Disclaimer
The application of this manual does not guarantee that the resulting traffic simulation models will be ‘fit-for-purpose’. This manual only provides a framework for model development, calibration and validation and subsequent model auditing. Some models, particularly models to be used for financial analysis will require more stringent standards and it is the responsibility of the modeller to ensure that the models they develop are fit for their intended purpose.

This document should only be considered relevant in South Australia and for no other purpose than as a guide for modellers and managers undertaking work for the South Australian Department of Planning, Transport and Infrastructure (DPTI).

DPTI and the authors of this guideline accept no liability or responsibility for any errors or omissions or for any damage or loss arising from the application of the information provided.
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Table of Contents

1 Introduction ............................................................................................................................................... 2
2 The Role of Traffic Simulation Modelling ............................................................................................ 3
3 Model Characteristics .............................................................................................................................. 4
  3.1 Model Scope ...................................................................................................................................... 4
  3.2 Model Years ...................................................................................................................................... 4
  3.3 Model Type ...................................................................................................................................... 5
    3.3.1 Single Intersection Models ............................................................................................................ 5
    3.3.2 Linear Models ............................................................................................................................... 5
    3.3.3 Sub-Area Network Models ............................................................................................................. 6
  3.4 Model Time Period ............................................................................................................................. 8
  3.5 Signal Control .................................................................................................................................. 9
  3.6 Model Calibration and Validation ..................................................................................................... 10
  3.7 Scenario Modelling .......................................................................................................................... 11
4 Model Development ............................................................................................................................... 12
  4.1 Model Folder Structure ...................................................................................................................... 12
  4.2 Data Exchange .................................................................................................................................. 12
  4.3 Base Year Model ............................................................................................................................... 13
    4.3.1 Define Sub-Area and Create Centroid Configuration .................................................................. 13
    4.3.2 Create Real Data Sets .................................................................................................................. 13
    4.3.3 Build / Refine Base Year Model .................................................................................................. 15
    4.3.4 Code / modify public transport routes passing through the sub-area ........................................ 17
    4.3.5 Code / verify / adjust the signal control plans ........................................................................... 17
    4.3.6 Create Traffic Demands .............................................................................................................. 19
    4.3.7 Calibrate / Validate Base Year Model ......................................................................................... 20
  4.4 Future Year Base Models .................................................................................................................... 24
  4.5 Future Year Options Models ............................................................................................................... 25
5 Model Auditing ....................................................................................................................................... 26
6 Model Outputs and Documentation ....................................................................................................... 27
  6.1 Reporting Model Outputs ................................................................................................................ 27
  6.2 Using Model Outputs ....................................................................................................................... 28
  6.3 Model Documentation Requirements ................................................................................................. 28
Appendix A – Modelling Brief Outline
Appendix B – Model Documentation
Appendix C – Model Calibration Criteria
Appendix D – Preferred Sub-Area Modelling Process (Base Year Model)
Appendix E – Model Audit Checklist
1 Introduction

The Department of Planning, Transport and Infrastructure (DPTI) works as part of the community to deliver effective planning policy, efficient transport, and valuable social and economic infrastructure. As part of this task DPTI must ensure that the effects of all planned interventions on the strategic road network and proposed developments which are likely to impact this network are thoroughly understood before they are implemented. Comprehensive and accurate modelling which is fit for the intended purpose is necessary to ensure these interventions and proposals can be:

- fully assessed for impacts and benefits;
- effectively designed to satisfy the original objectives and mitigate any adverse impacts;
- clarified to avoid confusion or misinterpretation as the design is developed, and
- effectively and efficiently implemented and operated.

A common definition of the term ‘model’ in its most general form is:

“A model can be defined as a simplified representation of a part of the real world which concentrates on certain elements considered important for its analysis from a particular point of view.”

It is important to be aware of the simplifications and assumptions that have been made in creating any model and to understand how these affect overall model performance. These simplifications and assumptions can derive from decisions made by the modeller during model development or calibration, or can be inherent to the particular choice of modelling software used.

DPTI uses a range of analytical tools to assess road network performance and to plan future development of the network. Aimsun Next is the Agency’s preferred traffic simulation software, and this manual was initially developed to provide broad guidance on the overall process of developing Aimsun microscopic models. The previous version of this manual (released in 2013) was based on Aimsun Version 7.0. Since that time there have been significant changes to the software and also in the way DPTI uses Aimsun software. In terms of changes to the software, the capability to create and use mesoscopic models and hybrid models (a combination of the microscopic and mesoscopic approaches) has been enhanced, the capability of creating and using multi-network models has been added, the matrix adjustment capability has been significantly enhanced and path building / checking has also been improved. All recent traffic simulation modelling undertaken by / for DPTI has been part of / based on the Metropolitan Adelaide Traffic Simulation and Assessment Model (MATSAM), and this version of the manual has been expanded to reflect both the updated software capabilities and the wider use of MATSAM.

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Aimsun Next is the only traffic simulation software supported by DPTI and it is a DPTI requirement that all new traffic simulation models be part of / based on MATSAM. Any exceptions will need to be independently audited as outlined in Section 5, Model Auditing, with some specific additional attention on ensuring that model parameters / model operation are reflective of Adelaide traffic conditions and that the models are fit for the intended purpose.

It should also be noted that all traffic simulation models either developed by / for DPTI or by / for others and requiring DPTI involvement need to be endorsed / accepted by DPTI's Manager, Strategic Transport Modelling as being fit for the intended purpose.

This manual covers the broad areas of building, calibrating, validating, documenting, auditing and using both microscopic and mesoscopic models, and is to be used as the primary guide for the development of ‘fit-for-purpose’ models for use within DPTI. It draws upon experience and expertise from across the Agency and the industry more broadly and forms a comprehensive source of best practice.

It is intended that this manual will be regularly reviewed and updated so that it remains current, useful and relevant for users in what is a dynamic environment. This version of the manual primarily relates to Aimsun Next Version 8.4 and MATSAM Version 1.0 which are the current versions used within DPTI. Before undertaking any traffic simulation modelling, practitioners should ensure that they have the latest version of this document - which is available on the DPTI internet website and that they discuss their modelling proposal with appropriate staff within DPTI.
2 The Role of Traffic Simulation Modelling

Aimsun Next and MATSAM are not suitable for all analytical tasks requiring some form of computer based modelling of traffic / transport operations. For example, DPTI uses the CUBE network modelling software package for the macroscopic analysis of the complete strategic transport system, encompassing both road and public transport elements. This strategic model is referred to as the Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM). The Agency also uses other software packages such as SIDRA INTERSECTION, TRANSYT 15 and LINSIG for the detailed analysis of both individual and simply linked intersections. Within this range of applications, there is a 'middle ground' where the use of microscopic / mesoscopic traffic simulation models is both feasible and useful. One key advantage of these models is the ability to visually demonstrate traffic operations to decision makers and stakeholders. In general, microscopic models would be used for the detailed analysis of a small geographic area, whereas mesoscopic models are more suited to the analysis of larger geographic areas.

Microscopic modelling software represents the behaviour of individual vehicles / drivers and the interactions between them. They are flexible and sophisticated tools that combine a wide range of behavioural parameters, involving an element of randomness, and can be adapted to model most traffic conditions to a fine degree of detail. Because of this flexibility and sophistication, model developers and users need to have a high level of understanding of traffic operations and modelling in order to achieve accurate models that are ‘fit-for-purpose’ and to ensure that the behavioural parameters remain within acceptable bounds. Mesoscopic modelling software deals with the aggregate performance of network links and nodes and while they do not provide the same level of operational detail as microscopic models they can generally be developed more efficiently. As they require the same range of behavioural parameters as microscopic models, they also require a high level of understanding of traffic operations and traffic simulation modelling. One approach supported by the latest versions of the Aimsun software is the development of hybrid models in which most of the network can be modelled at the mesoscopic level of detail with specific, critical sites modelled at the microscopic level of detail. This approach should enable the more effective development of ‘fit-for-purpose’ traffic simulation models, particularly for those covering larger sub-areas.

