed (see Figure 10).

3.1.4.1 Adding treatment types

To add one or more new treatment types the same approach is used as for adding road types (see Section 3.1.2.1):

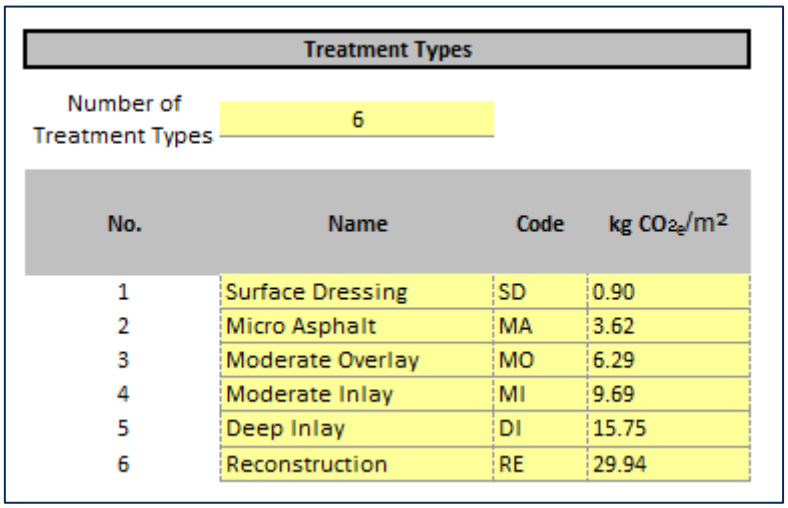
1. Enter the number of treatment types to be used in the analysis in the range 2 to 10.
2. Enter the new treatment type(s) below the current last record with the following data:

a. 'Name' (replaces 'New Treatment Type x', where x is the number of the treatment type record).

b. 'Code' (replaces 'TT#x', where x is the number of the treatment type record).

c. The value for 'kg $CO2_e/m^2$' (this initially appears as the same as the first treatment type). This value represents the CO_2 emitted during the production and laying of the material.

The tool automatically amends all associated data worksheets and tables to represent the additional condition band(s).



Treatment Types

Number of Treatment Types: 6

No.	Name	Code	kg CO_{2e}/m^2
1	Surface Dressing	SD	0.90
2	Micro Asphalt	MA	3.62
3	Moderate Overlay	MO	6.29
4	Moderate Inlay	MI	9.69
5	Deep Inlay	DI	15.75
6	Reconstruction	RE	29.94

Figure 10: Treatment Type information

3.1.4.2 Deleting treatment types

Treatment types can only be removed from the bottom of the list of treatment types. To remove one or more treatment types use the following steps:

1. Enter the number of treatment types to be used in the analysis in the range 3 to 10.

   Two messages will appear asking for confirmation to proceed.

2. Choose 'Yes' for both messages and the appropriate number of treatment types will be deleted from the bottom of the list.

Note, if a treatment type in the middle of the current list is to be removed, then that treatment type and the treatment types below that treatment type must be removed first and the treatment types originally below the treatment type to be removed must be re-entered.

The tool automatically amends all associated data worksheets and tables to represent the deletion of the treatment type(s).

3.2 Activity Allocation

The 'Activity Allocation' worksheet requires the user to define the maintenance activities to be considered in the analysis and the variation of their relative contribution depending on the size of the overall budget. It requires the following data:

- Name of each activity and quantitative analysis type to which it is relevant.
- Budgets that define the Lower, Mid and Upper budget envelopes.
- For each budget envelope:
    - The percentage of the budget spent on each activity.
    - For each activity:
        - The percentage of each maintenance driver that is affected by the activity.
    - The percentage of the budget spent on each road type.
    - The percentage of the budget spent on each treatment type.

3.2.1 Activity Types

The Activity Types specify the works to be included in the analysis. For each Activity, the user defines the relevant quantified analysis for the activity, using the drop-down 'Condition Analysis' field:

- Carriageway: activities where the budget contributes to a carriageway condition (excluding skid budgets) analysis.
- Skid: activities where the budget contributes to a skid-only related carriageway condition analysis.
- Lighting: activities where the budget contributes to a lighting analysis.
- None: activities that do not contribute to any of the available quantified analyses (carriageway condition, skid condition or lighting).

When supplied, HMAT uses 12 Activities but more can be added or some can be removed (see Figure 11).

3.2.1.1 Adding activity types

To add one or more new activity types the same approach is used as for adding road types (see Section 3.1.2.1). To add one or more new activity types the following steps are required (see Figure 11):

1. Enter the number of activity types to be used in the analysis in the range 1 to 50.
2. Enter the new activity type(s) below the current last record with the following data:
    a. 'Name' (replaces 'New Activity Type x', where x is the number of the treatment type record).
    b. Select the 'Condition Analysis' for the new activity (this will initially be the same as that used for the first activity type).

The tool automatically amends all associated data worksheets and tables to represent the additional activity type(s).

Activity Types

Number of Activity Types: 12

No.	Name	Condition Analysis
1	Reconstruction (capital)	Carriageway
2	Structural (capital)	Carriageway
3	Bridge (capital)	None
4	Road Safety (capital)	None
5	Lighting (capital)	Lighting
6	Planning, policy & strategy (revenue)	None
7	Structural - roads (revenue)	Carriageway
8	Structural -skid (revenue)	Skid
9	Structural - bridges (revenue)	None
10	Environment (revenue)	None
11	Lighting (revenue)	Lighting
12	TM & Road safety (revenue)	None

Figure 11: Activity types and condition analyses

3.2.1.2 Deleting activity types

Activity types can only be removed from the bottom of the list of activity types. To remove one or more activity types use the following steps:

1. Enter the number of activity types to be used in the analysis in the range 1 to 50.

   Two messages will appear asking for confirmation to proceed.

2. Choose 'Yes' for both messages and the appropriate number of activity types will be deleted from the bottom of the list.

Note, if an activity type in the middle of the current list is to be removed, then that activity type and the activity types below that activity type must be removed first and the activity types originally below the activity type to be removed must be re-entered.

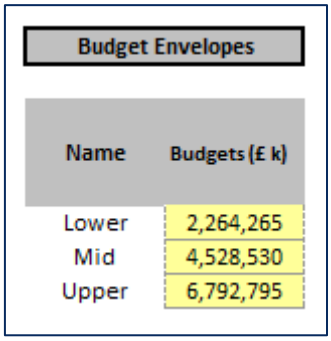
The tool automatically amends all associated data worksheets and tables to represent the deletion of the activity type(s).

3.2.2 Budget envelopes

Three 'Budget Envelopes' are specified in the Activity Allocation worksheet (see Figure 12). These allow the percentages of spend for activities, road types and treatment types to vary depending on the in-year budget. For example, the spending on new reconstruction may be a low percentage of the total budget for lower budgets where other activities have a higher priority.

Enter the budget for each of the three budget envelopes:

- Lower (maximum value of the Lower envelope).
- Mid (a budget level between Lower and Upper).
- Upper (minimum budget for the Upper envelope).



Budget Envelopes

Name	Budgets (£ k)
Lower	2,264,265
Mid	4,528,530
Upper	6,792,795

Figure 12: Budget envelopes

3.2.3 Budget percentages and drivers

For each budget envelope, enter:

- Percentage of the budget spent on each activity.
- Percentage of the spend on each activity affecting each maintenance driver.

The tool checks the percentages for all activities in the budget envelope sum to 100. Figure 13 shows the data for the Lower budget envelope. Note that the tool automatically creates the list of activities from those previously defined by the user (see Figure 11).

Budget Percentages and Drivers for Allocation Ranges

No.	Name	Lower Envelope						
		Total Budget Percentage	Maintenance Drivers					
			Safety	Accessibility	Condition	Reliability	Customer Service	Environment
1	Reconstruction (capital)	0	20	10	0	40	30	0
2	Structural (capital)	11	15	0	65	0	10	10
3	Bridge (capital)	5	30	10	20	0	30	10
4	Road Safety (capital)	4	90	0	0	0	10	0
5	Lighting (capital)	4	60	0	0	20	20	0
6	Planning, policy & strategy (revenue)	14	10	0	40	0	20	30
7	Structural - roads (revenue)	6	15	0	65	0	10	10
8	Structural -skid (revenue)	2	90	0	0	0	10	0
9	Structural - bridges (revenue)	2	30	10	20	0	30	10
10	Environment (revenue)	29	20	0	0	0	40	40
11	Lighting (revenue)	16	50	0	0	20	30	0
12	TM & Road safety (revenue)	7	90	0	0	0	10	0

Figure 13: Budget percentages and drivers for the lower budget envelope

The three Budget Envelopes allow the percentages of the budget allocated to each activity to vary. If the in-year budget is below the lower envelope value or above the upper envelope value, the lower or upper envelope value is used. For the middle envelope, if the budget is between the lower budget envelope value and the middle envelope value then the percentage is (linearly) interpolated between the percentages for those two budget envelope values. If the budget is between the upper budget

envelope value and the middle envelope value then the percentage is (linearly) interpolated between the percentages for those two budget envelope values.

For each activity enter the percentages that each activity contributes to each of the six maintenance drivers:

- Safety.
- Accessibility.
- Condition.
- Reliability.
- Customer service.
- Environment.

The percentage of the maintenance drivers for each activity must sum to 100.

3.2.4 Road type percentages

For each budget envelope, enter:

- Percentage of the total budget spent on each road type.

Note the tool automatically creates the list of road types using the data input by the user in the Standard Input worksheet.

The percentages for all road types in a budget envelope must sum to 100 (see Figure 14).

Road Types				
No.	Name	Total Budget Percentage		
		Lower Envelope	Mid Envelope	Upper Envelope
1	AR	34	22	20
2	AU	16	11	8
3	BR	6	4	4
4	BU	1	1	1
5	CR	12	14	17
6	CU	2	2	2
7	MR	1	1	1
8	MU	1	1	1
9	UR	13	22	23
10	UU	14	22	23

Figure 14: Road type budget percentages

3.2.5 Treatment type percentages

For each budget envelope, enter:

- Percentage of the budget for treatments used in the carriageway analysis (see Figure 15).

