Model Auditing Process

Version 4.0

Model Auditing Process (MAP) Version 4.0

Document reference: MQA-0685

Edited by

Lucy Beeston and Robert Blewitt

Disclaimer

This publication is intended to provide accurate information. However, TfL and the authors accept no liability or responsibility for any errors or omissions or for any damage or loss arising from use of the information provided.

Acknowledgements

The editors would like to thank the following individuals for their significant contributions during the creation of this document:

Alexander Clewes
John Green
Daniel Hornshaw
Andrew Lovell
Luis Perez Echevarria
Georgia Perraki
Paul Powell
Huagang Qu
Birendra Shrestha

The editors would also like to thank:

David Aspital
Andrew Beck
Jim Binning
George Codd
James Daniels
Tony Dichev
Anett Ehlert
Sean Fitzgerel
Fred Frank
Andrew George
Adam Greenland
Nymisha Gutti
Hussein Hakim Falih
Paul Harwood
Tessa Hayman
David Howard
Devrim Kara
David Korzeniowski
Tobias Kretz
Wissem Lakache
Michal Miklasz
Paul Moore
Abigail Moughal
John Nightingale
Michael Oliver
Raphael Santos
Simon Swanston
Jennifer Treen
Xiaoyan Zhang

Additionally, the editors acknowledge and appreciate all contributions from those not named who have participated in this and previous versions of the Model Auditing Process documents.

Contents

LIST OF FIGURES

LIST OF TABLES

Introduction

The Model Auditing Process (MAP) has been produced by Transport for London's (TfL) Network Management & Resilience Directorate (NM&R), within TfL Operations. It is intended to complement TfL's Traffic Modelling Guidelines document[1], to ensure that traffic modelling submitted to TfL meets a recognised standard. MAP represents the views and needs of a broad spectrum of traffic modelling practitioners, with contributions from departments across TfL and external industry experts.

The Director of NM&R is the Traffic Manager for the Transport for London Road Network (TLRN) and therefore has a duty to secure the expeditious movement of people and goods (collectively termed 'Traffic' in this document), as detailed in the 2004 Traffic Management Act[2]. NM&R is dependent on comprehensive modelling and supporting information from clients (including London boroughs and TfL departments) and consultants in order to design, assess, implement and operate traffic schemes effectively. Appropriate, comprehensive and accurate modelling is necessary to ensure permanent traffic schemes can be:

- Fully assessed for impacts and benefits;
- Effectively designed to satisfy original objectives and mitigate any adverse impacts;
- Clarified to avoid confusion or misinterpretation of the design;
- Effectively and efficiently implemented and operated; and
- Implemented with an accurate prediction of operation within a high level of confidence.

Since the previous update to MAP[3], modelling methodologies have evolved, software matured and a new version of the Traffic Modelling Guidelines has been published. This new version has therefore been produced to ensure continued alignment with the Traffic Modelling Guidelines, accommodate newer versions of traffic modelling software and reflect current best practice.

1 SQA-0507, Traffic Modelling Guidelines, Version 4.0, Network Management Directorate, Transport for London, 2021
2 Great Britain, Traffic Management Act 2004: Elizabeth II, Chapter 18, The Stationery Office, London, 2004
3 SQA-0685, Model Auditing Process (MAP) – Engineer Guide for Design Engineer (DE), Checking Engineer (CE) and Model Auditing Engineer (MAE), Version 3.5, Road Space Management Directorate, Transport for London, March 2017

Purpose

NM&R has developed MAP to provide a structured approach to model development and defined standards for model quality, together with a protocol for stakeholder engagement, model submission and acceptance. MAP encourages consistency, promotes best practice and ensures modelling quality. The aim is that this in turn promotes high quality scheme designs that deliver and maintain appropriate, balanced network performance across all transport modes, in accordance with TfL and Mayoral transport policies.

Models must be demonstrated to meet exemplary standards so that all stakeholders can have confidence in the outcomes of modelling studies and subsequently, the projected outcomes of proposals on our network. This enables decision-making, urban planning, and the operational management of London's transport network.

What's New in this Version of MAP?

This version of MAP contains a number of changes from previous versions. While many of these are minor in nature, others represent significant and fundamental differences. These have been driven by the evolution of modelling methodologies within TfL, changes in the modelling software we use and user feedback.

Areas of MAP that have significantly changed include:

- TfL's Three Stage Modelling Process has been incorporated, with MAP stages covering all levels of modelling and the interaction between them (see **A2.3.2**);
- MAP Stage 5 (previously the Proposed model audit), has been separated out into Stage 5a, covering Future Base models, and Stage 5b, covering Proposed models;
- Dedicated cycling and pedestrian checks have been added to the software-specific MAP checks to give greater prominence to these active travel modes, reflecting the Healthy Streets approach outlined in the **Traffic Modelling Guidelines**;
- New MAP (JMAP) introduced for Junctions models (see Chapter **B4**);
- New MAP (IMAP) introduced for TfL's ONE Model (see Chapter **B6**);
- New MAP (PMAP) introduced for pedestrian models (see Chapter **B7**);
- LinSig MAP (LMAP) updated with expanded acceptance for matrix-based flow allocation (see Chapter **B5**);
- Vissim MAP (VMAP) streamlined, combining previous Stages 2a and 2b into a single Stage 2 Calibrated Base model stage (see **B9.2**);
- MAP Overview and Engineer Guide documents unified into a single document. The new document includes **Part A** for a non-technical audience and **Part B** covering technical content, aligning with the format used in Traffic Modelling Guidelines;
- MAP check sheets have been updated with a new format, providing space for more detailed audit comments; and
- Minor updates have been made to the Aimsun Next MAP (AMAP) and TRANSYT MAP (TMAP) chapters to correspond with process changes across all chapters (see Chapters **B3** and **B8**).

Structure and Target Audience

MAP is separated into two parts to make the document accessible for a wide audience, separating technical and non-technical content:

Part A

Part A has been written to give a high-level understanding of MAP. It is designed to be read by a wide audience, both internally and externally, including non-technical decision makers, project managers and scheme Promoters. It does not assume any prior knowledge of traffic modelling.

Part B

Part B contains an overarching framework for model auditing together with technical standards and acceptance criteria relating to the use of specific traffic models and modelling software. It is designed to be read by a technical audience, both internally and externally, including model developers, engineers and model auditors.

About the Authors

MAP has been developed and edited by staff from TfL's Network Performance (NP) department, within NM&R. NP staff possess a high level of technical modelling expertise that has been developed internally within TfL and predecessor organisations, such as the Traffic Control Systems Unit. Modelling specialists within NP are responsible for developing TfL's key operational modelling assets and undertaking advanced model assessments to support highway development.

A wide range of TfL staff, including subject matter experts in traffic modelling and operational network management, have contributed significantly to the development and review of this version of MAP.

PART A – Overview

1 Introduction to Part A

1.1 Purpose

Part A of this document provides context for the Model Auditing Process (MAP) and outlines themes explored in greater detail within TfL's Traffic Modelling Guidelines. It is intended to introduce key interfaces, traffic modelling concepts and processes that are expanded upon in **Part B**.

Chapter **A2** introduces the background to traffic modelling in London, with an overview of TfL's legislative responsibilities and Traffic Manager duties, together with modelling documents that have been developed by TfL to support these responsibilities. It covers the applicability of MAP within TfL's project lifecycles and internal modelling processes.

1.2 Target Audience

Part A contains useful information for all parties involved in MAP, however it is particularly relevant for scheme Promoters, providing background and assisting them in understanding MAP, their responsibilities and those of their appointed representatives.

1.3 Expected Awareness and Competencies

Part A of MAP has been written to give a high-level understanding of TfL's model auditing requirements. It is designed to be read by a wide internal and external audience, including non-technical project managers and scheme Promoters. It does not assume any prior knowledge of traffic modelling.

It is recommended that the reader also familiarises themselves with Part A of the **Traffic Modelling Guidelines**, which provides further high-level background information on traffic modelling fundamentals for a non-technical audience.

2 Background to the Model Auditing Process

TfL is responsible for operating 5% of the roads and all of the traffic signals in London. There are legal regulations that place responsibilities on TfL and its management of the road network, as well as a requirement to adhere to current TfL and Mayoral polices. Modelling can be used to understand both the impacts and benefits of a proposal, to allow TfL to operate the road Traffic scheme developers usually commission external experts to undertake traffic modelling assessments on their behalf. There is therefore a need to audit such models to confirm they are fit for their intended purpose. Traffic model development is however a complex task that can be completed in a variety of ways, and the process of auditing a model can therefore be challenging. TfL have developed MAP, in conjunction with the Traffic Modelling Guidelines, to advocate best practice.

This Chapter reviews the legislative requirements placed on TfL, together with TfL's modelling guidance documents and how MAP is applied to ensure fit-for-purpose modelling is developed to meet these requirements.

2.1 Legislative Responsibilities

The Traffic Management Act (TMA) was introduced in 2004 to control congestion and disruption on the road network. The Act, with text updated by virtue of the Infrastructure Act (2015) requirements, places a Network Management Duty (NMD) on Local Traffic Authorities (LTAs) to:

- Ensure the expeditious movement of traffic on their or adjacent road networks; and
- Facilitate the expeditious movement of traffic on the networks of others.

TfL's responsibility under the TMA includes:

- The Transport for London Road Network (TLRN), a network of nearly 580km of the Capital's roads (shown in blue in **Figure 1**). The TLRN makes up 5% of London's roads but carries 30% of its traffic;
- The Strategic Road Network (SRN), comprised of a further 500km of routes which are considered to have a strategic importance in terms of network operation, including major bus routes (shown in pink in **Figure 1**). Boroughs have overall responsibility for these routes, however TfL has operational oversight and has to be notified of activities which will affect, or are likely to affect, them. TfL also has powers to intervene in relation to activities which will affect, or are likely to affect the SRN, where it is necessary to do so; and
- All of the traffic signals in London, whether or not they are on the TLRN or SRN.

Part of the NMD is to ensure the best possible movement of all modes of transport at signal-controlled junctions within the road network. The modes of transport that need to be considered are:

- Pedestrians
- Cyclists
- Public transport
- Specialist service vehicles and
- Other motor vehicles, including cars, taxis and goods vehicles.

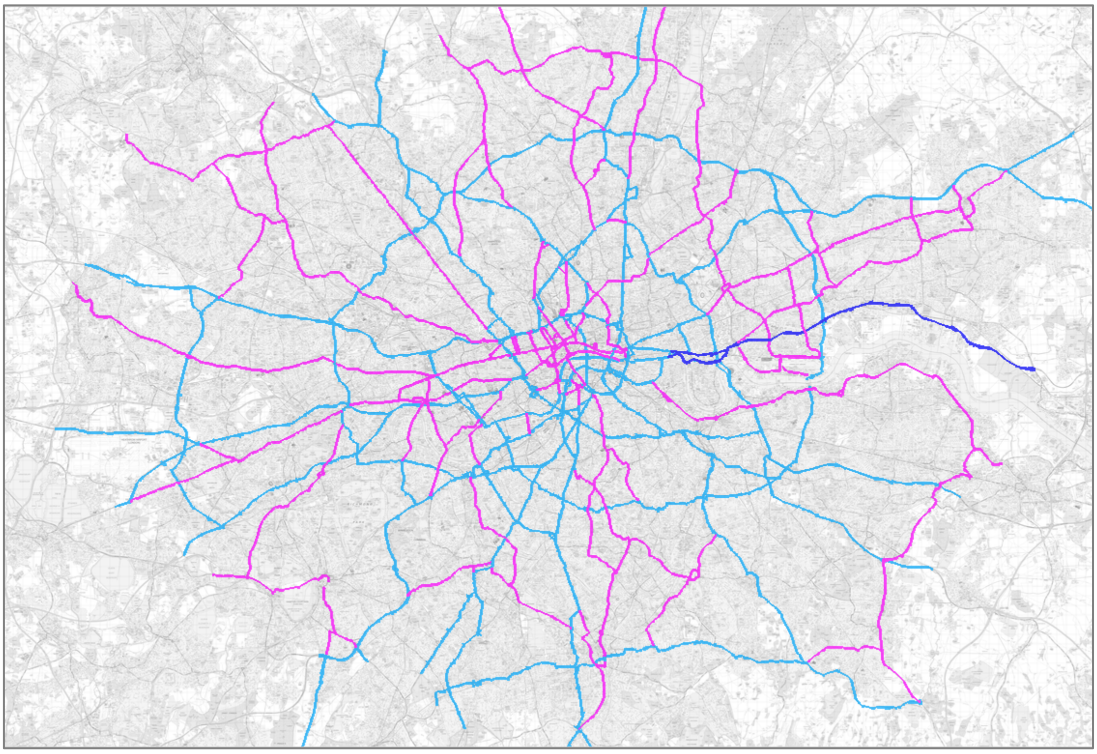


Figure 1: The TLRN (shown in blue) and the SRN (shown in pink)

Modelling can be a powerful tool in understanding the potential traffic impacts or benefits of proposals, if used in an appropriate way. It can also enable strategies to be developed to mitigate adverse impacts or encourage behavioural changes.

TfL provides independent technical support to scheme Promoters, in the form of a Scheme Impact Report (SIR). This enables TfL Operations to make informed decisions when executing this part of the NMD. Paramount in any decision is whether the scheme has a detrimental impact on sustainable modes – walking, cycling or use of public transport.

The TMA places a requirement on LTAs to appoint a Traffic Manager. Within TfL, this role is fulfilled by the Director of the Network Management and Resilience Directorate (NM&R), within TfL Operations.

NM&R is responsible for the management and operation of London's 6,000+ traffic signals and their accompanying systems, technologies and equipment. NM&R is a centre of expertise for traffic engineering, network operation and traffic modelling. These functions are split between the following parties:

- The Network Performance Delivery (NPD) section, where traffic models are used for signal design optimisation, operational timing reviews and traffic scheme impact assessments;

- The Network Performance Modelling & Visualisation team (M&V), which provides modelling assurance through expert modelling support for traffic scheme impact assessments. It is also responsible for developing and maintaining MAP, the Traffic Modelling Guidelines and the Operational Network Evaluator (ONE) assignment model; and
- TfL's Network Performance Network Impact Specialist Team (NIST), who work on behalf of the Traffic Manager to ensure that the NMD has been fully complied with in the development, design and implementation of highway and traffic proposals impacting the TLRN and SRN.

Highway Authorities are also required to make decisions about highway changes in the context of current policies. TfL is responsible for supporting the Mayor of London to deliver their Transport Strategy. The current Mayor's Transport Strategy (MTS)[4] was published in March 2018 and is available at **https://tfl.gov.uk/corporate/about-tfl/the-mayors-transport-strategy**.

4 Mayor's Transport Strategy, Greater London Authority, March 2018

2.2 MAP and the Traffic Modelling Guidelines

MAP and the Traffic Modelling Guidelines are produced by TfL to encourage adoption of best practice by all parties in the development and auditing of traffic models. The latest versions of the documents are available, without charge, at **https://www.tfl.gov.uk/trafficmodelling**.

MAP and the Traffic Modelling Guidelines are complementary. As illustrated within **Figure 2**, they provide a framework to deliver the modelling quality required by TfL for both Base and Proposed models, from scheme consideration through to a detailed design.

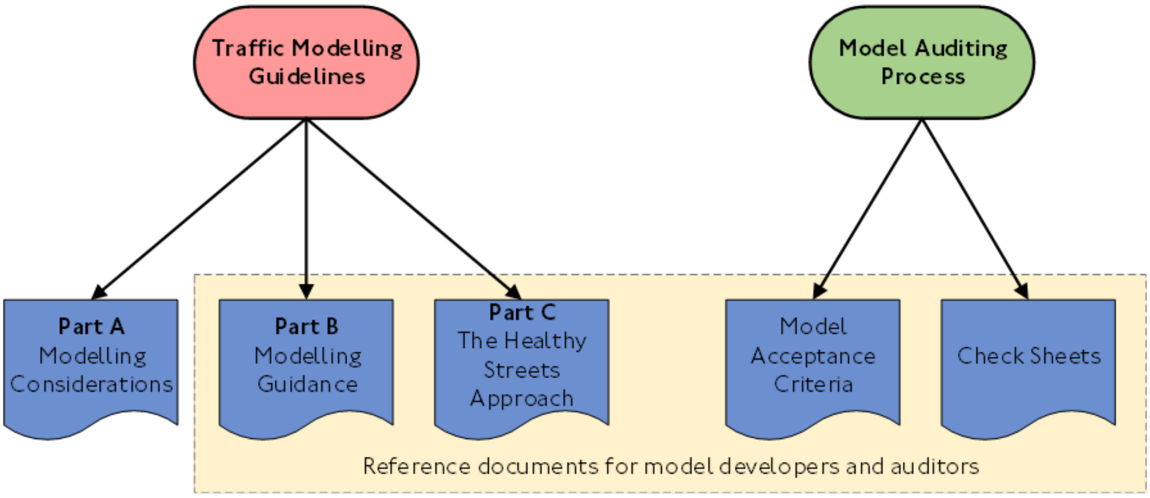


Figure 2: Relationship between the Traffic Modelling Guidelines and MAP

MAP defines the standards expected for all modelling submitted to TfL Operations for auditing. The Traffic Modelling Guidelines indicate recommended 'Best Practice' relating to the approach and methodology for model development in order to reach those standards. In this context, MAP provides a structural process framework for auditing models against software-specific modelling standards prior to further phases of development. The Traffic Modelling Guidelines provide overarching guidance on approaches which may be adopted to efficiently meet the standards defined by MAP.

The level of detail and accuracy of a model must reflect the purpose for which the model is intended. The objectives of a scheme will directly influence the type and purpose of any required modelling.

Traffic modelling to support a permanent scheme through NM&R approval represents the highest level of detail and accuracy required for a model.

2.3 MAP Applicability

MAP applies in all circumstances where NM&R require operational traffic modelling to assess impacts on the TLRN or SRN. However, where a Borough is the Promoter of a scheme that does not impact on the TLRN, SRN or bus operation the use of MAP is still recommended. All operational traffic models commissioned by, or submitted to, TfL are audited in accordance with MAP.

This section further describes TfL's project management processes and how they relate to traffic model development and auditing. It also introduces TfL's approach to the consistent development of different levels of modelling relating to a project or scheme, and how MAP is applied in the context of planning applications.

2.3.1 Pathway Methodology

TfL's Pathway delivery methodology for projects and programmes refers to the strategic planning and management of the various programmes and projects that TfL implements to enhance and maintain its transport infrastructure and services.

Pathway is a structured and coordinated approach to managing projects and programmes, which involves:

- Defining goals and objectives;
- Developing strategies;
- Planning and coordinating activities;
- Allocating resources;
- Monitoring progress; and
- Evaluating outcomes.

Pathway represents a holistic approach that focuses on the delivery of long-term benefits rather than short-term gains.

TfL uses Pathway to ensure that its transport infrastructure and services are efficient, safe, and accessible for everyone. This involves working closely with stakeholders, including customers, employees, contractors, and local authorities, to deliver programmes that meet the needs of all parties. Pathway is a key element of TfL's overall strategy to provide safe, reliable, and sustainable transport services to Londoners.

2.3.1.1 Pathway Lifecycle Stages

A project is defined as a unique set of coordinated activities with definite start and finish points, undertaken to meet specific objectives within defined time, cost and performance parameters. All projects follow the Project Lifecycle as shown in **Figure 3** and detailed in **Table 1**:

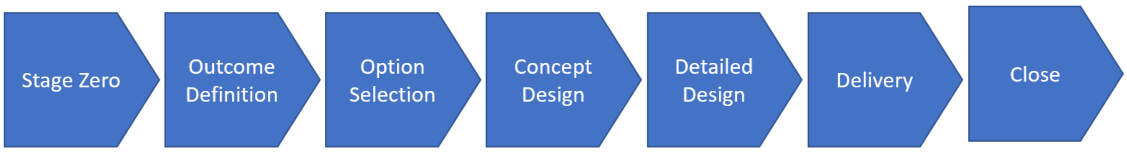


Figure 3: Project lifecycle as detailed in TfL's Pathway methodology

Table 1: Descriptions of Project Lifecycle Stages

Lifecycle Stage	Description
Stage Zero	Inception
Outcome Definition	Establishes the business outcomes and benefits that the project must deliver
Option Selection (also referred to as Feasibility)	Determines whether the outcomes and benefits are achievable – the options for their delivery and the option that will deliver them for the best value
Concept Design	Defines the design principles and freezes the scope of the project
Detailed Design	Produces a detailed design that delivers the required outcomes and is used as the basis of a contract for delivery of the physical outputs
Delivery	Builds the physical outputs of the project, confirms acceptance by end users and hands the outputs over into operational / business use and maintenance, including necessary supporting documentation
Project Close	Ensures that the project is closed in a controlled manner

In some simpler situations stages can be combined based on professional judgement, for example, by combining Outcome Definition with Option Selection or by combining Concept Design with Detailed Design.

More complex projects may require the project to be broken down either into a number of sub-projects, or for specific stages to be broken down into a number of sub-stages.

The decision as to which stages apply to a project must be made consciously, in consultation with relevant stakeholders and with the agreement of the Sponsor.

2.3.1.2 MAP Integration with Pathway

Prior to Inception / Stage Zero, TfL's Spatial Planning Directorate provide early traffic modelling assessment support for third party developers (see A2.3.3). This sits before the Pathway project lifecycle begins with the Pathway process initiated later ahead of formal project assurance and delivery.

NM&R support any necessary traffic modelling from the Outcome Definition Stage through to the end of the Option Selection Stage. These first two parts of the overall programme are considered to be the Assessment Stage, which is then followed by the Delivery Stage as shown in Figure 4. The MAP timeline fits within the Assessment Stage after Stage Zero, which is congruent with any requests for TfL support or model asset access via TfL's cost recovery processes, the Process for Commercial Access to Modelling (PCAM).

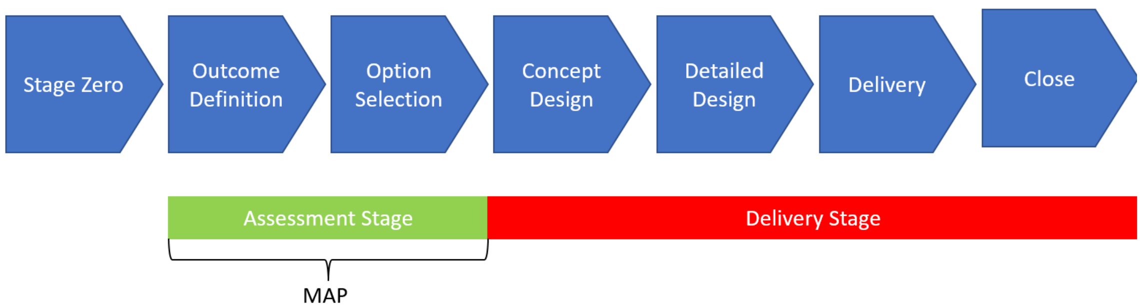


Figure 4: MAP timeline within the Pathway project lifecycle

When appraising proposed traffic signal designs, TfL Engineering & Asset Strategy provide a level of assurance that is reflective of the respective stage in the Pathway project lifecycle. At the Assessment Stage a Traffic Signal Option Selection Review is carried out to provide indicative safety-critical timings in order for scheme assessment modelling to be undertaken.

These preliminary safety-critical timings are however subject to change as the design process progresses through later stages of Pathway, which could affect modelled outcomes. This is reflected in caveats included within the Scheme Impact Report (SIR), produced at MAP Stage 6 (see **A2.3.1.3**).

The SIR is submitted to NIST ahead of the approval plenary, Road Space Performance Review Group (RSPRG) if required, and acceptance of the proposed scheme changes onto TfL's network. Once this has occurred, the project is handed over from NM&R to TfL's Capital Directorate ownership for the Delivery Stage.

2.3.1.3 Traffic Manager Duty – Scheme Impact Report

The SIR is a document that is used to evaluate the effectiveness of a particular TfL scheme or project. It provides an overview of the project, its objectives, the outcomes achieved, any lessons learned and recommendations for future improvement.

The SIR is an essential tool for evaluating the success of a project and determining its impact on the community, the environment, and the transport system as a whole. The report typically includes an assessment of the project's costs and benefits, expected impacts for all road users, safety considerations and their contribution to TfL's broader objectives and environmental considerations.

These reports are used to inform decision-making around future investments and to ensure that resources are allocated effectively. They are also used to communicate the results of TfL's activities to stakeholders, including customers, employees, investors, and local authorities and ensuring that they meet the needs of the public while delivering value for money.

2.3.2 Three Stage Modelling Process

TfL's Three Stage Modelling Process has been developed in order to capture the interaction between modelling levels and understand impacts such as traffic reassignment due to neighbouring schemes. The process allows both the isolated impacts of a proposed scheme and the overall future state of the network to be assessed. Full details of the process are explained in Part A of the **Traffic Modelling Guidelines**, however the three stages of the process are outlined in **Figure 5**.

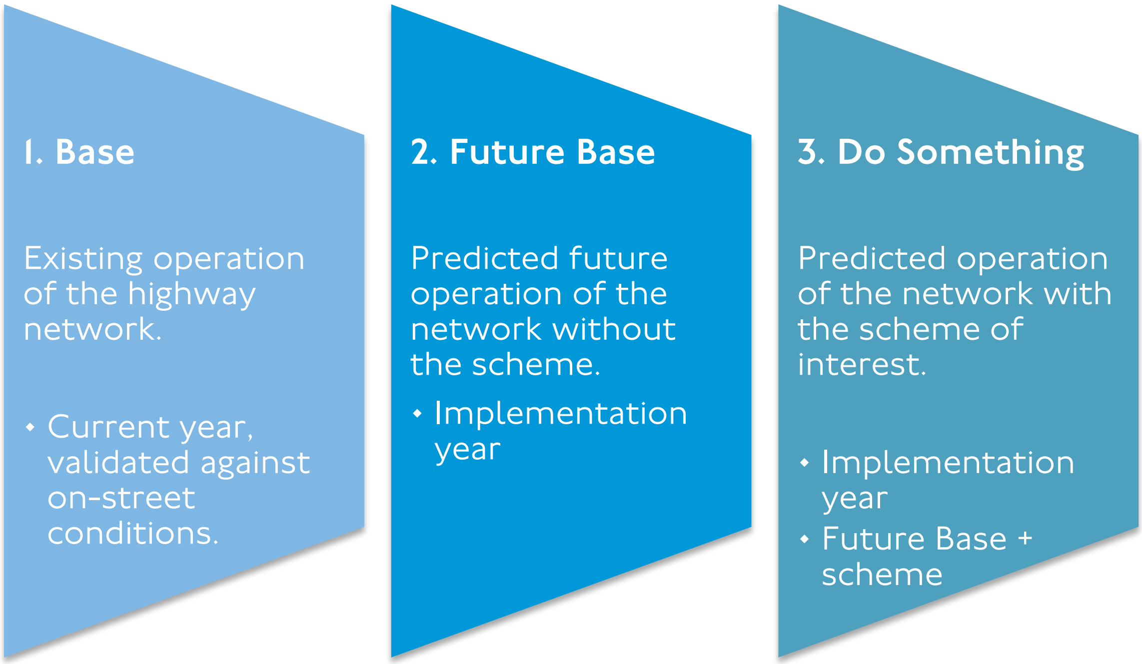


Figure 5: The TfL Three Stage Modelling Process

It is recommended that the Three Stage Modelling Process should be used in operational scheme assessments when:

- Traffic reassignment is anticipated as a result of the scheme;
- Traffic reassignment is anticipated as a result of adjacent scheme(s); or
- Network changes occur within the model boundary as a result of other nearby schemes.

The Future Base model provides a reference for comparison when assessing Proposed model results, which is considered more meaningful than comparing against the Base model alone.

The application of the Three Stage Modelling Process is typically optional when following MAP, and it would be decided during the Base Scoping Meeting at MAP Stage 1 (see **A3.2.1**) whether a scheme should follow it. However, for ONE MAP (see Chapter **B6**) and Pedestrian MAP (see Chapter **B7**) it is necessary to follow the Three Stage Modelling process for all scheme assessments.

2.3.2.1 Model Integration

Information is typically shared between modelling levels during scheme assessments to inform model development, share data and improve the reliability of model results. During the Base Scoping Meeting it is important to consider all modelling levels required for the scheme assessment, and how the different modelling levels will integrate. This is often an iterative process to ensure consistency in model data across different software platforms.

Common interactions between modelling levels are shown in **Figure 6**, and detailed in full in Part A of **Traffic Modelling Guidelines**.

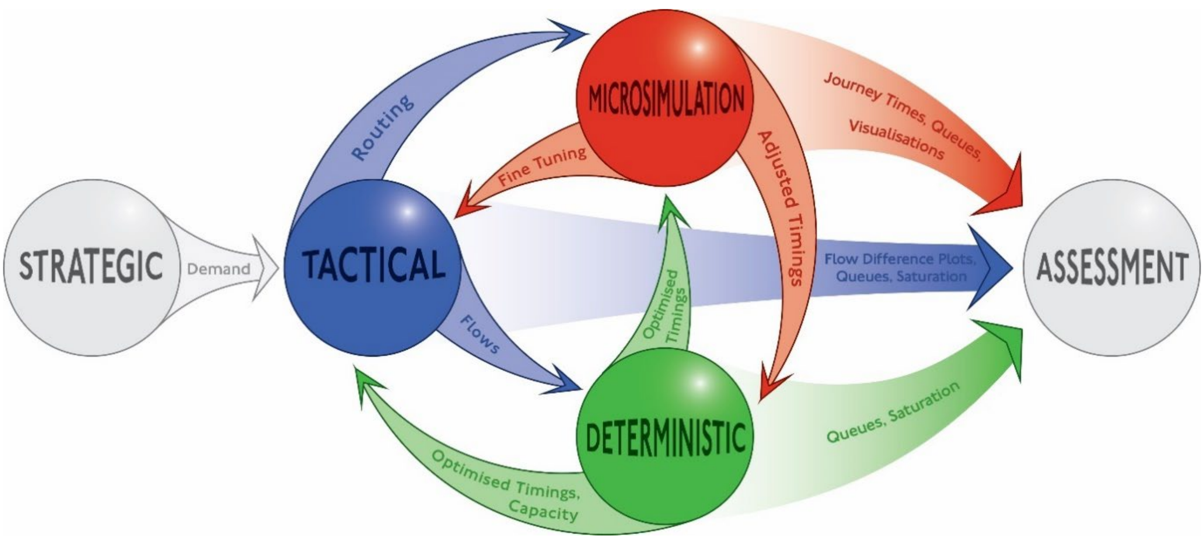


Figure 6: Interactions between different types of modelling

2.3.3 Planning Model Audits

The Spatial Planning Directorate, within TfL Customer and Strategy, is involved in the assessment and approval of planning applications in London. A key consideration as part of a planning approval is to predict and assess any impact of a proposed development on the operation of the highway. Spatial Planning, as part of its Transport Assessment Guidance, recommends that modelling assessments are required when a new development could impact on one or more of the following:

- Traffic flow including cyclists;
- Pedestrian crossings and footways;
- Highway layout and signal operation;
- Bus journey times; and
- The capacity and reliability of the TLRN and SRN.

Planning Model Audits are required to review the impact of proposals and to develop mitigation strategies. The outputs of this exercise could be used to support the planning application, which may be conditional on securing mitigation proven necessary through modelling, or object to it. Full details on the modelling requirements for planning applications can be found at **https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-applications/modelling**.

As planning applications fall before the Option Selection Stage of the Pathway project lifecycle (see **A2.3.1.1**), MAP does not directly apply to associated modelling. However, Spatial Planning advise that MAP principles are applied during Planning Model Audits to validate model outputs and to address potential network performance issues forming part of the planning decision. This is to ensure that external consultants acting for their clients, the developers, are providing an accurate assessment of the development impacts and any associated works that are proposed.

Planning Model Audits differ from MAP in the following key areas:

- Planning applications are assigned a Case Officer, from Spatial Planning, who is responsible for providing a collective and comprehensive response to the planning application. The Case Officer should be involved throughout the audit process and in decisions relating to the modelling requirements. The Case Officer may appoint a Principal Technical Planner to assist with the review of the modelling requirements. The Case Officer or Principal Technical Planner will liaise and coordinate with the MAE;
- For Planning Model Audits, further consideration may be given to the following at the MAP Stage 1 and MAP Stage 4 meetings, with respect to the model purpose:
    - Use of historic data;
    - Development trip assumptions;
    - Background trip assumptions; and
    - Sensitivity modelling.
- Correspondence should be sent to **PALMRequests@tfl.gov.uk** and not to **NMSchemeAssessments@tfl.gov.uk**;
- The MAP NAE role will be filled by a Principal Technical Planner to confirm that Spatial Planning's requirements have been met when responding to the planning application on behalf of TfL;
- Where any departures from MAP standards are suggested, they must be discussed and agreed by the Case Officer / Principal Technical Planner, in consultation with the MAE;

- In Planning Model Audits the SAE role involves undertaking viability checks on proposed designs, however this does not automatically include a review of safety-critical timings. Spatial Planning may request further checks on safety-critical timings, such as intergreens, on a project-specific basis. Ultimate responsibility for safety-critical timings within a planning model are the shared responsibility of the DE and CE;
- Standard MAP check sheets are not issued at MAP Stage 5b during Planning Model Audits, as the audits do not constitute scheme approval under MAP.
- Once the MAE has completed their audit checks and given feedback on model operation, the Principal Technical Planner will confirm as NAE that Spatial Planning's requirements have been met and a Technical and Planning Compliance Report will be issued; and
- MAP Stage 6 (MAP Completion) is not required for Planning Model Audits, therefore once the Technical and Planning Compliance Report has been issued the Planning Model Audit is considered complete.

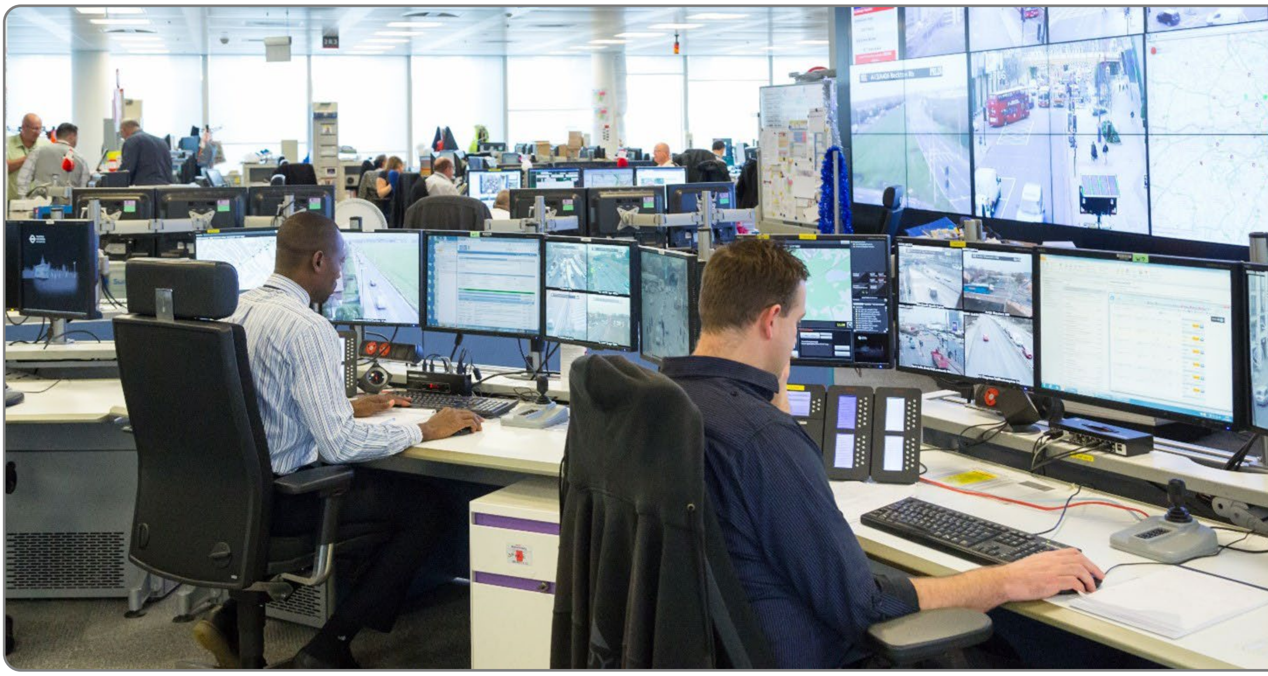
Further reviews of the modelling against full MAP standards will typically be needed at the Feasibility stage of Pathway as the planning proposal progresses towards implementation.

2.4 Fit for Purpose Modelling

The level of detail and the accuracy of a model must reflect the purpose for which the model is intended, as described in Part A of the **Traffic Modelling Guidelines**. The objectives of a scheme will directly influence the types and purpose of any required modelling, and which software will provide the most appropriate means of assessment. These will be agreed during MAP Stage 1 to define whether modelling will be deemed fit for purpose to assess the proposed design.

For a specific scheme a model may pass through a number of development phases, and at each subsequent stage the required level of detail and modelling accuracy typically increases. MAP formally applies to the final approval stage of the process but TfL may be engaged during previous phases as described in section **A2.3.1**.

3 MAP Overview and Involved Parties



There are typically seven stages for a MAP submission:

- Stage 1: Base Scoping Meeting (see **A3.2.1**);
- Stage 2: Calibrated Base Model Submission (see **A3.2.2**);
- Stage 3: Validated Base Model Submission (see **A3.2.3**);
- Stage 4: Proposal Scoping Meeting (see **A3.2.4**);
- Stage 5a: Future Base Model Submission (see **A3.2.5**);
- Stage 5b: Proposed Model Submission (see **A3.2.6**); and
- Stage 6: MAP Completion (see **A3.2.7**).

In IMAP the stage names differ from the above, however they follow a similar path in that Stages 2 and 3 cover the Base modelling stages and Stages 5a and 5b the Proposed modelling stages.

The parties involved in these MAP Stages are described in **Table 2** along with a basic description of each role.

Table 2: Role descriptions for the different parties involved in MAP

Role	Title	Description
Promoter	P	The person responsible for delivering and project managing the proposal
Design Engineer	DE	The modeller or engineer responsible for creating the modelling for the Promoter
Checking Engineer	CE	The modeller or engineer responsible for checking and signing off the Design Engineer's work as fit-for-purpose for the Promoter
TfL Signals Appraising Engineer	SAE	The engineer from Engineering & Asset Strategy, responsible for providing early design comments on the Proposal in the terms of safety and compliance to TfL Engineering standards
TfL Model Auditing Engineer	MAE	The engineer from / on behalf of NPD responsible for auditing the modelling, coordinating with the Network Manager[5] and communicating the network impact of the scheme
TfL Network Assurance Engineer	NAE	The NIST representative responsible for the assessment, then approval / rejection of the Promoter's proposal (under the TMA)

The scheme Promoter (P) is advised to ensure that the person(s) engaged to develop the modelling related to any scheme meet the following requirements:

- Considerable modelling experience with relevant software;
- Considerable experience in on-site data collection of traffic control parameters identified in the **Traffic Modelling Guidelines**, including saturation flows, degrees of saturation, lane utilisation identification and measurement of Underutilised Green Time;
- A good understanding of the capabilities of modern signal controllers, particularly with respect to interstage design and phase delays; and
- Experience of modelling signal controllers using modelling products such as LinSig.

5 The Network Manager is an NPD representative with local knowledge and responsibility for network operation in a specific area of London.

The skills outlined above should also exist at a senior (Checking Engineer) level for preliminary auditing prior to delivery of any traffic modelling within MAP.

3.1 Software-Specific MAP

MAP is designed to give a common structure for all model submissions. However, for different software / model types an auditor will apply distinct criteria during MAP Stages 2, 3, 5a and 5b when assessing the quality of the traffic modelling. MAP is therefore currently available for the most common traffic modelling packages used for scheme appraisal within TfL:

- Aimsun Next Model Auditing Process (AMAP) – see Chapter **B3**;
- Junctions Model Auditing Process (JMAP) – see Chapter **B4**;
- LinSig Model Auditing Process (LMAP) – see Chapter **B5**;
- ONE Model Auditing Process (IMAP) – see Chapter **B6**;
- Pedestrian Model Auditing Process (PMAP) – see Chapter **B7**;
- TRANSYT Model Auditing Process (TMAP) – see Chapter **B8**; and
- Vissim Model Auditing Process (VMAP) – see Chapter **B9**.

3.2 Scheme Progression through MAP

The following section contains an idealised representation of each party's involvement during progression through MAP. A flow chart representing the progression through MAP is shown in **Figure 7**.

In summary, the P should engage a DE to develop traffic modelling for their proposed scheme. The traffic modelling must be assessed internally by a Checking Engineer (CE), before being submitted to the Model Auditing Engineer (MAE) for auditing. Failure by the CE to audit a model before submission to TfL may result in additional costs due to programme delays or unnecessary audits and resubmissions, due to extra iterations between the DE and the MAE.

Standardised check sheets are used for communication between the DE, MAE and SAE during MAP Stages 1 to 5b.

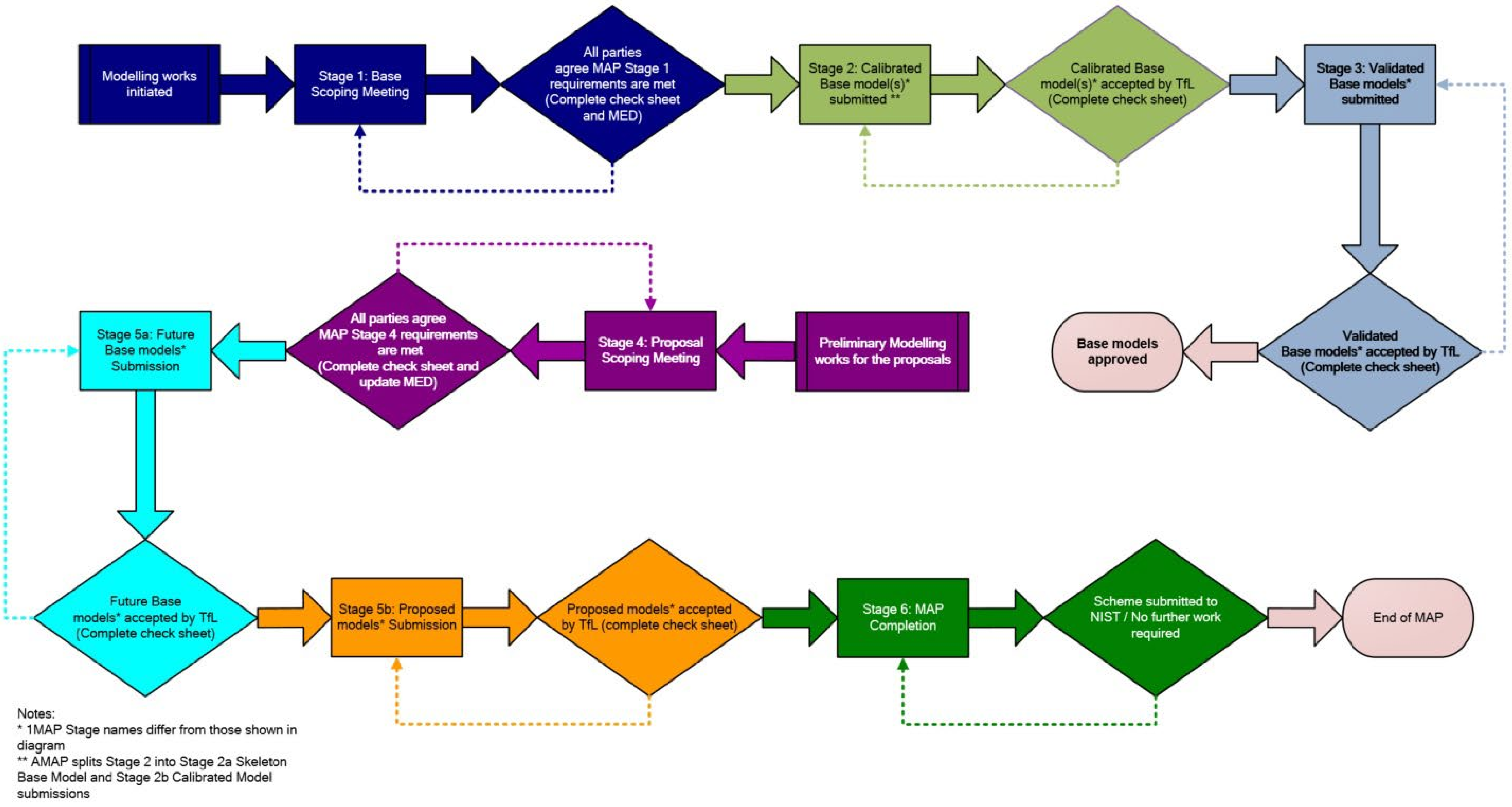


Figure 7: MAP Flow Chart

3.2.1 MAP Stage 1

On initiation of the modelling works for a scheme, the P or their representative should set up a Base Scoping Meeting (see **B2.2**) with all parties listed in **Table 2**. This meeting should discuss the scheme, and the modelling work that is required for both base and proposed modelling stages.