To support the efficient development of such sub-area models (either microscopic, mesoscopic or hybrid) DPTI has developed the Aimsun Next based MATSAM traffic simulation model which is closely linked to the MASTEM strategic transport model. MATSAM provides a basis for all traffic simulation modelling to be undertaken by / for DPTI within the Greater Adelaide area. This guide primarily focuses on the development, auditing and application of sub-area models within the scope of MATSAM, although the broad principles are generally applicable to all Aimsun Next based traffic simulation models. Any traffic simulation models which are outside the scope of MATSAM should use the full set of MATSAM model parameters – i.e. section types, lane types, vehicle types, etc. and comply with the broad principles set out in this guide.
3 Model Characteristics

Traffic simulation models can be very data intensive and complex to develop, calibrate and validate. The greater the scope of the model, or the level of detail, the more time and cost is involved in collecting the necessary data, building the model, calibrating and validating the model and documenting the model development process. In order for the development of traffic simulation models to be cost effective, the issues of model scope, model years, model type, form of intersection operation, model time periods, traffic demands, calibration / validation data / criteria, the level of documentation, and scenario testing all need to be considered and defined in the Modelling Brief. An outline Modelling Brief which is to be used as the basis of all requests to undertake any traffic simulation modelling is attached as Appendix A.

3.1 Model Scope

The extent of the area to be modelled should be clearly defined by way of an aerial photograph included in the Modelling Brief. The model network should generally extend beyond the scope of the problem to be investigated so that the pattern of arriving traffic is realistic. The extent of the model should also allow for all traffic to enter the model without significant virtual queues at the model boundary at the end of the analysis period.

The model network should include all strategic roads as well as the major local roads, all signalised intersections / junctions / pedestrian crossings (signalised and unsignalised), all other significant traffic controls (such as roundabouts, Stop and Give Way signs), all turning lanes / bays, all public transport priority facilities (such as bus lanes, bus priority signals, etc.), all public transport stops and any other relevant features / facilities. The model should be built using the GDA 1994, Zone 54 projection.

It should be noted that while the MATSAM model contains outline networks imported from the MASTEM model for each of the MASTEM model years, these networks will generally need to be enhanced to include additional local roads and network loading points and the level of detail at intersections / junctions are also required to be improved to meet the needs of each specific sub-area model.

3.2 Model Years

All microsimulation models should include a base year model, representing existing conditions, which has been calibrated and validated. A number of future year models should also be developed to enable the various proposed scenarios to be assessed and compared. While it is desirable that the base year should match the standard MASTEM model years of 2016, this will not always be practicable as it is frequently determined by the availability of the data needed to construct the Real Data Sets. Future years are to match the standard MASTEM model years of 2021, 2026, 2031 and 2036 as appropriate. Both the base year and future years to be modelled should be defined in the Modelling Brief.
3.3 Model Type

Traffic simulation models developed within MATSAM using the Aimsun Next software may be either microscopic models, mesoscopic models or hybrid models. Microscopic models will generally be single intersection models, linear models involving a small number of linked intersections or small sub-area network models involving a few linked / un-linked intersections. Mesoscopic and hybrid models will generally be larger sub-area network models involving many linked / unlinked intersections, some of which in the case of a hybrid model will be modelled as microscopic pockets. The key differences between these model types is the approach taken to network loading and it is desirable that each model be based on a set of model parameters which produce acceptable results for all of these possible approaches.

3.3.1 Single Intersection Models

Most single intersection models will be developed using other more appropriate software packages such as SIDRA INTERSECTION, however there are some circumstances where the use of a microscopic traffic simulation model may be preferred. These include

• using the model for consultation purposes, given the strong visual presentation capability of microsimulation software,
• in circumstances where the capacity of the signalised intersection is affected by such behaviours as weaving, lane changing, or merging,
• assessing public transport priority initiatives,
• assessing complex traffic control arrangements, and
• assessing grade-separated interchanges.

3.3.2 Linear Models

Linear models are generally used to assess the performance of closely spaced intersections where queuing from one adversely affects the operation of adjacent intersections. There are some other circumstances where a microsimulation model may be used in preference to alternative models such as TRANSYT 15 and LINSIG. These include:

• a more detailed assessment of intersection performance is required than can be provided by alternative tools,
• assessing public transport priority initiatives,
• assessing transit initiatives such as high occupancy vehicle lanes,
• assessing the operation and capacity of public transport interchanges,
• assessing the operation of freeway corridors, and
• assessing signal linking strategies, including a dynamic linkage to the SCATS traffic signal software.
3.3.3 Sub-Area Network Models

3.3.3.1 General

The development of sub-area network models is the most frequent circumstance in which microscopic and mesoscopic traffic simulation models are used. These models may include an element of route choice which adds to overall model complexity.

The development of such models requires significant time, effort and data. However, a traffic simulation model will provide a more detailed analysis and has the added advantage in the case of a microsimulation model of providing a visual presentation of traffic operation. The MATSAM model has been developed in order to minimise overall modelling effort and to ensure greater consistency across the range of models developed by / for DPTI. For example, for the development of any model within the scope of an existing sub-area model within MATSAM which has been calibrated and validated, a base year model including full network details, signal control plans, demand matrices, public transport services, route choice inputs and other details can be easily and quickly developed.

One complication of these models is the need to develop complex origin–destination matrices. Separate matrices will be needed for each vehicle type, each model year and for each model scenario. The complexity of this process increases with the size of the model and the number of available routes between the origin–destination pairs. These matrices rely on an Aimsun Centroid Configuration which is defined when the sub-area is first created within MATSAM. These sub-area centroid configurations are based on a parent / child concept where the parent centroids match the MASTEM centroids and there is a child centroid for each MASTEM centroid connector. It is important to understand that it is the child centroids which control the loading of traffic demands onto the sub-area network and there must be one child centroid for each network loading point, although additional child centroids may be added to improve the distribution of the traffic demands onto the sub-area network particularly where there are differences in flows between intersections.

The simplest way to produce these matrices is to extract sub-area matrices from the MASTEM strategic model and then adjust these to better match turning movements included in the Real Data Set. Future year matrices are also derived in a similar way except that the adjustment is based on the differences between the unadjusted (MASTEM) and calibrated and validated (MATSAM) base year sub-area matrices.

The process adopted to develop / adjust these matrices for the base and future year models is to be described in relevant documentation. It should be noted that adjusted matrices for future year models cannot be prepared until the base year model has been calibrated and validated.
Public transport vehicles (buses, trains and trams) should be included in the model where appropriate, and their operation should be based on relevant route / time-table information. As they are controlled by the Aimsun Public Transport Lines / Plans, they will rarely need to be included in origin–destination matrices and should be separately identified in the turning movement / traffic flow Real Data Sets.

3.3.3.2 Route Choice

One further complication of these models is the need to develop a reliable and verifiable approach to determine the paths used by traffic to move from the trip origin to the trip destination. Aimsun Next offers a broad range of path building approaches ranging from the simple all-or-nothing approach which uses a static single path for each origin–destination pair under all conditions to much more complex dynamic multi-path approaches which vary paths as congestion levels within the model scope change. The Aimsun Next documentation provides details on this range of possible approaches. The preferred approach involves creating a path file, usually as an output of a static assignment for each model / time period / scenario, which is stored using the Aimsun Next Path Assignments feature. This simplifies the creation / checking / comparison of paths used for traffic demand assignment across all scenarios.

Path costs for static assignments are based in part on the link parameter Volume Delay Function, the turn parameters Turn Penalty Function and Junction Delay Function and the turn attributes Cycle_AM, Cycle_PM, Green_AM and Green_PM. Path costs for dynamic assignments are based in part on the turn parameters Initial Cost Function and Dynamic Cost Function. All of these functions / attributes need to be consistently defined within the scope of the sub-area model.