Note, the tool automatically creates the list of treatment types. The percentages for all treatment types in a budget envelope must sum to 100.

Treatment Types				
		Total Budget Percentage		
No	Name	Lower Envelope	Mid Envelope	Upper Envelope
1	Surface Dressing	35	25	20
2	Micro Asphalt	25	20	15
3	Moderate Overlay	20	20	25
4	Moderate Inlay	15	20	20
5	Deep Inlay	5	10	10
6	Reconstruction	0	5	10

Figure 15: Treatment type budget percentages

3.3 Activity Budgets

The 'Activity Budgets' worksheet is used to enter an overall maintenance budget. For each year of the analysis period, enter:

- The overall maintenance budget (in £k).

Figure 16 shows the overall maintenance budgets entered for the first five years of an analysis.

	2013	2014	2015	2016	2017
Overall Maintenance Budget (£ k)	4,528,530	5,528,530	4,528,530	4,528,530	4,528,530

Figure 16: Overall maintenance budget data entry

When the user has calculated the budget splits (see Section 4) it is important that for a budget run the budget breakdown by road type and treatment type (the bottom table on the Budgets tab) for each year should be transferred into the HMEP budgets tab '5 – Budgets' in order for the HMEP Toolkit to correctly use the same budget levels (i.e. the transfer of data from the Activity Budgets worksheet to the HMEP worksheet '5 – Budgets' is not automated).

3.4 HMEP Toolkit – data inputs

HMAT uses the HMEP Toolkit to model the future carriageway performance. Data entry for the Toolkit is as described in the HMEP User Guidance for Lifecycle Planning Toolkit (HMEP, 2012). Screen shots are provided in the HMEP guidance.

3.4.1 1 – Homog Asset Groups

For HMAT, the asset groups referred to in the HMEP Toolkit are the road types. In the '1 – Homog Asset Groups' worksheet, enter:

- Total road carriageway length for each road type and the carriageway width that represents that road type group.
- Initial condition data of each road type (i.e. percentage of the road length in each condition band).

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'HOMOGENOUS ASSET GROUPS'.

3.4.2 2 – Transition Matrices

In the '2 – Transition Matrices' worksheet, enter the transition matrices used for the projection of condition data.

It is recommended that the default matrices provided in HMAT are used until users are experienced in the definition and use of the matrices. To make changes or to add a new transition matrix, detailed guidance can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'TRANSITION PROBABILITY MATRICES'.

3.4.3 3 – Treatment Effects & Costs

In the '3 – Treatment Effects & Costs' worksheet, enter:

- Change in condition resulting from application of each treatment.
- Treatment Costs.

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'TREATMENT EFFECTS AND COSTS'.

3.4.4 4 – Treatment Strategies

In the '4 – Treatment Strategies' worksheet, enter:

- Treatment strategies to be applied to the network.

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'TREATMENT STRATEGIES'.

3.4.5 5 – Budgets

In the '5 – Budgets' worksheet, enter:

- Budgets to be applied to each road type, for each treatment type.

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'BUDGETS'. For HMAT, the budgets to be entered are the Activity Budgets described in Section 3.3.

3.4.6 6 – Performance Targets

In the '6 – Performance Targets' worksheet, enter:

- Performance targets to be applied to the analysis.

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'PERFORMANCE TARGETS'.

3.4.7 7 - Scenario

In the '7 – Scenario' worksheet define the analysis scenarios. For each year of the analysis and for each road type (i.e. homogenous asset group):

- Select a transition matrix.

- Select a treatment strategy.
- Select either a budget constraint or a performance target.

Detailed guidance on using this worksheet can be found in the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'SETTING UP ANALYSIS SCENARIOS'.

It is important that the user makes sure the scenario has been set up for each road type and each year of the analysis to use the correct treatment strategy, transition matrix, budget and performance target where appropriate.

3.5 Traffic

The 'Traffic' worksheet is used to define the initial traffic data and traffic growth rates through the analysis period. In the worksheet, enter:

- Traffic flow (veh km).
- Traffic growth.

The traffic flow in each year is used in the calculation of:

- User delay costs, as part of the treatment impact analysis.
- Vehicle operating costs, as part of the condition impact analysis.

3.5.1 Traffic data

HMAT uses the annual traffic (veh km/1000) in the first year of the analysis for each of:

- Cars.
- Light Goods Vehicles (LGV).
- Other Goods Vehicle 1 (OGV1).
- Other Goods Vehicle 2 (OGV2).
- Public Service Vehicle (PSV).

Figure 17 shows the definition of the vehicle classes and categories for the commercial vehicles OGV1, OGV2 and PSV.

Traffic data can be entered in one of two formats (see Table 2):

- HMAT format: the data is entered in the same format as the tool output and as used in the analysis.
- DfT format: to align with how traffic data is used by DfT, enter the traffic data in the DfT format. HMAT then automatically converts the data to the HMAT format.

Select the required format to use for the data input (see Figure 18 and Figure 19). Note the link between the Road Type and the Road Class is automatically created by HMAT when the road types are defined.

Commercial vehicle (cv)	cv class*	cv category
	Buses and Coaches	PSV
	2-axle rigid	OGV1
	3-axle rigid	
	3-axle articulated	OGV2
	4-axle rigid	
	4-axle articulated	
	5-axle articulated	
	6 (or more) -axle articulated	

Figure 17: Commercial vehicle classes and classifications (source: DfT, 2006)

Table 2: Traffic data entry formats

	HMAT format	DfT Format
Vehicle Classifications	Cars	Cars and bikes
	LGV	Motorbikes
	OGV1	Light vans
	OGV2	Goods vehicles
	PSV	Buses and coaches

Traffic Data - annual thousand veh km			Data Entry Format	DfT			
No.	Road Type	Class (used for OGV1:OGV2 splits)	Cars and bikes	Motorbikes	Light vans	Goods vehicles	Buses and coaches
1	AR	Non Built-up Principal	55,285,782	613,588	9,663,396	3,377,652	466,001
2	AU	Built-up Principal	41,320,218	366,386	6,261,581	1,352,079	626,569
3	BR	Other	13,163,344	211,340	2,691,866	379,842	76,981
4	BU	Other	8,587,512	151,919	1,422,909	141,534	161,635
5	CR	Other	15,467,246	257,291	2,876,243	345,298	100,827
6	CU	Other	10,851,672	183,046	1,753,942	150,893	202,291
7	MR	Motorway	724,550	4,441	102,923	35,353	4,806
8	MU	Motorway	724,550	4,441	102,923	35,353	4,806
9	UR	Other	14,689,875	257,955	2,452,342	266,898	103,005
10	UU	Other	47,026,071	768,567	7,748,149	557,394	758,153

Figure 18: Traffic data entry - DfT format

Traffic Data - annual thousand veh km			Data Entry Format	Model			
No.	Road Type	Class (used for OGV1:OGV2 splits)	Cars	LGV	OGV1	OGV2	PSV
1	AR	Non Built-up Principal	55,285,782	613,588	9,663,396	3,377,652	466,001
2	AU	Built-up Principal	41,320,218	366,386	6,261,581	1,352,079	626,569
3	BR	Other	13,163,344	211,340	2,691,866	379,842	76,981
4	BU	Other	8,587,512	151,919	1,422,909	141,534	161,635
5	CR	Other	15,467,246	257,291	2,876,243	345,298	100,827
6	CU	Other	10,851,672	183,046	1,753,942	150,893	202,291
7	MR	Motorway	724,550	4,441	102,923	35,353	4,806
8	MU	Motorway	724,550	4,441	102,923	35,353	4,806
9	UR	Other	14,689,875	257,955	2,452,342	266,898	103,005
10	UU	Other	47,026,071	768,567	7,748,149	557,394	758,153

Figure 19: Traffic data entry - HMAT format

Note, 'Class (used for OGV1:OGV2 splits)' is derived automatically from the 'Road Type Look-up' selected on the 'Standard Inputs' worksheet (see Section 3.1.2). If the DfT format is used for the data, the 'Class' is used to apply the appropriate split to the 'Goods vehicles' category.

3.5.2 Traffic Growth

Traffic growth is specified for each year of the analysis period. Enter the annual traffic growth values (%) for each vehicle type (as defined on the 'DfT' or 'HMAT' 'Data Entry Format') (see Figure 18 and Figure 19).

Enter the traffic growth data in one of two formats:

- All road types: enter the growth data once for each vehicle type, with those values being applied to all of the different road types.
- By road type: enter the growth data separately for each vehicle type on each road type.

Select the traffic growth data format (see Figure 20).

Traffic Growth Data - annual growth (%)			Data Entry Format	All road types			
No.	Road Type	Vehicle	2013	2014	2015	2016	2017
1	All	Cars	0.75	0.75	1.70	1.70	1.70
2	All	LGV	0.75	0.75	1.70	1.70	1.70
3	All	OGV1	1.33	1.33	2.74	2.74	2.74
4	All	OGV2	-0.90	-0.90	1.08	1.08	1.08
5	All	PSV	0.89	0.89	0.00	0.00	0.00

Figure 20: Traffic growth data entry - 'All road types' example

3.6 Treatment Impacts

HMAT calculates the impacts of carriageway maintenance treatments used in the carriageway analysis. Enter the base data for the calculations:

- Carbon cost.
- Maintenance closure splits.
- Treatment output rates.

The treatment impact data is used in the treatment impact analysis to calculate:

- Embodied carbon costs of the material used in the carriageway works.
- Time delay costs from the user delays from carriageway maintenance.
- Air quality costs from the user delays from carriageway maintenance.
- Accident costs from the user delays from carriageway maintenance.

3.6.1 Carbon cost

Select the 'Carbon Cost' dataset to be used for the carbon calculations (see Figure 21).

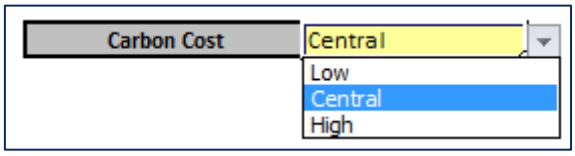


Figure 21: 'Carbon Cost' data selection

It is recommended that 'Central' carbon costs are used in initial analyses.

3.6.2 Maintenance closure splits

Enter the percentage of the periods of closures that are used for maintenance works on each road type:

- 24hr closures.
- Off-peak closures.
- Night closures.