It is recommended that Stage 1 meetings occur prior to initiating the scheme design process. This is to ensure that all TfL knowledge and requirements are known to the P and DE prior to development of the scheme. It also provides an opportunity for to ensure all parties understand their roles and responsibilities within MAP.

It is the collective responsibility of the DE and the MAE to compile the agreed details of the modelling works and notes from the Stage 1 meeting and to distribute these to all parties.

A Modelling Expectations Document (MED), which summarises the agreed modelling requirements, is typically drafted by the DE prior to being reviewed and agreed by the MAE with contributions from the P and SAE. A template to assist the MAE in producing an MED is available if required. A submission cannot progress onto the software-specific MAP Stage 2 without a completed MAP Stage 1 Check Sheet (**MQA-0544/1**) and MED.

3.2.2 MAP Stage 2

For MAP Stage 2, partially Calibrated Base models must be prepared by the DE so that the MAE can review the early stages of model development. For IMAP, Stage 2 involves the DE updating the TfL-provided Base ONE Model to represent the on-street conditions within the study area.

MAP Stage 2 submissions may consist of one or more models, which may be non time-specific or covering each modelled time period, depending on the software-specific MAP being followed. The modelling must be assessed by the CE, and signed off as fit for purpose by both the DE and CE prior to submission to TfL.

When considered fit for purpose, the MAP Stage 2 modelling should be submitted to TfL for the MAE to audit. It is important for the DE to liaise with the MAE prior to submission to ensure available auditing resource. The MAE will approve or reject the submission based upon the software-specific criteria detailed in **Part B**. If a submission is rejected it will be returned to both the P and DE, with MAP Stage 2 check sheets indicating areas that require further development. In instances where models are rejected at this stage, the DE and MAE will liaise to ensure the MAE is satisfied with the standard of resubmitted models and agree timeframes for future audits.

3.2.3 MAP Stage 3

Validated Base models for each time period under consideration should be prepared by the DE, and checked by the CE prior to model submission. When considered fit for purpose, the MAP Stage 3 modelling, accompanying reports and supporting data should be submitted to TfL for auditing by the MAE. It is important for the DE to liaise with the MAE prior to submission to ensure available auditing resource.

The MAE will approve or reject the submission based upon the software-specific criteria detailed in **Part B**. If a submission is rejected it will be returned to both the P and DE, with MAP Stage 3 check sheets indicating areas that require further development. In instances where models are rejected at this stage, the DE and MAE should liaise so the MAE can become satisfied with the standard of model development in order to subsequently accept the modelling as validated and thus fit for purpose.

3.2.4 MAP Stage 4

Following approval of the Base models within MAP Stage 3, the P, or their representative, should set up a Proposed Scoping Meeting (see **B2.3**) with all parties listed in **Table 2**. The meeting should continue from details documented in Stage I to discuss the scheme proposals and the requirements for the Future Base and Proposed models. At this stage the Future Base and/or Proposed model outputs should be discussed with specific reference to an agreed strategy for signal timing optimisation. The DE and CE can reference the **Traffic Modelling Guidelines** for further information on Future Base and/or Proposed model optimisation.

It is the collective responsibility of the DE and MAE to document the agreed details of the modelling works and compile the minutes from the Stage 4 meeting. The minutes should be distributed to all parties listed in **Table 2**. The MED should be reviewed and updated where necessary and the Stage 4 check sheet should be completed by the MAE and reviewed by all parties. If all are in agreement, MAP Stage 5a or 5b can commence.

3.2.5 MAP Stage 5a

Where the Three Stage Modelling Process is being followed, Future Base models (based on the Validated Base models approved during MAP Stage 3) should be prepared by the DE for each time period under consideration. These models must be checked by the CE and deemed fit for purpose prior to model submission. When considered fit for purpose, the MAP Stage 3 modelling, accompanying reports and supporting data should be submitted to TfL for auditing by the MAE. It is important for the DE to liaise with the MAE prior to submission to ensure available auditing resource.

The MAE will approve or reject the submission based upon the software-specific criteria detailed in **Part B**. If a submission is rejected it will be returned to both the P and DE, with MAP Stage 5a check sheets indicating areas that require further development. In instances where models are rejected at this stage, the DE and MAE will liaise to encourage further development so that it can subsequently be approved as fit for purpose.

3.2.6 MAP Stage 5b

The DE must submit proposed road layout drawings and method of control changes to the MAE that are compliant with TfL Engineering & Asset Strategy standards and guidance. The MAE must confirm that the submitted proposed methods of control and drawings cover the proposals identified in the MED, and arrange for SAE appraisal of the proposals through an Engineering Service Request (ESR).

The SAE must undertake a Traffic Signal Option Selection Review (**F7356**) for any proposed changes to signal infrastructure. The review provides early design comments on the proposal, ensuring that all issues which may affect the legality, maintainability and buildability of the proposed traffic signal assets are brought to the attention of interested parties at this point. The review provides safety-critical timings which must be used as the basis for any modelling.

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE, or provide feedback on required design changes. The MAE must confirm that approval has been received for each location with proposed changes prior to the MAP Stage 5b audit commencing.

Proposed models should be prepared by the DE for each time period under consideration, based on the Validated Base or Future Base models approved during MAP Stage 3 / 5a. These models must be checked by the CE and deemed fit for purpose prior to model submission. When considered fit for purpose, the MAP Stage 5b modelling, accompanying reports and supporting data should be submitted to TfL for auditing by the MAE. It is important for the DE to liaise with the MAE prior to submission to ensure available auditing resource.

The MAE will approve or reject the submission based upon the software-specific criteria detailed in **Part B**. If a submission is rejected it will be returned to both the P and DE, with MAP Stage 5b check sheets indicating areas that require further development. In instances where models are rejected at this stage, the DE and MAE will liaise to encourage further development so that it can subsequently be approved as fit for purpose.

3.2.7 MAP Stage 6

MAP Stage 6 is the final stage of MAP. At this stage the MAE will complete the modelling assessment and provide a summary to the P and DE.

Where the scheme may impact on TLRN, SRN or bus operation an SIR will be required. The MAE will provide the document and the P should add details of the scheme and proposals with help from the DE. This should be returned to the MAE and SAE, who will complete their respective sections. The completed SIR will be returned to the P, who can respond to discuss any queries with its content.

The P can choose to submit the completed SIR to NIST for a decision on formal scheme approval. Should the P decide not to submit the SIR, the P should provide written confirmation of this to the MAE before MAP is considered complete.

It is possible, but not common, that the P may decide to submit the SIR at a later date. Where this is the case the road network will need to be reviewed by the DE and MAE prior to submission to ensure there have been no significant changes to network operation.

Where an SIR is not required MAP is considered complete once the modelling assessment has been provided.

Should the modelling assessment indicate that further design changes are necessary, the scheme modelling must go back to MAP Stage 4. Where a significant amount of time has passed, or the model scope is impacted, it may be necessary to go back to MAP Stage 1.

3.2.8 Communication

The P, DE and CE are positively encouraged to contact the MAE to clarify any issues relating to MAP, their role responsibilities, stage submission requirements or check sheets.

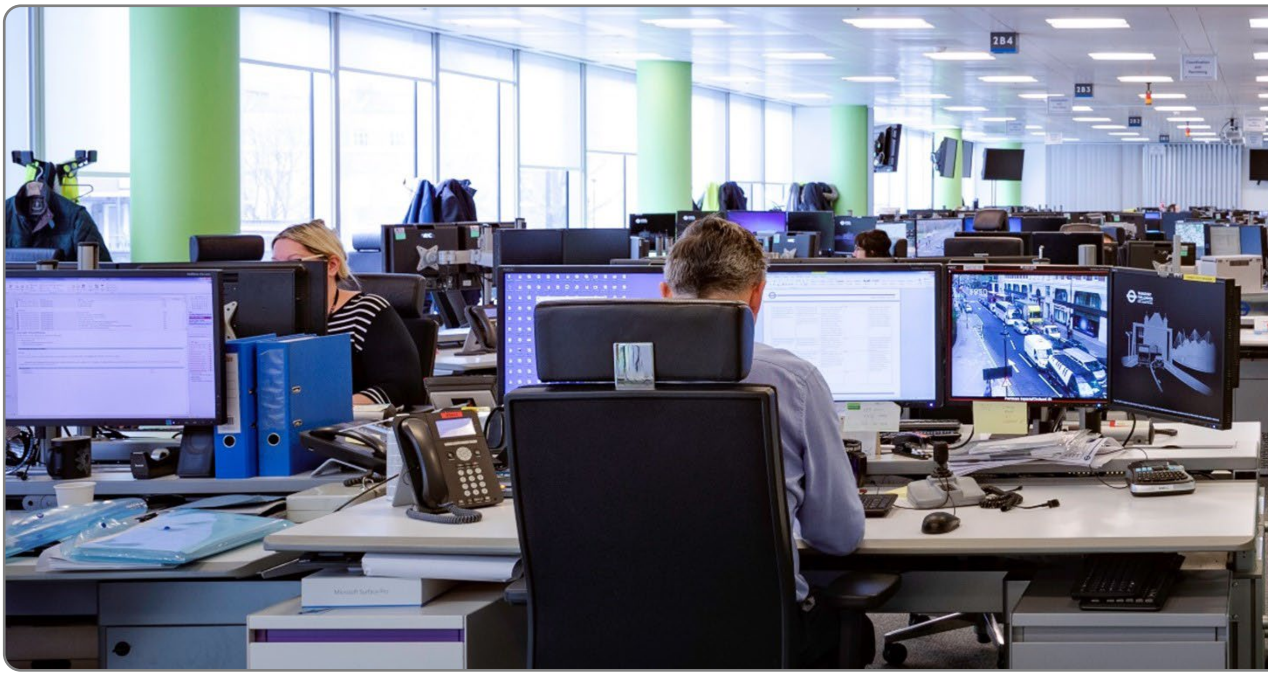
The DE is encouraged to communicate regularly with the MAE throughout the initial development of Base models, as the MAE may be able to provide valuable data or advice that will assist the DE in developing the models, such as through use of recommended modelling parameter values, background imagery, standard templates or other modelling tools. It is the collective responsibility of the MAE and the DE to ensure that models are developed using the latest version of any template files used.

Reaching agreement regarding modelling parameters before detailed development of the models should ensure that the models progress through the MAP process smoothly, and do not encounter auditing issues at later stages of MAP.

Formal submissions at all MAP stages must be sent to the following email address: **NMSchemeAssessments@tfl.gov.uk**. Formal responses from the MAE and SAE will also be copied to this address. Failure to formally submit modelling works at all stages of MAP may result in delays in progressing the model audit.

PART B – Modelling Standards and Auditing Guide

1 Introduction to Part B



1.1 Purpose

Part B of this document has a focus on technical model standards relating to model development and auditing best practice. The first chapter covers the scoping meeting stages of MAP, which are generic and cover all traffic modelling levels used in a scheme assessment.

The remainder of **Part B** is organised into chapters appropriate to MAP for different types of traffic model and modelling software. Individual chapters can be referred to for relevant guidance on the traffic model type and modelling software being used for a particular project.

1.2 Target Audience

The target audience for **Part B** is primarily the Design Engineer (DE) and Model Auditing Engineer (MAE) however the Checking Engineer (CE) should also be familiar with **Part B**. The technical and practical advice given in **Part B** is suitable for a traffic engineer, modeller or Network Manager with limited previous experience of model submission and auditing under MAP, whilst remaining relevant for those with more experience.

1.3 Expected Awareness and Competencies

Part B assumes some awareness of basic traffic engineering principles covering traffic surveys, traffic flows and traffic signal control. The DE, CE and MAE should be familiar with terminology such as phase minimum, phase intergreen, phase delay, stage minimum, interstage, cycle time, signal offset, saturation flow, degree of saturation, stopline flows, manual classified counts and demand flows.

This level of awareness would typically come from introductory courses to traffic signals as well as courses for industry-standard software packages, combined with some experience in the traffic engineering or transport planning fields.

If there are any additional competencies expected relating to a particular modelling package, these will be stated in the relevant MAP Chapter.

1.4 Approach to MAP

It is important to note that this document is only a guide and as such does not attempt to cover every modelling eventuality. This guidance note provides a structure to divide the auditing process into logical, manageable tasks. It should be used in conjunction with the Traffic Modelling Guidelines (see **A2.2**) and relevant software manuals to identify best modelling practice.

It is expected that the DE undertaking modelling work should be familiar with various techniques for traffic modelling and the applicable software to be used for specific tasks. Furthermore it is expected that the DE should have a thorough understanding of the area being modelled having carried out site visits. This is an essential aspect of modelling and crucial to being able to successfully complete an accurate model.

A competent modeller must act as a CE to review and approve the work completed by the DE before it is submitted to the MAE. This is important because the MAE is obliged to notify the Promoter (P) that further auditing will cease should they lose confidence in the ability of the DE.

When starting to audit a model, the MAE may face a substantial amount of data to interpret and audit. Additionally, there can often be non-intuitive adjustments and techniques applied within a traffic model in order to produce an accurate reflection of observed network behaviour.

For MAEs with limited experience and exposure to model auditing, support from TfL colleagues who have traffic engineering and modelling experience is recommended, and at times necessary. In addition, the MAE is required to be familiar with the modelled area (local knowledge), and to consider how traffic actually behaves on street (and whether this behaviour has been accurately modelled).

When auditing a model, it is understood that there can be instances where there is more than one method of modelling specific behaviour. However, there are also methods which can be clearly identified as inappropriate. Methodological flaws, as well as straightforward data input errors, will be highlighted through the structured auditing process outlined within this document.

A recommended approach for the comparison of different models, whether representing separate peaks during the same MAP stage or one peak at different MAP stages, is to use file comparison software or inbuilt auditing tools. This approach highlights differences in content between the files, allowing the auditor to focus on specific changes that have been made between models while saving the time that would be required looking through large amounts of modelling data that remain the same.

1.5 Familiarisation with MAP

Prior to undertaking a model auditing exercise in accordance with MAP, it is recommended that the DE. CE and MAE are familiar with **Part A**.

MAP is structured to include the following non-software-specific stages shown in **Figure 8**:

- **Stage 1:** Initiation of scheme Base modelling;
- **Stage 4:** Initiation of scheme Future Base / Proposed modelling; and
- **Stage 6:** Completion of the modelling assessment.

These stages are software independent because they collate information from several streams to both determine the overall purpose of the scheme and finally to assess whether that purpose has been satisfied within the proposed design.

While this document refers to ‘a model’ in relation to the scheme being audited in practice there could be a number of separate models relating to the one scheme, for example when proposals affect an area covering more than one UTC group or multiple time periods. Alternatively, where a scheme is following the Three Stage Modelling Process (see **A2.3.2**), there may be the requirement for several different modelling levels to be used in the scheme assessment each requiring MAP approval.

Where different modelling levels are used, there may a requirement for an iterative process sharing data and/or outputs between different models. Liaison between all parties involved with the model build and audit of each modelling level would be required so that the individual models can be approved appropriately once the iterations have been completed and data transferred.

It is vital that all parties are aware of the roles and responsibilities for each of the defined MAP participants as outlined in **A3**.

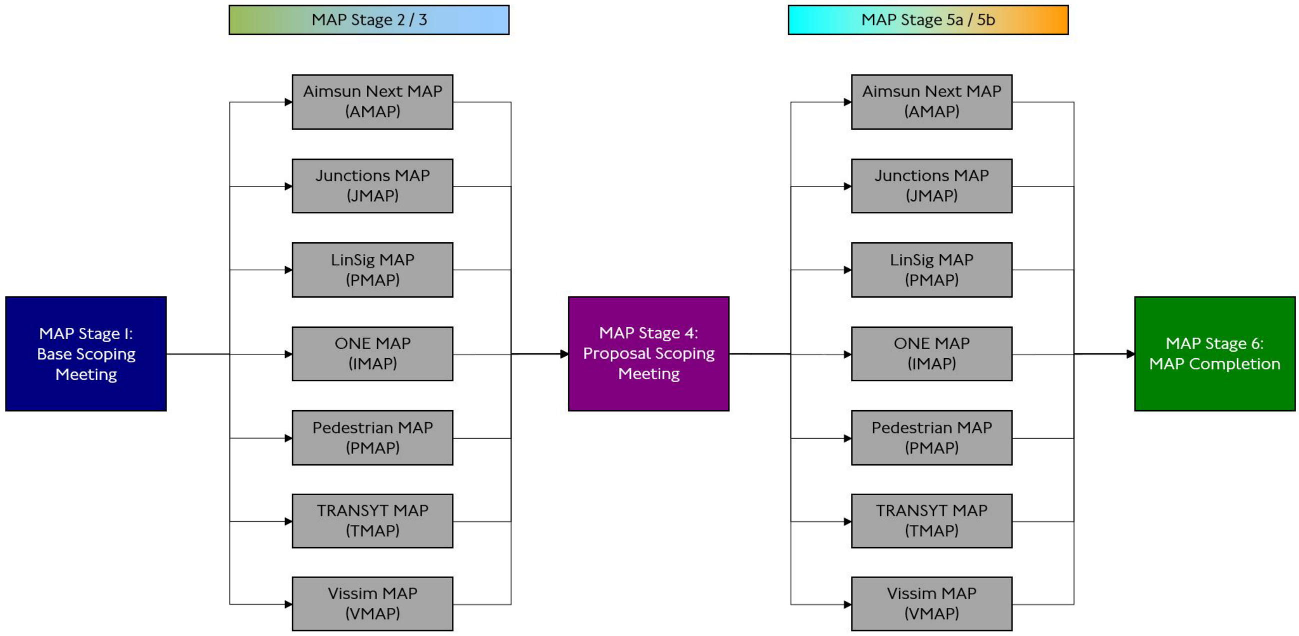


Figure 8: The software-independent stages within MAP

All formal MAP submissions and approvals / rejections at each MAP stage should be copied to **NMSchemeAssessments@TfL.gov.uk** to ensure that the progress of scheme submissions can be tracked and monitored.

2 MAP Scoping Meetings

2.1 Introduction

Prior to detailed modelling work meetings must be arranged with all parties involved in MAP, as described in **A3**. The scheme should be discussed at these meetings, along with the required outputs and modelling work required at the Base and Proposed modelling stages. Following these meetings all details of the modelling requirements must be recorded and updated within the Modelling Expectations Document (MED), which is discussed further in Part B of the **Traffic Modelling Guidelines** and used as a reference as the modelling work progresses.

MAP STAGE 1

2.2 MAP Stage 1 – Base Scoping Meeting

2.2.1 Introduction

It is encouraged, and highly recommended, that MAP Stage 1 Base Scoping Meetings occur prior to scheme detailed designs being developed. This will ensure that all TfL knowledge and requirements are captured by the Promoter (P) and the Design Engineer (DE) prior to development of the scheme.

A Base Scoping Meeting should be arranged as early as possible when it is clear that the P will require modelling to support their detailed design submission to Network Performance's (NP) Network Impact Specialist Team (NIST). The DE, CE and MAE key responsibilities for MAP Stage 1 are shown in **Table 2**.

It may be helpful to refer to the Part B of the **Traffic Modelling Guidelines**, prior to the Base Scoping Meeting.

2.2.2 MAP Stage 1 Check Sheet

MAP Stage 1 has a Check Sheet (**MQA-0544/1**) acts as a formal record of the Base Scoping Meeting and completion of the Modelling Expectations Document (MED) at MAP Stage 1. Once the MED is approved the MAE should distribute the completed MAP Stage 1 Check Sheet to all parties.

M.101 Roles and Responsibilities

The MAP roles and responsibilities should be discussed at the MAP Stage 1 meeting. During the meeting the DE must acknowledge that as a representative of the P, all roles and responsibilities within MAP are understood.

Once confirmed, the MAE will sign off the **M.101** Check Sheet entry on behalf of all parties.

M.102 Base Scoping Meeting

The MAE must ensure that the name and affiliation of all parties attending the Base Scoping Meeting, together with the date, have been captured on the MAP Stage 1 Check Sheet (**MQA-0544/1**).

Possible agenda items to cover during the Base Scoping Meeting include, but are not limited to:

- Clarification of MAP roles and responsibilities (**M.101**);
- Modelling purpose (**M.103**);
- Modelling methodology (**M.105**), including:
    - Requirement for the Three Stage Modelling process;
    - Levels of modelling required; and
    - Exchange of data.
- Model scope, including:
    - Junctions to be modelled (**M.106**);
    - Modelled time periods;
    - Modelled years; and
    - Critical approaches / areas in the network.
- Software and software version (**M.107**);
- Vehicle and/or pedestrian classifications;
- Survey requirements;
- Site observations (see **Traffic Modelling Guidelines**);
- Signal data, including:
    - Site paperwork;
    - Signal timing messages for sites operating under UTC control; and
    - Agree methodology for collecting signal timings for junctions not operating under UTC control.
- Public transport modelling;
- Cycling modelling;
- Pedestrian modelling;
- Validation requirements;
- Proposals:
    - List of proposed changes;
- Model outputs;

- Documentation:
    - Modelling Expectations Document (MED) (**M.108**)
    - Reports; and
    - Check Sheets.
- Programme;
- Submissions; and
- Working relationship.

The DE should document all agreements made during the Base Scoping Meeting in the MED.

M.103 Modelling Purpose

The level of detail and the accuracy of a model must reflect the purpose for which the model is intended. The objectives of a scheme will directly influence the type and purpose of any prerequisite modelling. Traffic modelling to support a scheme through TfL approval represents the highest level of detail and accuracy required of a model. The term used in MAP to assess whether a model is valid and accurate is 'Fit for purpose'. Through MAP, the MAE is being asked to assess the model and to declare whether a model is (or is not) 'Fit for purpose'.

As the purpose of every individual model is different, the DE must clearly describe the purpose of the modelling within the MED. The purpose of the modelling should be informed by the proposals and the P's design brief to the DE. It is this purpose that the MAE will assess the submitted modelling and model outputs against.

M.104 List of Proposed Changes

All parties should agree and document the junctions affected by the proposal. The DE can create an initial list based on their knowledge of the proposal. It is recommended that the DE creates this list prior to the first meeting and circulates the list to the interested parties. This will facilitate a productive meeting where the proposals can be discussed along with an agreement about the junctions affected.

Once agreed, the MAE must confirm the list of all junctions that are affected by the proposal (including TfL-Site References) and for which there are changes to the Method of Control and/or the road layout.

M.105 Modelling Methodology

Once the purpose of the modelling has been determined, the modelling methodology to accurately assess the proposals should be agreed between all parties. Possible modelling methodology topics to be reviewed include, but are not limited to:

- Three Stage Modelling;
- Exchanging data between modelling levels;
- Calibration requirements; and
- Validation requirements.

The DE must document the agreed modelling methodology in the MED (**M.108**).

M.106 List of Junctions to be Modelled

Once the modelling purpose (**M.103**) has been agreed, the MAE has to consider the proposals and determine and agree the extent of the affected road network which needs to be modelled in order to carry out a valid network impact assessment. The Base Scoping Meeting provides an opportunity for the extent of the area to be modelled to be discussed.

The DE must update the MED (**M.108**) with the agreed list of junctions to be modelled, including TfL-Site References. The final decision on the junctions to be included in the model is determined by the MAE, and may require additional information, data or conduct a site visit if necessary.

Familiarisation with the area of study and traffic modelling / auditing experience is needed to support this decision so it is likely that the MAE may need support from colleagues such as the NAE and other stakeholders in making a decision.

M.107 Software and Software Version

It is the collective responsibility of the DE and the MAE to ensure that models are developed using the most appropriate software and software version following the Base Scoping Meeting. The DE must ensure the agreed software and version have been correctly documented within the

MED (M.108) and the MAE must confirm to the DE that this software is available for use and supported within TfL.

M.108 Modelling Expectations Document

The Modelling Expectations Document (MED), which summarises the agreed modelling requirements, is a collective responsibility of all parties. It is typically drafted by the DE before being reviewed and agreed by the MAE with contributions from the P and SAE. A template to assist the DE in producing an MED is available on request from NP.

The DE must ensure that any scheme-specific TfL modelling requirements as agreed in M.101 – M.107 are correctly documented, which should be confirmed by the MAE. The Traffic Modelling Guidelines may be used as a reference source when justifying any additional scheme-specific modelling requirements stipulated by TfL.

2.2.3 Agreement to Proceed to MAP Stage 2

It is the collective responsibility of the P, DE, CE and MAE to ensure that all of the MAP Stage 1 requirements have been met and the audit can proceed to MAP Stage 2.

The P, DE, CE and MAE must review and approve the updated Modelling Expectations Document. Once approved the MAE should distribute the completed MAP Stage 1 Check Sheet (**MQA-0544/1**) and the updated Modelling Expectations Document, which should also be copied to **NMSchemeAssessments@TfL.gov.uk**.

End of MAP Stage 1

2.3 MAP Stage 4 – Proposal Scoping Meeting

MAP STAGE 4

2.3.1 Introduction

As with the MAP Stage 1 Base Scoping Meeting, the P, DE, MAE, SAE and NAE must meet to discuss the details of the proposals and re-confirm how they are to be modelled. The bulk of the modelling work will have been completed during the development of the Base model. Following the meeting it is the responsibility of the DE and the MAE to review and update the MED.

2.3.2 MAP Stage 4 Check Sheet

MAP Stage 4 has a Check Sheet (**MQA-0544/4**), which acts as a formal record of the Proposal Scoping Meeting and the updating of the MED at MAP Stage 4. Once the updated MED is approved the MAE should distribute the completed MAP Stage 4 Check Sheet to all parties.

M.401 Proposal Scoping Meeting

The MAE must ensure that the name and affiliation of all parties attending the Proposal Scoping Meeting, together with the date, have been captured on the MAP Stage 4 Check Sheet (**MQA-0544/4**).

Possible agenda items to cover during the Proposal Scoping Meeting include, but are not limited to:

- Review of MAP roles;
- Review of model purpose (**M.401**);
- Modelling methodology (**M.403**), including:
    - Requirement for the Three Stage Modelling process;
    - Levels of modelling required; and
    - Interaction between different modelling levels, including inputs / outputs.
- Review of model scope, including:

    - Alignment of modelled years between different modelling levels; and
    - Critical approaches / areas in the network.

- Review of modelling software:
    - Any requirement for additional modelling using different software if conditions have changed, such as congestion or modal shift.
- Vehicle and/or pedestrian classifications:
    - Any additional classifications required in the proposed scenarios.
- List of schemes to be reflected in the Future Base modelling, if Three Stage Modelling required (**M.404**);
- Update on proposals, including;
    - Physical layout / signal changes (**M.405**);
    - Future Demand (**M.406**).
- Public transport modelling;
- Cycling modelling;
- Pedestrian modelling;
- Operational optimisation strategies;
- Proposed signal design checks (**M.407**), including:
    - Engineering Service Requests;
    - SAE review of traffic signal proposals.
- Model outputs;
- Presentation of model results;
    - Banding;
    - Caveats; and
    - Distribution.
- Documentation (**M.408**):
    - MED update (**M.108**)
    - Reports; and
    - Check Sheets.
- Programme;
- Submissions; and
- Working relationship.

The DE should update the MED with all agreements made during the Proposal Scoping Meeting.

M.402 Modelling Purpose

During the Proposal Scoping Meeting the purpose of the modelling should be reviewed. Any revisions to the scheme objectives, these may impact whether the proposed modelling methodologies will result in Fit for Purpose models being developed.

The DE should ensure that the modelling purpose is updated within the MED to reflect any changes to the scheme objectives. It is this purpose that the MAE will assess the submitted modelling and model outputs against.

M.403 Modelling Methodology

The modelling methodology was agreed during MAP Stage 1 (**M.105**), however it should be reviewed during the Proposal Scoping Meeting to account for any changes to the modelling purpose since the Base Scoping Meeting. Possible modelling methodology topics to be reviewed include, but are not limited to:

- Three Stage Modelling;
- Exchanging data between modelling levels;
- Iteration between modelling levels; and
- Mitigation measures.

The DE must update the MED (**M.409**) with any agreed changes to the modelling methodology.

M.404 Future Schemes

During the Proposal Scoping Meeting, agreement between all parties is required on whether the Three Stage Modelling process is followed for the assessment.

When the Three Stage Modelling process is followed, agreement is required on the relevant planned schemes and likely network changes that should be included as part of the Future Base and Proposed modelling assessment. These could include schemes within the model boundary or outside the boundary but many impact the demand or network of the model.

The process for the DE to obtain the details of the planned schemes and likely network changes, such as drawings and accompanying modelling, should be confirmed by the MAE.

The DE should update the MED with all agreements on the inclusion of planned schemes / likely network changes.

M.405 Physical Layout / Signal Changes

It is possible that in some cases a significant amount of time may have passed between approval of MAP Stage 3 and the start of MAP Stage 4. In this case the required changes to the physical layout and signals should be discussed at the Proposal Scoping Meeting to outline any adjustments required to the Base modelling to represent the Future Base / Proposed scenarios.

The proposed strategy for signal timing optimisation during each modelled period should be discussed and agreed, alongside agreements on the impact of UGT or demand dependency in the Proposed modelling. The DE / MAE should liaise with the appropriate Network Manager to seek guidance on the proposals and any operational strategies that may impact on the Proposed modelling.

The DE should update the MED with agreements on the physical layout and signal changes, which should be reviewed and agreed by the MAE.

M.406 Future Demand

During the Proposal Scoping Meeting the future demand to be used in the modelling assessment should be reviewed for the following modes:

- Traffic (general);
- Public Transport;
- Cyclists; and
- Pedestrians

When reviewing the changes in demand, consideration should be given to the impact of:

- Forecasted growth or sources of additional demand;
- Potential for rerouting, either from the scheme being assessed or planned schemes / likely network changes; and
- Modal choice.

There may be the requirement to have different methodologies for representing the Future Demand depending on the modelling level or the software-specific MAP chapter being followed.

The DE should update the MED with agreements on the Future Demand, which should be reviewed and agreed by the MAE.

M.407 SAE Design Submission

It is a requirement of MAP Stage 5b that any new or modified traffic signal infrastructure should undergo a review by the SAE to identify issues affecting the legality, maintainability and buildability of the proposals. Lack of a review by the SAE will prevent a MAP Stage 5b audit beginning in earnest.

During the Proposal Scoping Meeting, all parties should reach agreement on the proposals being submitted to the SAE for review, which will match the MAP Stage 5b model submission.

The DE should update the MED with the agreed SAE design submission details.

M.408 Reporting Requirements

NPD will use modelling outputs and analysis to assess the likely impacts of the scheme. It is important to document the modelling development process, including assumptions, together with reporting the results of a scheme assessment.

During the Proposal Scoping Meeting the following reporting requirements should be agreed:

- Required documentation;
- Model outputs, including comparisons between scenarios; and
- Exchanging data between modelling levels.

The DE should document any agreements in the MED (**M.409**), which will be checked by the MAE.

M.409 Modelling Expectations Document

The Modelling Expectations Document produced during MAP Stage 1 should be reviewed and updated to incorporate any new information raised during the Proposal Scoping Meeting, and agreed in **M.401** - **M.408**. This is to be updated by the DE and agreed by the P, MAE and SAE.

2.3.3 Agreement to Proceed to MAP Stage 5a / 5b

It is the collective responsibility of the P, DE, CE, SAE and MAE to ensure that all of the MAP Stage 4 requirements have been met and the audit can proceed to MAP Stage 5a / 5b.

The P, DE, CE, SAE and MAE must review and approve the updated Modelling Expectations Document. Once approved the MAE should distribute the completed MAP Stage 4 Check Sheet (**MQA-0544/4**) and the updated Modelling Expectations Document, which should also be copied to **NMSchemeAssessments@TfL.gov.uk**.

End of MAP Stage 4

3 Aimsun Next MAP (AMAP)

3.1 Scope

AMAP applies to all Aimsun Next modelling submitted to TfL Operations for auditing.

3.1.1 Supporting Modelling

It is common practice, and highly recommended, that both Base, Future Base and Proposed Aimsun Next models are developed for networks which already have supporting MAP-approved modelling using traffic signal optimisation software such as LinSig or TRANSYT. This allows for signal optimisation of the proposal and easier auditing of signal timings and saturation flows in Aimsun Next.

LinSig Skeleton models, although not covered by MAP, may also be useful for the purpose of auditing signal timings and controller behaviour in addition to any MAP-approved models.

AMAP STAGE 2a

3.2 AMAP Stage 2a, Aimsun Next Skeleton Model Submission

3.2.1 What is an Aimsun Next Skeleton Model?

An Aimsun Next Skeleton model is a non-time-specific model that contains the basic network structure and correct fundamental parameter sets required for model development. The skeleton model should be submitted with a report detailing the modelling methodology, including detailing the approach used for traffic flow assignment and routing.

It is recommended that a base TfL Aimsun Next template file containing recommended settings is used, and is available upon request. Use of the template is not compulsory, but Aimsun Next Skeleton models should contain TfL-approved values for the following:

- Simulation Parameters;
- Coordinate System and Model Units;
- Visual overlay or GIS data;
- Vehicle Types;
- Road Types;
- Sections; and
- View Styles and Modes.

A single Skeleton model submission is required for AMAP Stage 2a.

3.2.2 What is the purpose of an Aimsun Next Skeleton Model?

The development of calibrated and validated microsimulation modelling can be time-consuming and resource-intensive.

AMAP Stage 2a ensures the model is being constructed using an agreed template and is unlikely to require further changes during subsequent development and auditing stages of AMAP. It is important that the MAE and the DE agree fundamental Aimsun Next modelling parameters prior to any model development, calibration and validation.

Once a model has been validated, changing the basic parameter sets outlined in section **A3.2.1** may significantly impact the model performance and require the model to be re-calibrated and re-validated

3.2.3 AMAP Stage 2a Check Sheet

AMAP Stage 2a has a Check Sheet (**MQA-0544/A2a**), which must be completed by the MAE when auditing the model.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

A.201 Technical Note

Aimsun Next Skeleton model submissions must be accompanied by a technical note.

The technical note provides an opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a 'tick box' requirement. It is a technical document and it should be specific to the model it accompanies.

Key elements are outlined below:

- The scope and purpose of the Aimsun Next models, as agreed at MAP Stage 1 and defined in the Modelling Expectations Document (MED);
- Extent of the modelling area, as agreed at MAP Stage 1;
- Modelling periods, as agreed at MAP Stage 1;
- Details of any variation from default Aimsun Next parameters defined within the TfL Aimsun Next template, with justification for the changes;
- Source of data used to define parameters within the Skeleton model;
- Source of the road network. This may be from a GIS import (for example Open Street Map), from another transport model, from a cordoned area of a larger Aimsun Next model or through manual entry using an overlay file;
- The method used to include traffic demand. An Aimsun Next 'Traffic State' uses entry flows and turn proportions only and is acceptable if there is no reason to model route choice or journey times. OD-based

demand must be used if there is route choice or if journey times are to be measured.

- The traffic assignment method to be used in the models. TfL prefers the use of static paths, however if dynamic paths are deemed necessary to support the proposal, this must be discussed and agreed at MAP Stage I with supporting justification provided by the DE; and
- Any other modelling assumptions that will impact development of the AMAP Stage 2b Calibrated Base Aimsun Next models.

A.202 Software and Simulation Parameters

The software version should be as agreed at MAP Stage I and documented in the MED.

The DE should ensure the following parameter sets are appropriate, which will be checked by the MAE:

- **Rule of the Road:** should be 'Left for UK models;
- **Simulation period:** should include the peak period, a warm-up and cool-down period as defined within the **Traffic Modelling Guidelines**; and
- **Simulation step:** by default the simulation step corresponds to the reaction time of all vehicles. Values that should be used are in the range 0.6-I.0 seconds. Lower values should be used only if the study requires different vehicles to have different reaction times, as each reaction time must be an integer multiple of the simulation step; this will result in mathematically more accurate model behaviour but slower simulation speeds.

A.203 Coordinate System and Model Units

The TfL Aimsun Next template uses the UTM coordinate system, EPSG:32630. To ensure compatibility between models, this should not be altered. Aimsun Next supports the re-projection to UTM of data from sources in different coordinate systems upon importing.

Aimsun Next model units may be set to either metric or imperial and switched at any time without altering the simulation results. The TfL Aimsun Next template uses metric units and it is recommended that the

DE and MAE use these units for analysis of model results. The MAE should therefore ensure that metric units are applied within the Skeleton model.

A.204 Background, Model Import or Cordon

The DE should use an appropriate background - either a CAD drawing, an aerial photo or an image from a mapping system. The background data must be checked to ensure it is scaled correctly and if aerial photos are used, orthographically corrected to prevent distortion. If not, it will result in the development of an Aimsun Next network to incorrect dimensions and potentially erroneous layout data. The network structure should be correct within a AMAP Stage 2a submission.

The DE should ensure the Aimsun Next background file is at a resolution sufficient for network development, up-to-date, and correctly scaled and undistorted. This will be checked by the MAE.

The background data may also be used to import the network topology directly from mapping data, from GIS systems or from Open Street Map. If this option is taken, the resulting network must be checked to verify:

- That the correct road types have been imported (in essence, the major routes, the secondary routes, but not the car park internal routes);
- For road type and road attribute consistency. The use of Aimsun Next view modes to display the static attributes of road sections and visually check consistency is recommended;
- That junction geometry, turns and conflicts are correct; and
- Allocation of imported objects to the correct layers.

The road network may also be generated as a subnetwork of a wider area Aimsun Next model. If this option is taken then the same checks should be conducted as for a GIS import to verify the network

It should be noted that after importing or editing data, a change in the coordinate system will not make Aimsun Next re-project the current data. Because of that, the coordinate system must be set before adding any geographic information.

A.205 Vehicle Classes and Types

Vehicle classes and types are provided in the TfL Aimsun Next template as follows:

- Vehicle Classes:
  - **Bicycle Class:** This class is able to use bicycle lanes;
  - **Car Class:** Light goods vehicles, taxis, and cars;
  - **Heavy Class:** Heavy goods vehicles and buses; and
  - **Public Class:** Public service vehicles which includes taxis as they are permitted in bus lanes.

- Vehicle types:
  - **Car:** A private car;
  - **LGV:** A typical 'white van'. This has the dimensions of a mid-range van and the performance of a car;
  - **OGVI:** A subclass of HGV (Heavy Goods Vehicles). Other Goods Vehicles (I) are two or three axle rigid trucks;
  - **OGV2:** A subclass of HGV (Heavy Goods Vehicles). Other Goods Vehicles (2) are four axle rigid trucks, or articulated vehicles;
  - **Taxi:** A TX4 London taxi;
  - **Routemaster Bus:** The iconic London bus (modern version);
  - **Pedestrian;** and
  - **Bicycle**.

The Taxi and Routemaster have the same physical dimensions as their real counterparts. Other less specific vehicle types have a range of standard dimensions.

For each vehicle type, the template provides default average, deviation, minimum, maximum of the truncated normal distribution for vehicle parameters including:

- Length;
- Width;
- Maximum desired speed;
- Speed acceptance;
- Clearance;
- Maximum give-way time;
- Guidance acceptance
- Maximum acceleration;
- Maximum deceleration;

- Sensitivity factor; and
- Margin For Overtaking Manoeuvre.

Each vehicle type should have a 3D model associated with it to be used when 3D views are required.

The default values for Reaction Times in normal driving and at stops or traffic signals for vehicles are specified as a probability set for the vehicle type. These may be amended if required in an 'Experiment' and this is preferable to changing the vehicle type defaults.

If the chosen assignment method includes both static and dynamic paths, the proportion of each vehicle type using each type of path must be specified.

Changes to vehicle behaviour parameters from default values, as defined within the appropriate TfL Aimsun Next template, should be specified in **A.201** and supported by suitable field data or documented TfL advice.

The use of incorrect vehicle parameters may have a significant impact on network performance and hence journey times in later stages of model development. All vehicle types in the Skeleton model should therefore be correctly defined.

A.206 Road and Lanes Types

Road types define different sets of default behaviour parameters for Sections and Turns. The number of road types in any model should be kept to a minimum. The creation of additional road types may sometimes be necessary, but supporting evidence explaining their use should be presented in **A.201**.

Lane types are used to reserve lanes for specific classes of vehicle types. The following lane types are recommended by TfL:

- Reserved (Compulsory for Public Vehicle Class);
- Reserved (Compulsory for Heavy Vehicle Class); and
- Reserved for Bicycles

TfL recommends use of the following road types taken from WebTAG Unit 3.1, modified to be classified by speed rather than by lane number:

- Bicycle Track / Pedestrian way;
- Motorway / Dual 40 mph;
- Motorway / Dual 50 mph;
- Motorway / Dual 60 mph;
- Motorway / Dual 70 mph;
- Rural 50 mph;
- Rural 60 mph;
- Urban 20 mph;
- Urban 30 mph;
- Urban 30 mph narrow; and
- Urban 40 mph.

For each road type, the template provides default values for road parameters including:

- Speed limit;
- Capacity (Per lane);
- Lane width;
- Lane-changing cooperation;
- Lane-changing aggressiveness;
- Braking intensity;
- Imprudent lane-changing;
- Yellow box speed;
- Distance zone 1;
- Distance zone 2;
- Waiting time before missing a turn;
- Initial safety margin;
- Final safety margin;
- Initial give-way time factor;
- Final give-way time factor;
- Visibility to give way; and
- Visibility along main stream.