If a stochastic route choice approach is chosen, the Aimsun Next software applies a small degree of variability (stochasticity) to vehicle / driver behaviour through the use of a seed value for each replication coupled with a random number generator. For this reason each model replication will produce slightly different results. For each stochastic route choice assignment, the average of all replications should be the basis of any analysis and documentation. Some indication of model variability should also be included in any model documentation, e.g. Total Travel Time and Flow by each 15-minute time period should be compared for all replications and the average. While 5 replications will generally suffice, if there is significant variability in the results for the individual replications, 10 replications should be run and consideration given to excluding any exhibiting unreasonably high levels of variability. The decision to exclude any replications should be justified in any model documentation.
If a dynamic user equilibrium approach is chosen there is no need to undertake multiple replications as this is an iterative / convergence based approach; however, Aimsun Next software will still use a random seed approach to provide some variability of either one or all of network loading (i.e. vehicle behaviour), public transport (i.e. schedule times and stopping times), traffic management, traffic assignment (i.e. vehicle routes) or vehicle parameters. The values of these seeds may be randomly chosen. If this approach is used, it will also be necessary to define and document the convergence criteria as well as reporting the seed value used.

3.4 Model Time Period

While the time period(s) to be modelled will be model specific, some general guidance is provided below.

Generally two separate time periods will suffice for most models, covering, as a starting point, the morning and evening peak hours, which are to provide the basis for model analysis and any comparison of outputs from the modelled scenarios. Noting that the evening peak hour can be difficult to accurately discern, it may be necessary to adopt a longer model period in these circumstances. Both of these periods, i.e. morning and afternoon, need to be extended to provide a pre-peak 'warm-up' period and a post-peak 'cool-down' period. The additional warm-up period is required to load traffic onto the network to provide a realistic level of congestion prior to the analysis period. This can be achieved by using one of the two available pre-loading options:

- an additional warm-up period equal to at least twice the expected longest travel time through the model (rounded up to the nearest 15 minutes and not less than 30 minutes), or
- using a saved initial state matrix to load the network

Note: The second option, i.e. using saved initial state matrix, should not to be used if travel time data is used for model validation which is the usual case.

It should be noted that this warm-up period is in addition to the warm-up period defined in the Main tab for each Experiment which should be set to either 30 minutes.

The additional cool-down period is required to allow vehicles loaded during the analysis period to complete their trips and to allow congestion at the end of the analysis period to dissipate. Generally, the length of this additional period should also be at least the maximum time taken for a vehicle to travel through the model, but should not be less than 30 minutes.

Demand profiles for the full model period should be split into 15 minute blocks and based on a detailed analysis of available traffic count data. Generally one profile will suffice for most models, but there may be some circumstances where the profile may need to be varied for each loading point or vehicle type. In these circumstances, separate O-D matrices for each different profile should be constructed. Running an Aimsun O-D Departure Adjustment scenario significantly simplifies the process of developing an appropriate set of profiled 15-minute matrices for the full model period.

The time periods to be modelled should be defined in the Modelling Brief.
3.5 Signal Control

Aimsun Next provides a range of signal control strategies, including:
- fixed time signal control with fixed offsets between intersections,
- vehicle actuated signal control, again with fixed offsets between intersections, and
- use of the SCATSIM interface plug-in.

The first two of these are likely to cover most circumstances.

Of these, fixed time is by far the simplest approach and is generally adequate for simpler models. However, while vehicle actuated signal control can be more complex and time consuming, it is generally preferred as it more closely models SCATS operation and is useful to model such things as public transport priority, rail crossings, variable phase sequences (i.e. phase skipping), part time signals and ramp metering.

For all forms of signal control, the whole phase sequence, including all interphases, should be completely defined. Phase times should be based on average SCATS phase times, although if vehicle actuated control is adopted the maximum phase times for all non-coordinated movements should be set slightly above the SCATS average value to provide for non-peak operation and an appropriate value for the passage time parameter be used to reduce the time for these phases during peak demands. Interphase times should also be based on either SCATS operation for existing signals of the DPTI Yellow-Red calculation spreadsheet for any proposed signals, noting that were SCATS intergreen times are fractional – e.g 3.5 seconds – the overall intersection intergreen time should closely match the SCATS total. A comparison between modelled and SCATS average phase times throughout the analysis period should be included in relevant documentation, as should the results of the Aimsun Next Discharge Rate Evaluation Extension at specific stop lines identified in the Modelling Brief.

The naming of signal groups, phases and vehicle detectors should conform to standard DPTI practice.

The start of right turn filter movements and any vehicle movements which interact with pedestrian movements should be delayed and it may be necessary for some movements to have an early cut-off to ensure that filtering traffic waiting within the intersection can clear the intersection before phases with conflicting movements start.

The form of signal control to be adopted should be defined in the Modelling Brief.
3.6 Model Calibration and Validation

Model calibration is the process of firstly verifying that the network is well constructed, then adjusting model parameters and the origin–destination matrices so that the model adequately reflects observed traffic behaviour, generally based on traffic movement data. Calibrating a traffic simulation model can require significant time and effort, particularly as model scope / complexity increases.

Model validation is used to assess a model’s fitness-for-purpose, and should desirably be undertaken using an independent data set. If DPTI’s installed Bluetooth transceivers cover the model boundary and the validation routes, travel time data extracted from DPTI’s AddInsight travel time database should be used, with the comparison being between the maximum and minimum values of observed travel time and the average value of modelled travel time. Alternative approaches for collecting travel time data need to be discussed with and agreed to by DPTI.

Model validation is usually a more subjective process than calibration, however for a model to be fit-for-purpose, it must be demonstrated that the model provides a sound basis for scenario testing and that relevant conclusions about the performance of the scenarios can be made with an appropriate level of confidence.

For all models it will be necessary to construct Real Data Sets for both vehicle turning movements and travel times to enable model calibration and validation. Given the significant dependence on the calibration Real Data Set, the underpinning traffic movement data is itself to be verified and validated. Further information can be found in Section 4.3.2. It is also important to understand that any model should be representative of typical conditions throughout the year and the observed data sets should be consistent with this requirement.

One important aspect which is often overlooked, particularly when modelling high levels of congestion, is the distinction between traffic demand (the number of vehicles seeking to pass through the network) and traffic counts (the number of vehicles succeeding in passing through each of the network features). Failure to reconcile these differences may lead to an underestimation in delays and queuing within the model. It is also important to understand that MASTEM results are estimates of network based traffic demand and are not necessarily limited by localised network constraints. For this reason it is desirable to include an assessment of queue formation / discharge as part of the model calibration process.

Model calibration criteria should be defined in the Modelling Brief for each model; however, standard DPTI values provided in Appendix C will be suitable in most circumstances.

Given the fundamental complexity of traffic simulation models, it is possible for a model to provide acceptable outputs based on inputs which are outside the bounds of acceptability. Consequently, reviewing and assessing model
inputs and outputs is an important part of assessing whether a model is fit-for-purpose.

3.7 Scenario Modelling

The future year scenarios to be modelled need to be carefully defined and they should be based on the base model(s) for each future year, which also needs to be carefully defined as there may need to be different models for economic analysis and traffic operations analysis. Again, if the stochastic route choice assignment approach has been adopted, it is desirable that at least 5 model replications are run for each scenario / time period. It is also essential that the replication seed values are the same as those used for all base models.

Changes made to the base model to develop each future year scenario model may include:
- network changes (additional road links, mid-block lanes, signalised intersections, etc.),
- signal operations (changed phasings / timings, etc.),
- changes to public transport routes / timetables, and
- changes to traffic demands.

All changes to the base model(s) should be managed through a series of Aimsun Geometry Configurations and should be described in relevant model documentation.

Any comparison of outputs for the modelled scenarios is to be based on each of the modelled peak hours.
4 Model Development

4.1 Model Folder Structure

The folder structure shown in Figure 4.1 should be adopted.

![Figure 4-1: MATSAM Traffic Simulation Folder Structure](image)

It is important that the provided copy of the MATSAM master model and any revisions are always stored in the same folder along with the model outputs which should be saved using the “Automatic Using SQLite” option in the Database box on the “Outputs to Generate” tab for each Scenario. It is also important that only the current version of the master model be saved in this folder – all older copies should be deleted. The project folder should also contain separate sub-folders for any images, for the real data sets and for the stored path files named “Images”, “Real Data Sets” and “Path Files” respectively.

4.2 Data Exchange

For all model development involving MATSAM, DPTI will provide a new revision and a copy of the MATSAM master model. All model edits / changes / corrections are to be made in this revision and no changes are to be made to the provided copy of the MATSAM master model. At each hold point, a copy of the latest version of the revision, the Real Data Set(s), the path files, the model outputs database in SQLite format and copies of all input data are to be returned to DPTI.