The percentages for each road type must sum to 100. A tick to the right of the three data input cells indicates the percentages sum correctly to 100 (see Figure 22). A cross shows the data needs to be modified and the analysis cannot be completed with the current data.

No.	Road Type	Delay Lookup	Maintenance closure split (%)			
			24hr closures	Off-peak closures	Night closures	
1	AR	A-Road Rural Single	40	30	30	✓
2	AU	A-Road Urban Single	40	30	30	✓
3	BR	B-Road Rural	40	30	30	✓
4	BU	B-Road Urban	40	30	30	✓
5	CR	C-Road Rural	40	30	30	✓
6	CU	C-Road Urban	40	30	30	✓
7	MR	M-way Rural	40	30	30	✓
8	MU	M-way Urban	40	30	30	✓
9	UR	U-Road Rural	40	30	30	✓
10	UU	U-Road Urban	40	30	30	✓

Figure 22: Maintenance closure split data entry

The 'Delay Look-up' field is derived automatically from the 'Road Type Look-up' selected on the 'Standard Inputs' worksheet (see Section 3.1.2). The 'Delay Look-up' is used to apply the appropriate user delay data (derived from QUADRO) to the maintenance work on each road type.

3.6.3 Treatment output rates

Enter the treatment output rate (square metres per hour) for each treatment type on each road type (see Figure 23).

Output Rates - sq.m / hr					
Surface Dressing	Micro Asphalt	Moderate Overlay	Moderate Inlay	Deep Inlay	Reconstruction
189.57	139.50	81.67	114.00	88.50	49.50
134.83	113.00	61.33	88.50	64.00	36.50
189.57	139.50	81.67	114.00	88.50	49.50
134.83	113.00	61.33	88.50	64.00	36.50
189.57	139.50	81.67	114.00	88.50	49.50
134.83	113.00	61.33	88.50	64.00	36.50
490.00	453.00	231.43	356.00	259.00	109.50
490.00	453.00	231.43	356.00	259.00	109.50
189.57	139.50	81.67	114.00	88.50	49.50
134.83	113.00	61.33	88.50	64.00	36.50

Figure 23: Output rates data entry

Note. Figure 23 is the right-hand side of the screen shown in Figure 22

3.7 Road Condition Impacts

HMAT calculates the impacts of changing carriageway condition. Enter the base data for the calculations:

- CO_2 produced by vehicle engines, in grams CO_2 per litre of fuel

The condition impact data is used in the condition impact analysis for the calculation of:

- Vehicle operating costs - carbon.

The condition impact analysis also calculates:

- IRI distribution of the network from the predicted carriageway conditions.
- Vehicle operating costs – journey time.
- Vehicle operating costs – vehicle depreciation and running costs.

The 'Road Condition Impacts' worksheet contains two other data options:

- Edit IRI Tables.
- Edit Base Vehicle Speeds.

It is recommended that these options are only used by experienced users and they are explained further in Section 3.7.2 and Section 3.7.3.

3.7.1 CO_2 produced by vehicle engines

Enter the value of the CO_2 produced by vehicle engines for each engine/fuel type (see Figure 24):

- Petrol.
- Diesel.
- Electric.

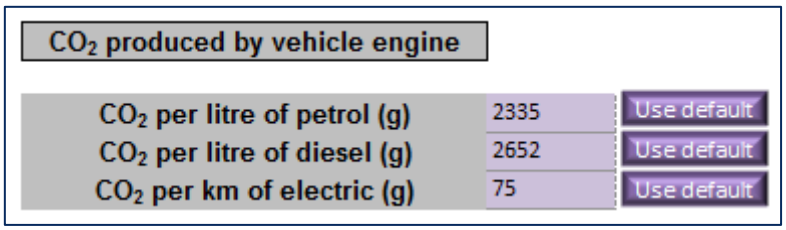


Figure 24: CO2 produced by vehicle engines data entry

Values can be input directly or the default value chosen for each engine/fuel type.

3.7.2 Edit IRI Tables

The 'Edit IRI Tables' option (see Figure 25) is recommended for experienced users only.

Figure 25: 'Edit IRI Tables' option

When selected the 'Condition Bands to IRI Tables' worksheet is displayed. Select the 'Recreate Tables' option (see Figure 26) if the number of tables does not align with the current setup as entered on the 'Standard Inputs' worksheet (e.g. if the number of road types does not equal the number of tables currently created). A warning message appears at the top of the worksheet advising if the tables need recreating (see Figure 27). If the tables need to change the analysis cannot proceed until this is done.

Figure 26: 'Recreate Tables' option

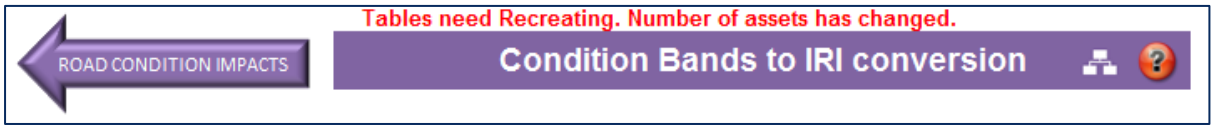


Figure 27: Error message showing the need to recreate IRI tables

The tables show the IRI distribution that will be applied to each condition band for the 11 IRI bands specified (0-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10+).

If the five condition bands (VG, G, F, P, VP) and the thresholds (see Section 3.1.3) shown in the model when supplied are to be used then the IRI conversion values can be selected for each road type (see Figure 28). If the number of condition bands, or the thresholds, are different the IRI/condition bands conversion tables need to be recreated with appropriate values.

If the values supplied with HMAT have been used, the data values will be coloured lilac. If any of the values have been updated, the cell will show as yellow if it is not a default value. Any combination of default and non-default values can be used but the sum across each condition band must be 100%. This is shown by a tick at the end of each row. A cross shows the data needs to be modified and the analysis cannot be started.

	AR										A-Road Rural
IRI	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10+	
VG	2%	45%	40%	10%	2%	1%	0%	0%	0%	0%	0%	✓
G	1%	22%	38%	23%	11%	4%	1%	0%	0%	0%	0%	✓
F	0%	10%	21%	19%	16%	13%	9%	6%	3%	2%	1%	✓
P	0%	6%	16%	15%	11%	9%	8%	7%	6%	6%	16%	✓
VP	0%	4%	14%	14%	12%	9%	8%	6%	6%	5%	22%	✓

Figure 28: Example road type table

3.7.3 Edit Base Vehicle Speeds

The 'Edit Base Vehicle Speeds' option (see Figure 29) is recommended for experienced users only.

Figure 29: 'Edit Base Vehicle Speeds' option

When selected, the 'Base Vehicle Speeds' worksheet is displayed (see Figure 30).

Base Vehicle Speeds (mph)

Road Type	VOC Lookup Group	Vehicle Type				
		Car	LGV	OGV1	OGV2	PSV
AR	A-Road	60	60	50	50	60
AU	A-Road	30	30	30	30	30
BR	B-Road	60	50	40	40	50
BU	B-Road	30	30	30	30	30
CR	C-Road	60	50	40	40	50
CU	C-Road	30	30	30	30	30
MR	M-way	70	70	60	60	70
MU	M-way	50	50	50	50	50
UR	U-Road	60	50	40	40	50
UU	U-Road	60	30	30	30	30

Figure 30: 'Base Vehicle Speeds' data entry

The data field 'VOC Look-up Group' is derived automatically from the 'Road Type Look-up' that was selected on the 'Standard Inputs' worksheet (see Section 3.1.2). The 'VOC Look-up Group' is used to apply the appropriate VOC look-up data (derived from HDM-4) to each road type.

For each road type select the base vehicle speed (mph) for each vehicle type. This free flow speed is representative of the vehicle speeds on the road type and assumes the carriageway to be in good condition. The options for the base speeds (mph) are:

- 30.
- 40.
- 50.
- 60.

In addition, if the road type is a motorway, an additional base speed is available:

- 70.

The vehicle speeds are used in the calculation of vehicle operating costs.

3.8 Accidents

The 'Accidents' worksheet is used to specify the data for calculating the costs of accidents using data for:

- Accident records (for accidents from all causes).
- Lighting related accident records and an associated budget for street lighting.
- Skid resistance accident impacts:
    - Resurfacing budget that leads to the proportion of the associated network with negative SCRIM.

The accident data is used to calculate:

- Change in the number of accidents for each year of the analysis based on the budgets available for:

- Skid related activity types.
- Lighting related activity types.

3.8.1 Accident records

Enter accident records (number of accidents per year in the start year of the analysis period) for all accidents with severity categories of slight, serious and fatal (see Figure 31).

Accident Record	
Severity	Number of Accidents
Slight	123,033
Serious	20,901
Fatal	1,637

Figure 31: Accident records data entry

3.8.2 Lighting related accidents

The user must enter a base lighting budget (see Figure 32) for the road network which corresponds with the total number of accidents records entered for the start year of the analysis period.

For each of the three different accident severities (slight, serious, fatal) enter:

- Number of accidents in daylight.
- Number of accidents in darkness for lit conditions.
- Number of accidents in darkness for unlit conditions.
- Number of accidents in darkness where lighting was unknown.