The DE should ensure that the speed limit of each road section corresponds to the relevant prescribed speed limit, altering the default value where needed. As part of the calibration process, the DE should also adapt the other parameters at section or turn level where needed. Significant changes that override values defined by the road type should be specified in **A.201** and supported by suitable observed data.

A.207 Assignment and Route Choice Model

The DE must ensure, and MAE verify, that the correct traffic assignment choice has been used as agreed during MAP Stage 1.

If OD matrices are used to specify traffic demand, then paths are required to route vehicles in the model. TfL prefers that models are submitted with static paths that do not vary as the model is run. These paths may be entered manually, generated either as the model starts, or at the end of the warm-up period, or imported from either a traversal generated by a wider area model or from an assignment process in the current model.

TfL advises against use of dynamic models unless static routes cannot be established with accuracy. In cases where dynamic modelling is justified, a combined static-dynamic assignment is preferred to aid convergence within congested networks. TfL only require dynamic assignment to be used if the network includes routing alternatives, and if the changes introduced in future scenarios significantly change travel times or introduce / remove routing options. This should have been agreed at MAP Stage 1. The results analysis must then include an assessment of their impact on vehicle path choice.

The DE should report to the MAE which method was used to generate paths and how vehicles were assigned to them.

If the use of dynamic assignment has been justified and agreed during MAP Stage 1, the MAE should already have informed the DE of the convergence criteria required. Additional MAE checks on stability parameters and convergence of the assignment will be required during AMAP Stage 2b

A.208 Network Structure

The initial model network structure should be accurate and consistent to the base mapping. TfL guidance concerning appropriate section and node structures should be observed.

Key elements of the network structure are:

- Sections:
  - Number of lanes;
  - Length;
  - Reserved lanes and lane closures;
  - Presence of lateral lanes; and
  - Pedestrian and cycle links.
- Nodes:
  - All possible movements;
  - Lane to lane connectors;
  - Intermediate stoplines;
  - Priority rules; and
  - Turn geometry / speed.

TfL guidance on the length of road sections, coding their shape and their entry and exit angles should be observed. Similarly lateral lanes, lane drops and lane gains should be coded as a single section of adequate length to allow correct vehicle behaviour and lane to lane connections should be coded to avoid conflict, except when it may be necessary, such as in the circulating lanes of a roundabout.

A.209 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **A.201 – A.208.**

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the AMAP Stage 2a Check Sheet (**MQA-0544/A2a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **A.201 – A.208**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

3.2.4 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **A.201** – **A.209** and there are no other issues the MAE will approve the model and authorise the AMAP Stage 2a Check Sheet (**MQA-0544/A2a**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide a completed AMAP Stage 2a Check Sheet (**MQA-0544/A2a**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of AMAP Stage 2a

3.2.5 Stage 2a to Stage 2b, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system. Demand dependency data must be collected for the same time as other traffic surveys and should be recorded separately for each modelled period. If a junction is able to alternate between single cycling or double cycling, careful consideration should be given the interpretation of the demand dependency data.

AMAP STAGE 2b

3.3 AMAP Stage 2b, Aimsun Next Calibrated Base Model Submission

3.3.1 What is an Aimsun Next Calibrated Base Model?

An Aimsun Next Calibrated Base model should have:

- Appropriate traffic demand data from on-street surveys, in accordance with the scope and purpose of the model as defined in MAP Stage 1;
- Public transport data collected from reliable sources, and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model as defined in MAP Stage 1;
- Correct on-street signal control data with representative signal timings for the network during the period under consideration. These may be modelled using fixed times, actuated signals, or by including SCOOT control depending on the application of the model;
- Calibrated saturation flows at signalised junctions using the Discharged Rate Evaluation Extension;
- Accurately modelled give-way behaviour that results in the correct modelled representation of existing on-street conditions; and
- An appropriate road section structure to replicate on-street traffic behaviour.

Calibrated Base models are required for all time periods in AMAP Stage 2b. Where multiple scenarios exist in a model, it is important that the DE specifies which scenario is being submitted for auditing.

3.3.2 What is the purpose of an Aimsun Next Calibrated Base Models?

The submission of Calibrated Base models prior to model validation is useful for both the DE and the MAE, and will improve the standard of the Validated Base model submissions. Calibrated Base model submissions provide an opportunity to ensure that the DE has understood the UTC and network data they have been provided with, and have collected sufficient knowledge of the network.

3.3.3 AMAP Stage 2b Check Sheet

AMAP Stage 2b has a Check Sheet (**MQA-0544/A2b**), which must be completed by the MAE when auditing the models.

> A separate AMAP Stage 2b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

A.221 Calibration Report

The DE is required to submit a Calibration Report with the Calibrated Base model, as described in the Traffic Modelling Guidelines. The Calibration Report provides an opportunity for the DE to outline to the MAE how the model has been constructed. It should not be treated as a 'tick box' requirement. It is an engineering document and it should be specific to the model it accompanies.

The Calibration Report should contain:

- The stated purpose of the model, as agreed during MAP Stage 1 and defined in the Modelling Expectations Document;
- A list of all the TfL-referenced nodes in the network with addresses, as agreed during MAP Stage 1;
- Notes covering site observations which detail physical constraints within the network and driving behaviour. Where behaviour is specific to a time of day, this should be noted. It is important for the DE to

explain how these observations have determined the structure of the model;

- Site datasheets with measured saturation flows or data from accompanying approved TMAP Stage 3 TRANSYT or LMAP Stage 3 LinSig models and those derived from the Aimsun Next Calibrated Base model;
- The source signal timings. If there are no accompanying MAP Stage 3-approved LinSig or TRANSYT models, then in the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated using an approved method and clearly presented for audit;
- List of any network changes to the approved AMAP Stage 2a model with justification;
- Sources of data used for development of the Aimsun Next model (such as traffic data, signal data and public transport timetables / routes and source of the background or if it is from a model import or Cordon);
- List of all modelling assumptions with supporting evidence; and
- List of any default parameter changes with supporting evidence.

A.222 Base Traffic Data

The DE should define the following parameters, which will be audited by the MAE:

- **Simulation warm-up period:** to define an initial state for the simulation period, with sufficient duration to give observed network conditions at the start of the simulation (to be agreed with the MAE);
- **Simulation period:** should cover a pre-peak period (to be able to undertake the analysis required to set the warm-up), the whole of the modelled peak and a post-peak period (to be able to analyse the time required to recover from peak conditions);
- **Vehicle types and the associated parameters:** The vehicle types should those specified in the TfL Aimsun Next Template with additions made only if required to include behaviour or circumstances specific to the modelled area.
- **Traffic Demand:** The demand in the network may be introduced either by using an Aimsun Next 'Traffic State' (using input flows and

turning proportions only) or by using an OD matrix and set of route paths. This must be agreed at MAP Stage 1, and should be applied as follows:

- For Traffic states:
  - Entry flows per vehicle type on all input sections to the modelled area;
  - Turn per vehicle type proportions at each junction. The option to highlight incorrect definitions in the Traffic State must be used to check turn proportions are defined, and that they sum to 100%.
- For OD matrices:
  - The OD matrices appropriately disaggregated by vehicle class; and
  - Either:
  - a scenario in which paths (either static initial paths or recalculated dynamic paths) are automatically generated, and a note to describe how this is achieved in the model; or
  - a 'Path Assignment' object and its associated (***.apa**) file with a description of how these paths were generated.

The DE must ensure that:

- Turn and link count data used to generate a Traffic State must represent the volume of traffic in the modelled period;
- Origin-Destination (OD) matrices must similarly represent the volume of traffic in the modelled period; and
- If OD matrices and paths are used then the paths are realistic and capture different access to travel time information, such as Static paths or Dynamic User Equilibrium paths for drivers following habitual paths based on past experience and Stochastic Route Choice paths for drivers who have access to pre-trip or on-trip information;

The MAE should also use the Aimsun Next 'Dynamic Check Tool' verify that there are no 'Lost Vehicles' in the simulation indicating that vehicles have no path. If there are vehicles with 'Missed Turns', indicating that they have changed to a new path, the cause should be noted and accepted or not depending on the circumstances causing the change.

The DE must ensure, and MAE verify, that the correct traffic assignment choice has been used as agreed during MAP Stage 1.

A.223 Public Transport

The purpose and scope of the Aimsun Next model, as agreed during MAP Stage 1, will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a bus priority scheme on bus journey times, the DE should ensure all public transport elements have been modelled in detail.

The DE should ensure that the following public transport elements are correctly calibrated, which will be checked by the MAE:

- Bus routes;
- Bus lanes;
- Bus schedules including departure times and departure time variance;
- Bus stop dwell time distributions;
- Location and size of bus stops and stands; and
- Interference with general traffic.

The DE should provide the MAE with details and sources of all data used to calibrate bus routes and their frequencies to allow them to carry out necessary audit checks. Bus lanes, hours of operation and vehicle type restrictions should be checked against on-street data to ensure correct restrictions are active where necessary during the modelled period. Data collection may also include measurement of dwell times per route, per time period on-street, or use of actual passenger numbers at each bus stop.

The interaction between public transport and general traffic can have a significant impact on network performance. Site visits should therefore be carried out by the DE to ensure that any disruptive behaviour that influences junction or section capacity has been modelled correctly, which should be detailed in the DE's Calibration Report (**A.221**). Site visits should also be undertaken by the MAE to observe behaviour and ensure it is accurately reflected in the submission.

A.224 Signal Data

The DE has a responsibility to use this data and incorporate the following into the Aimsun Next Calibrated Base model submission, which will be verified by the MAE:

- Signal groups;
- Cycle length;
- Phase sequence and duration;
- Detectors associated to actuated phases;
- Actuated parameters
- Interphases:
    - Duration;
    - Yellow duration
    - Red percentage;
- Node offsets; and
- The presence of SVD Bus Priority (or in case of Aimsun Next pre-emption strategies).

It is common practice for MAP Stage 3-approved LinSig or TRANSYT models to be submitted with all Base Aimsun Next models. If this is not the case, the DE must produce LinSig Skeleton models for more complex junctions and provide to the MAE to enable an audit of signal data in Aimsun Next, as outlined in section **B3.1.1**. These LinSig Skeleton models need to contain signal data, although no traffic flow data is required

If Base LinSig or TRANSYT models have been submitted with Aimsun Next models, it is essential that these are approved MAP Stage 3 models which correctly represent on-street data. The signal data held in both Aimsun Next and accompanying approved LinSig / TRANSYT models should be consistent.

The DE and MAE should use the Simulation Control dialogue of the node to verify the operation of signal controllers in Aimsun Next, allowing the interphase, signal group duration and phase change points to be visualised.

The DE should ensure that demand-dependent stages within the network show a frequency that is within 10% of that observed on-street, which will be audited by the MAE. The average count should be reported by the DE in the Calibration Report (**A.221**) and supplied along with control plan statistics generated by Aimsun Next for each simulation run.

A.225 Nodes and Turns

Behaviour at nodes has an impact on congestion and vehicle journey times, especially in networks with give-way junctions and opposed movements at signalised junctions. It is important that the DE models give-way behaviour correctly in Aimsun Next, thus replicating on-street behaviour in the models.

At nodes, the DE should ensure that the following are appropriate:

- Signs associated to the turns;
- Give-way behaviour between turns;
- Stopline position (at the end of the link, or an advanced stopline)
- Stoplines within a turn where queuing within a junction is allowed;
- Distance Zone settings
- Gap-acceptance model parameters; and
- Yellow box junction parameters.

The network submitted in AMAP Stage 2a will ensure that lane connectivity between the arms of a junction has been set in accordance with road markings. If, in calibration using observed behaviour, lane connectivity is adjusted, the DE must notify the MAE.

The DE should calibrate junction behaviour by:

- In the Node and Turn Editor:
    - First ensure the lane connectivity is consistent with observed behaviour;
    - Adjust stopline positions;
    - Set the Distance Zone values to ensure vehicles make their lane changes on their approach to the junction; and
    - Finally, adjust turn speeds only if the default Aimsun Next settings are unsatisfactory.
- In the Section Editor on the approach to a Node:
    - Adjust the Additional Reaction times for Queue Discharge;
    - Adjust the Queue Discharge Acceleration Factor;
    - At lane merges; adjust the Co-operation Distance and Merge Distance; and
    - If there is a significant weaving section on the junction approach, adjust the Lane Changing Co-operation, Braking and Aggressiveness values.

A.226 Network Operation

The network structure was confirmed during AMAP Stage 2a, but it is not until traffic is simulated that the structure of the modelled network can be fine-tuned by the DE. The experience of the DE, with guidance from CE and MAE, will determine how the network is structured to deliver the best on-street representation and ensure the modelled network is 'fit for purpose'.

The DE should ensure the following are performed correctly:

- Network changes from the approved AMAP Stage 2a model;
- Lateral lanes (on ramps, off ramps, turning bays);
- Lane to lane connectors, especially at roundabouts;
- Localised lane restrictions;
- Lane change behaviour (distance zones, cooperation);
- Overtaking behaviour;
- Node and turn behaviour parameters affecting queue discharge;
- Checking for lost vehicles, missed turns and virtual queues; and
- Saturation flow calibration at stoplines.

The DE should maintain an active dialogue with the MAE throughout **A.227** as this allows the DE to explain the techniques used, for approval by the MAE. Techniques may not be approved if they achieve certain behaviour at the cost of unrealistic representation of on-street conditions.

A.227 Real Data Sets

The data sets containing observed data must be included in the Aimsun Next model submitted to the MAE as a 'Real Data Set' object and linked to the Calibrated Base model scenario. Real Data Sets can include journey time, section and turn based data, and are used in calibration to compare simulation results with observed data.

Inclusion of the Real Data Set in the submitted model ensures the MAE can audit the calibration process from data source to calibration comparison. Files referenced by the Real Data Set must be included and their contents documented by the DE in the model technical note.

A.228 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **A.221** – **A.227**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the AMAP Stage 2b Check Sheet (**MQA-0544/A2b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **A.221** – **A.227**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

3.3.4 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **A.221** – **A.228** and there are no other issues the MAE will approve the model and authorise the relevant AMAP Stage 2b Check Sheets (**MQA-0544/A2b**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed AMAP Stage 2b Check Sheets (**MQA-0544/A2b**) , which should be copied to **NMSchemeAssessments@TfL.gov.uk**.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of MAP Stage 2b

AMAP STAGE 3

3.4 AMAP Stage 3, Aimsun Next Validated Base Model Submission

3.4.1 What is an Aimsun Next Validated Base Model?

AMAP specifies that an Aimsun Next Validated Base model should be based on an approved AMAP Stage 2b model. In addition, the DE will be required to demonstrate that the models have been validated against on-street data that is independent of data used for model calibration.

The DE must demonstrate evidence of model validation, including validation of saturation flows and the use of random seeds (minimum twenty) to demonstrate model stability. For this reason validation should be conducted using a minimum of twenty seed values and results presented as a mean average of all simulation runs.

> Validated Base models are_required for all time periods in AMAP Stage 3.

3.4.2 AMAP Stage 3 Check Sheet

AMAP Stage 3 has a Check Sheet (**MQA-0544/A3**), which must be completed by the MAE when auditing the models.

> A separate AMAP Stage 3 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

A.30I Validation Report

Validated Base model submissions must be accompanied by a Validation Report, as described in Part B of the **Traffic Modelling Guidelines**.

The DE should ensure that the following information is provided:

- Detail of the network source:
    - The origin of any data used in importing a network, such as GIS, another traffic model or a cordon from an Aimsun Next model; and
    - The origin of any images, maps or aerial photographs used to code the model.
- Detail on the traffic flows:
    - When the traffic surveys were done and by who;
    - What data was collected during the traffic surveys;
- Demand dependency calculations:
    - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing Calibrated Base model timings to the Validated Base model timings;
    - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the Validation Report;
- Evidence of validation, including comparison between on-street data and LinSig / TRANSYT results;
- Flare usage observed on-site;
- Flashing amber usage at pelican crossings;
- Queue lengths (if surveyed);
- Observed network bottlenecks;
- Parking / loading restrictions / behaviour;
- Details on priority intersections; and
- Details on observed congestion or recorded Underutilised Green Time (UGT).

The Validation Report should contain a list of all changes made to the approved AMAP Stage 2b Calibrated Base model, with justification for any revisions, alongside validation support data aligned to the AMAP Stage 3 Check Sheet (**MQA-0544/A3**).

Validation data collected from Aimsun Next models should be taken from an average of many (minimum twenty) replications using different random seeds, as stated in **B3.4.1**.

A.302 Adjustments from Stage 2b Model

There should be few changes from the AMAP Stage 2b approved model other than for adjustments for satisfactory validation of saturation flows (**A.303**), traffic flows (checked in **A.304**), queue length correlation (checked in **A.305**) and journey times (checked in **A.306**).

Where significant changes have been made, these should be detailed in the Validation Report as described in **A.301**.

The DE and MAE must ensure that any changes are both appropriate and reasonable, and that the following data that was previously checked during AMAP Stage 2a and AMAP Stage 2b remains satisfactory:

- **A.202:** Software and Simulation Parameters;
- **A.203:** Coordinate System and Model Units;
- **A.204:** Background, Model Import or Cordon;
- **A.205:** Vehicle Classes and Types;
- **A.206:** Road and Lane Types;
- **A.207:** Assignment and Route Choice Model;
- **A.208:** Network Structure;
- **A.222:** Base Traffic Data;
- **A.223:** Public Transport;
- **A.224:** Signal Data;
- **A.225:** Nodes and Turns; and
- **A.226:** Network Operation; and
- **A.227:** Real Data Sets.

A.303 Saturation Flows / Degrees of Saturation

The DE must ensure that saturation flows are measured on-site for all key sections where queues are observed and that these are used to validate the saturation flows derived from the Aimsun Next model.

Saturation flows are measured in Aimsun Next by exporting Link Headway files, which contain the headways of vehicles as they cross a stopline at the junction. These must be processed to calculate the saturation flow at each signalled stopline.

Comparison of the observed and modelled saturation flows is required during model validation as it provides a measure of the capacity of signal-controlled approaches. All observed and modelled saturation flows should be tabulated and the percentage difference between the two values reported.

Modelled saturation flow values should be within 10% of observed values, or values used in any corresponding approved LinSig or TRANSYT modelling.

The MAE should not approve a model beyond AMAP Stage 2b where the saturation flows do not meet these criteria.

Degrees of saturation (DoS) can only be observed in Aimsun Next and not directly measured. It should be estimated to ensure it correlates with on-street observations at signalled stoplines within the modelled network. This may not be the case for entry sections as there will be no coordination with upstream signals outside the modelled network. Where the modelled DoS is found to differ significantly from observations, it may indicate that areas of the model are in error, which the DE and MAE should investigate.

A.304 Traffic Flow Comparison

The Validation Report (**A.301**) should contain evidence of a comparison between traffic flows and turning counts recorded on-site against modelled flows and turning counts.

The DE must ensure that the traffic flows and turning counts closely match surveyed data, which will be verified by the MAE. The GEH statistic is fully explained within the **Traffic Modelling Guidelines** but generally it is a standard measure of the 'goodness of fit' between observed and modelled flows. Unlike flow comparison using percentage difference the GEH statistic places more emphasis on larger flows than on smaller flows.

The DE should aim for GEH values less than five when comparing modelled flows to observed flow volumes. However, TfL advocates GEH values of less than three for all important or critical links within the model area. Results should be presented in the DE's technical note (**A.301**), showing all observed and modelled flows together with calculated GEH values. Modelled flows should be averaged over multiple seeds, as described in **B3.4.1**. Significant discrepancies between modelled and actual traffic flows should be queried by the MAE.

> All entry links into the network should show modelled flows within 5% of observed flows. This requirement should be achieved for all entry links as vehicle flows on external links are direct input values.

The MAE should not approve a model beyond AMAP Stage 2b where entry flows do not match observed counts to ensure that all assigned vehicle flows are successfully loaded onto the network during the peak modelled period.

A.305 Queue Length Analysis

Given the difficulty of measuring queue lengths on the road in the same way as in a model, a direct comparison of queue lengths is not a reliable validation indicator; journey time validation on defined sub-paths is a more robust indicator of congestion levels but is only available if OD matrix based demand is used.

Queues should, however, appear in the model at locations where they are observed in reality, and queuing behaviour in the model should be consistent with site observations.

If turning count traffic surveys have been used to determine model input flows, then in reality no significant virtual queues should exist on model entry sections as the collected on-site data represents the counted flow across the stopline. However, queues may occur due to high traffic demand during the warm-up period (for example queues at the start of the peak hour), or small queues forming due to fluctuations in vehicle arrival patterns.

A.306 Journey Time Comparison

Journey time validation combined with section and turning count validation is the most suitable measure of Aimsun Next model validation.

> Modelled journey times should be averaged over multiple seeds and be within 15% of surveyed on-street journey times. Journey time output should be measured for vehicles originating from the start of the route, and be presented as the average journey time for individual journey time segments coded as separate subpaths. It may also be necessary to restrict journey time measurements from Aimsun Next to the same vehicle type that the site measurements were based on (such as private vehicles, buses, or taxis).

The MAE will need to be satisfied that journey time validation has been completed according to the principles set out in Part B of the **Traffic Modelling Guidelines**. If the model has not been validated satisfactorily, the MAE will not approve the model at AMAP Stage 3.

A.307 Experiment Checking and Error Logs

Before an experiment is run, the 'Check and Fix' tool must be used to verify the Aimsun Next model has no errors or inconsistencies. All errors must be corrected; warnings may either be fixed or documented to justify any decision not to take action over them.

Additional errors and warnings may appear in the log window in Aimsun Next during the simulation. These messages should be audited by the DE, CE and MAE as they may indicate such errors as:

- Impossibility of loading an input path file;
- No feasible path between an OD pair that has demand; and
- Public transport route that has gaps.

In addition to the messages reported in the log window, the DE, CE and MAE should use the appropriate view modes and output statistics to detect issues such as:

- Vehicles missing turns or getting lost in the network; and
- Not all vehicles being loaded onto the network (virtual queues).

If Virtual Queues are present, this indicates that not all vehicles are being loaded onto the network immediately as they are generated. This is not an error, but it is indicative of congestion spreading outside the modelled area and the DE should notify the CE and MAE if Virtual Queues are considered to be excessive

Ideally, none of the issues mentioned above should occur during the simulation. However, a few non-critical issues are acceptable. The DE must seek further advice from the CE or MAE if unsure about any errors or warnings that are indicated.

A.308 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **A.301** – **A.307**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the AMAP Stage 3 Check Sheet (**MQA-0544/A3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **A.301** – **A.307**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

3.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks A.301 – A.308 and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant AMAP Stage 3 Check Sheets (**MQA-0544/A3**).

If the MAE fails the model on any of the checks A.301 – A.308, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed AMAP Stage 3 Check Sheets (**MQA-0544/A3**), which should be copied to NMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of AMAP Stage 3

AMAP STAGE 5a

3.5 AMAP Stage 5a, Aimsun Next Future Base Model Submission

3.5.1 Introduction

MAP Stage 5a is an optional MAP stage dependant on whether the scheme assessment is following the Three Stage Modelling Process. The scope of the scheme assessment agreed in the MAP Stage 1 meeting will determine the requirement for Future Base models and a MAP Stage 5a audit.

The majority of the work both in terms of creating and auditing an Aimsun Next model is completed during the first three stages of MAP, such as when generating fit for purpose Base models. Once an Aimsun Next Base model has been accepted by the MAE there will often be a relatively small amount of work required to complete the remaining stages of AMAP.

Future Base models are_required for all time periods in AMAP Stage 5a. It is important that the DE clearly specifies which scenario is being submitted for auditing where multiple scenarios are used.

The DE should make a copy of the accepted AMAP Stage 3 Base models and update them in line with the any likely future network changes within the model boundary agreed during MAP Stage 4. The DE must create new Master Control Plans, new Demand Plans and new Public Transport plans in the Aimsun Next Project File and edit them to describe new methods of control, changes in Demand and Public Transport. It is recommended that the DE uses Geometry Configurations to make any changes in the road layout, which can be grouped with other Future Base changes into a new Aimsun Next scenario.

It is common practice that Future Base LinSig or TRANSYT models are also produced alongside the Future Base Aimsun Next models. The signal timings from these models are often incorporated into the Aimsun Next models, and are manually fine-tuned where necessary. The Traffic Modelling Guidelines contain a strategy for traffic signal optimisation.

The Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing against the Base model results alone.

3.5.2 AMAP Stage 5a Check Sheet

AMAP Stage 5a has a Check Sheet (**MQA-0544/A5a**), which must be completed by the MAE when auditing the models.

> A separate AMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

A.501 Future Base Report

Future Base submissions must be accompanied by a report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria **A.502** – **A.507**.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the results of the Validated Base models and the Future Base models for the corresponding periods.

The inclusion of comparisons for all areas of the network that are deemed critical is required. It is the responsibility of the DE to identify all the critical areas. Normally (but not exclusively) critical areas would be those which experience high traffic flows, are close to capacity and/or those areas which are affected by the proposals.

A.502 Physical Layout / Signal Changes

There are likely to be three main changes from Base to Future Base models which should be detailed by the DE:

- Junction control changes, in which case turns and sections will need to be changed;
- Road layout changes, in which case the sections and turns and their related parameters will be changed; and
- Signal timings may have been changed as a result of the Future Base likely network changes. These changes would normally be represented in an accompanying LinSig or TRANSYT model. If signal timings have subsequently been fine tuned in Aimsun Next, the DE should be aware that all sources of signal timing information must corroborate within the final submission.

The DE will need to ensure that all modelling parameters including driving behaviour parameters, vehicle type, road type and others are consistent with the Base models passed during AMAP Stage 3. If there are inconsistencies these should be highlighted for the MAE and discussed in the Future Base Report (**A.501**).

A.503 Stage Timings and Demand Dependency

The Future Base Report (**A.501**) should comment on the frequency of demand-dependent stages in the Base model and whether any assumptions have been applied to the Future Base model. If any changes are based on estimates then these should be detailed for assessment by the MAE.

The MAE will audit stage timings to ensure they corroborate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design.

A.504 Future Base Flows

The DE should provide the MAE with the detailed methodology, assumptions and other relevant data used to reassign traffic flows from the approved base case. In particular, any input equilibrium path file should be obtained by ‘fixing’ the one used in the Base model and warm-starting the assignment process with it, rather than calculating a new equilibrium assignment from scratch. The MAE will audit these outputs during **A.504**.

A.505 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **A.502** – **A.504**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**A.501**):

- Physical layout changes;
- Traffic signal changes; and
- Expected traffic flow changes.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved AMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

A.506 Saturation Flows, Queue Lengths and Journey Times

The Future Base Report (**A.501**) should contain a comparison of Base and Future Base saturation flows, and the implications for the operation of the network. The MAE must be satisfied that the Future Base saturation flows are acceptable. Any adjustments to the network that may impact saturation flows or lane usage must therefore be documented by the DE.

The report does not have to contain a comparison for every part of the model, but it is the responsibility of the DE to ensure that all areas which are considered as critical to the model or the proposals are included.

The Future Base Report (**A.501**) should contain a comparison of Base and Future Base queue lengths and journey times. There should be interpretative comment regarding the implications of this data upon network performance.

A.507 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **A.501** – **A.506**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the AMAP Stage 5a Check Sheet (**MQA-0544/A5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **A.501** – **A.506**.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

3.5.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **A.501** – **A.507** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant AMAP Stage 5a Check Sheets (**MQA-0544/A5a**).

If the MAE fails the model on any of the checks **A.501** – **A.507**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed AMAP Stage 5a Check Sheets (**MQA-0544/A5a**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of AMAP Stage 5a

AMAP STAGE 5b

3.6 AMAP Stage 5b, Aimsun Next Proposed Model Submission

3.6.1 Introduction

The Proposed models should be based on the approved AMAP Stage 3 model, or when following the Three Stage Modelling process (**A2.3.2**) the approved AMAP Stage 5a model.

> Proposed models are required for all time periods in AMAP Stage 5b. It is important that the DE clearly specifies which scenario is being submitted for auditing where multiple scenarios are used.

The DE should make a copy of the accepted AMAP Stage 3 Base or AMAP Stage 5a Future Base models and update them in line with the proposals agreed during MAP Stage 4. The DE must create new Master Control Plans, new Demand Plans and new Public Transport plans in the Aimsun Next Project File and edit them to describe new methods of control, changes in Demand and Public Transport. It is recommended that the DE uses Geometry Configurations to make any changes in the road layout, which can be grouped with other proposed changes into a new Aimsun Next scenario. It is important that the DE clearly specifies which scenario is being submitted for auditing where multiple scenarios are used.

It is common practice that Proposed LinSig or TRANSYT models are also produced alongside the Proposed Aimsun Next models. The signal timings from these models are often incorporated into the Aimsun Next models, and are manually fine-tuned where necessary. **The Traffic Modelling Guidelines** contain a strategy for traffic signal optimisation.

In addition to ensuring that the model is correctly developed from a technical point of view the DE should demonstrate that the proposals can be accommodated without jeopardising the day to day operation of the network. This will include maintaining acceptable levels of saturation and queue lengths as well as sufficient provision for the pedestrian demand being modelled.

In common with the preceding stages of AMAP, the MAE will need to consider the technical data, however unlike the previous stages there must be interpretation of their implication. An important additional responsibility for the MAE at AMAP Stage 5b is to make a judgement on whether the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager, who will have a duty to manage the new network (if the proposal is given approval by the Network impact Specialist Team), the MAE should highlight any issues and concerns with the proposal. These issues are likely to be in respect of safe, efficient network operation and current policy / guidelines.

The DE will receive feedback from MAE and will need to address any highlighted issues. The MAE will use their operational experience and knowledge of the network in making informed comments and decisions.

If required by the model scope defined at MAP Stage 4, the proposed timings within the Aimsun Next model must be suitable to be used as controller-held background timings. This means that the MAE's audit is implicitly asking the DE:

> 'Are you satisfied that, if observing on-site when these proposals are commissioned, the timings in each of the submitted Aimsun Next models would provide appropriate network operation under local control and that the network impacts would be as described in the SIR?'

3.6.2 AMAP Stage 5b Check Sheet

AMAP Stage 5b has a Check Sheet (**MQA-0544/A5b**), which must be completed by the MAE when auditing the models.

> A separate AMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

A.551 SAE-Approved Proposed Methods of Control

Before submitting any Proposed modelling, the DE must submit proposed drawings and methods of control to the MAE. The MAE must ensure that all the proposed methods of control and drawings reflect the proposals identified in the MED. Once the MAE has confirmed the details are correct, they can arrange for an Engineering Service Request (ESR) to be undertaken. The SAE will undertake a review to identify issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE. The MAE must confirm that SAE approval has been received for any new or modified signalised infrastructure prior to auditing.

> Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from proceeding with the AMAP Stage 5b.

A.552 Proposed Model Report

Proposed model submissions must be accompanied by a report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria **A.553** – **A.559**.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the results of the Validated Base models and Future Base models, if required, and the Proposed models for the corresponding periods.

The inclusion of comparisons for all areas of the network that are deemed critical is required. It is the responsibility of the DE to identify all the critical areas. Normally (but not exclusively) critical areas would be those which experience high traffic flows, are close to capacity and/or those areas which are affected by the proposals.

A.553 Physical Layout / Signal Changes

There are likely to be three main changes from the Base or Future Base models to the Proposed models which should be detailed by the DE:

- Junction control changes, in which case turns and sections will need to be changed;
- Road layout changes, in which case the sections and turns and their related parameters will be changed; and
- Signal timings may have been changed as a result of the proposals. These changes would normally be represented in an accompanying LinSig or TRANSYT model. If signal timings have subsequently been fine tuned in Aimsun Next, the DE should be aware that all sources of signal timing information must corroborate within the final submission.

The DE will need to ensure that all modelling parameters including driving behaviour parameters, vehicle type, road type and others are consistent with the Base and Future Base models passed during AMAP Stages 3 and 5a. If there are inconsistencies these should be highlighted for the MAE and discussed in **A.552**.

A.554 Stage Timings and Demand Dependency

The Proposed Model Report (**A.552**) should comment on the frequency of demand-dependent stages in the Base or Future Base Model and whether any assumptions have been applied to the proposed network. If any changes are based on estimates then these should be detailed for assessment by the MAE.

Proposals should allow for sufficient appearance of pedestrian stages where they operate on demand. The MAE will audit stage timings to ensure they corroborate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design.

A.555 Proposed Flows

The DE should provide the MAE with the detailed methodology, assumptions and other relevant data used to reassign traffic flows from the approved Base / Future Base model. In particular, any input equilibrium path file should be obtained by 'fixing' the one used in the Base / Future Base model and warm-starting the assignment process with it, rather than calculating a new equilibrium assignment from scratch. The MAE will audit these outputs during **A.555**.

A.556 Other Adjustments from Stage 3 / 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **A.553** – **A.555**, concerning specific changes to the following areas resulting from the proposed scheme that should be detailed in the Proposed Model Report (**A.552**):

- Physical layout changes;
- Traffic signal changes; and
- Expected traffic flow changes;

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved AMAP Stage 3 / 5a model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

A.557 Saturation Flows, Queue Lengths and Journey Times

The Proposed Model Report (**A.552**) should contain a comparison of Base, Future Base and Proposed saturation flows, and the implications for the operation of the network. The MAE must be satisfied that the proposed scheme saturation flows are acceptable. Any adjustments to the network that may impact saturation flows or lane usage must therefore be documented by the DE.

The report does not have to contain a comparison for every part of the model, but it is the responsibility of the DE to ensure that all areas which are considered as critical to the model or the proposals are included.

The Proposed Model Report (**A.552**) should contain a comparison of Base, Future Base, if required, and Proposed queue lengths and journey times. There should be interpretative comment regarding the implications of this data upon network performance. If Aimsun Next indicates a negative impact on queue lengths and journey times (for traffic and/or public transport) these should be investigated and discussed by the DE.

The MAE should report the overall network impact of a proposal in the SIR. The MAE will cite reported changes in saturation flow, degree of saturation, queue lengths, and journey times as justification for any assessment of network impact.

A.558 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence, the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see **A2.1**) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the

MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

A.559 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **A.551** – **A.558.**

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the AMAP Stage 5b Check Sheet (**MQA-0544/A5b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **A.551** – **A.558**.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

3.6.3 Acceptance / Rejection of the Model

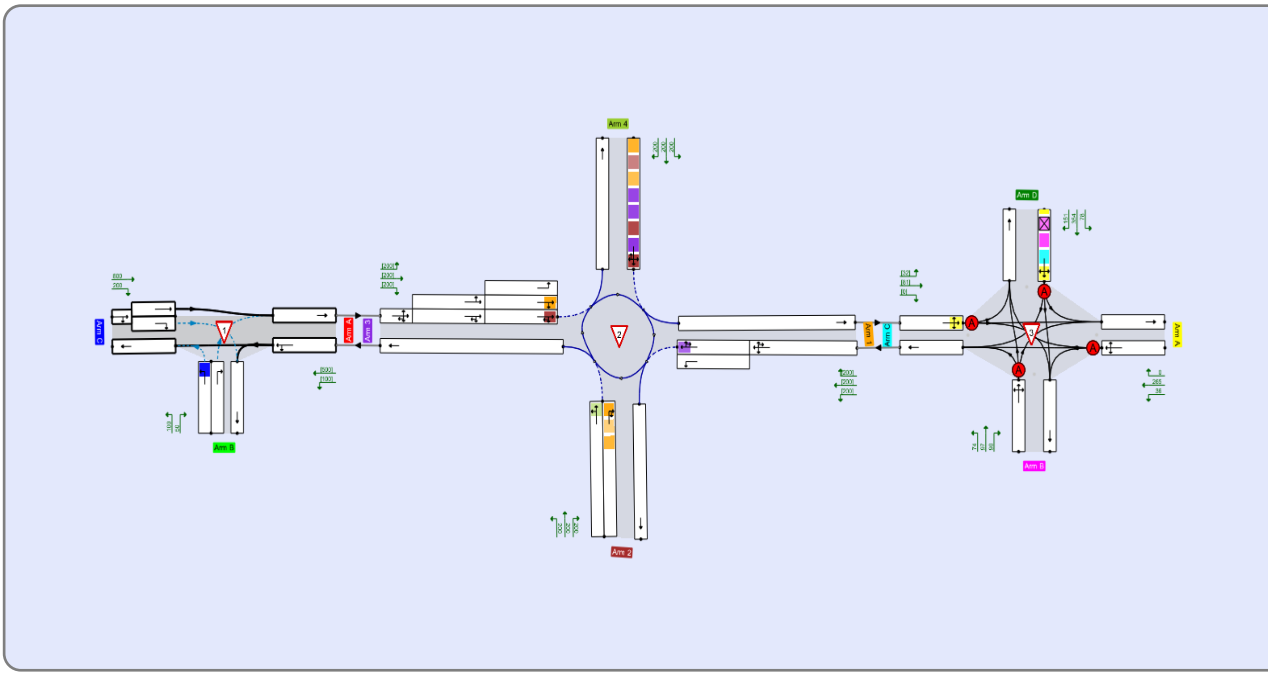
If the MAE passes the model on all of the checks **A.551** – **A.559** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant AMAP Stage 5b Check Sheet (**MQA-0544/A5b**).

If the MAE fails the model on any of the checks **A.551** – **A.559**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE, CE and SAE of the Approval or Rejection of the submission and provide completed AMAP Stage 5b Check Sheets (**MQA-0544/A5b**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of AMAP Stage 5b

4 Junctions MAP (JMAP)



4.1 Scope

JMAP applies to all Junctions models submitted to TfL Operations for auditing.

Please note that the version of Junctions in use at TfL at the time of publication is Junctions 10, however much of the content will remain relevant for other versions of the software.

Junctions 10 allows multiple junctions to be linked within a single model, which may include priority junctions (PICADY module), priority roundabouts (ARCADY module), and isolated signalised junctions (OSCADY module). Priority or signalised pedestrian crossings in the vicinity of these junctions can also be modelled.

Where multiple signalised junctions are located closely enough to allow for signal coordination, network signal optimisation modelling software such as LinSig or TRANSYT should be used, which can be supported with estimated give-way parameters from Junctions. Junctions 10 allows models to be exported directly to a TRANSYT file if needed.

When assessing scenarios with and without signals (as in the case of signalisation or signals removal), careful consideration needs to be given to the software used if comparing model outputs directly.

JMAP STAGE 2

4.2 JMAP Stage 2, Junctions Calibrated Base Model Submission

4.2.1 What is a Junctions Calibrated Base Model?

A Junctions Calibrated Base model should contain:

- appropriate junction types and layouts;
- appropriate Analysis and Demand Sets;
- geometries measured from scaled drawings / images; and
- if applicable, representative signal timings and signal control data for signalised pedestrian crossings or junctions during the periods under consideration.

A single Junctions Calibrated Base model, which should include all modelled time periods, is required for JMAP Stage 2. Unlike MAP stages for some other software packages, the Junctions Validated Base model defined in JMAP Stage 3 (see **B4.3.1**) can optionally instead be submitted for auditing, with Stage 2 and 3 audit checks carried out together.

The Junctions software version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document.

4.2.2 What is the purpose of a Junctions Calibrated Base Model?

Experience has shown that the submission of one model early in the modelling exercise is a very useful starting point for both the DE and the MAE, and will improve the standard of subsequent model submissions.

The Calibrated Base model submission will provide the MAE the opportunity to see that the DE has collected relevant knowledge of the network. This is particularly relevant if the MAE has not received any modelling from the DE previously.

4.2.3 Tasks before looking at the JMAP Stage 2 Check Sheet

It is recommended that the DE obtains TfL Signal Timing Sheets and Controller Specifications from TfL[6] for any signalised pedestrian crossings or junctions in the network, as described in Part B of the **Traffic Modelling Guidelines**. Signal Timing Sheets should be checked against relevant Controller Specifications for accuracy.

Site observations and traffic flow / queue surveys should also be carried out for each period being modelled, together with pedestrian flow surveys for any dedicated pedestrian crossings. Surveys should be carried out and averaged over multiple days to capture representative behaviour.

Where isolated signalised junctions are present, additional surveys may be required to record signal timings if they are not under UTC control.

4.2.4 JMAP Stage 2 Check Sheet

JMAP Stage 2 has a Check Sheet (**MQA-0544/J2**), which must be completed by the MAE when auditing the model.

This section identifies the checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

J.201 Calibration Report

The DE is required to submit a Calibration Report along with Calibrated Base model submissions, as described in Part B of the **Traffic Modelling Guidelines**. Where a single model is submitted for combined JMAP Stage 2 / 3 audit checks, the accompanying technical report should cover both Calibration and Validation Report requirements.

The DE should ensure that the report contains, at a minimum:

- The stated Purpose of the model, as agreed with the P and MAE during MAP Stage 1 and defined in the Modelling Expectations Document (MED);

6 TfL Signal Timing Sheets and Controller Specifications can be requested from **AssetOperationsDataLegalRequest@tfl.gov.uk**

- A list of all junctions in the model, which should also include TfL site IDs for any signalised pedestrian crossings or isolated signalised junctions to be modelled with OSCADY;
- Notes on all relevant site observations, covering both the physical constraints of the network and vehicle behaviour. Where the behaviour is specific to a time of day, this should be noted. It is important to clearly explain how these factors have determined the structure of the model;
- Details of traffic survey and pedestrian survey dates; and
- Marked diagrams clearly showing geometry measurements needed for Junctions model parameters.

J.202 Software, Units and Network Settings

Here, the MAE will check the following aspects of the DE's model:

Software version:

- The software version should be as agreed at MAP Stage I and documented in the MED.

Advanced Mode:

- Junctions has two available modes, Basic Mode and Advanced Mode, which needs to be specified for each model file. Basic Mode is primarily intended for those new to the software and hides several options and features, which may be needed in later stages of JMAP.

  It is therefore recommended that Advanced Mode is used to ensure that all model data and options are visible. It also ensures that all model features can be enabled, including Lane Simulation Mode, intercept correction, queue markers and entry / exit capacity restrictions. This can be set as the default for new files in the File/Preferences/General menu options.

Units:

- **Distance unit:** should be set to Metres;
- **Traffic input unit:** can be set to either Vehicle or PCU, which should correspond with the unit to be used for traffic flow data entry in J.303 Base Traffic Flows. Note that this should not be changed after flows have been entered unless necessary, as Junctions will automatically convert previously entered data to the new unit. Care is therefore required and flows may need to be re-entered;

- **Traffic flow time reference:** per minute, per hour or per time segment. This should again correspond to the values used for flow entry in **J.303** – specifying flows per time segment may simplify data entry from traffic count survey data; and
- **PCU length:** the default value of 5.75m should remain unchanged.