For all project specific stand-alone models at each hold point the latest copy of the model, the Real Data Set(s), the path files, the model outputs database in SQLite format and copies of all input data are to be returned to DPTI.
4.3 **Base Year Model**

The preferred process to build, calibrate and validate the base year model is outlined in Appendix D and further details are given below. This model should accurately represent existing conditions and the process to develop this model generally involves:

a) define the sub-area and create the centroid configuration,
b) create Real Data Sets,
c) build / refine base model - including both the network and the centroid configuration,
d) code / verify / adjust the signal control plans,
e) create traffic demands,
f) calibrate and validate base year model, and
g) document the base model development process and model performance.

4.3.1 **Define Sub-Area and Create Centroid Configuration**

The boundary used to define the sub-area should be consistent between MASTEM and MATSAM to ensure that all matrices have a consistent set of boundary and parent centroids and this will usually be defined in the Modelling Brief.

The MATSAM sub-area is created by running a static traversal based on path files for the full scope of the MATSAM model. This process also creates a set of peak hour Traversal Matrices which serve to create the Centroid Configuration for the sub-area. As part of this process, a set of peak hour Prior Matrices are extracted from MASTEM for the sub-area by DPTI for importation into the MATSAM sub-area model. At this stage all traffic demands are associated with the boundary / parent centroids.

4.3.2 **Create Real Data Sets**

The calibration Real Data Set will usually consist of a comprehensive set of turning movement data covering the complete sub-area model. This data set should comprise as a minimum cars, trucks and buses separately as well as total traffic, although there may be some circumstances where more detail is required, for example single and multi-occupant private vehicles, or light and heavy commercial vehicles. Generally it is preferable to create a single data set which cover both the morning and evening peak periods rather than creating a separate data set for each time period. Data that may assist the development of this Real Data Sets includes:

a) intersection turning movement data,
b) SCATS Volume Storage (VS) data,
c) mid-block vehicle classification data, and
d) origin-destination surveys.
In general, both manual turning movement data and SCATS VS data will need to be used, with the former providing information about the proportions of the different vehicle types, the use of shared lanes and undetected / uncontrolled movements (generally left turns at signalised locations or all turning movements at un-signalised locations), while the latter provides information about vehicle flows at particular locations within the model across a consistent date / time period.

There should also be an assessment of changes to traffic flows between adjacent intersections which may identify the need for additional / changes to network loading points. In undertaking this assessment, it is important to understand the difference between demand and supply which is evidenced by the remaining queue of vehicles which could not pass the stop line at the end of each time period. Consequently, a traffic count at the stop line / detector may not represent the actual demand for the movement. In these situations, the traffic demand should be captured from the upstream links or estimated by taking account of the residual queues.

The validation Real Data Set will usually consist of travel time data covering the important paths within the model and sourced from DPTI’s AddInsight travel time data base. These paths should be defined in the Modelling Brief. This data set should include information about the range of observed values by including the minimum and maximum values derived from the average value and standard deviation.

All real data set files should be in *.csv format and be structured as follows:

a) Traffic Flow Real Data Set
   i. The data items should be in the order of, Object External ID, Cars, Trucks, Buses, Total Vehicles, Time Period Ending

b) Travel Time Real Data Set
   i. The data items should be in the order of, Object External ID, Minimum Travel Time, Average Travel Time, Maximum Travel Time, Time Period Ending

Note 1: It is important that Real Data Sets are built using the object External ID. Aimsun Next object IDs should not be used as these are changed by the model consolidation process.

For both files the addition of some descriptive information – either as additional rows / columns - should be considered.

The Real Data Set files should be saved in the Real Data Sets folder and named as “Base model year Time period Data type Sub-area model name”, although there are some advantages in combining the am and pm period data into one 11 or 13-hour file - depending on the availability of turning movement count data - in which case the Time period should be “Daily”.

The sources of all data used to construct the Real Data Sets together with the process adopted to develop both data sets and to verify and validate the calibration data set is to be included in model documentation.
4.3.3 Build / Refine Base Year Model

The process of building / refining the base year model network is aimed at ensuring that the model is well constructed and accurately reflects the base year conditions. It is important to ensure that the model is well constructed, before beginning the model calibration / validation process as relatively minor changes to the way the model has been constructed can significantly affect this process. In general, network details should be suitable for a microscopic model regardless of the model type intended to be used. The following steps generally apply:

a) add / verify / modify sections,
 i. check section name, road type and maximum speed,
 ii. check section external id - which is based on the MASTEM section node numbers - noting that the section attributes ‘A’ and ‘B’ should also be checked,
 iii. check maximum speed – noting that the maximum speed of most minor local roads needs to be set to 30 km/h to minimise the intrusion of arterial traffic,
 iv. check lane change parameters for merge sections - all merging is to be achieved within a specific mid-block section and not extend into section joins,
 v. to achieve a reasonable level of merge section capacity, the value of Lane Changing Cooperation should be around 80%, that of Side Lane Cooperation Distance should be around twice the section speed limit, that of Side Lane Merging Distance should be close to the section speed and Merge: First Vehicle On Is First Vehicle Off should not be checked - actual values / settings of these parameters may need to vary to more closely match observed behaviour such as approach / departure lane utilisation or downstream queuing as part of the model calibration process outlined in 4.3.7 below,
 vi. Diverge settings should be thoroughly investigated and defined accordingly in the model to represent the existing operation in terms of lane utilisation and upstream lanes feeding the downstream lanes.

b) check that any merges / lane drops / diverge are achieved by auxiliary lanes within defined road sections.

c) add / verify / modify junctions, including all signal controlled junctions / intersections - and associated signal control plan details - and roundabouts,
 i. check all approach lane lengths / utilisation,
 ii. check that detectors are located at the end of the approach sections, that they are close to 5.0 metres long, that they cover only one lane and that they are named in accordance with the following protocol:

- the name reflects the possible movements e.g. LEFT:THROUGH, THROUGH, THROUGH:RIGHT etc. as appropriate,
• the external id refers to the SCATS TS number and detector number – coded as TS\text{Number}_Det\text{Number} - if known,

III. check that all roundabouts are correctly set up,
• the circulating roadway section external IDs are to be defined as "\textit{MASTEM Node Number}_MASTEM Node Number" – if the MASTEM Node Number is not defined use 9999,
• internal section speeds and turn speeds should be set to realistic circulating speeds – generally at least 10 km/h less than the approach section speeds,

IV. check that all turn speeds are consistently set to within about 10 to 20 km/h of the approach section speed,

V. check that the turn parameters / attributes which influence dynamic and static path costs are consistently defined – Initial Cost Function and Dynamic Cost Function on the Dynamic Model tab, Turn Penalty Function and Junction Delay Function on the Static Model tab and Cycle_AM, Cycle_PM, Green_AM and Green_PM in the turn attributes list.

d) it should be noted that the parameters associated with filter right turns may need to be adjusted to match observed capacity, particularly when the opposing priority flow is high, while at the same time not reducing the capacity for other conflicting movements. This may involve realigning the turn to increase storage space, carefully locating the stop line within the turn and modifying the give way parameters Visibility to Give Way and Visibility along Main Stream (Micro and Meso) on the Dynamic Model tab. It may also be necessary to increase the inter-green time following the filter turn phase to ensure that all right turning traffic can complete the movement and clear the intersection before the conflicting movement phases begin, although it should be recognised that this change will reduce capacity for the conflicting flows which may adversely impact overall intersection operation.

e) add / verify / modify section joins,
   I. check the section join name – which should match the section name – and also that the Yellow Box tick box is off,
   II. check that the section joins are minimal in length and maintain a consistent number of lanes between the joined sections – except where this is the entry to and exit from a short left turn slip lane or where one of the central lanes splits.

f) modify the sub-area Geometry Configuration to improve road network flows / loadings,
   I. add any additional network loading points as child centroids – noting that each child centroid is to load to one node or one set of associated sections,
   II. check that all child centroids are linked to a parent centroid and correctly named as “Parent Centroid MASTEM Zone Number_Child Centroid Descriptor” and the external ID is set to “Parent Centroid Id_Network Element Id”,

16
III. check that the Volume Delay Function of the child centroid connectors matches that of the parent centroid.
IV. check that the Volume Delay Functions for centroid connectors are defined correctly (the Default VDF is not to be used)

4.3.4 Code / modify public transport routes passing through the sub-area
   a) PT Lines Schedules
      As all PT lines schedules are imported from MASTEM the time table details generally need to be adjusted to more closely matched to observed timetable information - this particularly applies to train and tram services.
   b) PT stop operation
      In the case of buses the stopping patterns need to be carefully checked and adjusted such that the arrival of buses at stops are randomised sufficiently so that instances of vehicles waiting to access stops are minimised.