Lighting related Accidents						
Lighting Budget (£k)	Severity	Daylight	Darkness - Lit	Darkness - Unlit	Darkness - Unknown	
555,512	Slight	87,801	25,392	7,512	2,328	✓
	Serious	14,044	4,942	1,462	453	✓
	Fatal	971	480	142	44	✓

Figure 32: Lighting accident data entry

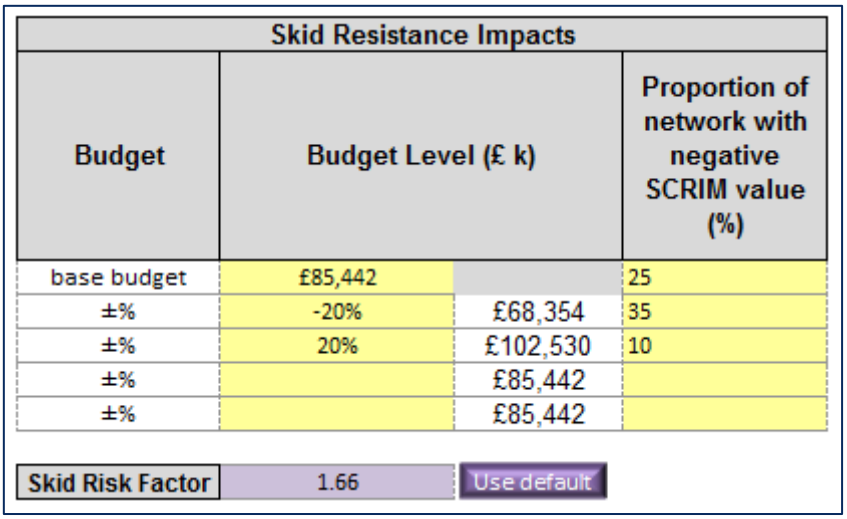
The breakdown of the lighting related accidents must sum to the 'Number of Accidents' entered in Figure 31. A tick at the end of row shows that the breakdown of the accident records sum to the correct total. If a cross is shown, the data needs to be modified.

3.8.3 Skid related accidents

Enter the budget used to treat skid accidents and a related proportion of the network that has negative SCRIM associated with that budget (see Figure 33). This data should be associated with the accident records entered in Figure 31.

Up to four deviations from the base budget can be entered which must be between ±999%. For each budget deviation enter the associated proportion of the network with negative SCRIM deficiency (i.e. SCRIM value below the Investigatory Level).

A 'Skid Risk Factor' can be entered or HMAT has a default value which can be used.



Skid Resistance Impacts			
Budget	Budget Level (£ k)		Proportion of network with negative SCRIM value (%)
base budget	£85,442		25
±%	-20%	£68,354	35
±%	20%	£102,530	10
±%		£85,442	
±%		£85,442	
Skid Risk Factor	1.66	Use default	

Figure 33: Skid Resistance accident data entry

A graph is displayed to show the change in the proportion of the network with negative SCRIM deficiency for the changes in the budget.

3.9 Job Impacts

The 'Job Impacts' worksheet is to input the data used to calculate the job impacts associated with changes in the maintenance budget and requires:

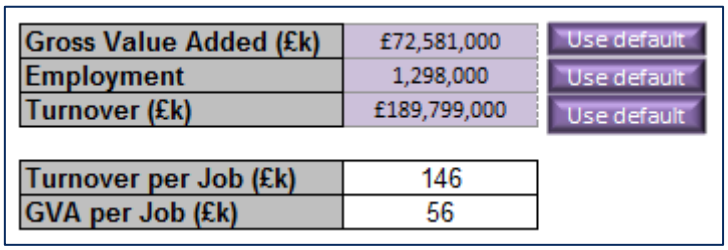
- Job employment related data.

The job employment data is used to calculate the job impacts for each year of the analysis based on the output maintenance budget for each year.

Data to enter for the road maintenance sector is:

- Gross Value Added (£k).
- Employment.
- Turnover (£k).

Values can be entered for each data item or default values can be used (see Figure 34).



Gross Value Added (£k)	£72,581,000	Use default
Employment	1,298,000	Use default
Turnover (£k)	£189,799,000	Use default

Turnover per Job (£k)	146
GVA per Job (£k)	56

Figure 34: Job impacts data entry

The entered values are used to calculate:

- Turnover per job (£k).
- Gross Value Added per job (£k).

These are used with the output maintenance budget to calculate the job impacts for each year of the analysis:

- Total jobs.
- Gross Value Added (£k).

4 Run analysis

Running an analysis is controlled through the 'Run Analysis' tab. There are two ways to run an analysis:

1. Run all calculation processes as one process after completing pre-analysis steps; or
2. Run the separate processes individually.

Whichever method is selected the user must complete the same first four pre-analysis steps in order to calculate budgets and check the setup of the run before the main calculations are performed.

The outputs created are the same with both methods (if the same data is used). Note, if the Separate Runs option is used, then all the Run options on the worksheet on which data was changed, through to the end of the analysis process (i.e. the 'Job Impacts' worksheet) must be run.

4.1 Initial calculations steps

The 'Run Analysis' tab lists four pre-analysis steps that are required to be completed or checked in advance of undertaking any analysis:

1. Calculate the budget splits;
2. Transfer any required budgets into the HMEP budgets tab;
3. Setup any required performance targets; and
4. Setup the analysis.

4.1.1 Calculate budget splits

On the 'Activity Budgets' worksheet the total budget defined by the user for each year is transformed into four different budget splits (see Figure 36):

1. By activity type.
2. By condition analysis.
3. By asset driver.
4. By road type and treatment.

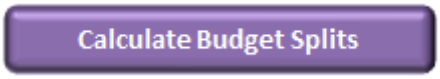


Figure 35: 'Calculate Budgets' option

Calculate the four budget splits after entering the budget data in the 'Activity Budgets' tab and the various breakdowns in the 'Activity Allocation' tab. The budget splits show the budgets categorised by each of the four different breakdowns. The budget splits are also used in the interpretation of some of the results of the analysis.

4.1.2 Transfer any required budgets

If the analysis requires any budget constraints the relevant budgets (specified by road type and treatment type) must be transferred from those calculated in the 'Activity Budgets' tab (from the bottom) table into the HMEP budgets tab '5 – Budgets'.

For each year in which there is a different budget by road type and treatment type, the HMEP Toolkit requires a separate budget to be defined on the tab '5 – Budgets'. Therefore the user should review the budgets by road type and treatment type in the 'Activity Budgets' tab and transfer the relevant budgets to tab '5 – Budgets', giving each a unique label which is then referenced in the '7 – Scenario' tab of the HMEP Toolkit (see Section 3.4 of the HMEP User Guidance for Lifecycle Planning Toolkit for further guidance).

4.1.3 Set any required performance targets

If the analysis requires any performance targets then they must be specified in the HMEP tab '6 – Performance Targets' before setting up the scenario.

4.1.4 Setup the analysis scenario

Prior to starting the main analysis, the user must have correctly setup the analysis in the HMEP tab '7 – Scenario' tab. Further guidance on this can be found in the HMEP User Guidance for Lifecycle Planning Toolkit.

4.2 Running an analysis using the single run button

After populating all the data entry cells for all the worksheets in the tool and completing the pre-analysis steps the analysis can be run for all the processes using 'Run Highways Appraisal Tool' on the 'Run Analysis' worksheet (see Figure 36). This initiates the data checking, data validation and calculation stages described in Section 4.3.

Figure 36: 'Run Highways Maintenance Appraisal Tool' button

4.2.1 Data warnings

When the 'Run Analysis' option is used to complete an analysis, any data population or validation warnings will be displayed. The message highlights which data needs to be corrected (e.g. see Figure 37).

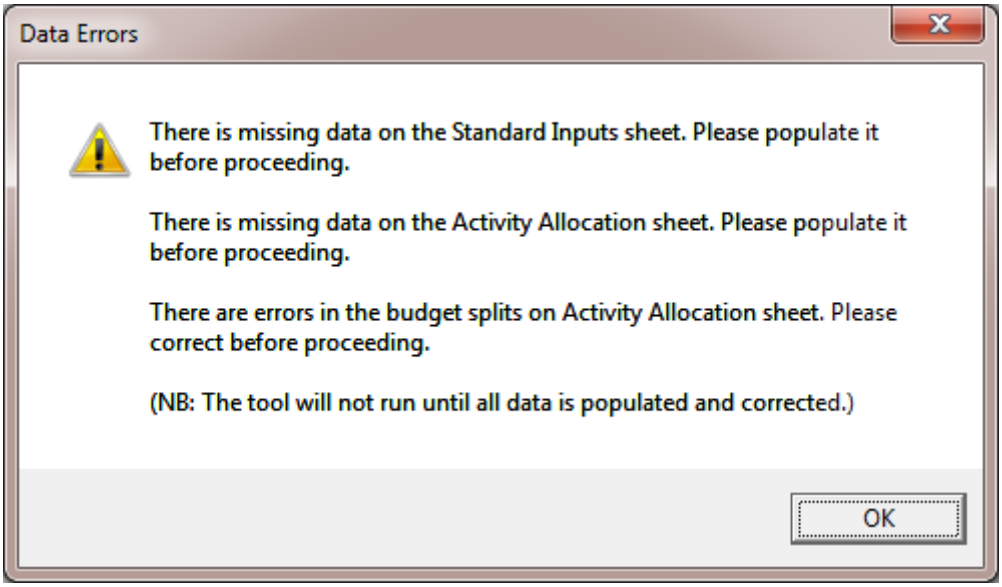


Figure 37: Data warning example

4.3 Running analysis using individual processes

For each individual module in the tool there are specific options in each module to run calculations related to that module. The calculations should be undertaken in the order in which they are listed (i.e. the same as the order of the tabs in the tool) and will result in a full data analysis being completed following completion of the Job Impacts calculations.

4.3.1 Run HMEP Condition Analysis

The condition projection calculations use the existing HMEP Toolkit and logic (see Figure 38). The works quantity and resulting condition predicted in the analysis are used as input data into the modules that follow.

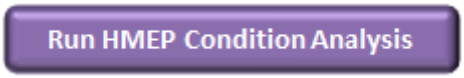


Figure 38: 'Run HMEP Condition Analysis' button

Following this process the output budgets from the HMEP projections are entered into the 'Budget Split by Condition Analysis' table on the 'Budgets' worksheet. The output budgets show any differences between the input and output budgets (i.e. the tool will not necessarily spend all the available budget if there is not enough network in a condition that requires maintenance).

4.3.2 Calculate Projected Traffic

The projected traffic for each specified vehicle classification (i.e. Cars, LGV, OGV1, OGV2, PSV) for each year of the analysis are created by selecting 'Calculate Projected Traffic' (see Figure 39) and the 'Projected Traffic' results worksheet is populated:

Figure 39: 'Calculate Projected Traffic' button

4.3.3 Calculate Treatment Impacts

Selecting 'Calculate Treatment Impacts' (see Figure 40) populates the following results worksheets, using the HMEP calculated works quantity as the input data:

- 'Scheme Analysis'.
- 'Road Works Impacts Time'.
- 'Road Works Impacts Carbon'.
- 'Road Works Impacts Accidents'.
- 'Material Carbon Quantity'.
- 'Material Carbon cost'.