Network Settings:

- **Driving Side:** should be set to Left;
- **Lighting:** should be set to Normal / Unknown unless otherwise agreed with the MAE and supported by specific justification;
- **Road surface condition (required for mini roundabouts only):** should be set to Normal / Unknown unless otherwise agreed with the MAE and supported by specific justification;

J.203 Junction Type and Layout

The junction type and layout within the DE's model that the MAE will audit include:

- **Layout:** All junctions that significantly influence each other, or may be expected to influence each other in proposals, should be included within a single model file where possible. This allows the possibility of blocking effects to be considered and subsequent use of Lane Simulation Mode if necessary. Where blocking is regularly known to occur, use of microsimulation modelling may be necessary.
- **Junction Type:** The correct junction type must be chosen for each junction in the model (such as T-junction, crossroads, staggered junction, mini-roundabout or roundabout). Where a mini roundabout is chosen, its location should be marked as 'In London'.
- **Junction Arms:** The junction Arms should be labelled clearly, with major / minor Arms defined correctly. Further details that may be checked include:
    - Entry / Exit-only Arms should be defined as one-way movements;
    - Use of Bypass Lanes where appropriate; and
    - If multiple junctions exist within the same model, Entry / Exit Arms between adjacent junctions should be appropriately linked with any queue storage limits accounted for.

- **Arm Scaling Factor (set under Vehicle Demand):** The scaling factors for vehicle demands should by default be set to 100% for each Arm, unless another factor has been agreed with the MAE with appropriate justification.

J.204 Analysis and Demand Sets

The Analysis and Demand Set data that the MAE will check includes:

- **Analysis Sets:** Analysis Sets should be clearly labelled to make their purpose clear, such as representing particular scenarios or layouts. Relevant Analysis Sets must be specified on each JMAP Stage 2 Check Sheet (**MQA-0544/J2**) so that it is clear to the MAE which Analysis Sets are being submitted for auditing.

  Where different Analysis Sets are used to vary model parameters by time of day, any parameter that is changed should be highlighted in the Calibration Report and explained with justification. Analysis Sets that are intended to apply to a specific time of day should be associated with corresponding Demand Sets from the same time periods.

  The Network Flow Scaling Factor and Network Capacity Scaling Factor for each Analysis Set should each be set to the default value of 100%, unless use of another factor has been agreed with the MAE and justification supplied.

- **Demand Sets:** Demand Sets should at minimum be clearly labelled with the time of day and year they represent, for example identifying when traffic surveys were undertaken.

  It is also possible to combine multiple Demand Sets through use of Demand Set Relationships. These may be helpful for distinguishing between different transport modes (such as for the separate treatment of cyclist flows or buses from other motorised traffic), or to differentiate between Base flows and future year demand changes. If these are used then additional details should be recorded to describe each demand component within the Demand Set Relationship.

- **Traffic Demand Profile:** The 'DIRECT' profile should typically be used for Junctions models, with traffic and pedestrian surveys carried out and averaged over multiple days. This is the most accurate approach, since observed data is used to determine traffic and pedestrian flow profiles that are representative for the modelled location.

It may sometimes be acceptable to use an assumed synthetic 'ONE HOUR' or 'FLAT' profile rather than 'DIRECT' to prevent bias in observed data from a particular day if limited data is available. This should however be by exception and based on specific justification that must be agreed with the MAE.

- **Time Period Length / Time Segment:** A 15-minute time segment is recommended for use in Junctions models, allowing data entry and model outputs for every 15 minutes during the modelled time period. This also corresponds to the typical time resolution used in traffic counts.

  Junctions assumes that queues are zero at the start and end of the modelled time period, unless initial queues are manually specified. It is therefore normal to include both warm-up and cool-down periods before and after a modelled peak to allow queues to form before the peak and dissipate afterwards.

  When modelling a peak hour with 15-minute time segments, it is therefore typically recommended to use 15-minute warm-up and cool-down periods, giving a total modelled time period of 90 minutes. This can however be extended if peak conditions last longer than an hour.

  The Model Start Time and Model Time Period Length should be set to account for any warm-up and cool-down periods provided. A start time of 07:45 would therefore be needed to model a peak hour from 08:00 – 09:00 with 15-minute warm-up and cool-down periods, using a modelled time period length of 90 minutes.

J.205 Geometry Measurements

The DE must provide the MAE with suitably marked-up layout drawings for all junctions in the model, showing all geometry measurements used during model calibration. The markings should indicate where each measurement has been taken and the values recorded, so that they can be independently checked by the MAE during auditing.

It is important that the layout drawings are correctly scaled and include a known reference distance. This will be checked by the MAE to ensure that measured values taken from the drawings are accurate.

Junctions 10 provides the ability to include background images and associated geometry mark-up and measurements within the model file. This can be used to supplement other layout drawings, however each background must also be scaled within the software using appropriate known reference distances, which should be documented. If using aerial photography it must also be confirmed that images are up to date and reflective of the locations being modelled.

Examples of geometry data that may be checked includes:

- Widths of Lanes, roads and central reservations, including component measurements used to calculate average values;
- Flare and effective flare lengths, Lane and turning bay storage;
- Visibility distances;
- Pedestrian crossing distances and entry / exit storage;
- Entry radii, kerb line distances and conflict angles;
- Roundabout inscribed diameters; and
- Distance between roundabout Arms.

Particular attention is needed when measuring visibility distances, since potential obstructions to drivers' views may be less obvious from drawings or aerial photography. Site observations are therefore recommended together with use of Point-of-View (POV) imagery where available.

J.206 Pedestrian Crossings

Pedestrian crossings on entry and exit approaches to priority junctions and roundabouts should be included within Junctions models. The following details will be checked:

- Crossing type, such as Zebra, Pelican or Puffin;
- Crossings associated with the correct junction Arm;
- Crossing distance;
- Vehicle storage before junction entry / exit; and
- For signalised crossings, signal information will be checked against relevant TfL Signal Timing Sheets.

J.207 Signalised Junctions

For any isolated signalised junctions modelled with the OSCADY module, the following parameters should be checked (it may be helpful to refer to similar content in LMAP or TMAP, while referring to the OSCADY Junctions section of the Junctions user guide[7]):

- Traffic Streams;
- Lanes and lane movements;
- Lane geometry / saturation flows;
- Phases;
- Intergreen matrix / banned stage moves;
- Stages;
- Stage sequences;
- Phase delays;
- Cycle time;
- Signal plan and timings; and
- Demand dependency adjustments.

Note that where signalised junctions are within sufficiently close proximity to allow signal coordination, alternative signal optimisation modelling software such as LinSig or TRANSYT should be used.

J.208 Traffic Count Surveys

Traffic count surveys should ideally be carried out for all modelled junctions on the same dates, and at the same time as associated queue surveys (**J.210**) and pedestrian surveys (**J.209**).

Vehicle counts should be classified by vehicle type for all junction movements and be recorded in 15-minute increments. Surveys should be undertaken and averaged over multiple days to ensure that representative conditions are captured.

It is necessary to capture demand upstream of any queuing in addition to entry flows where significant queuing exists during the modelled peak period. This is necessary so that modelled queue lengths more closely match observed values, otherwise validation may be difficult to achieve.

7 Binning J C & Burtenshaw G, Junctions 10 User Guide , Application Guide 74 (Issue F), TRL, 2023, pp 305-316

The following traffic survey details will be checked by the MAE:

- **Survey dates:** were traffic surveys carried out on appropriate dates for each modelled time period?
- **Multiple days surveyed: i**t is recommended that traffic surveys should be undertaken for a minimum of 3 days for each period being modelled and averaged to capture representative traffic flows and arrival profiles. Additional days may need to be surveyed if significant variation is observed. A single day's data is not generally regarded as sufficient for modelling priority-controlled junctions since daily fluctuations can lead to significant variation in junction performance;
- **Survey comments and lighting / weather conditions:** comments should be included during the survey detailing lighting and weather conditions and describing any notable incidents or other disruption; and
- **Peak time period determination:** an appropriate methodology should be used to determine the peak periods to be modelled, which should be demonstrated for the MAE to review. Where multiple sites are included in a model, the modelled peak should be suitably representative for all sites. It should also be noted that there may be different peaks in recorded traffic flow, pedestrian and queue data.

J.209 Pedestrian Surveys

Pedestrian surveys should be carried out for all dedicated pedestrian crossings included in the models, ideally at the same time as associated traffic count surveys (**J.208**) and queue surveys (**J.210**). Pedestrian surveys should be recorded for each pedestrian movement in 15-minute increments, and for the same survey periods as for traffic surveys. Pedestrian surveys should similarly be averaged over multiple days to ensure that representative pedestrian behaviour is captured.

The following pedestrian survey details will be checked by the MAE:

- **Survey Dates:** were pedestrian surveys carried out on appropriate dates for each modelled time period?
- **Multiple days surveyed:** it is recommended that pedestrian surveys should be undertaken for a minimum of 3 days for each period being modelled and averaged to capture representative pedestrian flows and arrival profiles. Additional days may need to be surveyed if significant variation is observed. A single day's data is not generally

regarded as sufficient for modelling priority-controlled junctions since daily fluctuations can lead to significant variation in junction performance;

- **Survey comments and lighting / weather conditions:** comments should be included during the survey detailing lighting and weather conditions and describing any notable incidents or other disruption; and
- **Peak pedestrian activity:** where there is significant pedestrian activity it may be appropriate to assess whether the peak period for pedestrians coincides with the peak for vehicles. If this is not the case it should be taken into consideration when determining the time period and duration to be modelled.

J.210 Queue Surveys

Accurate queue survey data is essential to demonstrate the validation of Junctions models. Queue surveys should therefore be carried out for traffic movements that give-way at all modelled priority-controlled junctions and crossings, on the same dates and times as associated traffic count surveys (**J.208**) and pedestrian surveys (**J.209**).

Queues should be measured separately for each lane of queuing vehicles, typically at 5-minute intervals and recorded in PCUs or metres. Surveys should be undertaken and averaged over multiple days to ensure that representative queuing conditions are captured.

Where there is significant queuing during the peak period it may be difficult to see the back of the queue from the give-way line. This should be considered in advance to determine the most appropriate methodology and observation locations for data collection, particularly if upstream demand is being surveyed to ensure adequate queue validation data is captured.

The queue survey data that the MAE will check includes:

- **Survey dates:** were traffic surveys carried out on appropriate dates for each modelled time period?
- **Multiple days surveyed:** it is recommended that queue surveys should be undertaken for a minimum of 3 days for each period being modelled and averaged to capture representative queuing behaviour. Additional days may need to be surveyed if significant variation is observed. A single day's data is not regarded as sufficient for

validation of priority-controlled junctions models since daily fluctuation in pedestrian and traffic arrivals can lead to significant variation in junction performance;

- **Survey comments and lighting / weather conditions:** comments should be included during the survey detailing lighting and weather conditions and describing any notable incidents or other disruption .
- **Peak time period determination:** it may be the case that peak queuing conditions occur at a different time to recorded peak traffic flows. This may occur if there is a separate peak in pedestrian activity, or if traffic counts are being surveyed at the give-way line and queues do not clear by the end of the peak period. This should be taken into consideration along with the model purpose when determining the time period and duration to be modelled.

J.211 Site Visits / Observations

It is essential that the DE observes site operation to fully understand site-specific behaviour and to ensure that relevant calibration data is recorded that may not be captured during planned surveys. The MAE will need to see evidence of this through reporting of appropriate site observations. As traffic behaviour can change by time of day each modelled period should be observed separately, and ideally in coordination with other planned traffic surveys.

Recommendations for key observations to consider recording are covered in Part B of the **Traffic Modelling Guidelines**, and may include:

- Queuing behaviour and flare usage;
- Uneven lane usage and entry starvation;
- Blocking within the junction / roundabout;
- Congestion or exit-blocking caused by external queuing;
- Periods of oversaturation, during which collection of site-specific intercept correction data may be possible (see **J.306**);
- Interference due to bus stops, parking and loading bays;
- Unusual pedestrian crossing behaviour;
- Interaction between vehicles, pedestrians and cyclists; and
- Roadworks or other unanticipated network disruption.

J.212 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in J.201 – J.211.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the JMAP Stage 2 Check Sheet (**MQA-0544/J2**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in J.201 – J.211.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

4.2.5 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks J.201 – J.212 and there are no other issues the MAE will approve the model and authorise the JMAP Stage 2 Check Sheet (**MQA-0544/J2**). If the MAE fails the model on these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide a completed JMAP Stage 2 Check Sheet (**MQA-0544/J2**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**.

If a Junctions Validated Base model was submitted for auditing as described in B4.2, then the JMAP Stage 3 audit will commence immediately following JMAP Stage 2 audit approval.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of JMAP Stage 2

JMAP STAGE 3

4.3 JMAP Stage 3, Junctions Validated Base Model Submission

4.3.1 What is a Junctions Validated Base Model?

JMAP defines that a Junctions Validated Base model should be based on an approved Calibrated Base model where the correct geometries have been measured as well as detailed site observations have been carried out.

Validation in Junctions is completed by comparing modelled queue lengths with those recorded on site.

As for JMAP Stage 2, a single Junctions Validated Base model is required to cover all time periods in JMAP Stage 3.

4.3.2 JMAP Stage 3 Check Sheet

JMAP Stage 3 has a Check Sheet (**MQA-0544/J3**), which must be completed by the MAE when auditing the models.

A separate JMAP Stage 3 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

J.301 Validation Report

Validated Base model submissions must be accompanied by a technical report, as described in Part B of the **Traffic Modelling Guidelines**. Where a single model is submitted for combined JMAP Stage 2 / 3 audit checks, the accompanying Validation Report should also address Calibration Report requirements.

The DE should ensure that the following information is provided to the MAE and included within the report:

- Details of any adjustments from the Calibrated Base model;
- Details of traffic flow calibration, including processing of survey data;
- Public transport modelling calibration, if agreed as in scope;
- Cyclist transport modelling calibration, if agreed as in scope;
- Details of pedestrian flow calibration, including processing of survey data
- Details of any intercept / capacity adjustments undertaken;
- Details of adjustments to reflect observed lane usage;
- Details and justification for any use of Lane Simulation Mode;
- Comparison of modelled queues against queue survey data; and
- Analysis of junction performance including RFC and delays.

Where the model purpose includes estimation of give-way parameters for use in other modelling software (such as TRANSYT or LinSig), the relevant parameter values should be included within the report for auditing.

J.302 Adjustments from Stage 2 Model

Where submitted separately, there may be some changes in the Validated Base model as compared to the accepted Stage 2 Calibrated Base model. Where any changes have been made the DE should identify what was changed and why the change was considered necessary within the Validation Report.

The following data that was audited during JMAP Stage 2 should be checked:

- Software, Units and Network Settings in **J.202**;
- Junction Type and Layout in **J.203**;
- Analysis and Demand Sets in **J.204**;
- Geometry Measurements in **J.205**;
- Pedestrian Crossings in **J.206**;
- Signalised Junctions in **J.207**;
- Traffic Count / Pedestrian / Queue Surveys in **J.208** – **J.210**; and
- Site Visits / Observations in **J.211**.

J.303 Base Traffic Flows

Traffic flow data needs be checked to ensure that modelled flows are correctly represented. Where entered values have been derived from survey data, the DE must demonstrate to the MAE the methodology used to calculate them, with any supporting spreadsheets provided and including the formulae used in any calculations. The DE must also clearly show how representative average data has been derived from surveys covering multiple days.

The following will be checked by the MAE:

- **Traffic demand profile:**
  The demand profile should be unchanged from the profile previously audited in **J.204**, unless there is a justifiable reason which must be agreed with the MAE. It is typically expected that the DIRECT profile should be used.
- **Scaling factor:**
  The Scaling Factor for each Arm should be set at the default value of 100% unless otherwise agreed with the MAE, as previously checked in **J.203**.
- **Traffic demand flows:**
  Traffic flows need to be entered for relevant Demand Sets, which must be consistent with the units specified in **J.202** (PCU or vehicles, per minute, hour or time segment) and the demand profile specified in **J.204**. Specifying demand per time segment may be helpful to correspond with survey count time segments when using a DIRECT demand profile, otherwise it will be necessary to factor survey values for individual time segments to equivalent flow rates per minute or hour.

  Demand flows are typically entered as Origin-Destination (OD) values for traffic movements at each junction. These should be specified as varying over time and entered for each time segment during the modelled time periods. Alternatively demand flows can be separately entered for each approach entry with the OD data used to calculate turning proportions.

  Where flows are entered in PCU, the PCU values and treatment of each vehicle category should be documented, with reference to any agreed approach for motorcycles and cyclists (see **J.305**).

- **Heavy vehicles:**
  The proportion of traffic demands made up of heavy vehicles (commonly interpreted as meaning buses / coaches, MGVs and HGVs) needs to be entered for traffic movements at each junction to account for their characteristics and influence on junction performance.

  This vehicle mix is required whether traffic flows are entered in vehicles or PCUs. It should typically be specified as varying over time and entered for each time segment during all modelled time periods.

  The option to specify a 'default vehicle mix' must not be used.

  Where the vehicle mix source is specified as 'HV Percentages', the values should be entered as the proportion of heavy vehicles compared to the total number of vehicles for each OD movement. They must not incorrectly be calculated as the percentage of heavy vehicle PCUs as a proportion of the total number of PCUs.

  If the vehicle mix source is specified as 'PCU Factors' rather than 'HV Percentages' then alternatively the Average PCU per Vehicle for each movement can be calculated and entered, provided their calculation methodology is fully explained and demonstrated.

  In order for Junctions to switch between vehicles and PCU during internal calculations, the average PCU per vehicle will be used if entered. Otherwise, the specified 'PCU Factor for an HV' will instead be used – this is initially set at 2.0 in Junctions by default, but can be updated to a more representative value for the modelled location based on survey data covering all movements.

J.304 Public Transport Modelling

Junctions is primarily intended for estimating the vehicular capacity of junctions and roundabouts, and has limited capability to model buses specifically. Buses are typically grouped together with private coaches, MGVs and HGVs and treated as 'Heavy Vehicles' to represent their impact on junction performance due to their general vehicle characteristics.

The requirement for public transport modelling is considered at MAP Stage I, with reference to the model / scheme purpose and the number of TfL buses / bus routes in the Base year and the future year of interest. Where detailed public transport modelling or performance reporting is required microsimulation modelling is typically most appropriate.

If there are expected to be changes to TfL bus routes or frequencies in the future year, it may be helpful to separate TfL buses from other local buses and private coaches when entering Base demand flows to allow separate adjustment in the future year. This will also allow any future year growth factors for general traffic to be applied separately from buses.

Whether or not detailed bus reporting is required, the impact of buses on general traffic should be considered in determining whether Junctions is able to adequately represent observed junction behaviour and performance. Some situations that may need special treatment or reduce Junctions' ability to model satisfactorily include:

- Underutilisation of lanes due to bus stops and stands;
- Interaction between traffic and buses when queuing or changing lanes; and
- Bus lanes in the vicinity of modelled junctions / roundabouts.

The DE should provide in the accompanying technical report details of any site observations and methodologies used to demonstrate that capacity influences due to public transport are accurately represented. The MAE needs to be confident that public transport modelling requirements have been considered and any impacts on network performance accounted for.

J.305 Cyclist Modelling

As detailed in Part C of the **Traffic Modelling Guidelines**, numbers of cyclists in London have grown considerably over the last decade and there is increasing provision of cycle-related transport infrastructure. This has placed greater emphasis on the need to consider cyclists during modelling assessments.

Junctions is primarily intended for estimating the vehicular capacity of junctions and roundabouts and has limited capability to model cyclists. The requirement for cyclist modelling is considered at MAP Stage I, with reference to the model / scheme purpose and the number of cyclists present or expected in the relevant future year. Where detailed cyclist modelling or performance reporting is required microsimulation modelling is typically most appropriate.

While Junctions is unable to model cyclists directly, it can account for their influence on vehicular capacity and queuing by including their PCU contribution in modelled flows. The key factor is the PCU value used to model cyclists, and whether it should be applied to some or all movements.

The following options may need to be considered:

- **Ignore cyclist PCU contribution (PCU=0.0):** this may be appropriate if numbers are small and little significant interaction is observed between cyclists and other vehicles;
- **Include PCU contribution from all cyclists (PCU=0.2):** this may be appropriate if numbers are small and there is minor interaction between cyclists and other vehicles;
- **Include variable PCU contribution from cyclists (PCU=0.2 or 0.8):** where movements can be distinguished as fully giving way or having full priority (for example at a T-junction or crossroads) different cyclist PCU values can be applied in each case. Where a cyclist is giving way to others the lower PCU value reflects a smaller impact on capacity and queuing, while in a movement that other vehicles give-way to the higher PCU value reflects a greater impact, similar to a car;

Note that Junctions 10.1 allows separate PCU values to be specified for entering and circulating cyclists at roundabouts, provided that Lane Simulation Mode is used and flows are entered in vehicles, with a cyclist percentage specified.

- **Include PCU contribution from all cyclists (PCU=0.8):** where it is not possible to separate cyclist movements into fully giving way or having full priority (for example at a roundabout where they both queue and circulate, unless using Lane Simulation Mode in Junctions 10.1), it is more important to reflect the impact on those giving way to them, when they have a similar impact to a car. This will however overestimate their impact while giving way, leading to excessive modelled queuing when in practice they would filter through waiting traffic. In this case site-specific intercept correction should be applied to reduce modelled queuing to a more realistic level using the methodology recommended by TRL[8] or based on site-collected data.

If it is unclear which of the above approaches will provide the best option then it may be helpful to model multiple options in parallel to provide a sensitivity range when assessing model performance, or consider whether

8 https://trlsoftware.com/support/knowledgebase/how-to-model-a-large-number-of-bicycles-in-the-demand-matrix/

more detailed cyclist modelling is required. Whichever approach is taken it should be discussed and agreed with the MAE and fully documented in the Validation Report.

J.306 Pedestrian Modelling

Pedestrian demand data needs be checked for all pedestrian crossings identified in **J.206** to ensure their impact on junction capacity is correctly represented. Where entered values have been derived from survey data, the DE must clearly show how representative average data has been derived from surveys covering multiple days.

The following will be checked by the MAE:

- **Pedestrian demand profile:**
  As for vehicles it is recommended the DIRECT profile should be used. This is the most accurate approach when flows are averaged over multiple days, since observed data is used to determine pedestrian arrival flow profiles that are representative for the modelled location.

  It may sometimes be acceptable to use an assumed synthetic ONE HOUR or FLAT profile rather than DIRECT where pedestrian numbers are small or to prevent bias from a particular day if limited data is available. This should however be by exception and based on specific justification that must be agreed with the MAE.

- **Pedestrian demand flows:**
  Pedestrian flows need to be entered for relevant Demand Sets, which must be consistent with the traffic flow time reference specified in **J.202** (for example representing pedestrians per minute, hour or time segment).

  Specifying demand per time segment may be helpful to correspond with survey count time segments when using a DIRECT demand profile, otherwise it will be necessary to factor survey values for individual time segments to equivalent pedestrian flow rates per minute or hour.

J.307 Intercept and Capacity Adjustments

The core mathematical models within Junctions estimate capacity based on empirical data collected at a large number of locations. It is possible to refine these estimates further for a specific location using site-specific intercept and capacity adjustments, which can account for characteristics not included within the original mathematical models. For roundabouts these can be found in the 'Data/Roundabout Calibration' menu and for priority junctions within the Data Outline under 'Stream intercept adjustments'. When used appropriately these can allow for improved validation, with modelled queues more closely matching observed queues.

Where any intercept or capacity adjustments are applied, the DE must fully detail the methodology used, with appropriate justification and supporting evidence or data (other than queue lengths) used to calculate adjusted values. The MAE must be satisfied with the reason given for any adjustments and check that they have been applied correctly and appropriately.

Intercept adjustments can be calculated automatically for roundabouts within Junctions by recording observed entry and circulating flows for an Arm while there is continuous queuing. The calculated intercept can then be stored in the model file for use in subsequent model runs. A simple method for collecting such data is described in the Junctions user guide[9]. Note when using this method that where pedestrian crossings are present it is important that they do not cause starvation of the give-way line while entry and circulating flows are being recorded.

J.308 Modelled Lane Usage

The mathematical models used to estimate capacity within Junctions assume that the entire width of each give-way approach (as defined by the junction geometry) is available for use by all queuing traffic. If this does not happen in practice, Junctions is likely to overestimate the available capacity and modelled queues will be shorter than those observed. It is therefore important to account for such capacity reductions wherever traffic lanes are observed to be underused. This may be due to lane markings, signage, bus lanes, parking, loading or other factors influencing lane choice on approach to the junction.

9 Binning J C & Burtenshaw G, Junctions 10 User Guide , Application Guide 74 (Issue F), TRL, 2023, Appendix D, p381

Where significantly reduced lane usage is regularly seen to occur, the DE should record its occurrence, investigate its cause and provide supporting evidence in the Validation Report. Note that traffic behaviour may vary by time of day, particularly where lane markings restrict certain traffic movements, so lane usage should be observed in all periods being modelled.

When accounting for reduced lane usage, the DE must fully describe and justify the methodology used to account for it. This may include:

- Use of Lane Simulation Mode, to restrict Lane choice to specific traffic movements (see **J.309**);
- Modification of modelled geometry / flows; or
- Use of appropriately calculated intercept / capacity adjustments (see **J.307**).

The MAE must be satisfied that the DE has:

- Observed and recorded any occurrences of reduced lane usage;
- Investigated their cause and provided supporting evidence;
- Used an appropriate methodology to account for the reduced lane usage: and
- That the resulting modelled lane usage is suitably representative of observed conditions.

J.309 Lane Simulation Mode

Lane Simulation Mode is an analytical extension to the empirically-derived mathematical models used in Junctions, taking account of lanes, lane storage, lane movements and the random nature of vehicle arrivals. It is therefore able to model certain blocking effects caused by lane / destination choice and can also model some entry / exit capacity restrictions. Where multiple junctions are linked within the same model, Junctions can also take account of queues blocking back from one junction to another. For roundabouts, blocking of circulatory lanes is not modelled by default however these can optionally be included. Lane Simulation Mode is covered in more detail in the Junctions user guide[10].

Lane Simulation Mode should not be regarded as a replacement for the traditional PICADY / ARCADY models, and TRL advise that results should not be relied on as being as accurate as the empirically-derived models. Its

10 Binning J C & Burtenshaw G, Junctions 10 User Guide , Application Guide 74 (Issue E), TRL, 2021, Appendix D, pp230-283

use and interpretation of model results therefore requires engineering judgement. There may also be restrictions on which model outputs are available when using Lane Simulation Mode. It is therefore typically recommended that the traditional PICADY / ARCADY models should be used initially, with subsequent investigation using Lane Simulation Mode where appropriate (it may be helpful to use additional 'Lane Simulation' Analysis Sets for this purpose). It should also be noted that while Junctions can model some blocking effects, where there is significant congestion or exit-blocking between junctions microsimulation modelling may be necessary.

If the DE or MAE consider use of Lane Simulation Mode to be appropriate, this should be agreed and detailed within the Validation Report along with supporting justification. The MAE will check the following during auditing:

- Lane Levels correctly defined for each Arm;
- Lanes correctly defined within each Lane Level;
- Lane movements between Lanes reflect observed behaviour in each modelled period;
- Pedestrian crossings correctly defined;
- Lane storage values set appropriately for lanes with limited storage, and are consistent with any equivalent non-Lane Simulation Mode values used (storage between pedestrian crossings and junction entries / exits for example)
- Any applied bottleneck or other Lane capacity restrictions are considered reasonable, with an appropriate calculation methodology and supporting data provided in each case;
- The simulation random seed value must be set to a positive number, which must be included within the Validation Report. The default seed value of -1 must not be used within a JMAP model submission;
- Simulation model results are based on a sufficient number of simulation trials to be representative (typically based on convergence reaching the TRL default stop value of 1%);
- Model results are reproducible and correspond to reported values; and
- Depending on the initial justification for use of Lane Simulation Mode, such as uneven lane usage or blocking impacts, suitable analysis to confirm its use has been effective. Should this not be the case further calibration or additional microsimulation modelling may be required.

J.310 Model Errors / Warnings

The Errors and Warnings List, accessed by clicking the Errors toolbar icon, should be checked by the DE prior to model submission and any significant errors resolved. The MAE must be satisfied that the Errors and Warnings List does not contain any significant errors or warnings the that may impact the accuracy of model results.

J.311 Queue Length Analysis

Queue lengths represent one of the most important outputs from a Junctions model for demonstrating that a model is suitably representative of observed conditions and for assessing / communicating model results. Queue lengths are normally reported in either PCUs or vehicles by Junctions, which may be different to the units used for flow entry (see **J.202**). The equivalent queue length in metres will depend on how queuing vehicles use the available road space and any marked lanes, though this can optionally be accounted for when reporting results using Lane Simulation Mode (see **J.309**).

Note that summary results presented by Junctions show the maximum queue length for each Arm across the modelled peak period regardless of which time segment it occurred in, which may be different for each Arm. Full Junctions model results report queues at the start and end of each individual time segment, therefore average queue data for each time segment and the modelled peak as a whole need to be calculated from individual time segment results.

The DE should present the following data in the Validation Report, for each modelled peak period:

- The average modelled and observed queues for each Arm, in PCU;
- The maximum modelled and observed queues for each Arm, in PCU; and
- The time segments in which peak modelled / observed queues occurred should be identified for each Arm.

The MAE must be satisfied that the reported queue figures accurately reflect model results. Where average values are reported, the DE should demonstrate to the MAE how they have been calculated.

In order to demonstrate that the model accurately reflects observed network performance, the difference between modelled and observed queue values should be calculated and presented. The following criteria should be used to indicate model validation:

- Average modelled queue (in PCU) for the peak period within 2 PCU of the average observed queue, where the average observed queue is 10 PCU or less; and
- Average modelled queue (in PCU) for the peak period within 20% of the average observed queue, where the average observed queue is greater than 10 PCU.

When comparing model and survey data, it may be helpful to plot modelled and observed queues for each time segment to check that they exhibit a similar queue profile. If that is not the case it may indicate a model issue (such as an insufficient warm-up period or geometry measurement / calibration error), or a data issue (such as insufficient number of days surveyed or upstream demand flow not being fully captured). An initial queue can be manually specified on an Arm if there is insufficient queuing following the warm-up period, however this should be justified with supporting data and not used to artificially manipulate queue validation.

Where there are no obvious errors, it may be necessary to consider intercept or capacity adjustments to further refine the Junctions model to reflect site-specific behaviour (see **J.307**).

Once validation has been achieved, the DE should analyse the model results and provide a commentary summarising the performance of each modelled junction with respect to site observations. This should include any issues of concern relating to queue lengths, such as queues exceeding available storage space, blocking issues within the junction or queues reaching to / from neighbouring junctions or other significant locations. Where pedestrian crossings are present modelled queues due to pedestrian activity should also be reported and commented on.

J.312 RFC / Delay Analysis

RFC (Ratio of Flow to Capacity) and delay figures represent key network performance indicators that are used during model assessment. As for queue results in **J.311**, it should be noted that summary results presented by Junctions show the maximum RFC and delay for each Arm across the modelled peak period regardless of which time segment they occurred in, which may be different for each Arm.

The DE should present the following data in the Validation Report, for each modelled peak period[II]:

- The average modelled RFC and delay for each Arm;
- The maximum modelled RFC and delay for each Arm; and
- The time segment in which peak RFC / delay occurred should be identified for each Arm.

The MAE must be satisfied that the reported RFC and delay figures accurately reflect model results. Where average values are reported, the DE should demonstrate to the MAE how they have been calculated. If Level of Service (LoS) model results are reported these should also be checked.

Once validation has been achieved, the DE should analyse the model results and provide a commentary summarising the performance of each modelled junction with respect to site observations. This should include any issues of concern relating to junction capacity or delay, such as oversaturation, lane utilisation and any upstream / downstream bottlenecks.

Where pedestrian crossings are present their impact on capacity should also be commented on, particularly where they cause significant entry starvation for Arms entering the junction or internal junction blocking at Exit Arms.

J.313 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **J.301 – J.312**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the JMAP Stage 3 Check Sheet (**MQA-0544/J3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **J.301 – J.312**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should

II Where arm results are unavailable (e.g. due to use of Lane Simulation Mode), lane results should be presented where possible

be seen as constructive, to increase the likelihood of model approval following resubmission.

4.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks J.301 – J.313 and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant JMAP Stage 3 Check Sheet (**MQA-0544/J3**).

If the MAE fails the model on any of the checks J.301 – J.313, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed JMAP Stage 3 Check Sheets (**MQA-0544/J3**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of JMAP Stage 3

JMAP STAGE 5a

4.4 JMAP Stage 5a, Junctions Future Base Model Submission

4.4.1 Introduction

MAP Stage 5a is an optional MAP stage that is required when the scheme assessment is following the Three Stage Modelling Process (see **A2.3.2**). The need for Future Base models and corresponding MAP Stage 5a audits is typically initially discussed during the MAP Stage 1 Base Scoping Meeting and confirmed at MAP Stage 4.

The majority of the work, both in terms of creating and auditing a Junctions Model, is completed when generating fit for purpose Base modelling. Once JMAP Stage 3 has been passed there is often a relatively small amount of work required to complete the remaining stages of JMAP.

Future Base models at JMAP Stage 5a must include all time periods.

The DE should make a copy of the MAP-approved Base models and update them to reflect expected changes in the future year, as agreed at the MAP Stage 4 meeting. These should include all future schemes considered likely to have been implemented, but excluding the specific scheme under assessment. Changes that may need to be considered include:

- **Demand changes** – due to background growth, development flows, or reassignment resulting from other schemes;
- **Network changes** – physical layout changes within the model boundary resulting from schemes other than the one being assessed; and
- **Signal timing changes** – within the model boundary resulting from background growth, the influence of other schemes or associated mitigation measures.

The Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing to the Base model results alone.

4.4.2 JMAP Stage 5a Check Sheet

JMAP Stage 5a has a Check Sheet (**MQA-0544/J5a**), which must be completed by the MAE when auditing the model.

A separate JMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

J.501 Future Base Report

Future Base model submissions must be accompanied by a report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to assess criteria **J.502** – **J.514**, together with an assessment of the likely operation of the Future Base network.

As for the Validation Report in JMAP Stage 3, it is vital that the DE communicates all of their assumptions relating to the Future Base modelling. All changes to the models should be clearly stated, including the reasoning behind the changes and any supporting information.

Clear comparisons must be made between the Validated Base model results and the Future Base model results for the corresponding periods, including analysis of any differences and commentary on impacts to network operation.

J.502 Analysis and Demand Sets

For Future Base modelling, the following Analysis and Demand Set data will be checked by the MAE:

- **Analysis Sets:** Analysis Sets should be clearly labelled to make their purpose clear, such as representing particular scenarios or layouts. Relevant Analysis Sets must be specified on each JMAP Stage 5a Check Sheet (**MQA-0544/J5a**) so that it is clear to the MAE which Analysis Sets are being submitted for auditing.

  Where different Analysis Sets are used to vary model parameters by time of day, any parameter that is changed should be highlighted in the Future Base Report and explained with justification. Analysis Sets that are intended to apply to a specific time of day should be associated with corresponding Demand Sets from the same time periods.

The Network Flow Scaling Factor and Network Capacity Scaling Factor for each Analysis Set should each be set to the default value of 100%, unless use of another factor has been agreed with the MAE and supporting data supplied (such as to represent expected growth in the future year).

- **Demand Sets:** Demand Sets should at minimum be clearly labelled with the time of day and year they represent, so that they can easily be distinguished from those used in Base models.

  As described in **J.204**, Demand Set Relationships may be helpful for distinguishing between different transport modes (such as for separate treatment of cyclist flows or buses from other motorised traffic), or to differentiate between Base flows and future year demand changes. If these are used then additional details should be recorded to describe each demand component within the Demand Set Relationship.

- **Traffic Demand Profile:** The demand profiles for Demand Sets used in Base modelling should not be changed without justification.
- **Time Period Length / Time Segment**: should remain unchanged from the Base modelling in **J.204** unless there is specific reason and justification to believe that the peak time period being modelled will change in the future year.

J.503 Physical Layout Changes

The Future Base modelling must be updated to reflect any physical layout changes expected in the future year that fall within the boundary of the Junctions modelling, excluding the scheme under assessment. This may include:

- New junctions, which should be added to the Base model and linked with existing junctions appropriately. Any decommissioned junctions should similarly be removed;
- Changes to junction types, Arms or Lanes;
- Changes to junction geometry detailed in **J.205**;

- Changes to permitted traffic movements; and
- Changes to pedestrian crossings (covered in **J.508**).

The DE should provide full details of any physical layout changes and modelling amendments to account for them, including assumptions on lane usage, in the Future Base Report.

J.504 Traffic Signal Changes

The Future Base modelling must be updated to reflect any traffic signal control or timing changes expected in the future year that fall within the boundary of the Junctions modelling, excluding the scheme under assessment. This may include:

- New signalised junctions, or removal of existing signalised junctions;
- Changes to traffic signal methods of control;
- Changes to traffic signal phases, intergreens, stages, phase / stage minimums, phase delays, permitted stage moves or stage sequences;
- Changes to cycle times, signal plans or stage timings, due to changes in demand or mitigation measures;
- Saturation flow changes due to layout changes (such as lane widths or number of lanes); and
- UGT adjustments to account for assumed changes in demand, blocking or cycle times.

The DE should provide full details of any traffic signal changes, including details of any modelling amendments, methodologies and supporting data used to account for them in the Future Base Report.

Note that for newly added signalised junctions, particularly when in sufficiently close proximity to existing junctions for signal coordination, use of alternative signal optimisation modelling software such as LinSig or TRANSYT may be necessary. Where there is a need to compare model results between different software packages, the methodology for doing so should be carefully considered, agreed with the MAE and documented in the MED.

J.505 Future Base Traffic Flows

The methodology to determine and apply Future Base general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Future Base model may be determined by applying manual changes to existing Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Future Base traffic flows.

Software settings relating to traffic flows in the Future Base model should remain unchanged from the Base model unless otherwise agreed. These include:

- Traffic input units (vehicles/PCU);
- Traffic flow time reference (per minute/hour/time segment);
- Traffic demand profile for relevant Demand Sets (see **J.502**);
- Network Flow Scaling Factor for relevant Analysis Sets (see **J.502**);
- Arm Flow Scaling Factors for relevant Demand Sets (see **J.502**); and
- Start time and modelled duration for relevant Demand Sets (see **J.502**).

Heavy vehicle percentages (or equivalent average PCU values) should only be changed from Base flows if there is a specific reason they are expected to quantifiably change in the future year, which should be explained and documented. Examples where this may be appropriate include the result of banned turns, changes to public transport routes / frequencies, differing modal growth factors or if tactical modelling suggests composition changes due to wider network changes.

Future year flows for modes modelled separately from general traffic are checked in the Public Transport Modelling (**J.506**), Cyclist Modelling (**J.507**) and Pedestrian Modelling (**J.508**) sections.

J.506 Public Transport Modelling

The Future Base modelling must be updated to reflect any public transport changes expected in the future year, excluding the scheme under assessment, that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Bus routes and service frequencies;
- Bus lanes (including hours of operation); and
- Bus influence on general traffic behaviour (such as assumed lane or flare usage in the vicinity of bus stops and lanes).

The DE should provide details of any modelling amendments relating to public transport in the Future Base Report. Note that public transport flows should not be included when applying growth factors for general traffic, but should be treated separately and informed by current or expected service frequency data. Demand Set Relationships are recommended for the separate treatment of different vehicle categories, or to keep Base flows separate from future year demand changes.

J.507 Cyclist Modelling

The Future Base modelling must be updated to reflect any changes in cyclist numbers or infrastructure expected in the future year, excluding the scheme under assessment, that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Cyclist numbers and their routing, either due to background growth or as a result of specific schemes expected to influence local cyclist activity;
- Cycle lanes, with or without segregation;
- Cyclist phases at traffic signals; and
- Cyclist influence on general traffic behaviour (such as assumed lane or flare usage in the vicinity of cycle lanes and at junctions).

The DE should provide details of any modelling amendments relating to cyclists or cycle infrastructure in the Future Base Report.

J.508 Pedestrian Modelling

The Future Base modelling must be updated to reflect any changes in pedestrian flows or pedestrian crossing facilities expected in the future year, excluding the scheme under assessment. This may include changes relating to:

- Pedestrian demand, either due to background growth or as a result of specific schemes expected to influence local pedestrian activity; or
- Pedestrian crossing locations, geometry or types (such as Zebra, Pelican Puffin or pedestrian facilities at junctions).

The DE should provide details of any modelling amendments relating to pedestrians or pedestrian crossing facilities in the Future Base Report. Where pedestrian numbers are expected to change and influence junction capacity, the DE should provide a detailed methodology, assumptions and any other supporting data in the Future Base Report.

J.509 Lane Simulation Mode

As described in **J.309**, the use of Lane Simulation Mode may be considered appropriate where there are expected to be blocking issues or interaction between neighbouring junctions, either due to increased traffic / pedestrian flows or limited available capacity / queue storage. It should however be noted that while Junctions can model some blocking effects, where there is significant congestion or exit-blocking between junctions microsimulation modelling may be necessary.

Care should be taken if trying to compare non-Lane Simulation Mode model results from a Base model with Future Base model results based on Lane Simulation Mode. Additional Base model results should typically be generated and validated using Lane Simulation Mode before comparison to ensure consistency. The use of separate Lane Simulation Mode Analysis Sets in Base and Future Base modelling is therefore recommended for this purpose.

If the DE or MAE consider use of Lane Simulation Mode to be appropriate, this should be agreed and detailed within the Future Base Report along with supporting justification. The MAE will check the following during auditing:

- Lane Levels correctly defined for each Arm;
- Lanes correctly defined within each Lane Level;

- Lane movements between Lanes reflect expected behaviour in each modelled period;
- Pedestrian crossings correctly defined;
- Lane storage values set appropriately for lanes with limited storage, and are consistent with any equivalent non-Lane Simulation Mode values used (such as storage between pedestrian crossings and junction entries / exits)
- Any applied bottleneck or other lane capacity restrictions are considered reasonable, with an appropriate calculation methodology and supporting data provided in each case;
- The simulation random seed value must be set to the same positive number as in the Base modelling, which must be included within the Future Base Report. The default seed value of -1 must not be used within a JMAP model submission;
- Lane Simulation Mode model results must be based on a sufficient number of simulation trials to be representative (typically based on convergence reaching the TRL default stop value of 1%);
- Model results are reproducible and correspond to reported values; and
- Depending on the initial justification for use of Lane Simulation Mode, such as uneven lane usage or blocking impacts, suitable analysis to confirm its use has been effective. Should this not be the case further calibration or additional microsimulation modelling may be required.

J.510 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **J.502** – **J.509**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**J.501**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes;
- Public transport / cyclist / pedestrian modelling; and
- Use of Lane Simulation Mode where required.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

The software version used must remain unchanged from the approved JMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The file / data comparison functionality provided within the Junctions software can be helpful in assisting with this task.

J.511 Model Errors / Warnings

The Errors and Warnings List, accessed by clicking the Errors toolbar icon, should be checked by the DE prior to model submission and any significant errors resolved. The MAE must be satisfied that the Errors and Warnings List does not contain any significant errors or warnings the that may impact the accuracy of model results.

J.512 Queue Length Analysis

The Future Base Report should contain a comparison of Base and Future Base queue lengths and any implications for network operation. The DE should therefore present and compare the following, for all junctions in each modelled peak period:

- The average queues for each Arm, in PCU;
- The maximum queues for each Arm, in PCU; and
- The time segments in which peak queues occur for each Arm.