4.3.5 Code / verify / adjust the signal control plans
   a) check that sub-area specific copies of the master Control Plans have been created – they should be named as “Model year Time period Sub-area name”.
   b) the Offsets should be based on SCATS values, noting that offsets should refer to the start of the co-ordinated phase in the model.
   c) Yellow Time should match the SCATS value for existing signals and the value calculated by the DPTI Yellow-Red calculation, noting that were SCATS intergreen times are fractional – e.g 3.5 seconds – the overall intersection intergreen time should match the SCATS total.
   d) Red Percentage must always be set to 50.
   e) the Cycle time is to be based on the SCATS average value and should be consistent for all linked locations – generally this should be a multiple of 10 seconds.
   f) intergreen times should match SCATS values and the intergreens should be placed at the end of each phase.
   g) late start or early cut-offs should be used to provide realistic operation of filter turns either opposed by pedestrian movements or by conflicting traffic movements. Assumptions used for late start or early cut-offs need to be documented in the modelling reports.
   h) suggested signal settings for actuated Control Plans are:
      i. the SCATS stretch phase is to be set as co-ordinated and for consistency the Offset should be matched to the End of Phase,
      ii. the Max-Out time for all un-co-ordinated phases should generally be set slightly (generally 1 – 2 seconds) above the SCATS average value to allow for the highest 15-minute demand which is
often outside of the peak hour – noting that the SCATS phase percentages include the interphase time,

III. the Max-Out time for all phases is to match the values shown on the Phases graphic.

IV. the Minimum Green all un-co-ordinated phases time should be set to the SCATS value.

V. times for phases which may be skipped need to be carefully set – the Minimum Green should be set to the SCATS value and the Max-Out time should be set assuming that the phase is called every cycle. This may result in times for the co-ordinated phase being slightly reduced to maintain the cycle length.

VI. the Passage Time should be set to 2 seconds unless there is a significant proportion of heavy commercial vehicles or a single upstream lane feeding multiple turning lanes in which circumstances a longer Passage Time may be appropriate,

VII. the “Calculate Force_Offs” button should be used to calculate the Permissive Period and Force-Off parameters,

VIII. the detectors which are used to determine actual phase lengths need to be carefully selected, particularly where there are shared movements e.g. for leading / trailing right turn phases only the detectors for the right turn movements should be used,

IX. phase skipping can be achieved by providing a setback detector which is not actuated until a short queue forms.

i) suggested signal settings for rail crossings

I. actuated control should be used,

II. the Cycle Time should be 60 seconds,

III. the road traffic phase should be set to 14 seconds on the phase display, the Recall should be set to Max, the Minimum Green set to 0 seconds, the Max-Out set to 45 seconds and the following interphase should be set to 6 seconds,

IV. the rail traffic phase should be set to 15 seconds on the phase display, the Recall should be set to No, the Minimum Green set to 0 seconds, the Max-Out set to 3000 seconds, the passage time set to 5 seconds, and the following interphase set to 25 seconds and the approach rail detectors should be selected on the Detectors tab,

V. the approach rail detectors should be located about 25 seconds in advance of the crossing and the departure rail detectors should be located about 140 metres – the length of a 5-car consist train – or about 40 metres – the length of a typical tram – as appropriate after the crossing, although the location of approach detectors should be adjusted so that observed closure times for each direction of travel are matched,

VI. there should be a separate Pre-emption defined for each direction of travel on the rail line with the Minimum Dwell set to 40 and the Maximum Dwell set to either 60 – if there is no station immediately downstream of the crossing – or 90.
j) it is suggested that any queue relocation logic be implemented by using a Traffic Condition with Turn Closures to control specific movements:

i. the Visibility Distance for each turn closure should be set to 0.1 metres and the Percentage of Compliance should be set to 100

ii. each turning closure should use separate Triggers to activate and de-activate the closure and the Triggers should use appropriate values of downstream section density as the trigger Condition.

k) it is also suggested that SIDRA Intersection be used for any new signal installations to provide initial control plan settings – e.g. phase arrangements, phase times.

l) It is important that the MASTEM node configuration is maintained in MATSAM which will generally result in each of the junctions forming a staggered T-junction being separate nodes with separate control plans. The same offset and phase sequence / timings should be used for both control plans with the same detectors used to call the matching phases. The operation will need to be carefully checked to ensure that it is realistic.

4.3.6 Create Traffic Demands

Traffic demands are to be based on appropriate sets of origin–destination matrices generally split into cars and trucks, with information about public transport timetables, routes and stopping patterns derived from the MASTEM based public transport lines / plans embedded in MATSAM which nevertheless need to be checked and validated.

There are a number of specific sets of matrices which are generally produced as part of the development of any base year traffic simulation model. These are:

a) the Traversal peak hour matrices produced within MATSAM when the sub-area is created

   - these should be named as “Traversal Model Year Model Time Period PH Vehicle Type Model Name” and will generally have a Model Year of 2011 or 2016,
   - they are primarily used to create the sub-area centroid configuration and are not generally used in any Scenarios.

b) the Prior peak hour matrices extracted from MASTEM for the sub-area

   - these should be named as “Prior Model Year Model Time Period PH Vehicle Type Model Name” – noting that the Vehicle Type should be one of:
     - Car DPTI,
     - Truck DPTI,
     - Truck and Semi DPTI,
     - B-Double DPTI,
     - Cyclist DPTI, or
     - Pedestrian DPTI
unless the Modelling Brief requires a different model specific vehicle type.

- as these matrices are extracted directly from MASTEM, all trips are associated with either boundary centroids or parent centroids and there are no trips associated with any of the child centroids.
- they are also generally not used in any Scenarios but are used as the basis for the initial adjusted peak hour matrices.

c) the Adjusted peak hour matrices

- these should be named as “Adjusted Model Year Model Time Period PH Vehicle Type Model Name”,
- they are initially produced from the Prior peak hour matrices by transferring trips from parent to child centroids – an Aimsun script “DPTI – TransferTripsToChildCentroids” has been developed to assist this process – then progressively adjusted to better match the Real Data Set turning movements using firstly a static OD adjustment assignment then a series of static peak hour assignments with manual adjustments.

d) the Adjusted model period 15-minute matrices

- these should be named as “Adjusted Model Year Model Time Period MP Vehicle Type Model Name: Specific Time”,
- they are initially created from the adjusted peak hour matrices by using a static OD departure adjustment assignment and refined using a series of either micro or meso stochastic route choice assignments with manual adjustments.

The specific Traffic Demands generally produced as part of the development of any base year traffic simulation model are:

a) Prior Model Year Model Time Period PH Vehicle Model Name which contain the prior peak hour matrices for all vehicle types and are used for the static OD adjustment scenarios.

b) Adjusted Model Year Model Time Period PH Vehicle Model Name which contain the adjusted peak hour matrices for all vehicle types and are used for any static assignment scenarios.

c) Adjusted Model Year Model Time Period MP Vehicle Model Name which contain the adjusted peak hour matrices for each vehicle type stretched to cover the full Model Period and are used for the static OD departure adjustment scenarios.

d) Profiled Model Year Model Time Period MP Vehicle Model Name which use the adjusted 15-minute matrices for each vehicle type and are used for any dynamic assignment scenarios.

4.3.7 Calibrate / Validate Base Year Model

Model calibration essentially involves fine adjustment of both appropriate model parameters (to improve the ability of the model to reproduce observed vehicle / driver behaviour) and the origin-destination matrices (to improve the match between modelled and observed traffic movements). The more closely
the base model is calibrated against observed traffic conditions, the more confidence there is that the future year models will accurately model future traffic conditions across a range of different scenarios.