Figure 40: 'Calculate Treatment Impacts' option

4.3.4 Calculate IRI

'Calculate IRI' (see Figure 41) populates:

- 'IRI Table'.
- 'IRI Lengths'.

These show the percentage of each road type length in each IRI band.

Figure 41: 'Calculate IRI' button

4.3.5 Calculate VOCs

After populating the 'CO_2 produced by vehicle engine' inputs for petrol, diesel and electric engines, the VOCs for each road type for each year of the analysis can be calculated by 'Calculate VOCs' (see Figure 42) and the 'Road Condition Impacts Output' results worksheet is populated.

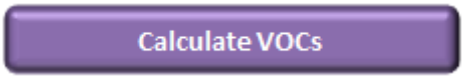


Figure 42: 'Calculate VOCs' button

4.3.6 Calculate Accident Forecast

After populating the accident data on the 'Accidents' worksheet the change in accidents over the analysis period and the associated cost for each year of the analysis can be calculated by the 'Calculate Accident Forecast' option (see Figure 43) and the 'Accident Analysis' results worksheet is populated.

Figure 43: 'Calculate Accident Forecast' button

4.3.7 Calculate Job Impacts

After populating the job impacts data the job impacts for each year of the analysis can be calculated by 'Calculate Job Impacts' (see Figure 44) and the 'Job Impacts' worksheet is populated.

Figure 44: 'Calculate Job Impacts' button

4.3.8 Page specific data warnings

After selecting the page specific operations, if there are any data population or validation warnings a message specific to the operation will be displayed (e.g. see Figure 45).

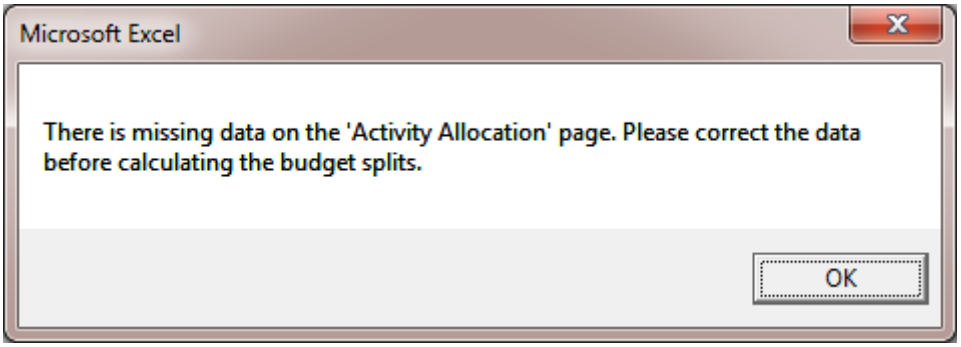


Figure 45: Example of individual data warning

4.4 Example run times

As per the guidance for the HMEP Toolkit, the duration of a run depends on different factors used for the analysis (e.g. number of road types, number of condition bands, treatment types) in addition to the specification of the computer used. Example run times for an HMAT analysis that used 10 road types, 6 treatments types and 5 condition bands over different analysis periods are:

- 60 year analysis period: 70 minutes.
- 30 year analysis period: 34 minutes.
- 10 year analysis period: 13 minutes.

5 Outputs

The following outputs are available from HMAT (orange tabs in the tool):

- 'Projected Traffic'.
- 'Scheme Analysis'.
- 'Road Works Impacts Time'.
- 'Road Works Impacts Carbon'.
- 'Road Works Impacts Accidents'.
- 'Material Carbon Quantity'.
- 'Material Carbon cost'.
- 'IRI Table'.
- 'IRI Lengths'.
- 'Road Condition Impacts Output'.
- 'Accident Analysis'.
- 'Job Impacts'.
- 'Analysis Graphs'.

In addition, outputs from the HMEP functionality are also available to view (yellow tabs in HMAT):

- 'Condition by Year'.
- 'Condition Graph'.
- 'Work Quantity'.
- 'Work Qty Graph'.
- 'Exp by Condition Band'.
- 'Exp by Cond Graph'.
- 'Exp by Treatment'.
- 'Exp by Treat Graph'.
- 'Area by Year'.

The HMAT specific outputs are described in the following sections. For information on the HMEP outputs please refer to the HMEP User Guidance for Lifecycle Planning Toolkit in the section 'ANALYSING OUTPUTS'.

5.1 Projected Traffic

The 'Projected Traffic' output shows the traffic flow for all years of the analysis period. An example output is shown in Figure 46 for two road types for five years.

Traffic Data - annual thousand veh km

No.	Road Type	Vehicle	2014	2015	2016	2017	2018
1	AR	Cars	55,899,370	56,318,615	56,741,005	57,705,602	58,686,597
2	AR	LGV	9,663,396	9,791,919	9,922,152	10,194,019	10,473,335
3	AR	OGV1	1,959,038	1,941,407	1,923,934	1,944,713	1,965,716
4	AR	OGV2	1,418,614	1,405,846	1,393,194	1,408,240	1,423,449
5	AR	PSV	466,001	470,148	474,333	474,333	474,333
6	AU	Cars	41,686,604	41,999,254	42,314,248	43,033,590	43,765,161
7	AU	LGV	6,261,581	6,344,860	6,429,247	6,605,408	6,786,396
8	AU	OGV1	932,935	924,538	916,217	926,112	936,114
9	AU	OGV2	419,144	415,372	411,634	416,079	420,573
10	AU	PSV	626,569	632,145	637,772	637,772	637,772

Figure 46: Projected traffic output

5.2 Scheme Analysis

The 'Scheme Analysis' output shows the number of maintenance schemes predicted for each road and treatment type for each year of the analysis. An example output is shown in Figure 47 for two road types for five years for an analysis using six types of maintenance treatments.

Scheme Analysis - no. schemes

No.	Road Type	Treatment	2014	2015	2016	2017	2018
1	AR	Surface Dressing	1,303	740	541	478	465
1	AR	Micro Asphalt	1,303	740	541	478	465
1	AR	Moderate Overlay	954	608	372	243	179
1	AR	Moderate Inlay	954	608	372	243	179
1	AR	Deep Inlay	382	423	380	308	238
1	AR	Reconstruction	81	135	186	219	231
2	AU	Surface Dressing	505	311	231	201	191
2	AU	Micro Asphalt	505	311	231	201	191
2	AU	Moderate Overlay	382	235	144	93	65
2	AU	Moderate Inlay	382	235	144	93	65
2	AU	Deep Inlay	220	199	167	133	104
2	AU	Reconstruction	53	66	74	77	75

Figure 47: Scheme analysis output

5.3 Road Works Impacts Time

The 'Road Works Impacts Time' output shows the user delay time costs from the predicted maintenance for each road and treatment type for each year of the analysis. An example output is shown in Figure 48 for two road types for five years for an analysis using six types of maintenance treatments.

Road Works - Time (£k)

No.	Road Type	Treatment	2014	2015	2016	2017	2018
1	AR	Surface Dressing	2,728	1,560	1,149	1,034	1,023
1	AR	Micro Asphalt	3,707	2,120	1,561	1,405	1,390
1	AR	Moderate Overlay	4,635	2,976	1,836	1,218	915
1	AR	Moderate Inlay	3,320	2,132	1,315	872	656
1	AR	Deep Inlay	1,713	1,912	1,730	1,425	1,122
1	AR	Reconstruction	649	1,093	1,515	1,812	1,951
2	AU	Surface Dressing	4,764	2,959	2,214	1,953	1,891
2	AU	Micro Asphalt	5,684	3,531	2,642	2,330	2,256
2	AU	Moderate Overlay	7,912	4,903	3,040	1,989	1,417
2	AU	Moderate Inlay	5,483	3,397	2,106	1,378	982
2	AU	Deep Inlay	4,365	3,986	3,366	2,737	2,169
2	AU	Reconstruction	1,858	2,313	2,609	2,756	2,757

Figure 48: Road works impacts (time) output

5.4 Road Works Impacts Carbon

The 'Road Works Impacts Carbon' output shows the carbon costs due to vehicle CO_2 emissions from the predicted maintenance for each road and treatment type for each year of the analysis. An example output is shown in Figure 49 for two road types for five years for an analysis using six types of maintenance treatments.

Road Works - Carbon (£k)

No.	Road Type	Treatment	2014	2015	2016	2017	2018
1	AR	Surface Dressing	23	13	10	9	9
1	AR	Micro Asphalt	31	18	13	12	12
1	AR	Moderate Overlay	39	25	16	10	8
1	AR	Moderate Inlay	28	18	11	7	6
1	AR	Deep Inlay	15	16	15	12	10
1	AR	Reconstruction	6	9	13	15	17
2	AU	Surface Dressing	51	32	24	21	20
2	AU	Micro Asphalt	61	38	28	25	24
2	AU	Moderate Overlay	84	52	32	21	15
2	AU	Moderate Inlay	59	36	22	15	11
2	AU	Deep Inlay	47	43	36	29	23
2	AU	Reconstruction	20	25	28	29	30

Figure 49: Road works impacts (carbon) output

5.5 Road Works Impacts Accidents

The 'Road Works Impacts Accidents' output shows the road works traffic accident costs from the predicted maintenance for each road and treatment type for each year of the analysis. An example output is shown in Figure 50 for two road types for five years for an analysis using six types of maintenance treatments.

Road Works - Accidents (£k)

No.	Road Type	Treatment	2014	2015	2016	2017	2018
1	AR	Surface Dressing	2,198	1,257	926	834	825
1	AR	Micro Asphalt	2,987	1,708	1,258	1,133	1,121
1	AR	Moderate Overlay	3,734	2,398	1,479	982	738
1	AR	Moderate Inlay	2,675	1,718	1,060	703	529
1	AR	Deep Inlay	1,380	1,540	1,394	1,149	905
1	AR	Reconstruction	523	881	1,221	1,460	1,574
2	AU	Surface Dressing	1,998	1,241	928	820	795
2	AU	Micro Asphalt	2,384	1,481	1,108	978	948
2	AU	Moderate Overlay	3,318	2,056	1,274	835	596
2	AU	Moderate Inlay	2,299	1,425	883	579	413
2	AU	Deep Inlay	1,830	1,671	1,411	1,149	911
2	AU	Reconstruction	779	970	1,094	1,157	1,159

Figure 50: Road works impacts (accidents) output

5.6 Material Carbon Quantity

The 'Material Carbon Quantity' output shows the embodied carbon quantity from the predicted maintenance for each road and treatment type for each year of the analysis. An example output is shown in Figure 51 for two road types across five years for an analysis using six types of maintenance treatments.