The MAE must be satisfied that the reported queue figures have been compared correctly and accurately reflect model results. As for **J.311**, where average values are reported the DE should demonstrate to the MAE how they have been calculated.

The DE should analyse and compare the model results and provide a commentary summarising how the performance of each modelled junction has changed, for each modelled time period. This should include any issues of concern relating to queue lengths, such as queues exceeding available storage space, blocking issues within the junction or queues reaching to / from neighbouring junctions or other significant locations. Queue percentile outputs can be used to help inform this analysis.

Where pedestrian crossings are present any changes to modelled queues resulting from pedestrian activity should also be reported and commented on.

J.5.13 RFC / Delay Analysis

The Future Base Report should also contain a comparison of Base and Future Base junction performance results (RFC and delay), and any implications for network operation. The DE should therefore present and compare the following, for all junctions in each modelled peak period[12]:

- The average modelled RFC and delay for each Arm;
- The maximum modelled RFC and delay for each Arm; and
- The time segments in which peak RFC / delay occurred for each Arm.

The MAE must be satisfied that the reported RFC and delay figures have been compared correctly and accurately reflect model results. As for **J.3.11**, where average values are reported, the DE should demonstrate to the MAE how they have been calculated. If Level of Service (LoS) model results are reported these should also be checked.

The DE should analyse and compare the model results and provide a commentary summarising how the performance of each modelled junction has changed, for each modelled time period. This should include any issues of concern relating to junction capacity or delay, such as oversaturation, lane utilisation and any upstream / downstream bottlenecks.

Where pedestrian crossings are present any changes in performance or capacity should also be commented on, particularly where they cause significant entry starvation for Arms entering the junction or internal junction blocking at Exit Arms.

12 Where arm results are unavailable (e.g. due to use of Lane Simulation Mode), lane results should be presented where possible.

J.514 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in J.501 – J.513.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the JMAP Stage 5a Check Sheet (**MQA-0544/J5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in J.501 – J.513.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

4.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks J.501 – J.514 and there are no other outstanding issues then, referring back to the MED from MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant JMAP Stage 5a Check Sheets (**MQA-0544/J5a**).

If the MAE fails the model on any of the checks J.501 – J.514 or has highlighted other significant issues with the models, then the models are not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed JMAP Stage 5a Check Sheets (**MQA-0544/J5a**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of JMAP Stage 5a

JMAP STAGE 5b

4.5 JMAP Stage 5b, Junctions Proposed Model Submission

4.5.1 Introduction

Proposed models must be based on approved JMAP Stage 3 Base models, or when following the Three Stage Modelling process (see **A2.3.2**) the approved JMAP Stage 5a Future Base models.

Proposed modelling at JMAP Stage 5b must include all time periods.

The DE should make a copy of the approved Base or Future Base models and update them with the proposed changes, including any new junction layouts or new methods of control.

In addition to ensuring that the models are correctly developed from a technical point of view the DE is responsible for demonstrating that the proposals can be accommodated without jeopardising normal day to day operation of the network. This includes maintaining acceptable levels of RFC / DoS, delay and queues as well as sufficient provision for expected pedestrian demand.

As a representative of the TfL Traffic Manager, who will have a duty to manage the network if the proposal is implemented, the MAE must decide whether they agree the network is likely to operate satisfactorily on a day-to-day basis. They must therefore highlight any apparent issues or concerns with the proposals, which will prioritise safe, efficient network operation together with relevant TfL / Mayoral policies and guidance.

The DE will receive feedback from MAE and will need to address any issues highlighted. The MAE will use their operational experience in making informed comments and decisions.

4.5.2 JMAP Stage 5b Check Sheet

JMAP Stage 5b has a Check Sheet (**MQA-0544/J5b**), which must be completed by the MAE when auditing the models.

A separate JMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

J.551 Proposed Model Report

Proposed model submissions must be accompanied by a report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to assess criteria **J.552** – **J.565**, together with an assessment of the likely impact of the proposals.

As for the Validation Report in JMAP Stage 3, and Future Base Report in JMAP Stage 5a, it is vital that the DE communicates all of their assumptions relating to the proposals and how they have been coded in the Proposed model. All changes to the models should be clearly stated, including the reasoning behind the changes and any supporting information.

Clear comparisons must be made between the Base / Future Base model results and the Proposed models results for the corresponding periods, including analysis of any differences and commentary on impacts to network operation.

J.552 Analysis and Demand Sets

For Proposed models, the following Analysis and Demand Set data will be checked by the MAE:

- **Analysis Sets:** Analysis Sets should be clearly labelled to make their purpose clear, such as representing particular scenarios or layouts. Relevant Analysis Sets must be specified on each JMAP Stage 5b Check Sheet (**MQA-0544/J5b**) so that it is clear to the MAE which Analysis Sets are being submitted for auditing.

Where different Analysis Sets are used to vary model parameters by time of day, any parameter that is changed should be highlighted in the Proposed Model Report and explained with justification. Analysis Sets that are intended to apply to a specific time of day should be associated with corresponding Demand Sets from the same time periods.

The Network Flow Scaling Factor and Network Capacity Scaling Factor for each Analysis Set should each be set to the default value of 100%, unless use of another factor has been agreed with the MAE and supporting data supplied (for example, to represent expected future year growth).

- **Demand Sets:** Demand Sets should at minimum be clearly labelled with the time of day and year they represent, so that they can easily be distinguished from those used in Base models. When following the Three Stage Modelling process, future year Demand Sets should be appropriately labelled where there are differences between Future Base and Proposed model flows.

  As described in **J.204**, Demand Set Relationships may be helpful for distinguishing between different transport modes (such as for separate treatment of cyclist flows or buses from other motorised traffic), or to differentiate between Base flows and future year demand changes. If these are used then additional details should be recorded to describe each demand component within the Demand Set Relationship.

- **Traffic Demand Profile:** The demand profiles for Demand Sets used in Base or Future Base modelling should not be changed without justification.

- **Time Period Length / Time Segment**: should remain unchanged from the Base / Future Base modelling unless there is specific reason and justification to believe that the peak time period will change as a result of the proposals.

J.553 Physical Layout Changes

The Proposed modelling must be updated to reflect any physical layout changes proposed as part of the scheme under assessment. Where these include changes to signalised infrastructure, proposed drawings will first need to be submitted to the MAE for SAE approval (see **J.554**) before the model audit can proceed.

Physical layout changes may include:

- New junctions, which should be added to the Base / Future Base model and linked with existing junctions appropriately. Any decommissioned junctions should similarly be removed;
- Changes to junction types, Arms or lanes;
- Changes to junction geometry detailed in **J.205**;
- Changes to permitted traffic movements; and
- Changes to pedestrian crossings (covered in **J.508**).

The DE should provide full details of any physical layout changes and modelling amendments to account for them, including assumptions on lane usage, in the Proposed Model Report.

J.554 Traffic Signal Changes

The Proposed modelling must be updated to reflect any traffic signal control or timing changes included as part of the scheme under assessment.

This may include:

- New signalised junctions, or removal of existing signalised junctions;
- Changes to traffic signal methods of control;
- Changes to traffic signal phases, stages, intergreens, phase / stage minimums or phase delays;
- Changes to signal plan timings or cycle times, due to changes in demand or mitigation measures;
- Saturation flow changes due to layout changes (such as lane widths or number of lanes); and
- UGT adjustments to account for assumed changes in demand, blocking or cycle times.

The DE should provide full details of any traffic signal changes, including details of any modelling amendments, methodologies and supporting data used to account for them in the Proposed Model Report.

Where any new or modified signalised infrastructure is proposed, the SAE must perform a review to identify issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings. Before submitting Proposed modelling, the DE must therefore submit proposed drawings and methods of control to the MAE, who will check that they reflect the proposals identified in the MED. Once the MAE has confirmed the details are correct, they will arrange an Engineering Service Request (ESR) for the SAE to undertake the review of the proposals.

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE. The MAE must confirm that SAE approval has been received for any new or modified signalised infrastructure prior to auditing.

> Lack of an approved Traffic Signal Option Selection Review form for any method of control changes will prevent the MAE from completing JMAP Stage 5b.

Note that for newly added signalised junctions, particularly when in sufficiently close proximity to existing junctions for signal coordination, use of alternative signal optimisation modelling software such as LinSig or TRANSYT may be necessary. Where there is a need to compare model results between different software packages, the methodology for doing so should be carefully considered, agreed with the MAE and documented in the MED.

J.555 Proposed Traffic Flows

The methodology to determine and apply Proposed general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Proposed model may be determined by applying manual changes to existing Base or Future Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Proposed traffic flows.

Software settings relating to traffic flows in the Proposed model should remain unchanged from the relevant Base / Future Base model unless otherwise agreed. These include:

- Traffic input units (vehicles/PCU);
- Traffic flow time reference (per minute/hour/time segment);
- Traffic demand profile for relevant Demand Sets (see **J.552**);
- Network Flow Scaling Factor for relevant Analysis Sets (see **J.552**);
- Arm Flow Scaling Factors for relevant Demand Sets (see **J.552**); and
- Start time and modelled duration for relevant Demand Sets (see **J.552**).

Heavy vehicle percentages (or equivalent average PCU values) should only be changed from Base / Future Base flows if there is a specific reason they are expected to quantifiably change as a result of the proposed scheme, which should be explained and documented. Examples where this may be appropriate include the result of banned turns, changes to public transport routes / frequencies, differing modal growth factors or if tactical modelling suggests composition changes due to wider network changes.

Proposed flows for modes modelled separately from general traffic are checked in the Public Transport Modelling (**J.556**), Cyclist Modelling (**J.557**) and Pedestrian Modelling (**J.558**) sections.

J.556 Public Transport Modelling

The Proposed modelling must be updated to reflect any public transport changes expected as a result of the proposed scheme that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Bus routes and service frequencies;
- Bus lanes (including hours of operation); and
- Bus influence on general traffic behaviour (such as the assumed lane or flare usage in the vicinity of bus stops and lanes).

The DE should provide details of any modelling amendments relating to public transport in the Proposed Model Report. Note that public transport flows should not be included when applying growth factors for general traffic, but should be treated separately and informed by current or expected service frequency data. Demand Set Relationships are recommended for the separate treatment of different vehicle categories, or to keep Base flows separate from future year demand changes.

J.557 Cyclist Modelling

The Proposed modelling must be updated to reflect any changes in cyclist numbers or infrastructure expected as a result of the proposed scheme that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Cyclist numbers and their routing, either due to background growth or proposed scheme changes expected to influence cyclist activity;
- Cycle lanes, with or without segregation;
- Cyclist phases at traffic signals; and
- Cyclist influence on general traffic behaviour (such as the assumed lane or flare usage in the vicinity of cycle lanes and at junctions).

The DE should provide details of any modelling amendments relating to cyclists or cycle infrastructure in the Proposed Model Report.

J.558 Pedestrian Modelling

The Proposed modelling must be updated to reflect any changes in pedestrian flows or pedestrian crossing facilities expected as a result of the proposed scheme. This may include changes relating to:

- Pedestrian demand, either due to background growth or proposed scheme changes expected to influence local pedestrian activity; or
- Pedestrian crossing locations, geometry or types (such as Zebra, Pelican Puffin or pedestrian facilities at junctions).

The DE should provide details of any modelling amendments relating to pedestrians or pedestrian crossing facilities in the Proposed Model Report. Where pedestrian numbers are expected to change and influence junction capacity, the DE should provide a detailed calculation methodology, assumptions and any other supporting data in the Proposed Model Report.

J.559 Lane Simulation Mode

As described in **J.309** / **J.509**, the use of Lane Simulation Mode may be considered appropriate where there are expected to be blocking issues or interaction between neighbouring junctions, either due to increased traffic / pedestrian flows or limited available capacity / queue storage. It should however be noted that while Junctions can model some blocking effects, where there is significant congestion or exit-blocking between junctions microsimulation modelling may be necessary.

Care should be taken if trying to compare non-Lane Simulation Mode model results from a Base or Future Base model with Proposed model results based on Lane Simulation Mode. Additional Base / Future Base model results should typically be generated and validated using Lane Simulation Mode before comparison to ensure consistency. The use of separate Lane Simulation Mode Analysis Sets in Base, Future Base and Proposed modelling is therefore recommended for this purpose.

If the DE or MAE consider use of Lane Simulation Mode to be appropriate, this should be agreed and detailed within the Proposed Model Report along with supporting justification. The MAE will check the following during auditing:

- Lane Levels correctly defined for each Arm;
- Lanes correctly defined within each Lane Level;
- Lane movements between Lanes reflect expected behaviour in each modelled period;
- Pedestrian crossings correctly defined;
- Lane storage values set appropriately for lanes with limited storage, and are consistent with any equivalent non-Lane Simulation Mode values used (such as storage between pedestrian crossings and junction entries / exits)
- Any applied bottleneck or other lane capacity restrictions are considered reasonable, with an appropriate calculation methodology and supporting data provided in each case;
- The simulation random seed value must be set to the same positive number as in the Base / Future Base modelling, which must be included within the Proposed Model Report. The default seed value of -1 must not be used within a JMAP model submission;
- Simulation model results are based on a sufficient number of simulation trials to be representative (typically based on convergence reaching the TRL default stop value of 1%);

- Model results are reproducible and correspond to reported values; and
- Depending on the initial justification for use of Lane Simulation Mode, such as uneven lane usage or blocking impacts, suitable analysis to confirm its use has been effective. Should this not be the case further calibration or additional microsimulation modelling may be required.

J.560 Other Adjustments from Stage 3 / 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **J.552** – **J.559**, concerning specific changes to the following areas resulting from the proposed scheme that should be detailed in the Proposed Model Report (**J.551**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes;
- Public transport / cyclist / pedestrian modelling; and
- Use of Lane Simulation Mode where required.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved JMAP Stage 3 / 5a model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The file / data comparison functionality provided within the Junctions software can be helpful in assisting with this task.

J.561 Model Errors / Warnings

The Errors and Warnings List, accessed by clicking the Errors toolbar icon, should be checked by the DE prior to model submission and any significant errors resolved. The MAE must be satisfied that the Errors and Warnings List does not contain any significant errors or warnings the that may impact the accuracy of model results.

J.562 Queue Length Analysis

The Proposed Model Report should contain a comparison of Base / Future Base and Proposed model queue lengths and any implications for network operation. The DE should therefore present and compare the following, for all junctions in each modelled peak period:

- The average queues for each Arm, in PCU;
- The maximum queues for each Arm, in PCU; and
- The time segments in which peak queues occur for each Arm.

The MAE must be satisfied that the reported queue figures have been compared correctly and accurately reflect model results. As for **J.311**, where average values are reported the DE should demonstrate to the MAE how they have been calculated.

The DE should analyse and compare the model results and provide a commentary summarising how the performance of each modelled junction has changed, for each modelled time period. This should include any issues of concern relating to queue lengths, such as queues exceeding available storage space, blocking issues within the junction or queues reaching to / from neighbouring junctions or other significant locations. Queue percentile outputs can be used to help inform this analysis.

Where pedestrian crossings are present any changes to modelled queues resulting from pedestrian activity should also be reported and commented on.

J.563 RFC / Delay Analysis

The Proposed Model Report should also contain a comparison of Base / Future Base and Proposed model junction performance results (RFC and delay), and any implications for network operation. The DE should therefore present and compare the following, for all junctions in each modelled peak period[13]:

- The average modelled RFC and delay for each Arm;
- The maximum modelled RFC and delay for each Arm; and
- The time segments in which peak RFC / delay occurred for each Arm.

The MAE must be satisfied that the reported RFC and delay figures have been compared correctly and accurately reflect model results. As for **J.312**, where average values are reported, the DE should demonstrate to the MAE how they have been calculated. If Level of Service (LoS) model results are reported these should also be checked.

The DE should analyse and compare the model results and provide a commentary summarising how the performance of each modelled junction has changed, for each modelled time period. This should include any issues of concern relating to junction capacity or delay, such as oversaturation, lane utilisation and any upstream / downstream bottlenecks.

Where pedestrian crossings are present any changes in performance or capacity should also be commented on, particularly where they cause significant entry starvation for Arms entering the junction or internal junction blocking at Exit Arms.

J.564 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence, the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see **A2.1**) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

13 Where arm results are unavailable (e.g. due to use of Lane Simulation Mode), lane results should be presented where possible.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

J.565 Other Modelling Issues

The DE has no direct input into this section, however its purpose is for the MAE to communicate any concerns with the model that have not already been covered by the checks in **J.551** – **J.564**. The DE should therefore take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the JMAP Stage 5a Check Sheet (**MQA-0544/J5b**) and address them.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

4.5.3 Acceptance / Rejection of the Model

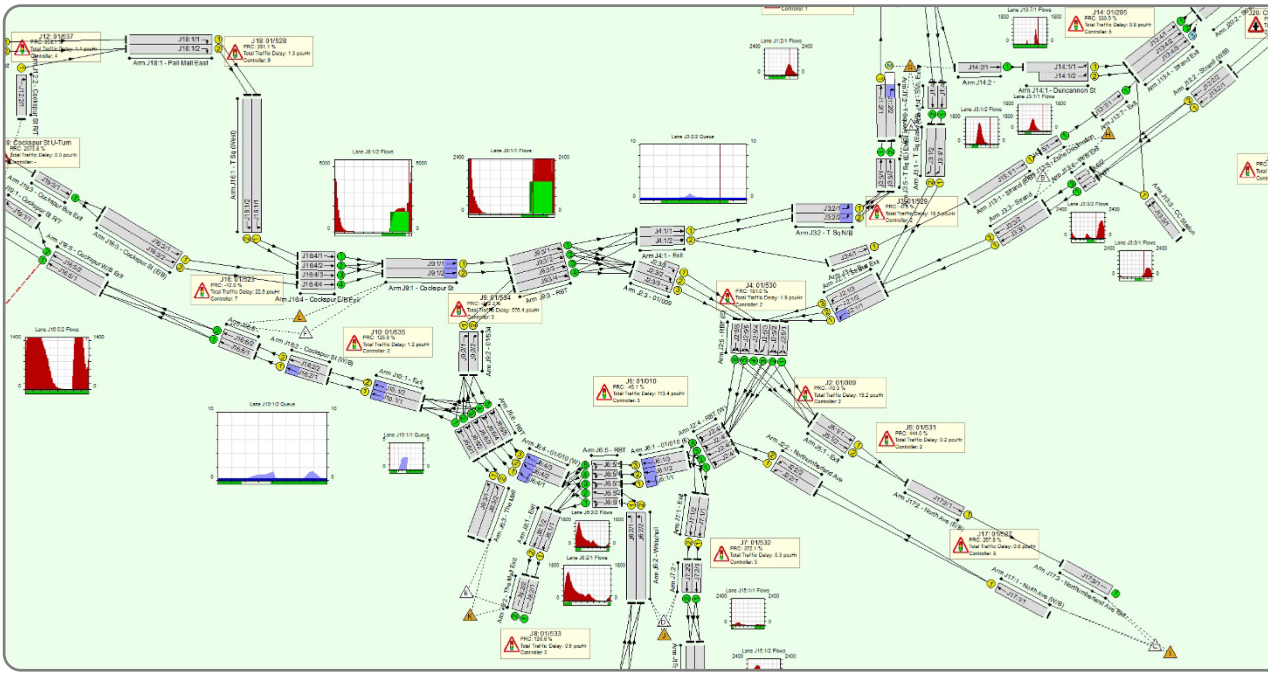
If the MAE passes the model on all of the checks **J.551** – **J.565** and there are no other outstanding issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant JMAP Stage 5b Check Sheets (**MQA-0544/J5b**).

If the MAE fails the model on any of the checks J.551 – J.565 or has highlighted other significant issues with the models, then the models are not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE, CE and SAE of the Approval or Rejection of the submission and provide completed JMAP Stage 5b Check Sheets (**MQA-0544/J5b**), which should be copied to NMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of JMAP Stage 5b

5 LinSig MAP (LMAP)



5.1 Scope

LMAP applies to LinSig models submitted to TfL Operations for auditing.

It is not necessary to apply LMAP to 'Skeleton' or 'controller-only' LinSig models without traffic flows that have been submitted to support modelling using other software such as Aimsun Next, TRANSYT or Vissim. These LinSig models should still be checked for accuracy, for which elements of LMAP may prove useful, however LMAP should not be applied in full.

LMAP STAGE 2

5.2 LMAP Stage 2, LinSig Calibrated Base Model Submission

5.2.1 What is a LinSig Calibrated Base Model?

A LinSig Calibrated Base model should contain:

- all the signal control data with representative signal timings for the network during the period under consideration, without adjustments to account for the non-appearance of demand-dependent stages; and
- the appropriate network structure, measured cruise times, measured saturation flows (or calculated, if necessary) and measured Lane lengths.

A single Calibrated Base model is required for LMAP Stage 2.

5.2.2 What is the purpose of a LinSig Calibrated Base Model?

Experience has shown that the submission of one model early in the modelling exercise is a very useful starting point for both the DE and the MAE, and will improve the standard of subsequent model submissions.

The Calibrated Base model submission will provide the MAE the opportunity to see that the DE has fully understood the UTC data they have been provided with, and has collected relevant knowledge of the network. This is particularly relevant if the MAE has not received any modelling from the DE previously. The initial model submission will ensure that the signal data is correct.

5.2.3 Tasks before looking at the LMAP Stage 2 Check Sheet

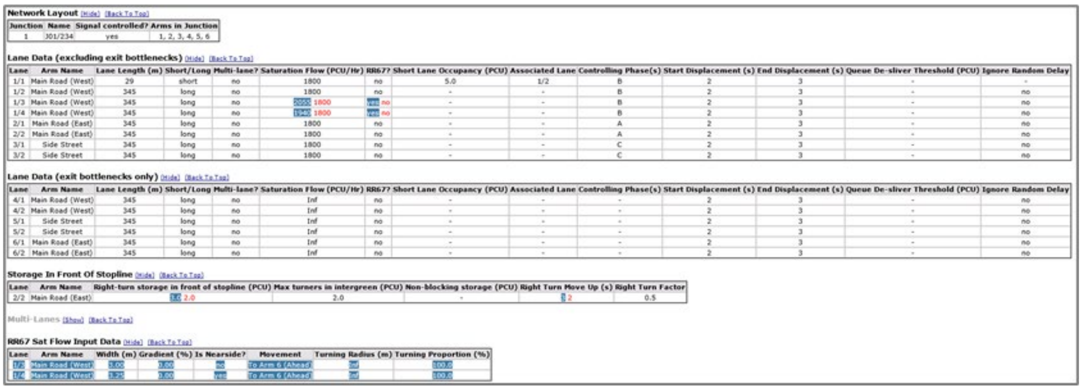
- It is recommended that the DE obtains TfL Signal Timing Sheets and Controller Specifications from TfL[14] for all the nodes in the network, as described in Part B of the **Traffic Modelling Guidelines**. Signal Timing Sheets should be checked against relevant Controller Specifications for accuracy. These documents need to be consistent, the only acceptable differences are those changed directly within the on-street controller, for example phase delays. These controller amendments should be listed in the 'Historical Amendments' section at the end of the TfL Signal Timing Sheet. If the TfL Signal Timing Sheet is not consistent with method of control on street, the MAE should detail the changes for the Data and Inspections team in TfL and ask for the TfL Signal Timing Sheet to be up issued.
- The DE should obtain a copy of each of the UTC timing plans from the MAE for all the nodes in the Network for all modelled periods.

5.2.4 LMAP Stage 2 Check Sheet

LMAP Stage 2 has a Check Sheet (**MQA-0544/L2**), which must be completed by the MAE when auditing the model.

This section identifies the checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

The most convenient, and recommended, way of checking the majority of data is through use of the 'Model Audit View' in LinSig, as shown in **Figure 9**.



Network Layout [Hide] [Back To Top]

Junction	Name	Signal controlled?	Arms in Junction
1	J01/234	yes	1, 2, 3, 4, 5, 6

Lane Data (excluding exit bottlenecks) [Hide] [Back To Top]

Lane	Arm Name	Lane Length (m)	Short/Long	Multi-lane?	Saturation Flow (PCU/Hr)	RR67?	Short Lane Occupancy (PCU)	Associated Lane	Controlling Phase(s)	Start Displacement (s)	End Displacement (s)	Queue De-sliver Threshold (PCU)	Ignore Random Delay
1/1	Main Road (West)	29	short	no	1800	no	5.0	1/2	B	2	3	-	-
1/2	Main Road (West)	345	long	no	1800	no	-	-	B	2	3	-	no
1/3	Main Road (West)	345	long	no	[illegible] 1800	yes no	-	-	B	2	3	-	no
1/4	Main Road (West)	345	long	no	[illegible] 1800	yes no	-	-	B	2	3	-	no
2/1	Main Road (East)	345	long	no	1800	no	-	-	A	2	3	-	no
2/2	Main Road (East)	345	long	no	1800	no	-	-	A	2	3	-	no
3/1	Side Street	345	long	no	1800	no	-	-	C	2	3	-	no
3/2	Side Street	345	long	no	1800	no	-	-	C	2	3	-	no

Lane Data (exit bottlenecks only) [Hide] [Back To Top]

Lane	Arm Name	Lane Length (m)	Short/Long	Multi-lane?	Saturation Flow (PCU/Hr)	RR67?	Short Lane Occupancy (PCU)	Associated Lane	Controlling Phase(s)	Start Displacement (s)	End Displacement (s)	Queue De-sliver Threshold (PCU)	Ignore Random Delay
4/1	Main Road (West)	345	long	no	Inf	no	-	-	-	2	3	-	no
4/2	Main Road (West)	345	long	no	Inf	no	-	-	-	2	3	-	no
5/1	Side Street	345	long	no	Inf	no	-	-	-	2	3	-	no
5/2	Side Street	345	long	no	Inf	no	-	-	-	2	3	-	no
6/1	Main Road (East)	345	long	no	Inf	no	-	-	-	2	3	-	no
6/2	Main Road (East)	345	long	no	Inf	no	-	-	-	2	3	-	no

Storage In Front Of Stopline [Hide] [Back To Top]

Lane	Arm Name	Right-turn storage in front of stopline (PCU)	Max turners in intergreen (PCU)	Non-blocking storage (PCU)	Right Turn Move Up (s)	Right Turn Factor
2/2	Main Road (East)	[illegible] 2.0	2.0	-	[illegible] 2	0.5

Multi-Lanes [Show] [Back To Top]

RR67 Sat Flow Input Data [Hide] [Back To Top]

Lane	Arm Name	Width (m)	Gradient (%)	Is Nearside?	Movement	Turning Radius (m)	Turning Proportion (%)
1/3	Main Road (West)	3.00	0.00	no	To Arm 6 (Ahead)	Inf	100.0
1/4	Main Road (West)	3.25	0.00	yes	To Arm 6 (Ahead)	Inf	100.0

Figure 9: Model Audit View in LinSig v3.2

---

14 TfL Signal Timing Sheets and Controller Specifications can be requested from **AssetOperationsDataLegalRequest@tfl.gov.uk**

L.201 Calibration Report

The DE is required to submit a Calibration Report along with Calibrated Base model submissions, as described in Part B of the **Traffic Modelling Guidelines**.

The DE should ensure that the note contains, at a minimum:

- The stated purpose of the model, as agreed with the P and MAE during MAP Stage 1 and defined in the Modelling Expectations Document (MED);
- A list of all the TfL-referenced nodes in the modelled network, with addresses;
- Notes on all relevant site observations, covering both the physical constraints of the network and vehicle behaviour. Where the behaviour is specific to a time of day, this should be noted. It is important to clearly explain how these factors have determined the structure of the model;
- Site datasheets with measured cruise times and saturation flows;
- A table of saturation flows for each Lane in the network. The table should indicate clearly whether the value has been measured on site or has been calculated using factored RR67 values. Where factored RR67 values have been used an explanation should be given detailing why it couldn't be measured and the calculations used, see Part B of the **Traffic Modelling Guidelines**; and
- The derivation of the signal timings.

The MAE may elect to collect their own on-site data to verify the accuracy of submissions, for example by measuring Lane lengths, cruise times or saturation flows.

L.202 Software and Network Settings

Here, the MAE will check the following aspects of the DE's model:

Software version:

- The software version should be as agreed at MAP Stage I and documented in the MED.

Network Settings:

- **PCU Length:** this should be unchanged from the default value of 5.75m.

L.203 LinSig Scenarios

It is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a specific Scenario must be entered on the LMAP Stage 2 Check Sheet (**MQA-0544/L2**) so that it is clear to the MAE which Scenario is being submitted by the DE for auditing.

In addition to the Scenario being submitted for auditing it may be useful to include additional Scenarios, for example when investigating alternative stage sequences or for looking at stage minimums.

L.204 Network Layout

The MAE will check the following aspects within the Network Layout View:

- **Junctions:** ensure that all junctions to be modelled are included and clearly labelled with an appropriate description. All Junctions should also be associated with the correct controller(s) where they include Arms with signal-controlled Lanes.
- **Arms:** ensure that all relevant Junction Arms are included in the model and are associated with the correct Junction. Junction Arms should be named where appropriate to ensure it is clear which roads they represent.
- **Short / Long Lanes:** Short Lanes should be used to model flares or right-turn bays, unless the Lane contains a Multi-Lane, and should be associated with an appropriate Long Lane. The physical length of the flare should represent the full length of the flare on street. Where

Multi-Lanes are used flare usage can be directly entered within the Multi-Lane properties. Flare usage will be checked in LMAP Stage 3. Note that blocking effects are not modelled when using Multi-Lane flares and may therefore need to be accounted for through other means, such as the addition of upstream Underutilised Green Time. Blocking effects are inherently accounted for when using Short Lanes.

- **Multi-Lanes:** where adjacent Lanes exhibit identical behaviour in terms of queuing and signal control they can be grouped using the Multi-Lane option (analogous to single TRANSYT links and traffic streams containing multiple lanes). Where these are used the number of grouped lanes and on-street signal-control / queuing behaviour should be checked.
- **Connectors:** all observed traffic movements at Junctions should be represented by individual Connectors, including any upstream Lane-to-Lane Connectors that may be required to capture the correct stopline queuing and turning behaviour.
- **Zones:** Zones and Zone-Based Routes are used where flows are entered using Origin-Destination (OD) format for Matrix-Based flow allocation, where OD surveys have been collected on street or Matrix Estimation from turning count data. Zones can also be used for Route-Based analysis of network performance (whether or not Matrix-Based flows have been used). Where Matrix Estimation is deemed necessary to obtain an OD matrix, it is recommended to use a fully validated assignment model based on dedicated assignment modelling software and a verified Prior Matrix, as detailed in Part B of the **Traffic Modelling Guidelines**.

The DE should perform site observations to ensure that relevant data is collected to recreate site-specific behaviour, which may need to be verified by the MAE.

Full details of typical site observations are provided in Part B of the **Traffic Modelling Guidelines** but commonly include queuing behaviour, flared approaches, parking and loading issues, bus lane usage and setbacks, right turn behaviour and exit-blocking. As traffic behaviour can change by time of day it may be necessary make observations during each modelled period.

It is advisable for DEs or MAEs with limited experience to ask for assistance for key observations, such as from the CE or other TfL colleagues. This will provide an understanding of more detailed site-specific issues which may be highlighted in later stages of MAP. For example, it may be found that whilst two lanes have been indicated on the site drawing, there is parking in the nearside lane close to the stopline, which results in a single lane discharge.

Flare lengths should be modelled with special attention to how traffic behaves on-street, for example where a bus lane setback creates an effective flare. It is important that all flared approaches are accurately captured at this stage of MAP. If flares are not correctly coded the model may overestimate stopline capacity with a consequent impact during model validation.

L.205 Lane Data

The Lane data within the DE's model that the MAE will audit include:

- **Lane length:**

  This should be as measured on-site for the Lane concerned.

  The DE should record in the technical note how Lane lengths were measured when building the model, which should determine the appropriate level of information required during auditing. The MAE may check Lane lengths on site or use measurements from available scaled drawings or electronic mapping for reference.

- **Saturation flow:**

  This should be as measured on-site, or where not possible calculated, for the Lane concerned.

  Saturation flows are fundamental to the integrity of any traffic model, and should have been measured on-site by the DE for all Lanes. If this was not possible, an explanation should be given in the Calibration Report. Where saturation flows have been calculated, factored RR67[15] values should have been used, see Part B of the **Traffic Modelling Guidelines**.

  It may be acceptable for the DE to use default saturation flows (1800 PCU/hr per Lane) for Pelican crossings or non-critical side roads and pedestrian crossings where there is insufficient traffic demand (or queuing) to measure saturation flows accurately, however this should be agreed with the MAE. Similarly, the DE should specify some Lanes as unconstrained (infinite saturation flow) where it is unnecessary or

15 Kimber R M, Macdonald M & Hounsell N B, The Prediction of Saturation Flows for Road Junctions Controlled by Traffic Signals, Transport and Road Research Laboratory, Department of Transport, Research Report 67, 1986.

inadvisable to model Lane capacity (for example exits from the network or dummy links modelling internal junction movements).

The DE and MAE should identify the critical Junction(s) and Lane(s) in the network, for which it is most necessary to accurately model and check saturation flows. If critical modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies during later stages of MAP.

- **Right-turn storage in front of stopline:**

  This should correspond to the storage (in PCU) available in front of the stopline for waiting vehicles from opposed, signalised movements.

- **Maximum turners during intergreen:**

  This should correspond to the maximum number of turners (in PCU) that are able to clear the junction during the intergreen period. This value should be recorded from on-site observations, and may be less than the storage provided in from of the stopline.

- **Right Turn Move Up:**

  This should be set to the default value of 'Auto-Calc Using Storage'.

- **Right Turn Factor:**

  This controls bonus capacity due to right-turning traffic storing in front of the stopline and should be left at the default value of 0.5. It should only be changed if accompanied by measured site data.

- **Non-blocking storage:**

  Where a Lane contains a mixture of both opposed and unopposed traffic, the number of PCUs of opposed vehicles that are able to store without blocking unopposed vehicles should be specified here.

- **Controlling phase(s) and controller:**

  For signal-controlled Lanes, the controlling phase(s) should be specified along with the corresponding traffic signal controller.

- **Multi-Lanes:**

  Where it is considered appropriate to use Multi-Lanes (see **L.204**), the following parameters must be checked are correct:

  - Number of Lanes to be represented by the Multi-Lane;

  - Saturation flow, which should be the cumulative total of saturation flows for all Long Lanes in the Multi-Lane;
  - Number of flares; and
  - Individual flare lane saturation flows.

- **Start and end displacements:**

  These should be left at the default values of 2s and 3s respectively, unless measured site data suggests different values (for example where a survey of start and end lost times has been performed).

- **Queue de-sliver:**

  This should be left blank (in essence, zero) during LMAP Stage 2. Values up to 1.0PCU can be applied later during LMAP Stage 3 if sliver queues are observed to be produced once flows are added to the model (see **L.312**).

- **Ignore random delay:**

  This option should be left unchecked unless appropriate for the specific Lane being modelled, for example circulating movements at signal-controlled roundabouts where the distance between entry and circulating stoplines are small and platoon arrival patterns are regular and non-random. Where this option is enabled its use should be reported and justified.

L.206 Connector Data

The Connector data that the MAE will check includes:

- **Cruise time / cruise speed:**

  Cruise times should be entered as measured on-site for each traffic movement. Cruise speeds should not be used, nor should the 'Custom Lane Length' feature be used unless agreed by the MAE and justified with valid site data.

  The cruise time for a Connector in LinSig is defined as the average time for a free-flowing vehicle driving in a platoon to travel from the stopline of the upstream Lane to the stopline of the downstream Lane. The Connector cruise time will apply to all flows that pass through the Connector unless a custom cruise time has been defined for a particular Flow Group or Route, which is checked in **L.306** during MAP Stage 3.

The MAE should pay particular attention to the accuracy of cruise times in view of the fact that they are based on vehicle speeds which can vary significantly both from network to network and within a network.

The MAE may wish to discuss with the DE how auditing time is best utilised within **L.204**. If necessary the MAE can identify critical journey times which should be checked for accuracy on-site. Less critical cruise times should be checked to ensure they are at least reasonable based on expected vehicle speeds at individual sites.

- **Platoon dispersion behaviour:**

  The platoon dispersion behaviour and dispersion coefficient can be used to control whether or not platoon dispersion should be modelled. It may be appropriate not to model platoon dispersion for short Lanes that are closely coordinated with adjacent upstream Lanes, where traffic platoons remain tightly defined. Where Use Platoon Dispersion has been unticked, this should be justified and documented in the Calibration Report (**L.201**).

  Where platoon dispersion is modelled the platoon dispersion coefficient should be unchanged from the default value of 35 unless supported by site-measured data.

L.207 Controller Data

The following controller data should be checked by the MAE:

- **Controller name and SCN:**

  Each LinSig controller should have a suitable description to aid in its identification, together with the specific TfL site reference number (SCN, or System Code Number) as shown on the appropriate TfL Signal Timing Sheet. The LinSig controller number that is used is arbitrary.

- **Controller type:**

  Where known, the controller type should be entered for the specific hardware that exists on-street (including ‘Siemens’, ‘Peek’ and ‘Microsense[16]’). Where the hardware type is not known and cannot be determined, it may be acceptable to leave the type as ‘Generic’.

---

16 At the time of publishing these are the Controller type names included in the current version of LinSig, although some company names have since been updated, for example Swarco and Yunex

It should be noted that the controller type can have a significant impact on the interpretation of values entered for phase delays in L.206. Where 'Generic' controller types are used, particular attention should be paid to ensure that phase delays are correctly represented.

- **Treat phase Minimums as Street / Controller minimums:**

  It is important that, in developing LinSig Models, phase minimums are treated as 'Controller Minimums' rather than 'street minimums'.

- **Allow multiple stage streams:**

  If a controller runs multiple streams on-street, then this should also be represented within the LinSig model. Where this option is specified the DE and MAE must ensure that all streams are correctly represented and associated with the correct controller.

- **Non-standard filters:**

  This value should be left unchecked, preventing filter phases from terminating when the associated phase loses green, as this signal behaviour is not used in London.

L.208 Phase Data

The following phase data will be checked by the MAE:

- **Associated stream and controller:**

  These should be checked to confirm that the phase has been associated with the correct controller and stream.

- **Phase letters:**

  These should correspond to the phase letters as used on the appropriate TfL Signal Timing Sheet and/or Controller Specification.

- **Phase description:**

  The phase description should be suitable to correctly identify the on-street phase and/or movement that the modelled phase represents.

- **Phase type:**

  This should be set to the appropriate value for the phase concerned, such as 'Traffic', 'Pedestrian', 'Bus', 'Cycle', 'Filter', 'Indicative Arrow' or 'Dummy'.

- **Phase minimum:**

  The phase minimums should be set to the values specified on the TfL Signal Timing Sheet and/or Controller Specification.

- **Phase delays:**

  These should be specified using the Interstage and Phase Delays View. They can be quickly checked using the Model Audit View and should correspond to entries on TfL Signal Timing Sheets and/or Controller Specifications. Particular care should be taken to ensure that phase delays are represented using the correct controller hardware and that appropriate values are used (such as relative or absolute values for phase-gaining delays).

  Typically, the values on TfL Signal Timing Sheets and Controller Specifications correspond to values for the specific controller, which may be either relative or absolute. These should correspond to the 'Controller Values' in LinSig, rather than the directly entered value. Common sense can often determine the purpose of the phase delay and therefore which representation is correct, however if in doubt the DE should consult the MAE and green times should be checked on-street and compared to the timings in LinSig.

L.209 Lane Behaviour and Control Data

The Lane behaviour and control data that the MAE will check includes:

- **Signalised / give-way control:**

  For Lanes with signalised control the controlling phase and controller should already have been specified in **L.205**. For Lanes with give-way movements, 'This movement gives way' should be selected for each individual give-way movement.

- **Opposing Lanes:**

  For each Lane that gives-way, the opposing Lanes and movements need to be individually specified. For each opposing Lane, the give-way coefficient and 'Clr Conflict' parameter need to be entered.

  The give-way (or 'slope') coefficient represents the effect of the opposing flow on the capacity at the give-way line and is determined by the nature of the give-way movement. The LinSig manual[17] suggests appropriate values of 0.22 for a give-way controlled left turn and 1.09 for an opposed right-turn at a signalised junction.

  The 'Clr Conflict' parameter represents the time for a vehicle to travel from the opposing stopline to a point where it is no longer in conflict with the give-way movement. Thus vehicles that are giving way and stored in the junction at the end of green cannot clear until the 'Clr Conflict' time has passed following the start of the intergreen. A default value of 2s is typically used; however a larger value may be required for large junctions.

- **Maximum flow while giving way:**

  This should be set to the maximum capacity for the give-way movement (in PCU/hr), during which vehicles are giving way but while there is no opposing flow (in essence the 'intercept'). The LinSig manual[17] suggests values of 715PCU/hr are appropriate for a give-way controlled left turn and 1439PCU/hr for an opposed right-turn at a signalised junction.

- **Flow when opposing traffic is stopped:**

  This is the maximum flow for the give-way movement when the opposing traffic flow is stopped. It should be set to either:

  - 'Use Maximum Flow when Giving Way', where the rate of flow is unlikely to be different from the flow while giving way. This may be the case for some left-turn give-way movements where it is not clear from a driver's point of view when the opposing traffic flow has stopped;
  - 'Use Lane Saturation Flow', where vehicles are free to discharge at the Lane's saturation flow, for example during an indicative right arrow where turning vehicles know they have priority; or

17 Moore P, LinSig Version 3.2 User Guide, JCT Consultancy Ltd, V3.2.18, Ch 3, 2014, pp44-45

- 'Use Custom Value, where a user-specified value is considered more appropriate. If this is the case the reasoning should be given along with how the entered value has been determined.

L.210 Stage Data

The stage data that will be audited for each controller and stream includes:

- **Stage number:** This should match the stage number shown on the TfL Signal Timing Sheet and/or Controller Specifications where possible, or alternatively appropriate stages should be renumbered in a logical fashion (for example stage 0 may be renumbered to the highest unused stage or for an additional stream stage numbering can restart from 1).
- **Phases red / green in stage:** These should correspond to the phase / stage relationship defined on the TfL Signal Timing Sheet and Controller Specification.
- **Stage minimums:** Stage minimums should be calculated for all observed stage sequences by reducing the cycle time to a minimum in LinSig (a separate 'MINS' LinSig Scenario is recommended for this purpose). These should then be compared against the UTC system. If there are discrepancies, these should be investigated. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a Principal Network Manager.

  Where controllers are configured with dummy phases these need to be replicated in LinSig to ensure the correct stage minimums. The stage minimums may also be dependent on the stage sequence followed.

L.211 Intergreen and Interstage Data

The phase intergreen tables for each of the controllers in the model should be specified individually using data from the relevant TfL Signal Timing Sheets and/or Controller Specifications. After entering intergreen data, the DE should also ensure that any prohibited stage moves have been correctly specified using the Interstage and Phase Delays View.

Assuming that phase (**L.208**), stage (**L.210**) and stage sequence (**L.211**) data is correct; the interstage durations for each controller should also be checked against the UTC system.

Any discrepancies in the intergreen or interstage times when compared to UTC data should be investigated by the MAE. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a Principal Network Manager as there can be UTC-specific explanations.