While calibration criteria will generally be model specific and depend on the purpose of the model, suggested values are provided in Appendix C.

Given the range of model parameters that affect vehicle / driver behaviour, this process tends to be highly iterative and needs to be carefully planned and managed. The following broad guidelines are provided to assist this process and provide some consistency between different models.

Aimsun parameters that may be adjusted to improve model calibration – once the verification that the model is well constructed has been satisfactorily completed - generally fall into one of two groups:

a) those that affect capacity
b) those that affect route choice

It is suggested that those parameters affecting capacity be checked and adjusted first, then those that affect route choice (if relevant).

4.3.7.1 Capacity

The capacity of most urban arterial networks is generally determined by the capacity of the signal controlled intersections / junctions, and accurately calibrating the capacity of these presents a number of challenges. Primarily, it is difficult to measure intersection capacity in the field, and frequently other analytical tools such as SCATS – at existing sets of signals – or SIDRA INTERSECTION – at proposed sets of signals – should be used to provide reasonable estimates of individual movement capacities that are useful for calibration purposes.

The key global parameters that may be changed to improve the calibration of intersection capacity against measured, observed, or estimated capacity are Reaction Time, Reaction Time at Stop and Reaction Time at Traffic Light which are defined in the Reaction Time tab for each Stochastic Route Choice Experiment. The same values are to be used for all model years but may be different for the AM and PM time periods. Table 1 provides some guidance on the range of acceptable values for these parameters.

<table>
<thead>
<tr>
<th>Table 1: Range of Acceptable Values for Reaction Time, Reaction Time at Stop and Reaction Time at Traffic Light</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microscopic Models</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Mesoscopic Models</strong></td>
</tr>
</tbody>
</table>
Notes:

i. The initial value adopted for Reaction Time for any microscopic model should be set to 0.9 seconds with the initial Reaction Time at Stop set to $1.5 \times 0.9 = 1.35$ seconds and the initial Reaction Time at Traffic Light set to $2.0 \times 0.9 = 1.8$ seconds. Similarly, for any mesoscopic model the initial values should be 1.26 seconds, 1.35 seconds and 1.8 seconds respectively.

ii. While these parameter values may change in order to better meet the calibration criteria in response to high levels of congestion, this should not happen until all operational issues have been identified and addressed. The highest value for Reaction Time which results in the calibration criteria being met should be adopted, and the values adopted for each of these parameters are to be included in relevant documentation.

iii. It will generally also be necessary to adjust the signal control plan settings – generally focusing on phase times – so that modelled capacity better matches observed capacity across the full model period. Final phase times are to be included in relevant documentation and compared against SCATS and / or SIDRA INTERSECTION values, as should the results of the Aimsun Next Discharge Rate Evaluation Extension at specific stop lines identified in the Modelling Brief.

Generally, no changes will be necessary to model parameters to provide reasonable levels of mid-block capacity; however, there are some specific circumstances where this may be necessary:

a) Merge section performance:
   The value of Lane Changing Cooperation, Side Lane Cooperation Distance and Side Lane Merging Distance should be varied so that modelled performance reasonably matches observed behaviour such as approach / departure lane utilisation or upstream queuing.

b) Imprudent lane changing, lane blockages, etc.:
   Observed instances should be minimised - details of any such instances regularly occurring and influencing model operation are to be included in relevant documentation.

4.3.7.2 Route Choice

Not all traffic simulation models involve an element of route choice; however, for models that do, the operation of the route choice approach will need to be calibrated to closely match modelled turning / mid-block counts / flows against observed data. All of the available path building approaches are based on estimated perceived travel costs involving both time and distance components, and it is the relative differences between these components that influence route choices.

For all models a path file should be created and used for each of the model time periods as outlined in Appendix D. These files should be produced as an output of a peak hour static assignment using the adjusted peak hour matrices and by adopting the most appropriate of the available assignment approaches. They should be stored in the Path Files / Sub-area model name folder using
the Aimsun Path Assignments feature and should be named as “Model year Time period PH Vehicle Sub-area model name_Assignment Experiment Id”. Generally a sub-set of the available paths – ranging from 1 to 3 depending on the dynamic route choice approach adopted - will be sufficient for most models.

4.3.7.3 Static Assignments

The section attribute Volume Delay Function and the turn attributes Junction Delay Function and Turn Penalty Function are used to build and compare paths using a peak hour static assignment and these should all be checked as part of the network build step. These functions use section / turn speed / flow and distance. The turn attributes Green_Model time period also influence the path building process and can be modified to produce a more realistic set of paths. The output path file should be carefully checked to ensure that the set of paths is reasonable and appropriate.

4.3.7.4 Dynamic Assignments

Generally, default values are appropriate for most dynamic assignment experiments, provided that a Path Assignment file is selected on the Main tab of the Dynamic Scenario. The default setting will assign all trips between each origin – destination pair to the Origin-Destination Route if one has been defined, otherwise to the available paths in the stored path file if provided, otherwise in accordance with the defined Stochastic Route Choice approach.

The turn attributes Initial Cost Function and Dynamic Cost Function influence any paths built and should also be checked as part of the network build step.

The path assignment results for at least one of the replications should be checked to ensure that the route choice process is performing as intended.

4.3.7.5 Origin-Destination Matrices

The preferred process to develop the adjusted Origin-Destination (OD) matrices as part of the model calibration process is outlined in Appendix D and involves the following steps:

a) Adjust Peak Hour Prior Matrices Using Static OD Adjustment Assignment

This step produces an initial adjusted peak hour matrix which is used in the following step.

It is suggested that the number of Iterations be set to 100 and the number of Gradient Descent Iterations be set to 1 on the Main tab of the Static OD Adjustment Experiment.

b) Refine Peak Hour Adjusted Matrices and Create Sub-Area Path File(s) Using Static Assignment

This step is intended to improve the accuracy of the peak hour matrices which simplifies the following steps. This assignment can also be used to produce the path files for use by the subsequent steps.
c) Calibrate Sub-Area Using SRC Dynamic Assignment – Peak Hour
   This step may be used to further refine the peak hour matrices and
   also check / verify the control plans.

d) Create Adjusted Model Period Matrices Using Static OD Departure
   Adjustment Assignment
   This step produces an initial set of 15-minute matrices for the full
   model period which are further refined / adjusted in the following step.
   This process should use the Path Assignment files created in the
   earlier step.
   It is suggested that the number of Iterations be set to 1000 and the
   Matrix Elasticities be set to 1 on the Main tab of the Static OD
   Departure Adjustment Experiment.

e) Calibrate Sub-Area Using SRC Dynamic Assignment – Model Period
   This step refines / adjusts model parameters, control plan settings and
   the 15-minute matrices to ensure that the calibration criteria are met.
   This process should also use the Path Assignment files created in the
   earlier step.

f) Validate Sub-Area Model
   This step compares model performance against the validation Real
   Data Set (usually AddInsight Travel Time data).

   Note: It is important that the boundaries of the sub-area model stay
   unchanged after the base sub-area network is provided and / or agreed by
   DPTI. Any changes to the sub-area boundaries need to be communicated with
   DPTI and endorsed by Manager, Strategic Transport Modelling. Failure to
   comply with this requirement may result in non-acceptance of the model.

4.4 Future Year Base Models

   Future year base models should be developed from the calibrated and
   validated base year model using the Aimsun revision and geometry
   configuration features and there should be no changes to any of the model
   parameters. The future year base model is used as a reference to compare
   future year options, and depending on the intended use of the model there
   may need to be more than one base model developed for each future year.
   For example, the base model required for economic analysis will generally not
   be the same as the base model required for traffic analysis.

   The base model for economic analysis should only include the committed /
   funded network improvements / changes. This model is often referred to as a
   ‘do-minimum’ model.

   The base model for traffic analysis should include all network improvements /
   changes included in the MASTEM Foundation Network\textsuperscript{2}. This model is often
   referred to as the ‘business-as-usual’ model.