Embodied Carbon - tonnes CO2e

No.	Road Type	Treatment	2014	2015	2016	2017	2018
1	AR	Surface Dressing	4,573	2,596	1,897	1,678	1,631
1	AR	Micro Asphalt	18,394	10,442	7,631	6,751	6,560
1	AR	Moderate Overlay	23,393	14,909	9,129	5,950	4,395
1	AR	Moderate Inlay	36,039	22,967	14,063	9,166	6,770
1	AR	Deep Inlay	29,795	32,997	29,639	23,997	18,568
1	AR	Reconstruction	9,452	15,800	21,732	25,540	27,030
2	AU	Surface Dressing	1,773	1,093	811	704	670
2	AU	Micro Asphalt	7,132	4,396	3,263	2,831	2,696
2	AU	Moderate Overlay	9,362	5,756	3,541	2,278	1,597
2	AU	Moderate Inlay	14,422	8,867	5,455	3,510	2,460
2	AU	Deep Inlay	17,137	15,526	13,010	10,406	8,108
2	AU	Reconstruction	6,229	7,692	8,608	8,943	8,800

Figure 51: Material carbon quantity output

5.7 Material Carbon Cost

The 'Material Carbon Cost' output shows the embodied carbon cost from the predicted maintenance for each road and treatment type for each year of the analysis. An example output is shown in Figure 52 for two road types for five years for an analysis using six types of maintenance treatments.

Embodied Carbon - £k

No.	Road Type	Treatment	2014	2015	2016	2017	2018
	1 AR	Surface Dressing	262,667	151,350	112,273	100,809	99,434
	1 AR	Micro Asphalt	1,056,504	608,762	451,587	405,476	399,946
	1 AR	Moderate Overlay	1,343,686	869,179	540,200	357,359	267,917
	1 AR	Moderate Inlay	2,070,002	1,339,006	832,200	550,527	412,737
	1 AR	Deep Inlay	1,711,393	1,923,716	1,753,905	1,441,315	1,131,942
	1 AR	Reconstruction	542,898	921,119	1,285,961	1,533,991	1,647,847
	2 AU	Surface Dressing	101,845	63,718	48,008	42,276	40,855
	2 AU	Micro Asphalt	409,643	256,286	193,097	170,044	164,328
	2 AU	Moderate Overlay	537,735	335,560	209,518	136,839	97,367
	2 AU	Moderate Inlay	828,403	516,944	322,770	210,806	149,998
	2 AU	Deep Inlay	984,343	905,160	769,876	624,981	494,287
	2 AU	Reconstruction	357,793	448,470	509,394	537,158	536,453

Figure 52: Material carbon cost output

5.8 IRI Table

The 'IRI Table' output shows the proportion of each road type that falls into each IRI band for each year of the analysis. An example output is shown in Figure 53 for two road types for five years for an analysis using 11 bands of IRI values.

IRI Distribution

Asset Group	IRI	2014	2015	2016	2017	2018
AR	0-1	1.05%	1.29%	1.45%	1.55%	1.62%
	1-2	25.64%	30.94%	34.14%	36.12%	37.39%
	2-3	34.03%	34.26%	34.99%	35.71%	36.31%
	3-4	17.85%	14.57%	12.99%	12.23%	11.86%
	4-5	9.26%	6.93%	5.54%	4.75%	4.29%
	5-6	5.11%	4.25%	3.48%	2.94%	2.60%
	6-7	2.64%	2.38%	1.95%	1.59%	1.33%
	7-8	1.55%	1.59%	1.39%	1.17%	0.97%
	8-9	0.93%	1.05%	1.01%	0.91%	0.79%
	9-10	0.73%	0.88%	0.88%	0.81%	0.71%
	10+	1.21%	1.84%	2.18%	2.24%	2.12%
AU	0-1	0.27%	0.51%	0.65%	0.73%	0.77%
	1-2	16.15%	22.41%	26.05%	28.23%	29.27%
	2-3	28.58%	32.10%	34.40%	35.94%	36.69%
	3-4	19.59%	17.41%	16.40%	15.95%	15.75%
	4-5	12.26%	9.60%	8.17%	7.38%	7.00%
	5-6	7.52%	5.42%	4.17%	3.42%	3.05%
	6-7	4.70%	3.38%	2.50%	1.92%	1.63%
	7-8	3.12%	2.37%	1.81%	1.41%	1.20%
	8-9	2.43%	1.93%	1.54%	1.24%	1.09%
	9-10	1.84%	1.49%	1.22%	1.00%	0.90%
	10+	3.54%	3.38%	3.10%	2.77%	2.67%

Figure 53: IRI table output

5.9 IRI Lengths

The 'IRI Lengths' output shows the length (carriageway km) of each road type that falls into each IRI band for each year of the analysis. An example output is shown in Figure 54 for two road types for five years for an analysis using 11 bands of IRI values.

IRI Lengths - km

Asset Group	IRI	2014	2015	2016	2017	2018
AR	0-1	196.3815	240.7218	270.7389	290.2268	303.0514
	1-2	4795.449	5787.416	6386.035	6754.613	6993.081
	2-3	6364.631	6408.566	6543.569	6678.297	6791.434
	3-4	3338.486	2725.241	2429.099	2287.367	2218.804
	4-5	1731.898	1296.249	1035.428	887.5482	803.2834
	5-6	955.7233	795.7326	651.0559	550.8029	485.824
	6-7	493.7592	444.705	364.9515	297.8477	248.2744
	7-8	289.8965	298.0375	260.3194	218.0501	182.2957
	8-9	173.9379	196.9314	188.7005	169.3579	148.1607
	9-10	136.5319	165.0846	165.0556	150.7493	132.1353
	10+	226.3063	344.3155	408.0482	418.1393	396.656
AU	0-1	20.8629	39.74382	50.29269	56.38506	60.06791
	1-2	1247.911	1731.674	2012.581	2181.257	2287.226
	2-3	2208.377	2480.711	2658.429	2777.293	2859.507
	3-4	1513.719	1344.91	1267.053	1232.796	1219.057
	4-5	947.3302	741.8659	631.0377	570.3221	536.1236
	5-6	581.0704	419.0432	322.5001	264.3565	228.4155
	6-7	363.169	260.9165	192.8643	148.3482	118.9591
	7-8	241.0824	183.2035	139.8327	108.9202	87.10484
	8-9	187.7661	148.8562	118.7159	95.93013	78.74619
	9-10	142.1768	115.0357	94.04092	77.64922	64.77388
	10+	273.5358	261.0402	239.6528	213.7417	187.0181

Figure 54: IRI length output

5.10 Road Condition Impacts Output

The 'Road Condition Impacts Output' shows the vehicle operating costs, journey time and carbon (from fuel use) as a result of the carriageway condition. The results are displayed for each type of impact for all years of the analysis. An example output is shown in Figure 55 for two road types for five years.

VOC costs - £ k

Road Type	Category	2014	2015	2016	2017	2018
AR	VOC	29,040,923	29,186,414	29,423,645	30,026,690	30,635,431
AR	Value of Time	10,184,248	10,450,815	10,728,518	11,112,969	11,503,516
AR	Carbon (from fuel)	1,150,412	1,137,006	1,116,785	1,111,305	1,106,470
AU	VOC	19,668,815	19,595,519	19,686,391	20,052,879	20,480,297
AU	Value of Time	13,594,873	13,897,748	14,267,054	14,793,487	15,346,347
AU	Carbon (from fuel)	582,208	575,024	563,537	558,862	554,765

Figure 55: Road condition impacts output

5.11 Accident Analysis

The 'Accident Analysis' output shows the number of lighting and skid related accidents predicted for all years of the analysis period, together with a summation of the total accidents. An example output is shown in Figure 56 for five years. The tool does not show a breakdown of the accidents by road type in the outputs.

	Category	2014	2015	2016	2017	2018
Lighting	Lighting Budget (£ k)	£555,512.063	£555,512.063	£555,512.063	£555,512.063	£555,512.063
	Slight Accidents	123033	123033	123033	123033	123033
	Slight Accidents Change	0	0	0	0	0
	Slight Change Costs (£ k)	£0	£0	£0	£0	£0
	Serious Accidents	20901	20901	20901	20901	20901
	Serious Accidents Change	0	0	0	0	0
	Serious Change Costs (£ k)	£0	£0	£0	£0	£0
	Fatal Accidents	1637	1637	1637	1637	1637
	Fatal Accidents Change	0	0	0	0	0
	Fatal Change Costs (£ k)	£0	£0	£0	£0	£0
Skid	Resurfacing Budget (£ k)	£46,292.672	£46,292.672	£46,292.672	£46,292.672	£46,292.672
	Slight Accidents	123,033	123,033	123,033	123,033	123,033
	Slight Accidents Change	0	0	0	0	0
	Slight Change Costs (£ k)	£0	£0	£0	£0	£0
	Serious Accidents	20,901	20,901	20,901	20,901	20,901
	Serious Accidents Change	0	0	0	0	0
	Serious Change Costs (£ k)	£0	£0	£0	£0	£0
	Fatal Accidents	1,637	1,637	1,637	1,637	1,637
	Fatal Accidents Change	0	0	0	0	0
	Fatal Change Costs (£ k)	£0	£0	£0	£0	£0
Totals	Total Slight Accident Change	0	0	0	0	0
	Total Slight Change Cost (£ k)	£0	£0	£0	£0	£0
	Total Serious Accident Change	0	0	0	0	0
	Total Serious Change Cost (£ k)	£0	£0	£0	£0	£0
	Total Fatal Accident Change	0	0	0	0	0
	Total Fatal Change Cost (£ k)	£0	£0	£0	£0	£0
	Total Accident Change Cost (£ k)	£0	£0	£0	£0	£0
	Total Accidents	145,571	145,571	145,571	145,571	145,571
	Total Accident Costs (£k)	£10,228,264	£10,228,264	£10,228,264	£10,228,264	£10,228,264

Figure 56: Accident analysis output

5.12 Job Impacts

The 'Job Impacts' output shows the job impacts (i.e. Total number of jobs and GVA) predicted for all years of the analysis. An example output is shown in Figure 57 for five years

Category	2014	2015	2016	2017	2018
Budget (£k)	4,884,811	4,212,393	3,815,706	3,503,963	3,142,753
Total Jobs	33,406	28,808	26,095	23,963	21,493
GVA (£k)	1,868,000	1,610,861	1,459,163	1,339,950	1,201,819

Figure 57: Job Impacts output

5.13 Analysis Graphs

The 'Analysis Graphs' worksheet enables any of the tabular data (described in Section 5.1 to Section 5.12) to be displayed in a chart and enables the displayed data to be customised in specific formats. Figure 58 shows an example of a graph for the impacts of time delays due to roadworks (£k).