L.212 Stage Sequence and Signal Timings (without Demand Dependency)

The DE and MAE must ensure that an appropriate stage sequence is used for each stream and controller in the Network Control Plan for the relevant LinSig Scenario being audited. The stage sequences used in the LinSig Calibrated Base model should contain all demand-dependent stages appearing with 100% demand.

The timings that will be checked by the MAE include:

- **Stage change points and cycle time:**

  If the modelled network is running under Fixed Time UTC, the stage change points and cycle time should directly correlate with the UTC plans. If the modelled network is running under SCOOT Control, it is important to note that SCOOT Stages are not the same as the UTC Stages modelled in LinSig. The MAE should examine the SCOOT background plans to understand the relationship between the SCOOT and UTC stages from the plan structure. The DE must provide details of the derivation methodology used to determine the average cycle time and SCOOT stage change points to the MAE in the DE's Calibration Report (**L.201**).

  A common method of modelling SCOOT Control in LinSig is by use of SCOOT stage duration messages (M16 and M37) together with offset messages (M18) recorded for a representative day, with no interventions to the weekly timetabled control. A DE or MAE with limited experience may require support from more experienced colleagues, such as the CE or a Principal Network Manager in order to corroborate that the timings are correct.

  When using stage duration messages, it is important to note that SCOOT Stages are not always the same as UTC Stages. The DE and MAE should examine the SCOOT background plans to understand the SCOOT stage change points relative to the UTC Stage change points (which are modelled in LinSig).

- **Phase green times:**

  Assuming that the stage change points, phase delays (**L.208**) and phase intergreens (**L.211**) have been correctly specified, the phase green times should also be correct. It is nevertheless worth checking the phase green times in the Signal Timings View to ensure timings are correct, and in the case of Fixed Time UTC plans these should correlate directly with observed phase timings on-street for the stage sequence modelled.

- **Stage and interstage durations:**

  Interstage durations should have been checked in **L.211**, however the Signal Timings View also provides a way of checking interstage and stage durations using a graphical interface. These should correlate with timings from the UTC system.

L.213 Model Errors / Warnings

The LinSig Error View should be checked by the DE and MAE as it may indicate errors or warnings within the model. Warnings within the Error View may be acceptable, however these items should be checked by the DE and MAE to ensure the model is accurate.

L.214 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **L.201 – L.213.**

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the LMAP Stage 3 Check Sheet (**MQA-0544/L2**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **L.201 – L.213**.

These additional issues may relate to project specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

5.2.5 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks L.201– L.214 and there are no other issues the MAE will approve the model and authorise the LMAP Stage 2 Check Sheet (**MQA-0544/L2**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide a completed LMAP Stage 2 Check Sheet (**MQA-0544/L2**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of LMAP Stage 2

5.2.6 Stage 2 to Stage 3, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the MAE needs to retrieve data from the UTC system. Demand dependency data must be collected for the same time as other traffic surveys and should be recorded separately for each modelled period. If a junction is able to alternate between single cycling or double cycling, careful consideration should be given the interpretation of the demand dependency data.

LMAP STAGE 3

5.3 LMAP Stage 3, LinSig Validated Base Model Submission

5.3.1 What is a LinSig Validated Base Model?

LMAP defines that a LinSig Validated Base model should be based on an approved Calibrated Base model where the frequency of demand-dependent stage appearance has been defined.

Validation in LinSig is completed by comparing modelled degrees of saturation (DoS) with those recorded on-site. Queue lengths may also be examined but are not considered compulsory criteria for validation.

Validated Base models are required for all time periods in LMAP Stage 3.

5.3.2 LMAP Stage 3 Check Sheet

LMAP Stage 3 has a Check Sheet (**MQA-0544/L3**), which must be completed by the MAE when auditing the models.

A separate LMAP Stage 3 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

L.301 Validation Report

Validated Base model submissions must be accompanied by a Validation Report, as described in Part B of the **Traffic Modelling Guidelines**. The DE should ensure that the following information is provided to the MAE:

- Detail on the traffic flows:
  - When were the traffic surveys done and by who?
  - What data was collected during the traffic surveys?
- Demand dependency calculations:
  - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing Calibrated Base model timings to the Validated Base model timings;
  - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the report;
- Evidence of validation, with comparison between on street data and LinSig results;
- Flare usage observed on-site;
- Flashing amber usage at pelicans; and
- Queue lengths (if surveyed).

L.302 Adjustments from Stage 2 Model

There should be few changes in the Validated Base model as compared to the Accepted Stage 2 Calibrated Base model, other than modification for peak-specific signal timings (checked in **L.304** and **L.305**), the addition of flows (**L.306**) and the inclusion of public transport (**L.307**). Flare usage may also be expected to vary between models and should correspond to observed measurements recorded in each peak. The DE should ensure, and MAE verify, that the use of Custom Occupancies on Short Lanes or effective flare usage for Multi-Lanes is correct and matches surveyed data.

Where any other changes have been made, the DE should identify what was changed and why the change was considered necessary within the Validation Report. The following data that was audited during LMAP Stage 2 should be checked:

- **Software and Network Settings (L.202):** Software version and PCU length;
- **LinSig Scenarios (L.203):** Scenario name.
- **Network Layout (L.204):** Junctions, Arms, Short / Long Lanes, Multi-Lanes and Connectors;
- **Lane Data (L.205):** Lane lengths, saturation flows, junction storage, flare usage, turners in intergreen, right-turn move-up, right-turn factor, start / end displacements, random delay;
- **Connector Data (L.206):** cruise times, platoon dispersion;
- **Controller Data (L.207):** controller types, streams, controller / street minimums, non-standard filters;
- **Phase Data (L.208):** phase letters / descriptions, phase types, phase types, phase minimums, phase delays;
- **Lane Behaviour and Control Data (L.209):** signalised / give-way control, opposing movements, give-way parameters (slope / intercept), clr conflicts, flow without opposed traffic;
- **Stage Data (L.210):** stage numbers, red / green phases in stages, stage minimums;
- **Intergreen and Interstage Data (L.211):** phase intergreens, interstages, prohibited stage moves; and
- **Stage Sequence and Signal Timings (L.212):** stage change points, UTC / SCOOT stage, relationship, cycle time, phase green times, stage and interstage durations, network control plan.

L.303 LinSig Scenarios

As for the LinSig Calibrated Base model at LMAP Stage 2, it is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a particular Scenario must be specified on the LMAP Stage 3 Check Sheet (**MQA-**

0544/L3) so that it is clear to the MAE which Scenario is being submitted for auditing.

In addition to the specific Scenario being submitted for auditing, it is encouraged to include additional Scenarios for investigating alternative stage sequences, for looking at stage minimums or with / without demand dependency.

The Scenario time period should match the specific peak period being modelled, which is determined by the start / end times of the relevant Flow Group (as audited in **L.306**).

L.304 Appropriate Peak-Specific Signal Timings

The checks that were performed in LMAP Stage 2 during **L.212** should be repeated for each LinSig Base model to ensure that appropriate peak-specific Base timings have been used for the period being modelled.

Note that the timings shown in the Signal Timings View should not be affected by adjustments for Demand Dependency and Underutilised Green Time (see **L.305**) as these will be implemented on a Lane-by-Lane basis using the Lane Timings View.

L.305 Adjustments for Demand Dependency and Underutilised Green Time

The DE should detail adjustments to the modelled signal timings to account for the non-appearance of demand-dependent stages over the modelled period, and for situations where congestion-related issues prevent fully saturated discharge.

The preferred method for modelling both demand dependency and Underutilised Green Time (UGT) in LinSig is to add or remove green time for individual Lanes through Lane Timing adjustments. This is performed by adjusting the start and end of Lane green times in the LinSig Lane Timings View, as shown in Figure 10.

Separate Lane Timing adjustments should be made for each bonus green type, which include 'Demand Dependency', 'Underutilised Green Time' or 'Other'. Disaggregating components of bonus green allows for simpler auditing and also differentiates between modelling adjustments and the original interstage design approved during MAP Stage 2.

Demand-dependent stage frequency can vary by time of day to affect Lane capacity. It is therefore imperative that the DE and MAE confirm that the modelled adjustments provide appropriate green times for critical Lanes. As an example, if a junction has been modelled with a pedestrian stage being called every cycle, when on site this situation occurs in 50% of signal cycles, then the model is likely to underestimate the capacity of one or more of the major movements.

All demand-dependent stages within the network should show a frequency matching on street observations, which must be verified by the MAE.

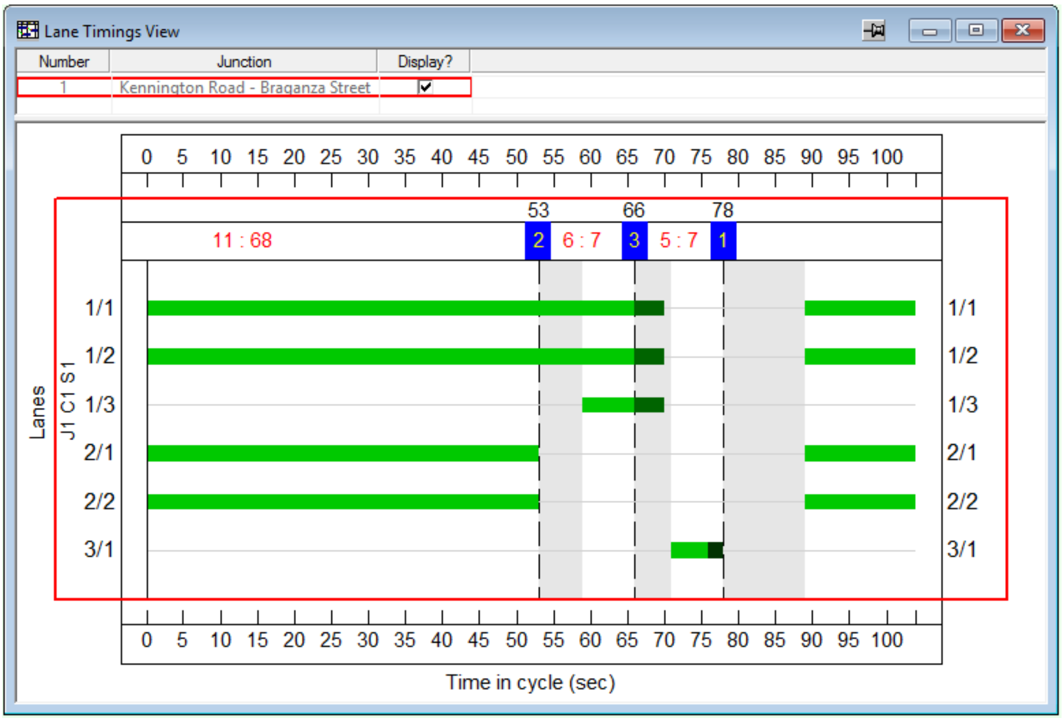


Figure 10: Lane Timings View, showing positive bonus green applied to Lanes 1/1, 1/2 and 1/3, and a negative bonus green applied to Lane 3/1

Where fully saturated traffic appears to discharge at a rate less than the saturation flow (for example due to driver behaviour or exit-blocking), this should not be accounted for by changing the saturation flow in a model. Instead, it is recommended that UGT is used to quantify this behaviour. UGT can commonly occur during periods of congestion within networks operating at or over capacity. Traffic may only be travelling marginally slower than would be the case during unrestricted saturation flow which may not be noticeable to an on-street observer but its impact will be captured by UGT during data processing. UGT is fully described within Part

B of the **Traffic Modelling Guidelines**. UGT should be collected at the same time as other traffic surveys.

The DE should measure the average amount of green time that is lost due to UGT (for example wasted green due to exit-blocking) and adjust the relevant Lane timings accordingly. Care should be taken when applying UGT, a positive UGT value recorded on street should be entered as a negative bonus green value in LinSig. If a negative UGT value is calculated in the survey, this means that traffic discharged quicker than the saturation flow during the measurement, in that case the saturation flow should be remeasured.

UGT should not be applied to opposed right turning movements, due to the discharge rate being controlled by the give-way parameters.

Site data showing how Demand Dependency and UGT values were measured and calculated should be provided in the Validation Report (**L.301**) for auditing by the MAE to verify that this aspect of modelling has been addressed correctly.

L.306 Base Traffic Flows and Routes

LinSig models are usually constructed using stopline flows from manual classified traffic surveys. The DE should have selected a common peak hour for the whole area under consideration which should be illustrated for the MAE, for example by a graph showing the sum of the total flow at each junction. The peak hour for all Junctions in the model can then be audited. In some situations, the appropriate peak may not be the peak for all modelled junctions but for a particular group of junctions within the network, such as a roundabout or gyratory system. This should be confirmed as acceptable with the MAE.

Flows can be entered into a LinSig Model either by Lane-Based flow allocation or Matrix-Based Flow allocation. The flow allocation methodology should be agreed at MAP Stage I and documented in the MED. When considering flow allocation methods, **Table 3** highlights the implications between the two methods:

Table 3: Comparison of Flow Allocation Methods in LinSig

Flow Allocation Method	Advantages	Disadvantages
Matrix-Based	• More detailed modelling of Routes through the network, allowing for accurate representation of cyclic flow profiles, indicative journey times and queuing. • Amendments to flow changes are quicker.	• Require additional data, such as OD counts or outputs from Tactical / Strategic Modelling. • Detailed checks on routing / Lane allocations required.
Lane-Based	• Disaggregation of flows into separate Flow Layers, by mode / bus routes. • Data entered directly from turning counts.	• Limited detail on routes traffic take through the network, resulting in less accurate representation of cyclic flow profiles, and queuing. This may be a disadvantage in complex junctions or closely spaced junctions. • Route-based outputs, such as travel times, are not reliable as signal coordination for different movements is not considered. • Flow changes need to be applied manually through the network elements and may be prone to errors.

Lane-Based Flow Groups require flows to be entered directly onto modelled Lanes and Connectors for each user-defined Flow Group layer. This gives control over flow allocation to Lanes, and also allows disaggregation of flows by traffic mode (or any other groups of interest) when entering flows and analysing model results.

For Lane-Based Flow Groups, Flow Group layer flows can be entered within the Edit Lane window for individual Lanes, or alternatively via an interactive 'drag and drop' process using the 'Lane-Based Flow Entry

Mode'. The Flow Group's start and end times should reflect the peak period being modelled.

Typical Flow Group layers would include 'Private Transport' and 'Public Transport' at a minimum, with a combined 'General Traffic' layer if appropriate. Additional Flow Group layers can be defined to break flows down into further vehicle categories if necessary, though the DE should be aware that this will increase the amount of auditing required.

Matrix-Based Flow Group entry is acceptable for fixed Routes (such as buses), or where minimal Route and Lane choice exists within the network, such as for smaller models where the OD matrix is known or can easily be estimated. When using Matrix-Based Flow Groups, the DE and MAE must ensure that unrealistic Routes do not exist (through configuration of LinSig's Permitted Routes), and that Lane usage is accurately represented (flows on specific Routes can be manually fixed where necessary). Zone-Based flow entry may also be useful to model and optimise complex junctions such as signalised roundabouts. If the OD matrix is not known and Matrix Estimation needs to be employed, it is recommended to use a fully validated assignment model based on dedicated assignment modelling software and a verified Prior Matrix.

The DE and MAE should verify that the total flow assigned to the model between OD pairs matches the desired flows using the Traffic OD Matrix Difference view. The assigned turning counts at an individual junction within a wider OD should be checked by the DE and MAE for consistency against the traffic survey data. Should any discrepancies occur the GEH statistic, as described in the **Traffic Modelling Guidelines**, should be applied between the observed and modelled flows. The DE should aim for GEH values less than five when comparing modelled flows to observed flow volumes. However, TfL advocates GEH values of less than three for all critical movements within the model area. Results should be presented in the DE's Validation Report (**L.301**), showing all observed and modelled flows together with calculated GEH values. The turning counts entering the model should show modelled flows within 5% of observed flows. The Turning Count View within LinSig can be used to display GEH values within the network if the 'display (diff, GEH) after count value' option is selected, see **Figure 11**.

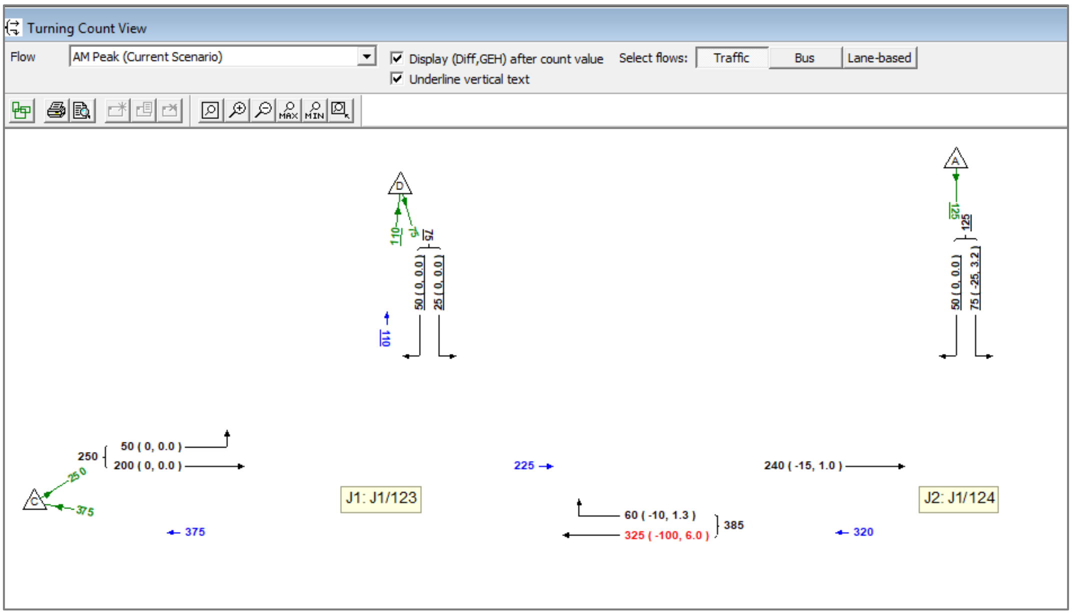


Figure 11: Turning Count View, showing turning count value, difference and GEH values. Turning counts with GEH values over 5 are highlighted in red

When allocating flows, custom cruise time values can be used for specific Lane-Based Flow Groups, Matrix-Based Flow Groups or Routes that will override the Connector cruise time, as explained in **L.206**. Where custom cruise times have been used for specific Lane flows the DE should clearly explain and document their use, which should be checked by the MAE.

As most traffic surveys are carried out manually, there will inevitably be human counting errors. It is not expected that neighbouring survey counts will match, and in cases where they do, this warrants closer inspection as they may have been manually adjusted.

Where there is a discrepancy in flows on a modelled Lane, the MAE should examine the flow data used for modelling. If this does not correspond with modelled flows and resolve the concerns, the MAE may conduct a sample spot count on site. To get an accurate count, it is recommended that the flow is recorded over a whole number of cycles, during a section of the modelled peak, for example start and end timings should be from the start of green on the movement being measured.

Where multiple upstream Lanes feed two Lanes downstream, the DE should provide evidence that they have recorded the percentage split of flow from each of the origin Lanes to each of the destination Lanes.

L.307 Public Transport Modelling

The MAE should examine the following public transport elements of the model:

- Bus flows and routes;
- Bus lanes;
- Location of bus stops;
- Bus stop dwell times;
- Bus Cruise Speeds; and
- Influence on general traffic.

The DE should calculate bus flows, routes and their frequencies as described in the **Traffic Modelling Guidelines**, based on available data which should be provided to the MAE for auditing. Bus lanes, hours of operation and vehicle type restrictions should also be checked against on-street data to ensure that bus lane usage is accurately represented. Buses should be added using one or more Lane-Based Flow Group layers on each Lane along their Routes, to distinguish Public Transport from Private Transport. When creating additional Lane-Based Flow Group layers for Public Transport in LinSig they should be specified as representing buses in the Flow Group layer options.

Alternatively Zone-Based Routes can be used, with specific Permitted Routes edited or fixed appropriately to ensure correct Lane usage. As with Lane-Based Flow Groups, relevant Zones should be specified as Bus Zones to distinguish them from other traffic types and to ensure they are correctly modelled.

Where a bus stop exists on a Lane, the 'Mean Stopped Time' on the upstream Connector should be set to the average bus stop dwell time that has been determined. Where more than one bus stop exists, the dwell times should be added together with an additional delay added to reflect the time lost slowing down and accelerating for the additional bus stop(s).

As mentioned in **L.306**, cruise times can be specified separately for each Lane-Based Flow Group layer, Matrix-Based Flow Group or Route when adding flows, allowing different cruise times to be specified for Public Transport compared to General Traffic if desired. In a similar manner, different 'Mean Stopped Time' values can also be specified for each Lane-Based Flow Group layer, Matrix-Based Flow Group or Route, allowing different dwell times to be used by different bus routes at the same bus stops if this level of detail is considered necessary.

The purpose and scope of the LinSig model agreed in MAP Stage I will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a public transport-related scheme, the DE should ensure that all relevant public transport elements have been modelled in detail. This may include detailed dwell times per bus stop and per time period from iBus data, or separate Lane-Based Flow Group layers or Matrix-Based Flow Groups for different bus routes. In models where public transport is considered less of a priority the use of a collective 'Public Transport' Lane-Based Flow Group layer or Matrix-Based Flow Group for all bus routes and/or default dwell times may be satisfactory.

The influence of public transport on general traffic often can have a significant impact on network capacity and performance, such as the creation of effective flares for general traffic in the case of bus lane setbacks and funnelling at bus lane entries. The DE should provide in the accompanying Validation Report any notes on site observations to demonstrate that any influences on capacity due to public transport are accurately represented. Site visits can be undertaken by the MAE to observe behaviour and ensure they have been accurately reflected in the submission.

L.308 Cyclist Modelling

The purpose and scope of the LinSig model agreed in MAP Stage I will determine the level of detail required for cyclist modelling. Where required, the MAE should examine the following cyclist elements of the model:

- Cycle flows;
- Cruise times
- Cycle phases
- Segregated facilities; and
- Saturation flows.

The DE should agree with the MAE whether to include cycle flows in the model, as per guidance in Part C of the **Traffic Modelling Guidelines**. Cycle flows can be added using a Lane-Based Flow Group layer, to distinguish cycle flows from general traffic modes. Alternatively, Zone-Based Routes can be used, with specific Permitted Routes edited or fixed appropriately to ensure correct Lane usage. Separate Zones should be used to represent cycle flows.

Connector cruise times can be overridden to represent cyclist travel times through the study area. This can be edited and audited using the 'Overrides' tab in the Edit Lane Connector view.

Cycle phases should be correctly specified within the Phases View, with correct Phase Type and Phase Minimum specified (see **L.208**).

The DE should ensure, and MAE verify, that any segregated cycle facilities are correctly represented by dedicated Lanes, and flows are correctly allocated using Lane-Based flows or Zone-Based Routes.

Careful consideration should be taken when collecting saturation flow data where significant cycling flows exist as this can impact the validation of the model. Specific guidance for collecting saturation flows is provided in Part C of the **Traffic Modelling Guidelines** for both segregated and non-segregated conditions.

L.309 Pedestrian Modelling

Where the agreed scope of the LinSig modelling, agreed at MAP Stage I, includes a comparative assessment of pedestrian journey time and delay values, the MAE should examine the following Pedestrian Link information:

- Associated junction;
- Controlling phase; and
- Crossing time (sec).

The mean walking time (sec) should be checked on the Pedestrian Link Connectors.

L.310 Model Errors / Warnings

The LinSig Error View should be checked by the DE and MAE as it may indicate errors or warnings within the model. Warnings within the Error View may be acceptable, however these items should be checked by the DE and MAE to ensure the model is accurate.

L.3.11 Degree of Saturation Validation

The correct recording of on-street DoS is essential to the validation of a model. The **Traffic Modelling Guidelines** outline the preferred approach for surveying DoS, however it is strongly recommended that the DE contacts the MAE prior to surveys being undertaken to discuss the approach to be used. It may also be appropriate for the MAE to accompany the DE on an initial site visit to observe and/or measure DoS.

The DoS recorded on-street and shown in the model should correlate. Lanes close to practical reserve capacity (90%+ DoS) should be given particular attention during auditing.

The following criteria should be used to indicate validation of LinSig Base models:

- Degrees of saturation within 5% of observed values for critical Lanes; and
- Degree of saturation within 10% of observed values for non-critical Lanes.

The classification of critical and non-critical Lanes within the model should have been identified by the MAE or Network Manager and documented within the MED. The 5% or 10% DoS tolerance should be applied to the modelled results as follows:

- Observed DoS: 60%
- Tolerance for critical Lanes: 55% - 65%; or
- Tolerance for non-critical Lanes: 50% - 70%.

It is important to note that, for models built using stopline counts, by definition, the degree of saturation cannot be over 100%. This is because a stopline count is the traffic that has cleared the stopline rather than the demand. For models with Lane DoS above 100%, model discrepancies may exist for one or more of the following: saturation flows, Lane / Connector structure, green times, and/or stopline flows.

Another consideration is that, although the signal timings in the model are accurate, the timings that were in operation during the traffic surveys may have been different to the modelled average signal timings, for example where contingency plans were in operation. This is possible but unusual if sufficient checks were made during the data collection phase of LMAP Stage 2. If the DE or MAE suspects this to have occurred it is appropriate to investigate UTC data for the traffic survey date. If in doubt, a sample traffic count during the modelled period (as detailed in **L.306**) is advisable.

Flare usage should be represented correctly in each model and fully documented in the DE's Validation Report (**L.301**), based on observed measurements recorded in each peak. If flare usage has not been documented then the MAE should request clarification from the DE with regards to the impact on degrees of saturation. Where short Lanes have been modelled, the Lane's Custom Occupancy should be adjusted to get the required flare usage and detailed in the Validation Report (**L.301**)

There may be instances where periods of Underutilised Green Time have occurred on-street that have not been correctly accounted for in the models. In these cases, the modelled DoS is likely to be lower than was recorded on-street for the Lanes in question. Please refer to **L.305** for further guidance.

The DE should undertake visual checks that the observed Cyclic Flow Profiles (CFP) for critical Lanes show similar peaks, dispersion and spacing within the Validated Base model.

L.312 Appropriate Queue De-Sliver and Queue Length Correlation

When analysing queue data in LinSig the DE should determine if and where it is appropriate to use queue 'de-sliver' and whether its use is justified. It is intended to be employed where artificially large and unrealistic queue lengths are generated due to LinSig's algorithms not accounting for actual driver behaviour. The 'De-Sliver Threshold' considers queue lengths less than a particular value to be treated as sliver queues, thus preventing additional vehicles from joining the back of an artificially created queue.

The DE should make clear in the accompanying Validation Report (**L.301**) where de-sliver adjustment has been applied, which should be checked by the MAE. The MAE must also ensure that de-sliver has not been employed elsewhere in the model where its use may not be considered appropriate.

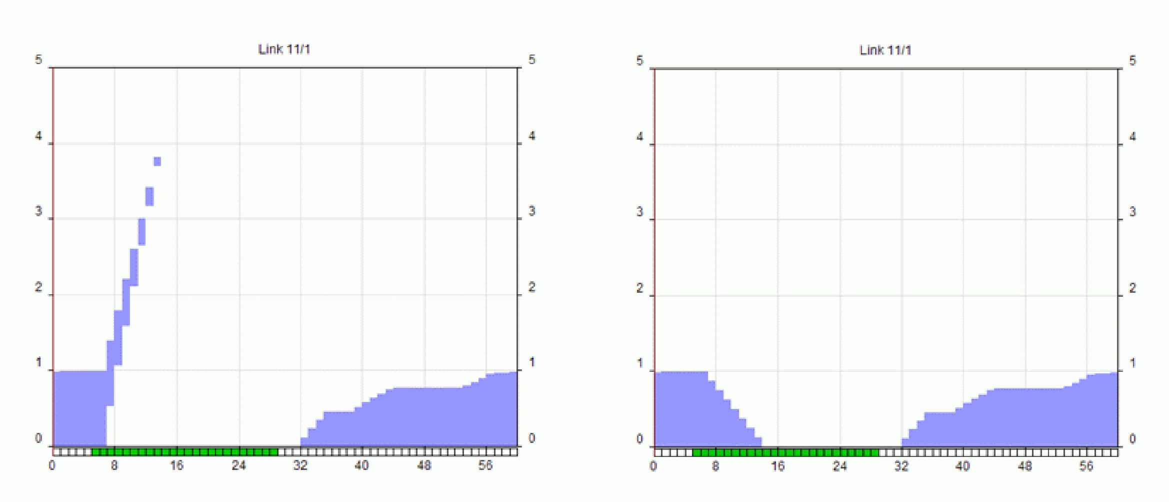


Figure 12: Uniform queue graphs showing formation of a Sliver Queue (left) and removal using correct use of the De-Sliver Threshold (right)

Where sliver queues are observed in a Uniform queue graph (see **Figure 12**), the value of the De-Sliver Threshold should be set to the smallest value that just removes the sliver queue from forming, and should be no larger than 1.0PCU. De-Sliver Thresholds should not be used where sliver queues are not observed.

LinSig allows the display of a variety of queue-related information from models including Uniform Queues, Random and Oversaturation Queues, Mean Maximum Queues and Lane Length Excess Queues.

Queue length analysis can be performed for individual Lanes by adding Uniform Queue Graphs to the LinSig Network View. This is achieved by first selecting a Lane, right-clicking the mouse and then choosing the 'Add Cyclic Flow Profile Graph / Add Queue Graph' option. Uniform Queue Graphs show the typical variation in uniform queue over a single cycle, but do not by default include the Random and Oversaturated Queue components, which become increasingly important above 90% DoS. These can be added by right-clicking the Uniform Queue Graph and choosing the 'Show Random and Oversat Component'.

Queue results can also be displayed for all Lanes simultaneously by accessing the Network Results View or Model Audit View. The most commonly referenced measure is the Mean Maximum Queue (MMQ) for each Lane, as this indicates the average of the Maximum Queue that occurs across all cycles, including Random and Oversaturated Queue components. This can be measured on-street when platoon arrival patterns are regular and distinct, however if vehicle arrival patterns are less pronounced the MMQ is difficult to observe.

If queue data has been surveyed, it is the responsibility of the DE to provide this data for audit by the MAE. Modelled queue lengths should not exceed the Lane length as it cannot physically do so on street. Excess queuing is indicated in LinSig through Lane Length Excess Queue values greater than zero. This parameter should therefore be checked for each Lane in the network to determine whether modelled queues exceed the storage space available on the Lane.

If queues in a model exceed Lane lengths, the DE and MAE have to consider whether the green times, offsets, saturation flows and flows for the Lanes are correct. If these parameters have been correctly modelled and queues are observed on-street to block upstream Lanes the DE may need to account for excess queuing by applying Underutilised Green Time to upstream Lanes. Please refer to **L.305** for further guidance.

L.313 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **L.301** – **L.312**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the LMAP Stage 3 Check Sheet (**MQA-0544/L3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **L.301** – **L.312**.

These additional issues may relate to project specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

5.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **L.301** – **L.313** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant LMAP Stage 3 Check Sheet (**MQA-0544/L3**).

If the MAE fails the model on any of the checks **L.301 – L.313**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the LMAP submission and provide completed LMAP Stage 3 Check Sheets (**MQA-0544/L3**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of LMAP Stage 3

LMAP STAGE 5a

5.4 LMAP Stage 5a, LinSig Future Base Model Submission

5.4.1 Introduction

MAP Stage 5a is an optional MAP stage that is required when the scheme assessment is following the Three Stage Modelling Process (see **A2.3.2**). The need for Future Base models and corresponding MAP Stage 5a audits is typically initially discussed during the MAP Stage 1 Base Scoping Meeting and confirmed at MAP Stage 4.

The majority of the work, both in terms of creating and auditing a LinSig model, is completed when generating fit for purpose Base modelling. Once LMAP Stage 3 has been passed there is often a relatively small amount of work required to complete the remaining stages of LMAP.

Future Base models are required for all time periods in LMAP Stage 5a.

The DE should make a copy of the approved Base models and input Future Base traffic flows. Where any likely future network changes, excluding the scheme being assessed, fall within the LinSig model boundary amendments will be required to reflect the new methods of control and/or Lane structure.

The Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing against the Base model results alone.

5.4.2 LMAP Stage 5a Check Sheet

LMAP Stage 5a has a Check Sheet (**MQA-0544/L5a**), which must be completed by the MAE when auditing the models.

A separate LMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

L.501 Future Base Report

Future Base model submissions must be accompanied by a Future Base Report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to assess criteria **L.502** – **L.514**, together with an assessment of the likely operation of the future year network.

As for the Validated Model Report in LMAP Stage 3, it is vital that the DE communicates all of their assumptions relating to the Future Base modelling. All changes to the models should be clearly stated, including the reasoning behind the changes and any supporting information.

Clear comparisons must be made between the Validated Base model results and the Future Base model results for the corresponding periods, including analysis of any differences and commentary on impacts to network operation.

It is a requirement to include comparisons for all links that are deemed critical – the classification of critical and non-critical Lanes within the model should have been identified by the MAE or Network Manager and documented within the MED.

L.502 LinSig Scenarios

As for the LinSig Validated Base model at LMAP Stage 3, it is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a particular Scenario must be specified on the LMAP Stage 5a Check Sheet (**MQA-0544/L5a**) so that it is clear to the MAE which Scenario is being submitted for auditing.

The Scenario time period should match the specific peak period modelled in the LMAP Stage 3 Validated Base model, which is determined by the start / end times of the relevant Flow Group (as audited in **L.306**).

L.503 Physical Layout / Signal Changes

Adjustments may be required to the Network Layout and/or signal control to represent the Future Base scenario. The changes from the approved Base model may include:

- Inclusion of any likely future network layout changes that fall within the boundary of the LinSig modelling, such as any changes to the number of Lanes, Lane allocation, flare lengths, saturation flows, Connectors, permitted movements.
- Changes to junction control, including give-way parameters, method of control, controller data, phase data and signal timings as a result of future network changes.
- Amendments to demand dependency and UGT assumptions, in which case Lane timings may have been amended; and
- The model will have been optimised following the pathway detailed in the **Traffic Modelling Guidelines**, including the application of any mitigation strategies, in which case the signal timings may have been modified. It should be noted that the signal timings in a Future Base model are likely to have undergone an iterative process with a tactical model and the model submitted for MAP Stage 5a audit should represent the agreed signal timings

All amendments should be detailed by the DE within the Future Base Report (**L.501**) and checked by the MAE. It is important that no changes that form part of the proposals are included in the Future Base Model. These should only be introduced in MAP Stage 5b.

L.504 Future Base Traffic Flows and Routes

The methodology to determine and apply Future Base general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Future Base model may be determined by applying manual changes to existing Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Future Base traffic flows.

Where the Future Base traffic flows have been supplied from iterations with tactical modelling, the submitted LinSig Future Base model should represent the flows from the agreed assignment of the corresponding tactical Future Base model. The DE should provide outputs from the tactical modelling and the MAE should check the application with in the LinSig model. It should be noted that for entry links into a LinSig model, queue lengths from the tactical model should be added to turning count outputs and entered onto the approach links.

Where Matrix-Based flow allocation has been used to input Future Base flows, checks should be carried out to ensure individual junction turning counts and OD Matrix allocations match those predicted. The assigned turning counts at an individual junction within a wider OD should be checked by the DE and MAE for consistency against the expected flows. Should any discrepancies occur the GEH statistic, as described in the **Traffic Modelling Guidelines**, should be applied between the expected and modelled flows. The DE should aim for GEH values less than five when comparing modelled flows to expected flow volumes. However, TfL advocates GEH values of less than three for all critical movements within the model area. Results should be presented in the DE's Future Base Report (**L.501**), showing all expected and modelled flows together with calculated GEH values. The turning counts entering the model should show modelled flows within 5% of expected flows.

Future year flows for modes modelled separately from general traffic are checked in the Public Transport Modelling (**L.505**), and Cyclist Modelling (**L.506**) sections.

L.505 Public Transport Modelling

Dependant on the model amendments required as part of the Future Base scheme coding, the MAE should examine changes the following public transport elements of the model:

- Bus flows and routes;
- Bus lanes (including hours of operation);
- Location of bus stops;
- Bus stop dwell times; and
- Influence on general traffic.

The DE should provide details of any amendments to public transport in the Future Base Report. Note that public transport flows should not be included when applying growth factors for general traffic, but should be treated separately and informed by current or expected service frequency data.

L.506 Cyclist Modelling

The purpose and scope of the LinSig model agreed in MAP Stages 1 and 4 will determine the level of detail required for cyclist modelling. Where changes are required as part of the coding of the Future Base schemes, the DE should refer to Part C of the **Traffic Modelling Guidelines** for advice on how to model proposed amendments to cyclists within the model. The MAE should examine the following cyclist elements of the model:

- Cycle flows;
- Cruise times
- Cycle phases
- Segregated facilities; and
- Saturation flows.

The DE should provide details of any amendments to cyclists in the Future Base Report (**L.501**).

L.507 Pedestrian Modelling

Dependant on the model amendments required as part of the Future Base scheme coding, the MAE should examine changes to the following Pedestrian Link information:

- Associated junction;
- Controlling phase; and
- Crossing time (sec).

The mean walking time (sec) should be checked on the Pedestrian Link Connectors.

The DE should provide details of any amendments to Pedestrian Links and Connectors in the Future Base Report (**L.501**).

L.508 Demand-Dependent Stage Frequencies

The DE's Future Base Report (**L.501**) should comment on the frequency of demand-dependent stages in the Base model and the assumptions regarding demand have been made for the Future Base model, according to the guidance provided in Part B of the **Traffic Modelling Guidelines**. The assumptions should be audited by the MAE.

L.509 Model Optimisation Strategy

The optimisation strategy to be used for the Future Base modelling should be agreed with the MAE and documented by the DE in the Future Base Report (**L.501**).

Factors to consider include the following:

- Demand dependency adjustments may need to be:
  - Left unchanged in the case of capacity assessment;
  - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
- Underutilised Green Time adjustments may need to be:
  - Included if the cause of the UGT is likely to remain in the Future Base scenario;
  - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
  - Removed if the cause of the UGT is likely to be removed in the Future Base scenario;
- Network control strategies:
  - Discussion with Network Managers to determine any factors that may impact or place restrictions on the optimisation of signal timings, for example the requirement to prioritise public transport movements at certain locations; and
- Iterative optimisation and flow adjustment:
  - A dedicated assignment model may be used in conjunction with a LinSig Future Base model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the LinSig model area.

This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 LinSig Validated Base model are clearly identified and justified, with any calculations used to produce estimated values included.

L.510 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **L.502** – **L.509**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**L.501**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes; and
- Public transport / cyclist / pedestrian modelling.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

The software version used must remain unchanged from the approved LMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The Model Audit View can be helpful in assisting with this task.

L.511 Model Errors / Warnings

The LinSig Error View should be checked by the DE and MAE as it may indicate errors or warnings within the Future Base model. Warnings within the Error View may be acceptable, however these items should be checked by the DE and MAE to ensure the model is accurate.

L.512 Degrees of Saturation

The DE's Future Base Report (**L.501**) should contain a quantitative comparison of Base and Future Base degrees of saturation and a commentary summarising how the performance of the network has changed. Where the degrees of saturation are observed to change, analysis should be presented to determine the reason for the change.

The report does not necessarily have to contain a comparison of every link in the model. The inclusion of comparisons for all links which are deemed critical is required. The classification of critical and non-critical Lanes within the model should have been identified by the MAE or Network Manager and documented within the MED. The DE must also ensure any adjustments to saturation flows, flare lengths / custom occupancies or traffic flows on a Lane have been fully documented. If they have not been documented then the MAE will approach the DE to fully explain their impact on degrees of saturation.

L.513 Queue Lengths

The DE's Future Base Report (**L.501**) should contain a quantitative comparison of Base and Future Base queue lengths and the implications for the operation of the network, in a similar manner to the analysis undertaken in **L.512** for DoS.

Modelled queue lengths should not exceed Lane lengths as they could not physically do so on street. Excess queuing is indicated in LinSig through Lane Length Excess Queue values greater than zero. This parameter should therefore be checked for each Lane in the network.

Particular attention should be paid to Lanes with limited stacking capacity for queued traffic. If small Lanes operate at or near physical capacity the network can be susceptible to cross junction exit-blocking and eventually locking up. Therefore, if the queue lengths on these Lanes are at, or close to, the Lane length then the DE and MAE should give consideration to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network.

L.514 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **L.501 – L.513**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the LMAP Stage 5a Check Sheet (**MQA-0544/L5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **L.501 – L.513**.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

5.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **L.501 – L.514** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant LMAP Stage 5a Check Sheets (**MQA-0544/L5a**).

If the MAE fails the model on any of the checks **L.501 – L.514**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed JMAP Stage 5a Check Sheets (**MQA-0544/L5b**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of LMAP Stage 5a

LMAP STAGE 5b

5.5 LMAP Stage 5b, LinSig Proposed Model Submission

5.5.1 Introduction

Proposed models should be based on approved LMAP Stage 3 Base models, or when following the Three Stage Modelling process (**A2.3.2**) the approved LMAP Stage 5a Future Base models.

Proposed models are required for all time periods in LMAP Stage 5b.

The DE should make a copy of the accepted Base or Future Base models and update them with the proposed changes, including any new junction layouts or new methods of control.

In addition to ensuring that the models are correctly developed from a technical point of view the DE is responsible for demonstrating that the proposals can be accommodated without jeopardising normal day to day operation of the network. This includes maintaining acceptable levels of DoS and queues as well as sufficient provision for expected pedestrian demand.

As a representative of the TfL Traffic Manager, who will have a duty to manage the network if the proposal is implemented, the MAE must decide whether they agree the network is likely to operate satisfactorily on a day-to-day basis. They must therefore highlight any apparent issues or concerns with the proposals, which will prioritise safe, efficient network operation together with relevant TfL / Mayoral policies and guidance.

The DE will receive feedback from MAE and will need to address any issues highlighted. The MAE will use their operational experience in making informed comments and decisions.

If required by the model scope the proposed timings must be suitable to be used as controller-held background timings for new methods of control. This means that the MAE's audit is implicitly asking the DE:

> 'Are you satisfied that, if observing on-site when these proposals are commissioned, the timings in each of the submitted LinSig models would provide appropriate network operation under local control and that the network impacts would be as described in the SIR?'

5.5.2 LMAP Stage 5b Check Sheet

LMAP Stage 5b has a Check Sheet (**MQA-0544/L5b**), which must be completed by the MAE when auditing the models.

> A separate LMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

L.551 SAE-Approved Proposed Methods of Control

Before submitting any Proposed modelling, the DE must submit proposed drawings and methods of control to the MAE. The MAE must ensure that the proposed methods of control and drawings reflect the proposals identified in the MED. Once the MAE has confirmed the details are correct, they can arrange for an Engineering Service Request (ESR) to be undertaken. The SAE will undertake a review to identify issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings.

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE. The MAE must confirm SAE approval has been received for any new or modified signalised infrastructure prior to auditing.

> Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from proceeding with LMAP Stage 5b.

L.552 Proposed Model Report

Proposed model submissions must be accompanied by a report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to assess criteria **L.553** – **L.566**, together with an assessment of the likely impact of the proposals.