\textsuperscript{2} MASTEM Foundation Network includes all improvements/changes to the network as per State’s strategic plans
and the implementation timings as prescribed in such those plans.
It is important that the assumptions underpinning the development of the future year base model(s) are reflected in the MASTEM network(s) used to produce the prior future year peak hour matrices and that all future year demand matrices are based on MASTEM sub-area matrices which have been adjusted based on a comparison between the base year MASTEM matrices and the calibrated and validated base year matrices. This adjustment process - if required and included in the Modelling Brief - is to be described in model documentation.

This process involves:

a) define and develop future year base model(s),
b) develop future year base model traffic demand(s),
c) develop future year base model public transport lines / plans,
d) update / adjust future year base model specific signal control plans, and
e) document the model development process and model outputs.

4.5 Future Year Options Models

All future year options models should be developed from the closest future year base model using the Aimsun revision and geometry configuration features. It is emphasised that there should be no changes to any of the model parameters.

This process involves:

a) define and develop each future year option model,
b) verify that the future year base demand is relevant, or, if not, develop any necessary future year proposed option specific demands,
c) update / adjust future year model specific signal control plans, and
d) document the future year option model development process and model outputs.

Note: It is important that the assumptions underpinning the development of the future year proposed options model(s) are reflected in the MASTEM network(s) used to produce the prior future year peak hour matrices, and that all future year demand matrices are based on MASTEM sub-area matrices which have been adjusted based on a comparison between the base year MASTEM matrices and the calibrated and validated base year MATSAM matrices.
5 Model Auditing

All traffic simulation models developed either by / for DPTI or by / for others and requiring DPTI involvement, are to be audited at defined hold points during this model development process. This audit is to be undertaken by a suitably qualified and experienced modeller who is wholly independent of the project team. The primary purpose of this audit is to ensure that all models have been developed, calibrated and validated to the specified standard, they are sufficiently accurate and robust given their intended purpose and DPTI is able to use the model outputs / results with confidence.

At each hold point, relevant model parameters / characteristics should be checked to ensure that acceptable values / approaches have been adopted. A checklist has been developed to assist this process and a copy is included as Appendix E. MS Excel version of this checklist is available at https://www.dpti.sa.gov.au/standards/transport_modelling_and_analysis (MASTAM Model Audit Checklist v8). At each hold point the auditor is to complete the relevant column in the checklist and return the checklist to DPTI for the Agency’s review (strategic and operational) and filling in the relevant column, i.e. DPTI response, based on the issues identified by the auditor and/or as a result of Agency’s review. The checklist is then to be provided to the modeller to make any necessary changes and to add the modeller’s response to the issues identified.

As mentioned above, any calibrated / validated base year model is subject to an operational review by DPTI, which is aimed at confirming that the observed operation of the model is a reasonably accurate match to observed traffic operations. Details of this review are to be included as part of the audit results.

Suggested hold points are:

1. built / refined base year model,
2. calibrated / validated base year model,
3. built future year base models,
4. completed future year base models,
5. built future year options models, and
6. completed future year options models.

Note: - hold points 2 and 5 are mandatory; other hold points are optional depending on the scale / complexity of the model(s).
6 Model Outputs and Documentation

6.1 Reporting Model Outputs

Model outputs will vary depending on the nature of each traffic simulation model.

For a base year model the following model calibration / validation results are to be reported separately for each model period, as well as the pre-peak warm-up period(s) and the individual peak hour(s) for each model period:

a) GEH values comparing observed and modelled turning movements
b) regression analysis of observed and modelled turning movements, and
c) comparison of observed and modelled travel times both through the model and between adjacent stop lines along defined routes

For all models the following model outputs are to be reported as a minimum for each model period as well as for each of the individual peak hours. Any additional required outputs should be included in the Modelling Brief:

a) average network delay, a comparison of input and modelled vehicle flows, density, number of stops and overall vehicle travel time and distance for the complete model, or any defined portion of the model,
b) turning movement data,
c) intersection cycle and phase times,
d) turning movement flows / capacities / saturation flow rates,
e) intersection delay,
f) intersection queue lengths,
g) mid-block merge performance,
h) virtual queues at the model boundary, and
i) lost vehicles

For all models, using the stochastic route choice assignment approach, there should also be some analysis of variability of these results between replications. It is this analysis which indicates the degree of model stability. If this analysis shows significant differences between the results of some replications, this may indicate some issues related to either the construction or the calibration of the model which will need to be addressed. In some circumstances, additional replications may be necessary to ensure model stability.

The analysis of model variability should consider the results for Travel Time and Flow by each 15-minute time period, and should include:

a) a scatter plot showing the result for all replications,
b) a box plot showing the range of values for all replications and the reported result value,
c) a frequency histogram showing the results for all replications, and
d) some analysis of:
   • the mean value,
   • the median value,
   • the standard deviation,
   • the 95% quartile,
• the range,
• the interquartile range,
• the minimum value,
• the maximum value,
• the sample size, and
• confidence intervals.

The model results reported and used for the comparison of future year scenarios will depend on which assignment approach has been adopted. If the stochastic route choice approach has been adopted the average results for all replications should be reported and used for comparison. If the dynamic user equilibrium approach has been adopted, generally only one result will be available and that should be reported and used for comparison. In all cases, the seed value(s) for all scenario models shall be the same as the seed value(s) used in the calibrated and validated base year model.

6.2 Using Model Outputs

As with any model, care must be taken when using any model outputs for either subsequent analysis or to input into another model.

In very general terms, model variables which have used as part of base year model calibration and are acceptably closely matched to base year observed values can be used with confidence; however, any other model outputs should be subject to a validation process by comparing base year model outputs and base year observed / measured / estimated values. Where this reveals differences, these model outputs should be adjusted before being used. For all model outputs which are adjusted before use, the rationale, justification and details of the adjustment process are to be described in the model documentation.

For most Aimsun Next models, this means that output traffic flow data – including total travel time, total travelled distance, individual turning movements, mid-block traffic flows, vehicle speeds (for the routes / road sections used for validation) and section densities – can be used directly; however, other outputs should not be used unless they have been rigorously reviewed and adjusted.

6.3 Model Documentation Requirements

Any project specific requirements should be defined in the Modelling Brief, but minimum requirements are for a Base Model Development, Calibration and Validation Report covering the base year model and Future Year Model Analysis Report covering the future year base and options models. These reports are to be accompanied by the completed audit checklists and – in the case of a calibrated and validated base year model – the results of the operational review.

All reports should identify the sources of all data used, identify the land use / network scenarios used for future traffic forecasts, document all changes to default model parameters and provide an analysis of network operation consistent with the broad purpose of the model.
In the Base Model Development, Calibration and Validation Report, it is useful to provide some commentary on comparative SIDRA INTERSECTION results and the traffic simulation model results for each of the signal controlled intersections, although it is essential that the SIDRA INTERSECTION models are well calibrated in accordance with the relevant DPTI guideline, i.e. Traffic Modelling Guidelines (SIDRA INTERSECTION) available at: https://www.dpti.sa.gov.au/standards/transport_modelling_and_analysis.

There should also be some commentary on comparative SCATS signal operation data and modelled signal operation data.

Model documentation should also include some commentary on the visual results of the simulation and the identification of any model limitations / operational issues. For all models involving the use of API plug-ins not developed by DPTI, full documentation of these API plug-ins should be included along with some evidence that they work as intended.
APPENDIX A

Modelling Brief Outline
A.1 Contractual Requirements (Note only include if necessary)

Project Management Framework

Critical Dates
Define the project management requirements, e.g.

‘The proposal shall include a detailed project timeline outlining each stage and the estimated timeframe for the development of the base model.’

Define all hold points, e.g. at the completion of the Base Model Development, Calibration and Validation Report consistent with the chosen model auditing approach.

Consultant Experience and Competency

“The Consultant shall demonstrate that they possess the experience and competency necessary to successfully undertake this work.”

Project Deliverables

Project Initiation
Project Handover
Scope Management
Stakeholders and Consultation
Provided Data
Define any data to be provided to the Consultant.

Data Collation
Define all data collation requirements on the part of the Consultant, typically:

“The Consultant shall be responsible for the collation all network timing, count and movement data and to document and report on that data”

Additional Data Requirements
Define all data collection requirements on the part of the Consultant, typically:

“The Consultant shall be responsible for the identification of any additional counting, inventory or survey data required for the successful calibration and validation of the model.”