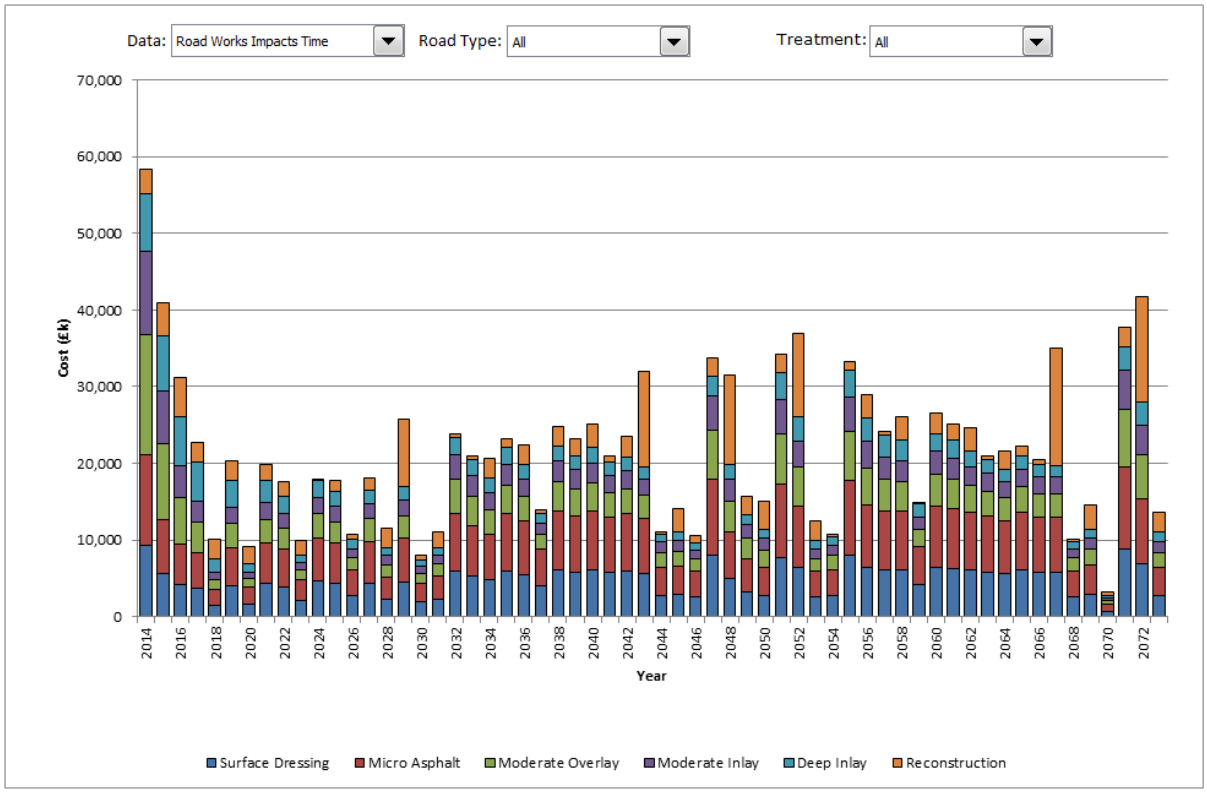


Figure 58: Projected traffic graph

The variables to be shown in the graphs can be selected (see Figure 59) and can be displayed by road type and treatment type, by vehicle type (for traffic reports) or category of vehicle operating costs (for 'Road Condition Impacts').

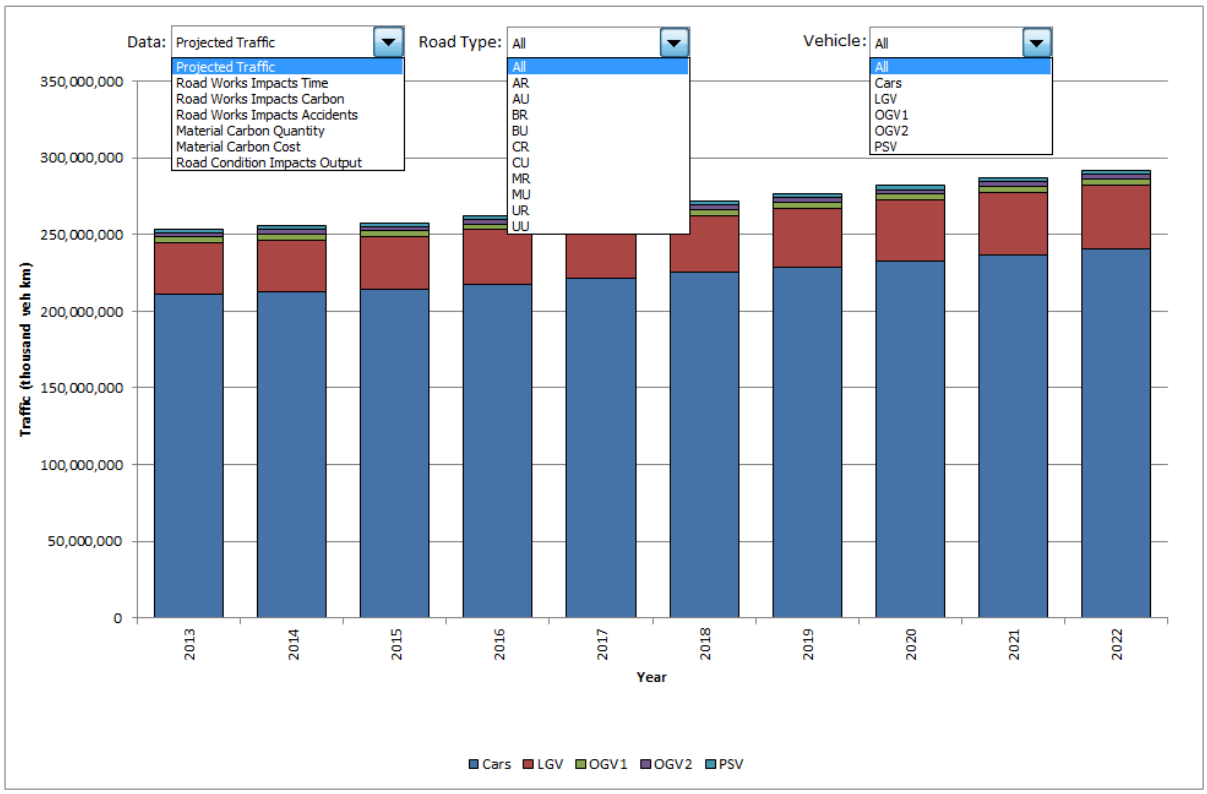


Figure 59: Graph data selection options for the traffic report

6 Aggregated outputs module

The Aggregated Output Module (AOM) is a stand-alone tool designed to allow the user to import data from multiple HMAT analyses. This module provides an easy to use tool for displaying the differences between various analyses.

6.1 Running AOM

The AOM tool is run independently of HMAT but can be accessed from HMAT by selecting the "Multiple Scenario Reviewer" on the front page (see Figure 2). Note that if this is the first time that the AOM is opened from HMAT, the directory location for the AOM specific to the computer will need to be set.

After the AOM has been opened, an option for "Open Analysis Folder" (see Figure 60) is displayed.

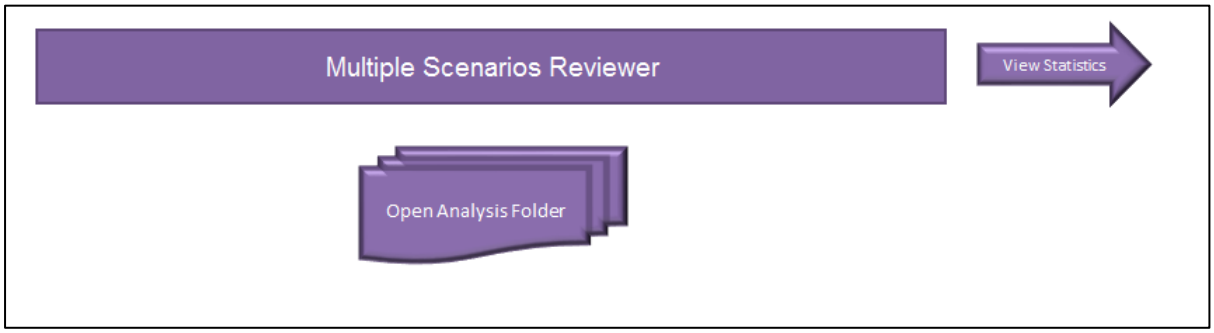


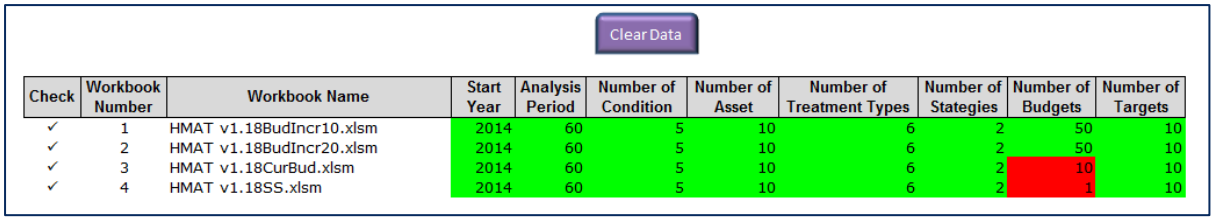
Figure 60: The Front screen of AOM

AOM can be used to show the results from up to 10 analyses held in a specified folder. Note that results from the HMAT analyses should be stored in a *single folder location that does not contain any other files*; otherwise there is a chance that the AOM may attempt to read data from other files that may not be in the correct format.