As for the Validated Model Report in LMAP Stage 3, and Future Base Report in LMAP Stage 5a, it is vital that the DE communicates all of their assumptions relating to the proposals and how they have been modelled. This should include detailed technical accounts of how all parameters that are not known have been derived. All changes to the models should be clearly stated along with the reasoning behind the changes and any required supporting information or data.

There must be clear comparisons between the results of the validated Base models and Future Base models, if required, and the Proposed models for the corresponding periods. The inclusion of comparisons for all links which are deemed critical is required. The classification of critical and non-critical Lanes within the model should have been identified by the MAE or Network Manager and documented within the MED. If the MAE believes that the DE has not included links in the comparison which are critical then they will ask the DE to amend the report accordingly.

L.553 LinSig Scenarios

As for the LinSig Validated Base model at LMAP Stage 3, and Future Base model at LMAP Stage 5a, it is important that all Scenarios contained within the LinSig model are clearly labelled so that their purpose can easily be understood. In addition, a particular Scenario must be specified on the LMAP Stage 5b Check Sheet (**MQA-0544/L5b**) so that it is clear to the MAE which Scenario is being submitted for auditing.

In addition to the specific Scenario being submitted for auditing, it may be useful to include additional Scenarios for investigating alternative stage sequences, for looking at stage minimums or with / without demand dependency.

The Scenario time period should match the specific peak period modelled in the LMAP Stage 3 Validated Base model, and/or LMAP Stage 5a Future Base model, which is determined by the start / end times of the relevant Flow Group (as audited in **L.306**).

L.554 Physical Layout / Signal Changes

There are likely to be physical layout and signal control changes to represent the scheme proposals. The changes from the Base or Future Base models may include:

- Changes to the network layout, such as any changes to the number of Lanes, Lane allocation, flare lengths, saturation flows, Connectors, permitted movements;
- Changes to junction control, including give-way parameters, method of control, controller data, phase data and signal timings as a result of the proposed scheme;
- Amendments to demand dependency and UGT assumptions, in which case Lane timings may have been amended; and
- The model will have been optimised following the pathway detailed in the **Traffic Modelling Guidelines**, in which case the signal timings may have been modified. It should be noted that the signal timings in a Proposed model may have undergone an iterative process with a highway assignment model and the model submitted for MAP Stage 5b audit should represent the final signal timings

All amendments should be detailed by the DE within the Proposed Model Report (**L.552**) and checked by the MAE.

L.555 Proposed Traffic Flows and Routes

The methodology to determine and apply Proposed general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Proposed model may be determined by applying manual changes to existing Base or Future Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Proposed traffic flows.

Where the Proposed traffic flows have been supplied from iterations with tactical modelling, the submitted LinSig model should represent the flows from the agreed assignment of the corresponding Proposed tactical model.

The DE should provide outputs from the tactical modelling and the MAE should check the application with in the LinSig model.

Where Matrix-Based flow allocation has been used to input Proposed flows, checks should be carried out to ensure individual junction turning counts and OD Matrix allocations match those predicted. The assigned turning counts at an individual junction within a wider OD should be checked by the DE and MAE for consistency against the expected flows. Should any discrepancies occur the GEH statistic, as described in the **Traffic Modelling Guidelines**, should be applied between the expected and modelled flows. The DE should aim for GEH values less than five when comparing modelled flows to expected flow volumes. However, TfL advocates GEH values of less than three for all critical movements within the model area. Results should be presented in the DE's Proposed Model Report (**L.552**), showing all expected and modelled flows together with calculated GEH values. The turning counts entering the model should show modelled flows within 5% of expected flows.

Proposed flows for modes modelled separately from general traffic are checked in the Public Transport Modelling (**L.556**) and Cyclist Modelling (**L.557**) sections.

L.556 Public Transport Modelling

Dependant on the model amendments required as part of the proposal, the MAE should examine changes the following public transport elements of the model:

- Bus flows and routes;
- Bus lanes;
- Location of bus stops;
- Bus stop dwell times; and
- Influence on general traffic.

The DE should provide details of any amendments to public transport in the Proposed Model Report (**L.552**). Note that public transport flows should not be included when applying growth factors for general traffic, but should be treated separately and informed by current or expected service frequency data.

L.557 Cyclist Modelling

The purpose and scope of the LinSig model agreed in MAP Stages 1 and 4 will determine the level of detail required for cyclist modelling. Where changes are required as part of the coding of the proposal, the DE should refer to Part C of the **Traffic Modelling Guidelines** for advice on how to model proposed amendments to cyclists within the model. The MAE should examine the following cyclist elements of the model:

- Cycle flows;
- Cruise times
- Cycle phases
- Segregated facilities; and
- Saturation flows.

The DE should provide details of any amendments to cyclists in the Proposed Model Report (**L.551**).

L.558 Pedestrian Modelling

Dependant on the model amendments required as part of the proposal, the MAE should examine changes to the following Pedestrian Link information:

- Associated junction;
- Controlling phase; and
- Crossing time (sec).

The mean walking time (sec) should be checked on the Pedestrian Link Connectors.

The DE should provide details of any amendments to Pedestrian Links and Connectors in the Proposed Model Report (**L.552**).

L.559 Demand-Dependent Stage Frequencies

The DE's Proposed Model Report (**L.552**) should comment on the frequency of demand-dependent stages in the Base or Future Base models and the assumptions that have been made for the proposed network, according to the guidance provided in Part B of the **Traffic Modelling Guidelines**. The assumptions should be audited by the MAE.

L.560 Model Optimisation Strategy

The optimisation strategy to be used for the Proposed modelling should be agreed with the MAE and documented by the DE in the Proposed Model Report (**L.552**). The choice of optimisation strategy is likely to depend on the nature and purpose of the Proposed modelling.

Factors to consider include the following:

- Demand dependency adjustments may need to be:
  - Left unchanged in the case of capacity assessment;
  - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
  - Removed to preserve offsets if the model is to be used to produce controller-held signal timings using offset-only optimisation;
- Underutilised Green Time adjustments may need to be:
  - Included if the cause of the UGT is likely to remain in the Proposed scenario;
  - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
  - Removed if the cause of the UGT is likely to be removed following the proposal implementation, which may in fact be one of the goals of the proposal;
- Network control strategies:
  - Discussion with Network Managers to determine any factors that may impact or place restrictions on the optimisation of signal timings, for example the requirement to prioritise public transport movements at certain locations; and
- Iterative optimisation and flow adjustment:
  - A dedicated assignment model may be used in conjunction with a LinSig Proposed model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the LinSig model area. This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 Validated Base model or Stage 5a Future Base model are clearly identified and justified, with any calculations used to produce estimated values included.

L.561 Other Adjustments from Stage 3 / 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **L.553 – L.560**, concerning specific changes to the following areas resulting from the proposed scheme that should be detailed in the Proposed Model Report (**L.552**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes; and
- Public transport / cyclist / pedestrian modelling.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved LMAP Stage 3 / 5a model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The Model Audit View can be helpful in assisting with this task.

L.562 Model Errors / Warnings

The LinSig Error View should be checked by the DE and MAE as it may indicate errors or warnings within the Proposed model. Warnings within the Error View may be acceptable, however these items should be checked by the DE and MAE to ensure the model is accurate.

L.563 Degrees of Saturation

The DE's Proposed Model Report (**L.552**) should contain a quantitative comparison of Base or Future Base and Proposed degrees of saturation and the implications for the operation of the network. Where these are observed to change, analysis should be presented to determine the reason for the change, what the impact is and whether it will have an adverse effect on operation of the network. The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable.

The report does not necessarily have to contain a comparison of every link in the model. The inclusion of comparisons for all links which are deemed critical is required. The classification of critical and non-critical Lanes within the model should have been identified by the MAE or Network Manager and documented within the MED. If the MAE believes that the DE has not included links in the comparison which are critical then they will ask the DE to amend the report accordingly. The DE must also ensure any adjustments to saturation flows, flare length or custom occupancy or traffic flows on a Lane have been fully documented. If they have not been documented then the MAE will approach the DE to fully explain their impact on degrees of saturation.

The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable. Degrees of saturation are affected by cycle time, available green time, traffic flow and saturation flow. Therefore, care must be taken to ensure techniques such as adjusting saturation flows or flows on a Lane have not been used in order to manipulate degrees of saturation. Particular attention should be paid to Lanes with little stacking capacity, for example. At signalised roundabouts or staggered junctions. The MAE should expect small Lanes to have spare capacity nearer to 20-30% (in essence a degree of saturation less than 70-80%), to prevent exit-blocking to closely associated upstream Lanes.

L.564 Queue Lengths

The DE's Proposed Model Report (**L.552**) should contain a quantitative comparison of Base or Future Base queue lengths and Proposed queue lengths together with the implications for the operation of the network, in a similar manner to the analysis undertaken in **L.563** for DoS.

Modelled queue lengths should not exceed Lane lengths as they could not physically do so on street. Excess queuing is indicated in LinSig through Lane Length Excess Queue values greater than zero. This parameter should therefore be checked for each Lane in the network.

Particular attention should be paid to Lanes with limited stacking capacity for queued traffic. If small Lanes operate at or near physical capacity the network can be susceptible to cross junction exit-blocking and eventually locking up. Therefore, if the queue lengths on these Lanes are at, or close to, the Lane length then the DE and MAE should give consideration to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network.

L.565 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see A2.1) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

L.566 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **L.551 – L.565**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the LMAP Stage 5b Check Sheet (**MQA-0544/L5b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **L.551 – L.565**.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

5.5.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **L.551 – L.566** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant LMAP Stage 5b Check Sheets (**MQA-0544/L5b**).

If the MAE fails the model on any of the checks **L.551 – L.566**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE, CE and SAE of the Approval or Rejection of the LMAP submission and provide completed LMAP Stage 5b Check Sheets (**MQA-0544/L5b**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of LMAP Stage 5b

6 ONE MAP (IMAP)

6.1 Scope

6.1.1 IMAP Scope

IMAP applies to all Operational Network Evaluator (ONE) Model scheme assessments. A ONE Model scheme assessment will be considered for an audit by TfL depending on several influencing factors, which are subject to review by M&V as part of the scheme acceptance process.

The Design Engineer (DE) has responsibility for ensuring the submitted ONE modelling is of a suitable standard and is fit for purpose. If a ONE Model scheme assessment is considered in scope for a TfL audit formal IMAP check sheets will be issued. The ultimate responsibility for any ONE Model scheme assessment that sits out of scope for audit lies with the Checking Engineer (CE) to ensure compliance with IMAP.

6.1.2 Supporting Modelling

It is common practice, and highly recommended, that all base and proposed ONE models have supporting MAP-approved modelling using traffic signal optimisation software such as LinSig or TRANSYT. This allows for signal optimisation of the proposal and easier auditing of signal timings and capacities in the ONE Model.

LinSig Skeleton models, although not covered by MAP, may also be useful for the purpose of auditing signal timings in addition to any MAP-approved models.

IMAP STAGE 2

6.2 IMAP Stage 2, Updated Base ONE Model Submission

6.2.1 What is an Updated Base ONE Model?

An Updated Base ONE Model should contain:

- London-wide network and TfL-approved values for the following:
  - Model Units;
  - Link Types; and
  - Impedance functions
- An appropriate network structure to replicate on-street conditions at both a Node and Link level; and
- Appropriate traffic demand, including Demand Segments, Zones, Connectors and Prior Matrices.

It is recommended that the TfL-provided Base ONE Model is used as a starting point for the Updated Base ONE Model.

Updated Base ONE Models are required for all time periods in IMAP Stage 2.

6.2.2 What is the purpose of an Updated Base ONE Model?

The development of an Updated Base ONE Model forms part of the Base Review process. This provides opportunity to review of the study area in the TfL-provided Base ONE Model and for the DE to demonstrate they have relevant knowledge of the local network. The submission of a model at this stage in the modelling exercise is a very useful starting point for both the DE and the Model Auditing Engineer (MAE), and will improve the standard of subsequent model submissions. It is important for the MAE and the DE agree fundamental modelling parameters prior to any model update, calibration, and validation.

6.2.3 IMAP Stage 2 Check Sheet

IMAP Stage 2 has a Check Sheet (**MQA-0544/O2**), which needs to be completed by the MAE when auditing the models.

> A separate IMAP Stage 2 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

I.201 Technical Report

Updated Base ONE Model submissions must be accompanied by a Technical Report.

The Technical Report provides an opportunity for the DE to outline the way in which the model has been updated and the modelling methodology. Key elements are outlined below:

- The scope and purpose of the Updated Base ONE Model, as agreed at MAP Stage I and defined in the Modelling Expectations Document (MED);
- Extent of the Base Review area, as agreed at MAP Stage I, including a list of all the TfL-referenced nodes;
- Modelled time periods, as agreed at MAP Stage I;
- Details of any variation from default parameters used within the TfL-provided Base ONE Model, with justification for the changes;
- Notes covering site observations which detail physical constraints within the network and vehicle behaviour. Where behaviour is specific to a time of day, this should be noted. It is important for the DE to explain how these observations have resulted in changes to the network structure of the model;

- Source of signal timings and capacities for the signalised junctions within the Base Review area, accompanied with approved LMAP or TMAP Stage 3 models;
- Notes detailing amendments made at priority junctions, such as Critical Gap and Follow Up Gap times, to represent existing on-street conditions;
- Details of data used, for example data type, source or time period, to update key elements of the TfL-provided Base ONE Model, such as traffic data, signal data and public transport timetables or routes;
- List of any changes to the TfL-provided Base ONE Model with justification; and
- List of all modelling assumptions with supporting evidence.

I.202 Software and Network Settings

The DE should ensure and the MAE verify that the following remain unchanged from the TfL-provided Base ONE Model, unless previously agreed at the MAP Stage I meeting:

- **Software version;** the software version used must match the version agreed at the MAP Stage I meeting and recorded in the MED;
- **System of units of network:** Metric (km, m, km/h); and
- **Direction of travel:** Left-hand traffic

I.203 Model Time Periods

The TfL-provided Base ONE Model has the following peak periods which should be unchanged, unless agreed at the MAP Stage I meeting:

- **AM peak:** 08:00 – 09:00; and
- **PM peak:** 17:00 – 18:00.

I.204 Demand Segments and Matrices

Seven Demand Segments, and corresponding Transport Systems, are represented in the TfL-provided Base ONE Model:

- Car;
- Car not compliant with ULEZ;
- LGV;
- LGV not compliant with ULEZ;
- HGV;
- Taxi; and
- Private Hire Vehicles (PHV).

Among these, motorised two wheelers are included within compliant car, non-compliant car using their PCU values (0.4). In the model, Taxis are black cabs which are permitted to use bus lanes and exclude other Private Hire Vehicles (PHV). Bus services are represented by fixed routes as a pre-load to the traffic assignment and hence not included in the above list.

The TfL-provided Base ONE Model includes demand matrices which represent the travel demand between all Zones in model. Separate demand matrices are provided for each Demand Segment. At IMAP Stage 2 the matrices should be unchanged from those provided by TfL.

DE should confirm and MAE should check that the Demand Segments and matrices have not been modified from those included in the TfL-provided Base ONE Model, unless previously agreed at the MAP Stage I meeting.

I.205 Zones and Zone Connectors

Existing number of Zones in the TfL-provided Base ONE Model should not be modified without prior agreement. MAE should check to ensure that there is no modification of Zones or modification as per the prior agreement.

As far as possible, Connectors in the TfL-provided Base ONE Model should not be modified. If a new Connector needs to be added, then it should be connected directly into a Centroid Link (Link Type 99). The Centroid Link should be connected to an unknown node unless there is justification otherwise. This ensures all demand flow from the Zone can be assigned onto the road network. The number of Connectors for each Zone should be, where possible, limited to one Connector per Zone. New Connectors should be set to type 0 and be open to all Transport Systems, except for 'walk'. The suggested Connector and Centroid Link layout is shown in Figure 13.

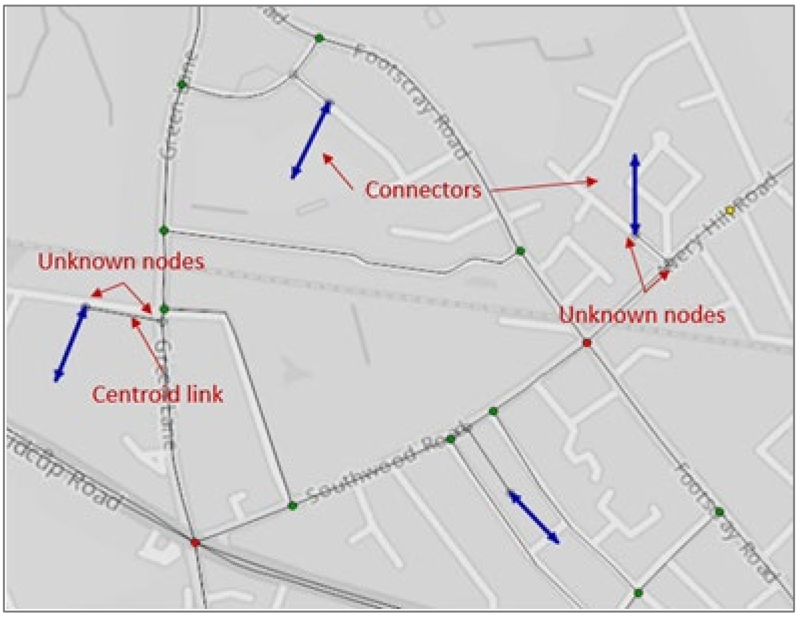


Figure 13: Suggested Connector and Centroid Link layout

If Connectors are added to the Updated Base models, then they need to be carried through to the Updated Future Base and Proposed (Do Something) models.

MAE should check to make sure that the new Zone Connectors (if any) are connected the existing network correctly.

I.206 Buffer Network

The buffer network in a tactical model is the area with simplified modelling assumptions which feeds into the key area, as detailed in Part B of the **Traffic Modelling Guidelines**. In the ONE Model the buffer network reflects the area outside of the M25 and is generally represented by Link Types 95 'Buffer' and 96 'Buffer VDF'. The existing buffer network in the TfL-provided Base ONE Model should not be modified without prior agreement.

DE should confirm and MAE should check that there is no modification to the buffer network. This could be carried out by creating a transfer (***.tra**) file and check for any changes in the buffer network. DE should contact the MAE for the standard transfer file template.

I.207 Link Types

A Link Type is a classifier that includes several attributes to define the traffic characteristics of a Link, such as capacity and link speed. There is a pre-defined list of Link Types in the TfL-provided Base ONE Model, see **Figure 14**. To make the model consistent, every Link is given a Link Type matching its observed characteristics.

Number: 100	No	Name	TSysSet	NumLanes	CapPrT	V0PrT	VdfNo
1	0	Motorway/Rural_70-Good	B,CC,CNC,H,LC,LNC,P,T	1	2100	112km/h	11
2	1	Motorway/Rural_70-Avg	B,CC,CNC,H,LC,LNC,P,T	1	1950	112km/h	13
3	2	Motorway/Rural_70-Poor	B,CC,CNC,H,LC,LNC,P,T	1	1800	112km/h	14
4	3	Motorway/Rural_60-Good	B,CC,CNC,H,LC,LNC,P,T	1	2100	96km/h	11
5	4	Motorway/Rural_60-Avg	B,CC,CNC,H,LC,LNC,P,T	1	1950	96km/h	13
6	5	Motorway/Rural_60-Poor	B,CC,CNC,H,LC,LNC,P,T	1	1800	96km/h	14
7	6	Motorway/Rural_50-Good	B,CC,CNC,H,LC,LNC,P,T	1	2100	80km/h	11
8	7	Motorway/Rural_50-Avg	B,CC,CNC,H,LC,LNC,P,T	1	1950	80km/h	13
9	8	Motorway/Rural_50-Poor	B,CC,CNC,H,LC,LNC,P,T	1	1800	80km/h	14
10	9	Motorway/Rural_40-Good	B,CC,CNC,H,LC,LNC,P,T	1	2100	64km/h	11
11	10	Motorway/Rural_40-Avg	B,CC,CNC,H,LC,LNC,P,T	1	1950	64km/h	13
12	11	Motorway/Rural_40-Poor	B,CC,CNC,H,LC,LNC,P,T	1	1800	64km/h	14
13	12		B,CC,CNC,H,LC,LNC,P,T	1	2100	48km/h	11
14	13	Like20-Suburban_70-Good	B,CC,CNC,H,LC,LNC,P,T	1	2000	112km/h	35
15	14	Like23-Suburban_60-Good	B,CC,CNC,H,LC,LNC,P,T	1	2000	96km/h	35
16	15	Like26-Suburban_50-Good	B,CC,CNC,H,LC,LNC,P,T	1	2000	80km/h	35

Figure 14: An example of the Link Types list in the ONE model

The DE should ensure, and the MAE verify, that the Link Types, and associated attributes, defined in the TfL-provided Base ONE Model are not amended. It is recommended that existing Link Types included in the supplied model should be chosen for newly added or modified Links in the network.

If the attributes of the existing Link Types are not suitable, a new Link Type with different attributes could be created and used. If a new Link Type is created, supporting evidence explaining their use should be presented in the DE's Technical Report (**I.201**).

MAE could use a transfer (***.tra**) file to check for any amendments to Link Types.

I.208 Link Structure

The Link structure in the Updated Base ONE Model should be modified to reflect on-street conditions within the Base Review area. The following Link attributes will be checked by the MAE:

- **Link Numbers [No]:** These should be checked to confirm that Link numbers have not been changed from those in the TfL-provided Base ONE Model. New Links should be numbered according to the TfL convention agreed at Stage I;

- **Link Type [TypeNo]:** These should be checked to confirm the correct Link attributes are applied to the Link, as described in 1.207;
- **Number of Lanes [NumLanes]**: This should reflect the number of general traffic lanes available on the Link, prior to any flaring. The number of lanes after flaring should be accounted at a Node level. Where a bus lane exists, it should be excluded from the number of lanes. The bus lane operation should be represented accurately, especially where operation hours vary throughout the day;
- **Free flow Link speed [V0PrT]:** This should be checked to confirm that the free flow Link speeds should be equal to the speed limit unless it is justified by on-street behaviour, such as vehicles speeding regularly. The free flow Link speed should be amended by changing the Link Type;
- **Link Capacity [CapPrT]:** This attribute will be dependent on the Link Type selected;
- **Transport Systems [TsysSet]:** These should correspond to the Transport Systems, and associated Demand Segments, permitted to use the Link;
- **Link Permeability [Permeability]:** Link permeability indicates whether queuing traffic can block other lanes. This should be left at its default of 0 for one lane Links, indicating no permeability. On Links with multiple lanes this should be set to 100, where vehicles can still pass in another lane when traffic is queuing in one lane;
- **Arrival Type [ICAArrivalType]:** The ICA arrival type should be left at the default value of 3 during IMAP Stage 2. This may be altered during the MAP Stage 3 Calibrated / Validated Base ONE Model process; and
- **Bus Lanes [BUS_LANES]:** This attribute should be checked where a bus lane exists on a Link. The bus lane operation should be represented accurately, especially where operation hours vary throughout the day.

The Link geometry should match the road layout. Any amendments to the Link geometry should be detailed in the Technical Report (1.201).

Where complex traffic layouts or behaviours exist, it is recommended that DEs or MAEs with limited experience seek advice from an experienced ONE / Visum modeller to ensure the effectiveness of a specific Link structure.

I.209 Nodes / Main Nodes

Nodes and Main Nodes in the Updated Base ONE Model Base Review area should be modified to ensure the operation and capacity of junctions are accurate and consistent with the on-street conditions. Key attributes of Nodes / Main Nodes in the Updated Base ONE Model that will be checked by the MAE are:

- **Major Flow:** 'Major flow manually' should be selected and the major flow arrows should match on-street behaviours, as seen in **Figure 15**. This is critical for priority-controlled junctions.

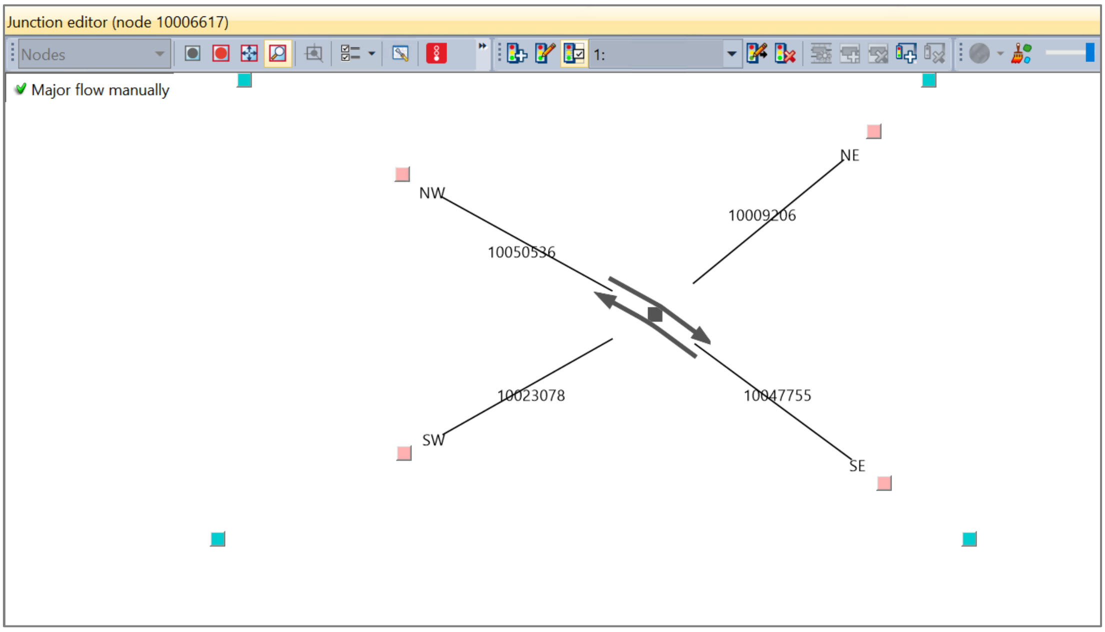


Figure 15: An example of the Major Flow attributes in the Junction Editor view, with the tick for 'Major flow manually' and black arrows showing the major movement through the junction

- **Number [No]:** Existing Node number should not be changed without prior agreement. New Nodes should be numbered according to a TfL convention agreed at MAP Stage I.
- **Type number [TypeNo]:** Node type number should be correctly allocated, see **Table 4**.
- **Junction code [Code]:** The junction code should represent the TfL site reference number as shown on the TfL Signal Timing Sheet (xx/yyyyyy). For example, 08/000134 – '08' is the borough code and '134' is the Node number.
- **Name [Name]:** The junction's name should be entered correctly.

Table 4: Node / Main Node Type Numbers and Control Types used in the ONE model

Type	Description	Control Type
0	Standard unknown	Unknown
2	Two-way stop	Two-way stop)
3	Signalised junction	Signalised
5	Roundabout	Roundabout
8	Signalised pedestrian crossing	Signalised

- **Control Type [ControlType]:** The MAE should verify that the Control Type is correct, in accordance with the information in **Table 4**.
- **Method of Impedance [MethodImpAtNode]:** The MAE should confirm the correct impedance method has been allocated. For the majority of Nodes / Main Nodes, 'Node impedance calculation (ICA)' should be used. Unknown Nodes, which are used to represent changes to Link attributes and do not impact on capacity, should use 'Turns VDF' method of 'Node impedance calculation'. No changes should be made to Nodes in the buffer network.
- **Method of Impedance [UseMethodImpAtNode]:** This should be selected for all signalised and priority-controlled Nodes / Main Nodes in the Base Review area. This should be unticked for Unknown Nodes.
- **Signal Controller [SC]:** Signal controller number is a short form of the junction code, for example, signal controller number of the junction 08/000134 is 8134. This is only available at signalised Nodes.

I.210 Turns / Main Turns

The Turn / Main Turn information should be modified in the Junction Editor for each Node / Main Node within the Base Review area to ensure the operation and capacity of junctions are accurate and consistent with the on-street conditions. Key attributes of Turns / Main Turns in the Updated Base ONE Model that will be checked by the MAE are:

- **Type [TypeNo]:** The Type should be correctly allocated based on the turning movement being made. Where a Turn is not permitted, Turn type 0 – None should be selected;

- **Transport Systems [TsysSet]:** These should correspond to the Transport Systems permitted to make the Turn. Where a Turn is not permitted, this should be empty; and
- **Initial Capacity at Unknown Nodes [CapPrT and INITCAP]:** Where a Turn does not have an initial value at Unknown Nodes, Visum considers it having no capacity and does not allow vehicles to assign onto that movement. All open Turns at Unknown Nodes should be initialised with a Turn capacity. It is recommended to initialise the 'CapPrT' and 'INITCAP' attributes with a value of '99999'.

It is recommended that all closed Links, closed Turns and Turns of blocked Links are displayed when checking Turn / Main Turn information to ensure all Turns are coded correctly.

I.2II Node / Main Node Geometry

The geometric elements of a Node or Main Node should be coded correctly representing on-street conditions. All Node or Main Node types should be modelled with the same level of detail. The MAE should check the following have been coded correctly in the Geometry tab on the Junction Editor:

- Number of legs;
- Number of lanes on each leg;
- Flared approaches and flare lengths;
- Permitted turning movements from each lane, known as Lane Turns. U-turning movements should not be included at Nodes, unless justified by site observations and agreed with the MAE;
- Permitted Transport Systems [TsysSet] should correspond to the Transport Systems permitted to use the lane or make the Lane Turn. Where a Turn is not permitted, this should be empty.

Complex and/or large junctions, such as dual carriageway junctions, should be represented by a collection of Nodes grouped into a single Main Node / junction. Main Nodes may also be used where there are banned movements between closely located junctions, for example where only traffic from certain approaches at an upstream junction can make a turning movement at a downstream junction due to lane allocation or physical barriers.

Large roundabouts with a diameter greater than 40m should be modelled as a series one-way Links and either signalised or priority-controlled Nodes depending on the operation of the roundabout. This method of coding allows Link lengths of the circulating carriageway to be included within route choice during the assignment process.

Roundabouts at major or grade separated junctions should have the approach and exit lanes modelled separately. The approach lanes should be attached to signalised or priority-controlled Nodes as appropriate, with the exit lanes leaving the circulating carriageway using an unknown Node.

Where a slip road exists at a roundabout, allowing vehicles to move through the junction without having to stop and give-way to opposing traffic, a Link is coded alongside the circulating carriageway to allow this movement to avoid the roundabout.

At small priority-controlled roundabouts, the geometric information required includes entry width, flare length and approach width.

I.212 Signal Timings

The MAP-approved LinSig or TRANSYT models used to input signal timing data should be submitted with the Updated Base ONE Models. Such models should correctly represent on-street data. The signal timings in both the Updated Base ONE Model and accompanying LinSig / TRANSYT models should be consistent.

The DE has a responsibility to input the signal timings correctly into the Updated Base ONE Model. The DE should follow TfL guidance provided with the models to clarify the modelling approach to be adopted.

MAE should check following parameters within the Junction Editor Signal Timing tab to ensure correct representation of Signal Timings in the Updated Base ONE Model:

- **Cycle time;**
- **Phases [Signal group]**;
- **Allocation of Phases [Signal groups] to lanes**: The correct signal groups can be allocated to each lane within the Junction Editor, Geometry, Lanes view; and
- **Phase start and phase end times [Red 1 (end) and Green 1 (end)]:** This should take account of phase delays, underutilised Green Time (UGT) and demand dependency. One second of effective green time should be added to the signal timings taken from the approved LinSig and TRANSYT models.

As the ONE Model takes account of blocking back, timing adjustments as a result of UGT should not typically be transferred into the model. However, if the cause of UGT is at the junction being modelled and not by a downstream junction the timing adjustments should be included. Where the cause of the UGT is not clear, the DE should refer to the MAE and Network Manager to determine the correct timing adjustments to be applied.

In some situations, in order to model the on-street signal operation correctly, there might be a requirement to model duplicate phases with different green times.

1.213 Saturation Flows and Turn Capacity

Turn capacity at signalised Nodes / Main Nodes is governed by the lane saturation flow. It is important for the DE to ensure that lane saturation flows are consistent with the associated MAP Stage 3-approved LinSig or TRANSYT models.

Opposed right turning movements need more consideration when assigning saturation flow. Where right turning traffic gives-way to opposing traffic, the DE should not attempt to match the capacity calculated by a deterministic model. In such cases, Visum should be allowed to estimate the capacity.

The capacity of a flare is dependent on the flow allocation in the supporting LinSig / TRANSYT models. The DE should follow the advice provided in the guidance documents and detail the methodology used to calculate the lane saturation flows for flared approaches.

DE and MAE need to ensure that the following attributes are specified correctly:

- **Saturation Flow [ICAPresetSatFlowRate]:** This should be checked to ensure that the lane saturation flow matches the saturation provided in the MAP Stage 3 approved LinSig or TRANSYT models. Exceptions are allowed in certain circumstances, as detailed above. This attribute can be checked in the Junction Editor Geometry tab;
- **Use Saturation Flow [ICAUsePresetSatFlowRate]:** Ensure this is ticked where appropriate for a saturation flow to be used. This attribute can be checked in the Junction Editor Geometry tab; and
- **ICA Final Capacity [ICAFinalCap]:** This should be checked to ensure the capacity for each turning movement at signalised Nodes / Main

Nodes matches or corresponds to the capacity in the approved MAP Stage 3 LinSig or TRANSYT models. There are known situations where it is not possible to match the capacity of Turns, such as for opposed right turning movements. This check can only be undertaken once all other Node information has been correctly inputted and the 'Execute ICA Calculation' option has been selected from the Junction Editor view toolbar. This attribute can be checked in the Junction Editor Geometry tab.

I.214 Give-way Parameters

Give-way parameters have an impact on traffic assignment in networks with give-way junctions. It is important that the DE models the give-way parameters correctly in the Updated Base ONE Model, thus replicating on-street behaviour in models.

As mentioned in **I.209**, the major flow arrows should be accurately represent the major traffic movement and 'Major flow manually' setting ticked.

Within the Junction Editor Turns tab, the DE and MAE should check following attributes (to ensure the following are set appropriately:

- **Critical Gap [ICAPresetCriticalGap]:** This attribute defines the time gap in the major traffic flow required for a vehicle on the side road to make its turn. Lowering the time will result in more vehicles making the turn and increasing this attribute will result in fewer vehicles turning;
- **Use Critical Gap [ICAUsePresetCriticalGap]:** This activates the Critical Gap time attribute;
- **Follow up time [ICAPresetFollowUpTime]:** This attribute defines the time gap in major traffic flow that is required for any secondary vehicle on the minor road to make their turn. A smaller time results in more vehicles turning, with a larger time resulting in less vehicles turning; and
- **Use Follow Up Time [ICAUsePresetFollowUpTime]:** This activates the Follow Up time attribute.

Any amendments to the Critical Gap and Follow Up time parameters should be documented in the Technical Report (**I.201**).

1.215 Public Transport Modelling

Public Transport services are already incorporated as line routes with fixed demand in the TfL-provided Base ONE Model.

The DE should document the details and sources of all data used to update bus routes and their frequencies with the Technical Report (1.201). Potential sources of data to review the public transport elements of the Updated Base ONE Model include:

- Surface Playbook;
- TfL Bus route maps / timetables;
- BusNet;
- iBus data; and
- Documented on street observations.

The DE should ensure that the following public transport elements are correctly defined within the Base Review area, which will be checked by the MAE:

- **Bus routes:** The route a line takes through the network should match the route taken on street. This can be reviewed in Line Routes, and selecting the correct route number and direction;
- **Bus frequencies:** A sense check is required to compare modelled bus flows versus observed bus flows;
- **Bus stop dwell times:** review the modelled dwell time against observed dwell times. This can be reviewed by amending the DefDwellTime_AM and DefDwellTime_PM attributes at each Stop point in the model;
- **Bus stops and stands:** the location of modelled Stop points, Stop areas and Stops in the Updated Base ONE Model should reflect their on-street position. Individual bus routes in the model should be checked to ensure they call at the correct stops within the Base Review area. The number of the Stop points, Stop areas and Stops should ideally be checked to ensure compatibility with the on-street bus number; and
- **Bus lanes:** the location, length and operation hours of Bus lanes should be checked in the Updated Base ONE Model. Bus lanes are represented by the Link attribute BUS_LANES and amending the number of lanes a Link, as detailed in 1.208.

1.216 Cyclist Modelling

Cyclists are only considered in the TfL-provided Base ONE Model where limited or no segregation is present between cyclists and motorised vehicles. Cycle flows are already included in the ONE Model as static pre-load onto Link volumes for each time period. The cycle volume in a Link reduces the Link capacity available for motorised traffic.

The DE should a sense check of the CYCLIST_AM and CYCLIST_PM Link attributes. The review should include a review of the Base Review area for any gaps in cycle volumes that cannot be attributed to justified reasons, such as segregated facilities. This review could be undertaking by plotting a Link Bar for the cyclist attributes, see **Figure 16**. The volume of cyclists, in number of cyclists, should be reviewed to determine where the modelled cycle flows differ significantly from any observed data. Any amendments to the CYCLIST_AM and CYCLIST_PM attributes should be documented and justified in the Technical Report (**1.201**).

Figure 16: Link Bar plot of Cyclist attribute, red circles indicate potential unexplained breaks in cycle volumes

1.217 Model Errors / Warnings

Network Check functionality available within the ONE model exposes any errors or warnings that impact model assignment process. The messages produced following a Network Check should be audited by the DE and MAE.

Prior to undertaking a Network Check, it is advised that the DE and MAE run the procedure sequence 'Update impedances at Node' procedure sequence, and review any errors generated. It is recommended that the Network Check settings identified in **Figure 17** are used.

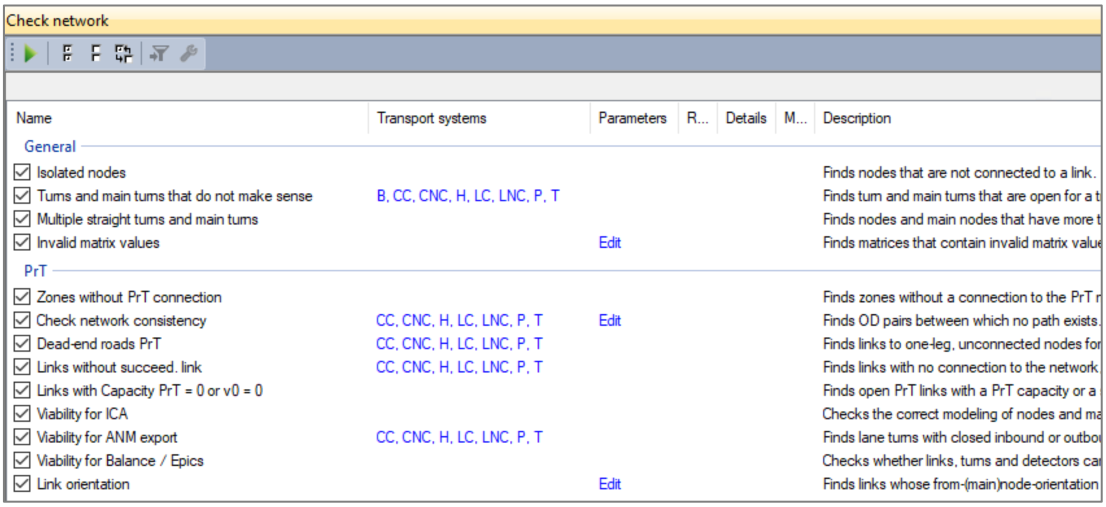


Figure 17: Network check settings

The DE should address the errors and warnings highlighted by the Network Check process within the Base Review area. Certain warnings such as 'allocation of signal controller to many Nodes' could be ignored if modelling is done correctly. The DE must seek further advice from the CE or MAE if unsure about the type of errors and warnings that have been produced.

1.218 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **1.201 – 1.217**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the IMAP Stage 2 Check Sheet (**MQA-0544/02**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **1.201 – 1.217**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

6.2.4 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks 1.201 – 1.218 and there are no other issues the MAE will approve the model and authorise the relevant IMAP Stage 2 Check Sheet (**MQA-0544/O2**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed IMAP Stage 2 Check Sheets (**MQA-0544/O2**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of IMAP Stage 2

IMAP STAGE 3

6.3 IMAP Stage 3, Calibrated / Validated Base ONE Model Submission

6.3.1 What is a Calibrated / Validated Base ONE Model?

IMAP defines that a Calibrated / Validated ONE Model should be based on the IMAP Stage 2 approved Updated Base ONE Model, where the model has been assigned and Matrix Estimation has been conducted as required to meet the calibration / validation targets.

Calibration / validation in the ONE model is completed by comparing modelled traffic flows and journey times and comparing against those recorded on-site. It is also required to ensure that there is a realistic representation of queue lengths.

Calibrated / Validated ONE models are required for all time periods in IMAP Stage 3.

6.3.2 IMAP Stage 3 Check Sheet

IMAP Stage 3 has a Check Sheet (**MQA-0544/03**), which must be completed by the MAE when auditing the models.

A separate IMAP Stage 3 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

1.301 Calibration / Validation Report

Calibrated / Validated Base ONE Model submissions must be accompanied by a Calibration / Validation Report.

The DE should ensure the following information is provided:

- The stated purpose of the model, as agreed during MAP Stage 1 and defined in the Modelling Expectations Document;
- List of all changes made to the approved IMAP Stage 2 Updated Base ONE Model with justification for any revisions;
- List of any changes to default parameters with supporting evidence;
- Details of the traffic data used for calibration and validation of the Base Review area, such as turning counts, Link flows and journey times:
    - What data was collected during the traffic surveys;
    - When the traffic surveys were done;
    - Who carried out the survey;
- Notes covering observed site conditions, including the location of any network bottlenecks in the Base Review area;
- Calibration table showing comparison of modelled and observed flow data for all available Turns / Main Turns and Links in the Base Review area as well as a summary table showing levels of calibration achieved;
- Validation table showing comparison modelled and observed data for all available journey times in the Base Review area as well as a summary table showing levels of validation achieved;
- Where journey time data is not available, comments on the realistic estimation of queues on the Links in the Base Review area; and
- List of all modelling assumptions made with supporting evidence;

I.302 Adjustments from Stage 2 Model

There should be very few changes from the IMAP Stage 2 approved model other than adjustments made for the satisfactory calibration / validation of traffic flows (I.306), journey times (I.307) and queue length correlation (I.308).

Where significant changes have been made, these should be detailed in the Calibration / Validation Report as described in I.301 The DE and MAE must ensure that any changes are both appropriate and reasonable, and that the data that was previously checked during IMAP Stage 2 (I.301 – I.309) remains satisfactory.

A recommended method for assessing changes made to the IMAP Stage 2 model, is to create a transfer (***.tra**) file between the MAP Stage 2 approved model and the Calibrated / Validated Base ONE Model.

I.303 Model Assignment

The assignment procedure provided within the TfL-provided Base ONE Model uses assignment with Intersection Capacity Analysis (ICA) method which should not be changed without prior agreement. The DE must ensure and MAE verify that the assignment procedure (***.xml**) files included in the TfL-provided Base Model have been used.