Data Exchange Requirements
Define any data exchange requirements allowing the transfer of any required and/or provided data, and of the completed models.

Model Calibration and Validation Criteria
Define the model calibration and validation criteria to be used. While these may be varied depending on the requirements of each project, a standard set which should suffice for most modelling work is included in Appendix C.
A.2 Scope of Works

Project Objectives
Outline of the broad purpose of the project.
Include the requirement that:

‘This brief requires that the DPTI Metropolitan Adelaide Traffic Simulation and Assessment Model (MATSAM) and Aimsun Next traffic simulation package (V8.4) shall be used for this modelling work.’

Background
Provide relevant background to the project, and set the context for the traffic simulation model.

Study Scope
Define the scope of the study.
Define the basic purpose of the model within the context of the project, typically:

“This work includes the development of a base year model and future year scenario models as defined in this brief.

The purpose of the base year model is to represent the current operation of the traffic system in the project area during both the morning and evening peak periods, and this model is to be used as the basis for the development of all future year scenario models.”

Model Characteristics

Model Extent
Define the expected extent of the model, including the level of detail expected.

Model Years
Define the years to be modelled, covering both the base model and future year models.

Model Type
Define the expected type of model (i.e. either a single intersection model, a linear model or a sub-area network model) and whether the model is expected to be a microscopic model, a mesoscopic model or a hybrid model and whether the assignment approach is expected to be either stochastic route choice or dynamic user equilibrium.

For stochastic route choice scenarios, the standard DPTI replication seed values if 5 replications are to be run are:

- Replication 1 6422
- Replication 2 12841
- Replication 3 17906
- Replication 4 18370
- Replication 5 22744
The additional standard DPTI replication seed values if 10 replications are to be run are:

- Replication 6 7234
- Replication 7 9560
- Replication 8 16885
- Replication 9 18829
- Replication 10 19199

Model Time Periods

Define the model analysis times (usually the morning and evening peak hours) and the requirement to include appropriate warm-up and cool-down periods.

Traffic Demand

Define any specific restrictions on the development of demand Origin-Destination matrices, as well as the MASTEM land use / network scenario to be used for all future year models.

Signal Operation

Define the type of signal operation to be used (e.g. fixed time or SCATS), and any special requirements, e.g. public transport priority, skip phase operations, etc.

Model Outputs

Define the model outputs required, usually:

- overall vehicle travel time and distance and vehicle stops for the complete model, or any defined portion of the model,
- travel times both through the model and between adjacent stop lines along defined routes,
- turning movement data,
- intersection cycle and phase times,
- turning movement flows, capacities, and saturation flow rates,
- intersection delay,
- intersection queue lengths,
- mid-block merge performance,
- virtual queues,
- number of vehicles, and
- lost vehicles.
Model Documentation

Define any project specific requirements, but minimum requirements are for a Base Model Development, Calibration and Validation Report covering the base year model and a Scenario Model Analysis Report covering the future year scenario models.

Base Model Development, Calibration and Validation Report

Minimum requirements for this report are given in Appendix B.1

Scenario Model Analysis Report

Minimum requirements for this report are given in Appendix B.2
APPENDIX B

Model Documentation
B.1 Base Model Development, Calibration and Validation Report
   Executive Summary
   Introduction
   Model Description
   Model Data
   Traffic Demand
   Model Calibration
   Model Validation
   Model Stability
   API Plug-Ins
   Model Outputs
   Model Limitations
   Summary and Conclusions

B.2 Future Year Model Analysis Report
   Executive Summary
   Introduction
   Base Models
   Options Models
   Forecast Demand
   Model Stability
   Model Outputs
   Comparative Performance for Options
   Operational Issues / Risks
   Preferred Option
   Summary and Conclusions
APPENDIX C

Model Calibration Criteria
**Model Calibration / Validation Criteria**

<table>
<thead>
<tr>
<th>Criteria and Measures – Full Model Period, Warm-Up Period and Peak Hour(s) to be reported</th>
<th>Acceptability Level</th>
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| **Turning Movements**  
GEH Statistic for individual flows / movements  
  Defined non-critical flows / movements  
    (Any values >5.0 to be documented)  
  All other flows / movements  
    (Any values >3.0 to be documented)  
Average GEH Statistic for all flows / movements  
Plot of observed vs modelled individual flows / movements  
  Line of Best Fit  
    Slope  
    $R^2$  
    (Slope equation to be included, intercept = 0) | All <5.0  
All <3.0  
<1.5  
1.00±0.01  
>0.99 |
| **Queue Lengths**  
Comparison required | Maximum modelled queue lengths to match the maximum observed queue lengths |
| **Travel Times**  
Plot for the full modelled period of minimum and maximum observed vs average modelled travel times required. | Average modelled travel time to fit within the observed minimum-maximum travel time band. |

The comparisons between observed and modelled turning movements are to be for the full model period, for the pre-peak warm-up period and for the peak hour(s). In addition to the above criteria, the visual performance of the model also needs to be satisfactory, particularly focusing on speed / flow performance, bottlenecks and queue formation and discharge.
APPENDIX D

Preferred Sub-Area Modelling Process

Base Year Model
Hold Point

MASTEM Model

Highway and PT System Descriptions, Junction Data

MATSAM Model

Step 1 – Define Sub-Area and Centroid Configuration, Build Real Data Sets

Step 2 – Refine Sub-Area Model

Step 3 – Adjust Peak Hour Prior Matrices Using Static OD Adjustment Assignment

Step 4 – Refine Peak Hour Adjusted Matrices and Create Sub-Area Path File(s) Using Static Assignment

No

Adjustment Criteria Met?

Yes

Peak Hour Adjusted Matrices and Path File(s)

Step 5 – Calibrate Sub-Area Using SRC Dynamic Assignment – Peak Hour

No

Calibration Criteria Met?

Yes

Step 6 – Create Adjusted Model Period Matrices Using Static OD Departure Adjustment Assignment

Model Period Adjusted Matrices

Step 7 – Calibrate Sub-Area Using SRC Dynamic Assignment – Model Period

No

Calibration Criteria Met?

Yes

Step 8 – Validate Sub-Area Model

No

Validation Criteria Met?

Yes

Calibrated and Validated Base Year Sub-Area Model

Hold Point
APPENDIX E

Model Audit Checklist
**Project Name - Sub-Area Model – Independent Audit Register**

**MODEL AUDIT**

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<td>3</td>
<td>Minor issue - to be addressed in next milestone</td>
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## 2 Model Development

### 2.1 Model Layout and Configuration
- **2.1.1 Centroid Configuration**
- **2.1.2 Intersections / Junctions / Section Joins**
- **2.1.3 Sections**

### 2.2 Traffic Demands

### 2.3 Origin - Destination Matrices

### 2.4 Public Transport Plans / Lines
- **2.4.1 Source / Model Year**
- **2.4.2 Train / Tram / Bus Stopping Patterns**

### 2.5 Vehicle Types

### 2.6 Road and Lane Types

## 3 Real Data Sets

### 3.1 Turning Movement
- **3.1.1 Source(s)**
- **3.1.2 Verified**

### 3.2 Travel Time

## 4 Model Parameters

### 4.1 Assignment Type

### 4.2 Reaction Times
- **4.2.1 Model Step / Reaction Time**
- **4.2.2 Reaction Time at Stop**
- **4.2.3 Reaction Time at Signals**

### 4.3 Arrival Type

### 4.4 Turn attributes
- **4.4.1 Paths**
- **4.4.2 Speeds**
- **4.4.3 Yellow Box Speeds**
- **4.4.4 Initial Cost Functions**
- **4.4.5 Dynamic Cost Functions**
- **4.4.6 Turn Penalty Functions**
- **4.4.7 Junction Delay Functions**
- **4.4.8 Initial Safety Margin**
- **4.4.9 Final Safety Margin**
- **4.4.10 Distance Zone 1**
- **4.4.11 Distance Zone 2**
- **4.4.12 Give Way Time Factor(s)**
- **4.4.13 Visibility to Give Way**
- **4.4.14 Visibility Along Main Stream**
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