When the data has been imported into AOM the rest of the module will be populated. Each analysis will be shown within the Statistics worksheet along with the initial setup values for each analysis. To compare analyses the AOM checks the initial setup for each analysis imported. Any outlying values are coloured red, otherwise the data will appear green (see Figure 61).

A red value in any analysis does not exclude that analysis from the comparison, but highlights potential conflicts. Some analyses may highlight red cells that prevent comparison of different analyses for legitimate reasons. For example, a condition target analysis does not require any budgets to be specified because the tool determines the budget required to meet the given condition. Therefore, when compared against a run with multiple budgets (e.g. comparing a steady state condition against a constant budget) the number of budgets would be flagged as red in the statistics page between the analyses. In that case the user should know that that is an acceptable difference between the analyses.

However, if one analysis is flagged red for the analysis period because that was different to all the other scenarios then the results for these analyses may not be comparable. This may be due to an error in input data and should be checked.



Check	Workbook Number	Workbook Name	Start Year	Analysis Period	Number of Condition	Number of Asset	Number of Treatment Types	Number of Stategies	Number of Budgets	Number of Targets
✓	1	HMAT v1.18BudIncr10.xlsm	2014	60	5	10	6	2	50	10
✓	2	HMAT v1.18BudIncr20.xlsm	2014	60	5	10	6	2	50	10
✓	3	HMAT v1.18CurBud.xlsm	2014	60	5	10	6	2	10	10
✓	4	HMAT v1.18SS.xlsm	2014	60	5	10	6	2	1	10

Figure 61: AOM Statistics Page populated with a Scheme

6.2 AOM quantitative comparison

For each analysis imported into the AOM there are associated quantitative results (see Figure 62). These results show the totals calculated from modules contained within HMAT. Each analysis is labelled as a 'scenario' on this worksheet and a specific base-case can be specified against which all the other displayed scenarios will be compared. All other results within the quantitative data worksheet will be referenced to the base case.

To change the base-scenario highlight the scenario name and "Select Base" button. All other values held in the other scenarios will change automatically when the base case is changed.

To change the cost basis from 'Discounted' costs to 'Undiscounted' costs (or vice-versa) select the required label in the 'Cost Basis' dropdown box at the top of the worksheet.

Select Base

Cost Basis: Discounted

	Scenario (Base)	Scenario	Scenario	Scenario
	1. 10% Incr y1-10; same total	2. 20% Incr y1-10; same t	3. Current Budget 60y	4. Steady State 60yrs
Direct Costs (Outturn)				
Carriageway Output (£k)	**14,270,360**	+365,893	-431,769	-397,921
Skid (£k)	**1,275,612**	+57,627	-59,809	-59,809
Lighting (£k)	**14,890,514**	+236,621	-300,882	-300,882
Other (£k)	**55,768,935**	+928,816	-1,057,817	-1,057,817
Total (Outturn) Direct Costs	**86,205,420**	**+1,588,958**	**-1,850,278**	**-1,816,430**
Direct Costs (Allocated) categorised by maintenance drivers				
Safety (£k)	**32,574,129**	+1,033,696	-1,024,051	-1,024,051
Accessibility (£k)	**2,124,857**	+70,564	-57,993	-57,993
Condition (£k)	**32,766,292**	+688,355	-608,313	-608,313
Reliability (£k)	**9,412,346**	+205,340	-172,246	-172,246
Customer Service (£k)	**28,123,497**	+508,547	-524,777	-524,777
Environment (£k)	**19,199,051**	+190,299	-232,531	-232,531
Total Direct (Allocated) Costs	**124,200,172**	**+2,696,802**	**-2,619,911**	**-2,619,911**
Indirect Costs				
Road Condition Impacts				
VOC (£k)	**3,535,252,244**	-6,908,636	+8,371,636	+40,041,406
Value of Time (£k)	**2,785,766,500**	-2,979,016	+3,655,586	+13,891,432
Carbon (from fuel) (£k)	**172,770,820**	+28,983	-37,060	+43,400
Road Works Impacts				
Accidents (£k)	**344,882**	+2,237	-2,886	-26,574
Carbon (from fuel) (£k)	**6,574**	+15	-23	-568
Time (£k)	**617,420**	+1,691	-2,433	-53,377
Accident Impacts				
Total Number of Accidents	**8,734,260**	0	0	0
Total Accident Cost (£k)	**268,628,934**	0	0	0
Carbon Impacts (embodied)				
Carbon Quantity (tonnes CO2e)	**11,816,830**	-80,794	-18,282	+1,868,739
Carbon Cost (£k)	**647,133**	-3,344	-484	+120,415
Indirect Benefits				
Job Impacts				
Jobs	**1,272,025**	+7,971	-10,958	-10,051
GVA (£k)	**32,477,992**	+585,596	-684,693	-671,749
Total Indirect Costs[1]				
Excluding Carbon Impacts (Carbon Cost) and Job Impacts (GVA)				
Total (£k)	**6,763,387,374**	**-9,854,726**	**11,984,821**	**+53,895,719**
Including Carbon Impacts (Carbon Cost) and Job Impacts (GVA)				
Total (£k)	**6,731,556,516**	**-10,443,666**	**12,669,031**	**+54,687,883**
Economic analysis (excl. Carbon Impacts and Job Impacts)				
Works costs change	**Base**	**+1,588,958**	**-1,850,278**	**-1,816,430**
Non-works costs change	**Base**	**-9,854,726**	**+11,984,821**	**+53,895,719**
Net Present Value[2]	**Base**	**+8,265,768**	**-10,134,544**	**-52,079,289**
Economic analysis (incl. Carbon Impacts and Job Impacts)				
Works costs change	**Base**	**+1,588,958**	**-1,850,278**	**-1,816,430**
Non-works costs change	**Base**	**-10,443,666**	**+12,669,031**	**+54,687,883**
Net Present Value[2]	**Base**	**+8,854,708**	**-10,818,753**	**-52,871,453**

Figure 62: Quantitative results from an analysis

6.3 AOM qualitative comparison

The AOM also generates a qualitative report. This report follows the standard DfT format for a qualitative report and specifies what data read in from an HMAT analysis might be relevant to each impact (see Figure 63). The 'Advice Notes' provide guidance for assessing differences in the qualitative impacts between the scenarios.

Impacts		Summary of key impacts	Advice Notes
Economy	Business users & transport providers	Scenario 1 has lowest costs for value of time impacts; Scenario 2 is worst.	Use value of time changes to inform impact.
	Reliability impact on Business users	Scenario 1 has lowest costs for value of time impacts; Scenario 2 is worst.	If there is a reduction in the value of time it can be used as a proxy for an improvement in the reliability of the route.
	Regeneration	Not Applicable.	Only considered if within one or more regenration areas. More applicable for localised analyses rather than national.
	Wider Impacts	Scenario 1 has lowest costs for wider impacts; Scenario 2 is worst.	Use comparison of total indirect costs to inform impact.
Environmental	Noise	Limited impact - same proprotions and spends of treatments resulted from all analyses therefore minimal impact on road surface noise change.	Any known changes in noise levels as a result of the maintenance. Splits of different treatment types could be used as a starting proxy.
	Air Quality	Scenario 3 has lowest impact from road condition (with little difference with scenario 1). Scenario 2 is worst case. Neglibile difference between all analyses for road works impacts.	Use differences in 'Carbon (from fuel)' from both road condition impacts and road works impacts
	Greenhouse gases	Carbon quantity is lowest for scenario 3.	Change in carbon impacts over the analysis period.
	Landscape	Not Applicable.	Are there differences between the networks analysed?
	Townscape	Not Applicable.	Are there differences between the networks analysed?
	Historic Environment	Not Applicable.	Are there differences between the networks analysed?
	Biodiversity	Scenario 3 has greatest impact due to more upfront spending in initial years.	Relate to spend on environment driver.
	Water Environment	Scenario 3 has greatest impact due to more upfront spending in initial years.	Relate to spend on environment driver.
Social	Commuting and Other users		
	Reliability impact on Commuting and Other users		
	Physical activity		
	Journey quality		
	Accidents	Not Applicable.	Changes in the number of accidents.
	Security	Scenario 3 has greatest impact due to more upfront spending in initial years.	Relate to spend on accessibility and customer service driver.
	Access to services		
	Affordability		
	Severance	Scenario 3 has greatest impact due to more upfront spending in initial years.	Relate to spend on accessibility driver.
	Option and non-use values	Not Applicable.	Are there effects on other transport modes?
Public Accounts	Cost to Broad Transport Budget	Scenario 3 has the least direct costs, scenario 2 has the greatest direct costs.	Changes in the total direct costs.
	Indirect Tax Revenues	Not Applicable.	Not applicable.

Figure 63: Qualitative data worksheet

The tool also includes a series of charts showing comparisons between the HMAT scenarios. These are accessed through the 'Graph' tab.

Before leaving AOM the results currently held can be saved as a stand-alone spreadsheet. Note that any future imports of data from HMAT analyses will overwrite the current analysis held in the AOM. To save analyses for later review, the AOM spreadsheet can be saved under a different name.

7 References

Buckland, T., Parkman, C., Booth, & Abell, R. (2015*). CPR 2137: Valuing the Benefits of Road Maintenance.* Wokingham: TRL.

Department for Transport (2006). *Traffic Assessment, HD 24/06*, in Design Manual for Roads and Bridges, Pavement Design and Maintenance, Pavement Maintenance Assessment. DMRB, Vol. 7, 2.

Highway Maintenance Efficiency Programme (HMEP), 2012. *Lifecycle planning toolkit incorporating default carriageway condition models: User guidance*. Sourced from http://www.highwaysefficiency.org.uk/ January 2014.