The convergence criteria that are already specified in the assignment procedure should not be modified without prior agreement. Any deviations in the convergence criteria or any assignment that does not achieve the criteria should be detailed in the Calibration / Validation Report and justified. Non-converged pockets within the Base Review area should be identified and reported using detailed Turn comparison of consecutive iterations

The MAE should check the modelling results by running the submitted Calibrated / Validated Base ONE Model using the assignment procedures supplied by TfL. The Link volumes and total delay outputs from the assignment should be compared with the submitted results, using a version comparison.

I.304 Matrix Estimation

The primary purpose of matrix estimation is to refine estimates of trips based on the recent traffic counts within the Base Review area. For this purpose, recent counts should merge / replace earlier counts or new counts should be added within the Base Review area. All other counts in the TfL-provided Base ONE Model should not be modified without prior agreement.

The DE should update / merge in, and the MAE verify, the following attributes with recent traffic count data:

- **Scheme code [OBS_SCHEME]:** DE should specify an identifying code name for the scheme being assessed d apply it to every turning count within the Base Review area;

- **Turning count code [OBS_CODE]:** This is a unique code that the DE should generate for each turning movement in the Base Review area;
- **Observed Car count [OBS_AM_CAR or OBS_PM_CAR]:** The observed traffic count for cars, PHV and factored motorcycles for each turning movement assessed in the Base Review area, entered as the factored number of vehicles;
- **Observed HGV count [OBS_AM_HGV or OBS_PM_HGV]:** The observed traffic count for heavy goods vehicles, including coaches, for each turning movement assessed in the Base Review area, entered as the number of vehicles;
- **Observed LGV count [OBS_AM_LGV or OBS_PM_LGV]:** The observed traffic count for light goods vehicles for each turning movement assessed in the Base Review area, entered as the number of vehicles; and
- **Observed Taxi count [OBS_AM_Taxi or OBS_PM_Taxi]:** The observed traffic count for taxis for each turning movement assessed in the Base Review area, entered as the number of vehicles;

Should any vehicle classes not have been separately counted during the traffic surveys the DE should liaise with the MAE and document the agreed approach for observed counts in the Calibration / Validation Report (I.301).

The DE should document the use of the following attributes related to matrix estimation for MAE to check:

- **ME_SELECT;**
- **ME_LEVEL use;** and
- **QUEUE_CORRECTION use:** At some junctions, there may be unrealistic queuing despite the supply being correctly coded and the capacities being realistic. In such situations, the demand patterns may need to be adjusted to match the on-street conditions using Queue Correction. The use of such correction needs to be justified with observed count data along the journey time or queue data and reported in the Calibration / Validation Report (I.301). The use of QUEUE_CORRECTION is carried out by populating the Turn / Main Turn attribute with a positive or negative value that will represent the number of vehicles to be increased or decreased. Where further information is required, the DE should liaise with the MAE.

I.305 Model Errors / Warnings

The DE should address the errors and warnings highlighted by the Network Check process within the Base Review area. Certain warnings such as 'allocation of signal controller to many Nodes' could be ignored if modelling is done correctly. The DE must seek further advice from the CE or MAE if unsure about the type of errors and warnings that have been produced.

I.306 Traffic Flow Comparison

The Calibration / Validation Report (**I.301**) should contain table of a comparison between traffic flows recorded on-site against modelled flows. The DE must ensure that the traffic flows closely match surveyed data, which will be verified by the MAE. The GEH statistic is a standard measure of the 'goodness of fit' between observed and modelled flows, as explained in the **Traffic Modelling Guidelines**. Unlike flow comparison using percentage difference the GEH statistic places more emphasis on larger flows than on smaller flows.

> The DE should aim for GEH values less than five at more than 85% of Turn / Main Turns and Link counts in the Base Review area when comparing modelled flows to observed flow volumes.

Results should be presented in the DE's Calibration / Validation Report (**I.301**), showing all observed and modelled flows together with calculated GEH values for each modelled Demand Segment and each time period. Significant discrepancies between modelled and observed traffic flows should be queried by the MAE.

The DE should prepare a Flow Difference plot covering the whole network between the Calibrated / Validated Base ONE Model and the TfL-provided Base ONE Model. In general, differences are expected within the Base Review area but less so in the wider ONE Model area. The magnitude of the differences will depend on different factors, such as the size of the Base Review area, changes in the traffic pattern and networks changes. The MAE should consider all factors when evaluating the differences to determine if they are acceptable.

I.307 Journey Time Comparison

The purpose and scope of the modelling assessment agreed in MAP Stage I will determine the level of detail required for journey time validation for general traffic and public transport. The validity of Calibrated / Validated Base ONE Model should be assessed by comparing the modelled travel times against on-site observations on a selected set of routes. This could be achieved by reviewing the Assigned_TT attribute within PrT Paths, alternative methodologies should be discussed with the MAE and documented in the Calibration / Validation Report (I.301).

The routes for the validation of journey times should be evenly distributed throughout the Base Review area and include critical Links and junctions.

As referenced in TAG[18], the validation routes should not be shorter than 3km or greater than 15 km, and should not take longer to travel than the modelled time periods.

> Modelled journey times should be within 15% of observed journey times. The MAE will need to be satisfied that journey time validation has been completed.

I.308 Queue Length Analysis

Due to the complexity related to queue lengths and traffic flows, comparison of queue lengths in the Calibrated / Validated ONE Model to observed queue lengths is not a suitable validation criterion. However, modelled queues should correlate reasonably with site observations of queuing behaviour and any significant discrepancies may indicate that areas of the model require further calibration.

It is possible that queue length output data will be required for comparison with the proposal as part of the report, which should be specified in the Modelling Expectations Document. This will provide an indication that queues have got longer or shorter, but should not be used as a prediction of the exact length.

The DE should observe the modelled queue lengths to identify unrealistic gridlocking or queues located near Zone Loaders which do not allow the demand to be assigned into the network.

18 **https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938864/tag-m3-1-highway-assignment-modelling.pdf**

1.309 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in 1.301 – 1.308.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the IMAP Stage 3 Check Sheet (**MQA-0544/O3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in 1.301 – 1.308.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

6.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks 1.301 – 1.309 and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant IMAP Stage 3 Check Sheet (**MQA-0544/O3**).

If the MAE fails the model on any of the checks 1.301 – 1.309, or has highlighted other significant issues with the model, then it is not considered fit for purpose. It will therefore be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the IMAP submission and provide completed IMAP Stage 3 Check Sheets (**MQA-0544/O3**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of IMAP Stage 3

IMAP STAGE 5a

6.4 IMAP Stage 5a, Updated Future Base ONE Model Submission

6.4.1 Introduction

An Updated Future Base ONE Model is a peak-time-specific model that contains the network structure and correct fundamental parameter sets reflecting current network as well as any future network changes planned for implementation up to the future year being assessed. It is recommended that the most recent TfL-provided Future Base ONE Model is used as a starting point, and updating this to reflect changes made during IMAP Stage 2 and Stage 3.

The Updated Future Base ONE Model results will be used as a reference to compare the Proposed (Do Something) ONE Model results against, which is considered more meaningful than comparing against the Calibrated / Validated Base ONE Model results alone.

Updated Future Base ONE Models are required for all time periods in IMAP Stage 3.

6.4.2 IMAP Stage 5a Check Sheet

IMAP Stage 5a has a Check Sheet (**MQA-0544/O5a**), which must be completed by the DE and CE before submission to the MAE.

A separate IMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

I.501 Future Base Report

Updated Future Base ONE Model submissions must be accompanied by a report, as described in Part B of the **Traffic Modelling Guidelines**.

As for the Calibration / Validation Report in IMAP Stage 3, it is vital that the DE communicates all assumptions relating to the Updated Future Base ONE modelling. Any other modelling assumptions that will impact development of the IMAP Stage 5b model should be documented.

All changes to the models should be clearly stated along with the reasoning behind the changes and any required supporting information or data. The key elements to be included are:

- Details of any variations to the default parameters from the TfL-provided Future Base ONE Model, with justification for the changes;
- Network changes applied to the TfL-provided Future Base ONE Model to make it consistent with the approved Calibrated / Validated Base ONE Model;
- Signal timing changes to take account of the changes in the traffic flows due to the changed network;
- Detailing the changes to the demand matrices, resulting from matrix estimation in IMAP stage 3 and uplift to reflect the future year demand; and
- Any other modelling assumptions that will impact development of the IMAP Stage 5b model.

There must be clear comparisons between the results of the Calibrated / Validated Base ONE Models and the Updated Future Base ONE Models in the Base Review area for the corresponding periods.

I.502 Updated Base Model Network Changes

The road network in the TfL-provided Future Base ONE Model needs to be updated to make it consistent with the network changes made to both the Updated Base ONE Model and Calibrated / Validated Base ONE Model in the Base Review area. The DE will need to ensure that all the network changes made during IMAP Stages 2 and 3 are transferred to the TfL-provided Future Base ONE Model accurately. The MAE may wish to use the following methodology to review the changes:

- Creating a transfer (***.tra**) file between Updated Future Base ONE Model and the approved Calibrated / Validated Base ONE Model; and

- Checking there are no network changes within the Base Review area, except for those required to code planned future network changes (see **I.503**), by visualising the transfer file.

The DE should ensure that all modelling parameters are consistent with the Calibrated / Validated Base ONE Models passed during IMAP Stage 3. If there are inconsistencies these should be highlighted for the MAE and discussed.

I.503 Future Network Changes

The TfL-provided Future Base ONE Model includes likely network changes planned for implementation up to the future year. However, the likely network changes may require updating with the latest scheme information or additional schemes may need to be included to accurately reflect the future year network conditions. The requirement for any updates or additions will be discussed and agreed at the MAP Stage 4 meeting.

All the schemes coded in the model should comply with the methodology specified in IMAP Stage 2 (**I.202** – **I.217**). DE should provide the details of the schemes coded. The MAE should check the schemes agreed during MAP Stage 4 are updated or included in the Updated Future Base ONE Model, according to the IMAP Stage 2 checks.

I.504 Signal Timing Changes

The signal timings in the Updated Future Base ONE Model may require updating to reflect changes in demand and road network in the Base Review area. The revised signal timings will be supplied from iterations with an optimised Future Base LinSig or TRANSYT model (see **A2.3.2.1**). The iterative process ends once convergence is reached, and there are no further changes to traffic assignment or signal timings. The Updated Future Base ONE Model submitted should reflect the agreed iteration, and the signal timings should reflect the MAP Stage 5a approved LinSig or TRANSYT model.

The DE should ensure the coding of the signal data should follow the methodology followed in **I.212**. The MAE should check that the signal timings in the Updated Future Base ONE Model match the signal timings in the MAP Stage 5a approved LinSig or TRANSYT model. The MAE should review the evidence of the iterative process and the stopping criteria used to determine that convergence has been reached.

The DE's Future Base Report (**I.501**) should comment on the frequency of demand-dependent stages and the application of UGT in the Calibrated / Validated Base ONE Model and the assumptions that have been made for the Updated Future Base ONE Model. These assumptions should be discussed with the Network Manager and MAE and need to be audited by the MAE.

I.505 Future Base Demand Matrices

The future demand matrices need to be updated to reflect changes made in the Base Review (IMAP Stages 2 and 3) and the future demand. Future demand matrices are created using the script provided by TfL that takes account of the approved Calibrated / Validated Base ONE Model matrices. The DE will need to ensure that the future demand matrices are created accurately and submit the output (***.prt**) files produced by the script.

MAE should check the demand matrices in the Updated Future Base ONE Model by running the TfL-provided script to produce the output (***.prt**) files and comparing this to the output provided by the DE.

I.506 Public Transport Modelling

Dependant on the model amendments required as part of the Future Base scheme coding, the MAE should examine changes to the following public transport elements of the model:

- **Bus Routes:** Checked against any planned amendments to the routes;
- **Bus Frequencies:** Updated to capture any planned changes to bus frequencies;
- **Bus Stops and Stands:** Ensure that the location of Stop Points, Stop Areas and Stops reflect changes required in the Future Base schemes. The number of new Stop Points, Stop Areas and Stops should be checked for compatibility with scheme coding numbers;
- **Bus Stop Dwell times:** Check that the dwell time attribute has been updated for any new or updated Stop Points; and
- **Bus Lanes;** The location and hours of operation of bus lanes should be updated to reflect the coding of Future Base schemes.

The DE should provide details of any amendments to public transport in the Future Base Report (**I.501**).

I.507 Cyclist Modelling

Changes to the cycle flows, modelled as a static pre-load on Link volumes, within the model maybe required to reflect the Future Base schemes. For example, cycle flows may be removed from a Link if segregated facility is proposed.

The DE should ensure that a sense check is undertaken on the cycle flows in the vicinity of Future Base schemes, which should be verified by the MAE.

The DE should provide details of any amendments to cyclists in the Future Base Report (**I.501**).

I.508 Other Adjustments from TfL-provided Future Base ONE Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **I.502 – I.507**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**I.501**):

- Base model updates;
- Future network changes;
- Traffic signal changes;
- Demand matrix changes; and
- Public transport / cyclist modelling.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the TfL-provided Future Base ONE Model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. Transfer files can be helpful in assisting with this task.

I.509 Model Errors / Warnings

The DE should address the errors and warnings highlighted by the Network Check process within the Base Review area. Certain warnings such as 'allocation of signal controller to many Nodes' could be ignored if modelling is done correctly. The DE must seek further advice from the CE or MAE if unsure about the type of errors and warnings that have been produced.

I.510 Relative Queue Lengths

The Future Base Report (**I.501**) should contain a comparison plot of relative queue lengths within the Base Review area between the Calibrated / Validated Base ONE Model and the Updated Future Base ONE Model. This will assist in identifying potential coding errors or any possible downgrades in performance which may have implications during IMAP Stage 5b.

I.511 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **I.501** – **I.510**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the IMAP Stage 5a Check Sheet (**MQA-0544/O5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **I.501** – **I.510**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

6.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks 1.501 – 1.511 and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant IMAP Stage 5a Check Sheet (**MQA-0544/O5a**).

If the MAE fails the model on any of the checks 1.501 – 1.511, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the IMAP submission and provide completed IMAP Stage 5a Check Sheets (**MQA-0544/O5a**), which should be copied to NMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of IMAP Stage 5a

IMAP STAGE 5b

6.5 IMAP Stage 5b, Proposed (Do Something) ONE Model Submission

6.5.1 Introduction

The Proposed (Do Something) ONE Model should be based on the approved Updated Future Base IMAP Stage 5a ONE Model. The DE should make a copy of the accepted Updated Future Base ONE Models and input the signal timings and network layout in line with the proposals agreed during MAP Stage 4.

Proposed (Do Something) ONE Models are required for all time periods in IMAP Stage 5b.

Approved MAP Stage 5b LinSig or TRANSYT models are also produced alongside the Proposed (Do Something) ONE models. Signal timings are generally optimised using a deterministic model with the initial flow input from ONE model. The optimum signal timings when used in ONE model, flows could change. Hence, it is an iterative process that needs convergence before stopping.

In addition to ensuring that the model is correctly developed from a technical point of view the DE should demonstrate that the proposals can be accommodated without jeopardising the day-to-day operation of the network. This will include maintaining acceptable traffic reassignment, congestion and queue lengths.

In common with the preceding stages of IMAP, the MAE will need to consider the technical data, however unlike the previous stages there must be interpretation of their implication.

As a representative of the Network Manager, who will have a duty to manage the new network (if the proposal is given approval by NIST), the MAE should highlight any issues and concerns with the proposal. These issues are likely to be in respect of safe, efficient network operation and current policy / guidelines.

The DE will receive feedback from MAE and will need to address any highlighted issues. The MAE will use their operational experience and knowledge of the network in making informed comments and decisions.

If required by the model scope the proposed timings within the ONE model must be suitable to be used as controller-held background timings. This means that the MAE's audit is implicitly asking the DE:

> 'Are you satisfied that, if observing on-site when these proposals are commissioned, the timings in each of the submitted ONE models would provide appropriate network operation under local control and that the network impacts would be as described in the SIR?'

6.5.2 IMAP Stage 5b Check Sheet

IMAP Stage 5b has a Check Sheet (**MQA-0544/O5b**), which must be completed by the MAE when auditing the models.

> A separate IMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

I.551 SAE-Approved Proposed Methods of Control

Before commencing the audit of any Proposed (Do Something) ONE Models which involve any new or modified signalised infrastructure, the DE and MAE must ensure that each proposed design has been approved by the SAE and documented on the Traffic Signal Option Selection Review form (**F7356**). This review identifies issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings.

The review is arranged as part of the supporting LMAP, TMAP or VMAP Stage 5b process.

> Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from completing IMAP Stage 5b.

I.552 Proposed (Do Something) Model Report

Proposed (Do Something) ONE Model submissions must be accompanied by a Proposed (Do Something) Model Report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria **I.553** - **I.562**.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the results of the approved Calibrated / Validated Base ONE Models, Updated Future Base ONE Models and the Proposed (Do Something) ONE Models for the corresponding periods.

Comparisons for the Base Review area are required. A review of the wider area should be included where significant reassignment is predicted.

I.553 Network Changes

There are likely to be several changes required to the approved Updated Future Base ONE Model network to represent the proposals. These changes may include:

- Changes to Zones or Zone Connectors;
- Changes to Link structure, reflecting changes such as Link Type, Number of Lanes, permitted Transport Systems;
- Amendments to Nodes / Main Nodes, such as changes to Control Type, Type Number, Method of Impedence, saturation flows, give-way parameters and geometry; and
- Changes to Turns / Main Turns, such as permitted Turns, Turn Type and capacity.

All amendments should be detailed by the DE within the Proposed (Do Something) Model Report (**I.552**) and checked by the MAE.

I.554 Signal Timing Changes

The Proposed (Do Something) ONE Model signal timings within the Base Review area may require updating to reflect changes in demand and the proposed scheme. The revised signal timings will be supplied from iterations with an optimised Proposed LinSig or TRANSYT model (see **A2.3.2.1**). The iterative process ends once convergence is reached, and there are no further changes to traffic assignment or signal timings. The Proposed (Do Something) ONE Model submitted should reflect the agreed iteration, and the signal timings should reflect the MAP Stage 5b approved LinSig or TRANSYT model.

The DE should ensure the coding of the signal data follows the methodology specified in I.212. The MAE should check that the signal timings in the Proposed (Do Something) ONE Model match the signal timings in the MAP Stage 5b approved LinSig or TRANSYT model. The MAE should review the evidence of the iterative process and the stopping criteria used to determine that convergence has been reached.

The DE's Proposed (Do Something) Model Report (I.552) should comment on the frequency of demand-dependent stages and the application of UGT in the Updated Future Base ONE Model and the assumptions that have been made for the Proposed (Do Something) ONE Model. These assumptions should be discussed with the Network Manager and MAE and need to be audited by the MAE.

I.555 Public Transport Modelling

Dependant on the model amendments required as part of the proposal coding, the MAE should examine changes to the following public transport elements of the model:

- **Bus Routes:** Checked against any proposed amendments to the routes;
- **Bus Frequencies:** Updated to capture any planned changes to bus frequencies;
- **Bus Stops and Stands:** Ensure that the location of Stop Points, Stop Areas and Stops reflect changes required in the proposed scheme. The number of new Stop Points, Stop Areas and Stops should be checked for compatibility with scheme coding numbers;
- **Bus Stop Dwell times:** Check that the dwell time attribute has been updated for any new or updated Stop Points; and
- **Bus Lanes;** The location and hours of operation of bus lanes should be updated to reflect the proposed scheme.

The DE should provide details of any amendments to public transport in the Proposed (Do Something) Model Report (I.552).

I.556 Cyclist Modelling

Changes to the cycle flows, modelled as a static pre-load on Link volumes, within the model maybe required to reflect the proposed scheme. For example, cycle flows may be removed from a Link if segregated facility is proposed.

The DE should ensure that a sense check is undertaken on the cycle flows in the Base Review area, which should be verified by the MAE. The DE should provide details of any amendments to cyclists in the Proposed (Do Something) Model Report (**I.552**).

I.557 Other Adjustments from Stage 5a Model

The main changes expected in the Proposed (Do Something) modelling are likely to have been covered by MAP checks **I.553** – **I.556**, concerning specific changes to the following areas that should be detailed in the Proposed (Do Something) Model Report (**I.552**):

- Network changes;
- Traffic signal changes; and
- Public transport / cyclist modelling.

Any other software settings (including the software version) or model parameters, such as the demand matrices, checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved IMAP Stage 5a model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. Transfer files can be helpful in assisting with this task.

I.558 Model Errors / Warnings

The DE should address the errors and warnings highlighted by the Network Check process within the Base Review area. Certain warnings such as 'allocation of signal controller to many Nodes' could be ignored if modelling is done correctly. The DE must seek further advice from the CE or MAE if unsure about the type of errors and warnings that have been produced.

I.559 Flow Difference Check

Overall, in the whole model, traffic flows in the Proposed (Do Something) ONE Model should be similar to those in the Updated Future Base ONE Model. However, there will be differences in the traffic flows in the vicinity of the Base Review area, depending on the magnitude of the scheme impacts.

The DE should review the Flow Difference plot between the Updated Future Base ONE Model and Proposed (Do Something) ONE Model for the entire network to make sure that there are no unreasonable flow differences. This should be included in the Proposed (Do Something) Model Report (**I.552**) and reviewed by the MAE.

I.560 Traffic Flows, Link Speeds and Relative Queue Lengths

The Proposed (Do Something) Model Report (**I.552**) should contain a comparison of assigned flows, Link speeds and relative queue lengths between the Updated Future Base ONE Models and the Proposed (Do Something) ONE Models. There should be interpretative comment regarding the implications of this data upon network performance. If the Proposed (Do Something) ONE Model indicates a negative impact these should be investigated and discussed by the DE. The comparison should focus on the Base Review area, but may highlight changes in the wider modelled area that should be reviewed.

1.561 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in enssence the Updated Base, Updated Future Base and Proposed (Do Something) ONE Models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see **A2.1**) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

1.562 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **1.552** – **1.561**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the IMAP Stage 5b Check Sheet (**MQA-0544/O5b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **1.552** – **1.561**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

6.5.3 Acceptance / Rejection of the Model

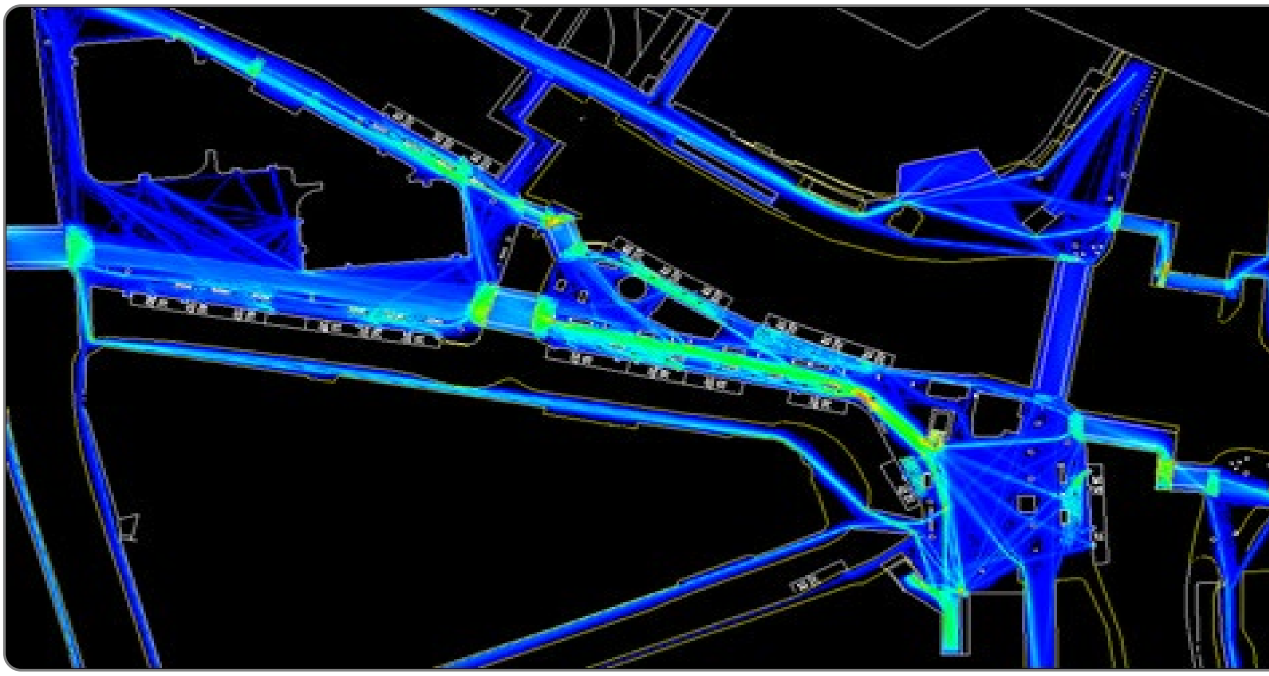
If the MAE passes the model on all of the checks 1.552– 1.562 and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant IMAP Stage 5b Check Sheet (**MQA-0544/O5b**).

If the MAE fails the model on any of the checks 1.552 – 1.562, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the IMAP submission and provide completed AMAP Stage 5b Check Sheets (**MQA-0544/O5b**), which should be copied to NMSchemeAssessments@TfL.gov.uk. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of IMAP Stage 5b

7 Pedestrian MAP (PMAP)



7.1 Scope

PMAP applies to all LEGION and Viswalk pedestrian modelling of street level infrastructure submitted to TfL Operations for auditing.

7.1.1 Supporting Modelling

Pedestrian modelling of street level infrastructure requires several numerical inputs; most prominently pedestrian demand or the number of pedestrians entering and exiting the model, traffic signal timings, and bus frequencies. Other common inputs include the number of persons with restricted mobility (PRM) and their attributes such as walk speed and size. While these inputs could be derived from desktop exercises, it is more likely that some form of additional modelling is required.

Pedestrian demand forecasting for street level modelling remains an ad-hoc process with approval completed on a case-by-case basis. This forecasting may require strategic modelling using tools such as Railplan to provide confidence that levels of growth are at an appropriate level. Where a Transport Assessment has been provided in support of a proposed development, additional future demand contained therein should be taken and used to support this process. It is important that alongside submission of pedestrian modelling and the associated demand therein, the methodology is used to determine the pedestrian demand is fully documented. An understanding of the forecasting provided should precede audit of the pedestrian modelling.

It is common practice and highly recommended that signal timings are taken from MAP-approved modelling using deterministic software such as LinSig or TRANSYT, which allow for signal optimisation. Pedestrian models using Viswalk will require a joint PMAP and VMAP audit to ensure that the traffic and pedestrian elements are fit for purpose. Each MAP stage will require joint approval, and any changes resulting from one MAP audit will result in reviews for any impacts in the other.

PMAP STAGE 2

7.2 PMAP Stage 2, Pedestrian Calibrated Base Model Submission

7.2.1 What is a Pedestrian Calibrated Base Model?

A Pedestrian Calibrated Base model should have:

- Appropriate demand data from either on-street surveys, tactical modelling or a combination of both. This should be in accordance with the scope and purpose of the model as defined in MAP Stage 1 and defined in the Modelling Expectations Document (MED).
- Public transport data collected from reliable sources and modelled accurately. The level of detail of public transport modelling is dependent on the purpose of the model as defined in MAP Stage 1 and defined in the MED.
- Correct on-street signal timings data for the network during the period under consideration.
- Pedestrian-accessible space, and supporting CAD files, modelled accurately which is fundamental in providing valuable quantitative analysis. Details of street furniture and other obstacles should be checked on site to ensure it is up to date.
- Appropriate pedestrian movement throughout the model. The DE should set out to achieve realistic pedestrian movements, including appropriate route choices that allow pedestrian entities within the model to reach their destination in a timely manner.

- As few model warnings as possible. Where warnings remain, they should be understood and documented if necessary.

Calibrated Base models are required for all time periods in PMAP Stage 2.

7.2.2 What is the purpose of Pedestrian Calibrated Base Models?

The submission of Calibrated Baes models prior to model validation is useful for both the DE and the MAE, and will improve the standard of the Validated Base model submissions. Calibrated Base model submissions provide an opportunity to ensure that the DE has understood the pedestrian demand, pedestrian environment, public transport provision and pedestrian movement through the modelled network.

7.2.3 PMAP Stage 2 Check Sheet

PMAP Stage 2 has a Check Sheet (**MQA-0544/P2/L** or **MQA-0544/P2/V**), which must be completed by the MAE when auditing the models.

A separate PMAP Stage 2 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

P.201 Calibration Report

Pedestrian Calibrated Base model submissions must be accompanied by a brief Calibration Report.

The Calibration Report provides an opportunity for the DE to outline the way in which the model has been built, and should allow the MAE to fully understand the model to an extent that they could use it for their own purposes. Each Calibration Report should be specific to the model it accompanies; key elements include:

- The scope and purpose of the models, as agreed at MAP Stage I;
- Extent of the modelling area, as agreed at MAP Stage I and defined in the MED;
- Modelled time periods, as agreed at MAP Stage I and defined in the MED;
- The source signal timings and accompanying MAP Stage 3-approved LinSig or TRANSYT models. It should be clear to the reader how the signals operate, and the associated pedestrian green times that the model is replicating;
- Sources of data used for development of the pedestrian model, such as bus timetables and routes; and
- Any other modelling assumptions made during the development of the PMAP Stage 2 Calibrated Base pedestrian models.

P.202 Software Version

The software version should be as agreed at MAP Stage I and documented in the MED.

P.203 Demand Data

The DE should ensure, and the MAE verify, that the pedestrian demand has been correctly entered into the model and is in accordance with the observed pedestrian data.

Upon provision of pedestrian demand data, the Origin-Destination (OD) matrices should be intuitive to the MAE and should align with the guidance on the formation of OD matrices in Part C of the **Traffic Modelling Guidelines**.

For LEGION models, the DE should provide the LEGION Data Template (LDT) that forms the basis for all demand within the model where possible. The DE should ensure and the MAE verify that the pedestrian demand is entered in pedestrians per hour, regardless of how the demand is profiled over the modelled period. Ideally the LDT should contain additional worksheets that contain the workings behind the default worksheets that are directly imported into LEGION. These additional worksheets should allow the MAE to understand the work and methodology that has gone into providing OD matrices, Data Profiles and any other necessary inputs. If a LDT has not been used, then the approach and methodology of demand preparation before import should be fully documented within the Calibration Report (**P.201**).

For Viswalk models, the pedestrian demand can be added using the OD Matrices or Pedestrian Inputs. The method used for inputting pedestrian demand into a Viswalk pedestrian model should be agreed at MAP Stage 1. The DE should ensure and the MAE verify that for both input methods the pedestrian demand is entered in pedestrians per hour, regardless of how the demand is profiled over the modelled period. Pedestrian demand should be added to entry areas (see **P.207**).

The DE should also specify the following parameters, which will be checked by the MAE:

- Simulation period(s); and
- Arrival profiles.

P.204 Pedestrian Types

The DE should ensure, and the MAE verify, that the default pedestrian types and associated characteristics have been used. Variations to the default pedestrian types and characteristics, specifically their speed profiles should be agreed in MAP Stage 1 and documented in the Calibration Report (**P.201**)

The DE must ensure that Persons with Restricted Mobility (PRMs) have been accurately included within the pedestrian model and that the appropriate speeds, sizes and routeing profiles have been assigned. Guidance on this can be found within TfL's LEGION Best Practice Guide[19] and the **Traffic Modelling Guidelines**.

P.205 Public Transport

The purpose and scope of the pedestrian model as agreed during MAP Stage 1 will determine the level of detail required for public transport modelling.

The DE should ensure that the following public transport elements (if modelled) are correctly calibrated, and verified by the MAE:

19 Modelling with LEGION: TfL Best Practice Guide, v4.0, Transport for London, June 2019

- Bus routes;
- Bus frequencies;
- Bus boarding and alighting profiles;
- Location and size of bus stops and associated street furniture.

The DE should provide the MAE with details and sources of all data used to calibrate bus routes and their frequencies to allow them to carry out necessary audit checks. Bus frequencies should be defined as per the collection of public transport data, with boarders and alighters completing and commencing their journeys in line with these frequencies. The model should allow for alighters to leave the bus before boarders enter the bus and exit the model.

The behaviours of entities waiting at bus stops should be checked against observed conditions, including any impacts to passing pedestrian entities in the model. This includes the accurate representation of any passengers unable to board buses.

For Viswalk pedestrian models, elements of public transport modelling will be included as part of the VMAP (**V.215** and **V.308**).

P.206 Signal Timing Data

The DE has a responsibility to incorporate the following into the Pedestrian Calibrated Base model submission, which will be verified by the MAE:

- Cycle times;
- Start of green times; and
- Green durations.

MAP Stage 3 approved LinSig or TRANSYT models should be submitted with the Pedestrian Calibrated Base models. The signal data held in both the Pedestrian Calibrated Base model and accompanying approved LinSig or TRANSYT models should be consistent.

Some pedestrian crossings will be demand-dependent or have variable cycle and stage times. Where this is the case for LEGION pedestrian model submissions, an alternative methodology to the standard fixed-time approach can be taken, which should replicate on-street timings as well as possible. The approach should be documented within the Calibration Report (**P.201**). In Viswalk, the modelling of demand dependency will be accounted for using pedestrian detectors.

For Viswalk pedestrian models, elements of signal timing data will be included as part of the VMAP (**V.310**). The MAE should verify that any Signal Heads and associated detectors are placed accurately on Pedestrian Links, see **P.207**, in the correct direction of travel.

P.207 Pedestrian-Accessible Space

The DE should ensure that the following criteria have been met:

- For LEGION pedestrian models:
    - CAD layers should be straightforward, simple to understand and aid presentation. A 'sim only' layer should be used where necessary to achieve a realistic accessible space footprint; presentation layers should be used efficiently and in a way that aids the viewer's understanding of the street scene, and a 'small objects' layer should be used for appropriately small CAD objects, which should be used in simulation but remain unchecked for autonavigation.
    - Accessible space should not 'leak' between CAD lines to maintain model efficiency.
    - Model dimensions should match the defined model extents closely by removing unnecessary CAD. The X and Y offset should also be kept suitably low to optimise model performance, and the amount of CAD lines should be minimised to reduce the size of the model and optimise performance.
    - The vertex count of the model CAD should be reduced as much as possible, with small features irrelevant to pedestrian-accessible space avoided.
    - CAD used in the model should be able to provide an accurate representation of the accessible space available to pedestrians at ground level. Where possible a level of detail that includes relevant objects such as lamp posts, traffic signals, bollards, electrical junction boxes, and guard railing should be included. Details included on the CAD should be verified on site.
    - Vehicular CAD should also be aligned appropriately with existing CAD, ensuring that the integrity of available accessible space is maintained. When modelling road-based public transport with multiple vehicle types using the same stop, it is important to ensure that the boarding and alighting locations are appropriately positioned. Accurate vehicular CAD is not mandatory but can be used when appropriate.

- For Viswalk Pedestrian Models:
    - Refer to guidance provided in VMAP **V.205** for the setting up background files;
    - Areas should be set up correctly to allocate the available space to pedestrians within the model, using the background files as a guide. Where assumptions have been made on any changes to the space made available to pedestrians, these should be justified by on street observations and documented in the Calibration Report (**P.201**);
    - Small Areas should be created to represent the location of each pedestrian input. Pedestrians can be generated anywhere within an Area, therefore the DE should create specific 'entry Areas' to be more representative of on street conditions to within the model;
    - Obstacles should be used to represent space within an Area that is inaccessible to pedestrians. Items such as lamp posts, traffic signals, bollards, electrical junction boxes, and guard railing should be included;
    - Links should be used to represent the accessible space for pedestrians to cross roads. These must have the 'Is pedestrian area' check box activated to be used by pedestrians; and
    - Where the pedestrian model is split over multiple levels, checks should be carried out to ensure the level has been allocated correctly to each area and stairs or ramps have been used to connect areas on different levels. Obstacles and pedestrian links should also be assigned to correct level.

P.208 Pedestrian Movement

The DE should incorporate the following into the calibrated pedestrian submission, which will be verified by the MAE:

- Strive to ensure that pedestrian entities are routed via a final destination wherever possible;

- Modeller intervention should be kept to a minimum. Pedestrian entities should use the shortest path available, instead of being manually re-routed to reduce congestion and allow the model to run more smoothly;

- Where signalised or non-signalised crossings are present, the modeller should make appropriate choices on which pedestrians use the crossings based on their final destination. These route choices should present intuitive movements, with any counter-intuitive movements explained and documented. Counter-intuitive movements could form part of a validation process, or an attempt to replicate observed behaviour;

- Ensure that pedestrian movements have been calibrated against given survey data;
- Ensure that pedestrian entities do not get 'stuck' in the model unless unavoidable due to the sheer volume of entities passing through a limited space. The modeller should ensure that pedestrian-accessible space and any routings used do not prevent an intuitive pedestrian flow; and
- For LEGION models, the DE should submit a .res output, which is indicative of a usual simulation run from the model (***.lgm**) file to verify model stability.

P.209 Model Errors / Warnings

Errors and warning messages should be reviewed and corrected during the calibration process, but it is understood that it is not necessarily possible to achieve best practice modelling, without some warning messages appearing within the modelling. It is recommended that a brief explanation of any error or warning messages present in the modelling is provided as part of the Calibration Report (**P.201**).

P.210 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **P.201** – **P.209**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the PMAP Stage 2 Check Sheet (**MQA-0544/P2/L** or **MQA-0544/P2/V**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **P.201** – **P.209**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should

be seen as constructive, to increase the likelihood of model approval following resubmission.

7.2.4 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks P.201 – P.210 and there are no other issues the MAE will approve the model and authorise the relevant PMAP Stage 2 Check Sheet (**MQA-0544/P2/L** or **MQA-0544/P2/V**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed AMAP Stage 2 Check Sheets (**MQA-0544/P2/L** or **MQA-0544/P2/V**), which should be copied to NMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of PMAP Stage 2

PMAP STAGE 3

7.3 PMAP Stage 3, Pedestrian Validated Base Model Submission

7.3.1 What is a Pedestrian Validated Base model?

A Pedestrian Validated Base model should demonstrate that outputs have been validated against survey data that is independent of data used for model calibration. The method and result of validation should be documented.

> Validated Base models are required for all time periods in PMAP Stage 3.

The overarching purpose of producing a Validated Base model is to provide evidence that it is reflective of a real-life situation. This then gives confidence to stakeholders and relevant parties that the modelling can be trusted to inform any decision-making process. A Validated Base model becomes the basis on which to build the Future Base and Proposed models, by providing consistent modelling methods to assess hypothetical scenarios.

It is suggested that surveys are designed with validation in mind, so that in addition to providing sufficient OD data, there are counts that can be used to independently verify model outputs.

It is helpful to carry out some visual validation by comparing simulation with observed movement through area knowledge, site observations or video, but in general this should be in support of a more exact approach of comparing outputs.

The **Traffic Modelling Guidelines** provide guidance to support pedestrian model validation, including the demonstration of model stability. For LEGION models, it is recommended that the DE submits an output (***.res**) file, which is indicative of a usual simulation run from the model (***.lgm**) file. It is also recommended that the MAE produces their own output (***.res**) file to verify that the submission aligns with a usual simulation output. For Viswalk models, validation should be conducted using a minimum of five seed values, or twenty seeds when modelling traffic through VMAP, and results presented as a mean average of all simulation runs. The seed values used should be detailed in the Validation Report using a common seed increment.

A Validated Base model should demonstrate a good correlation between observed survey data and modelled outputs. This should include pedestrian entity counts, OD matrices, and may include journey time outputs where applicable.

7.3.2 PMAP Stage 3 Check Sheet

PMAP Stage 3 has a Check Sheet (**MQA-0544/P3/L** or **MQA-0544/P3/V**), which must be completed by the MAE when auditing the models.

> A separate PMAP Stage 3 Check Sheet must be completed for all time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

P.301 Validation Report

Validated Base model submissions must be accompanied by a Validation Report.

The DE should ensure that the following information is provided:

- When the surveys took place and who undertook them;
- What data was collected during the pedestrian surveys;
- Evidence of validation, including comparison between survey data and model outputs;
- Evidence of model stability, including details of ***.res** file or random seeds used; and
- General pedestrian flow observations.

The Validation Report should contain a list of all changes made to the approved PMAP Stage 2 Calibrated Base model, with justification for any revisions, alongside validation support data aligned to the PMAP Stage 3 Check Sheet.

P.302 Adjustments from Stage 2 Model

Where changes have been made, these should be detailed in the Validation Report as described in **P.301** Most importantly this should include the methodology of how entity routing may have been amended to achieve Validated Base model outputs. The DE and MAE should ensure that any changes are both appropriate and reasonable.

P.303 Model Errors / Warnings

Errors and warning messages should have been corrected during the calibration process, but it is understood that it is not necessarily possible to achieve best practice modelling, without some warning messages appearing within the modelling. It is recommended that a brief explanation of any warning messages present in the modelling is provided as part of the Validation Report (**P.301**).

P.304 Pedestrian Entity Count Comparison

The Validation Report (**P.301**), should contain evidence of a comparison between observed pedestrian flows and crossing counts from survey data, against modelled pedestrian flows and crossing counts. A good example for street-level modelling is the comparison of pedestrian entity counts at crossings which are independent of the pedestrian entity counts used for model entity entrance points.

> The DE should ensure that these comparisons closely match, and ideally fall within a range of difference of no more than 20%.

P.305 Origin-Destination Matrix Comparison

A Validated Base model should demonstrate that the OD matrix imported into the model, closely corresponds with an exported OD matrix from the model output. In LEGION this can be found in the simulation file, in Viswalk using the Pedestrian Travel Times (OD Data). It is understood that some pedestrian entities may remain in the model as a result of not completing their journey within the simulation time; this discrepancy should be verified by extracting a count of pedestrian entities that remain in the model at the end of the simulation, and including it in the input-output comparison.

The DE should ensure that these comparisons closely match, and ideally fall within a range of difference of no more than 2%.

P.306 Journey Time Comparison

While journey or walk time comparison is not considered essential to the validation process, it can be considered useful in support of pedestrian flow comparison.

Modelled journey times should be within 15% of observed journey times. Journey time output should be measured for pedestrians originating from the start of the route, and be presented as the cumulative journey time for a common particular route. It may also be necessary to restrict journey time measurements from the model to the same pedestrian type that the site measurements were based on, such as commuter type with no restricted mobility.

P.307 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **P.301** – **P.306**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the PMAP Stage 3 Check Sheet (**MQA-0544/P3/L** or **MQA-0544/P3/V**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **P.301** – **P.306**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

7.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **P.301 - P.307** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant PMAP Stage 3 Check Sheet (**MQA-0544/P3/L** or **MQA-0544/P3/V**).

If the MAE fails the model on any of the checks **P.301 - P.307**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the PMAP submission and provide completed PMAP Stage 3 Check Sheets (**MQA-0544/P3/L** or **MQA-0544/P3/V**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of PMAP Stage 3

PMAP STAGE 5a

7.4 PMAP Stage 5a, Pedestrian Future Base Model Submission

7.4.1 Introduction

Most of the model-building - both in terms of creating and auditing pedestrian models is completed during the previous stages of MAP when generating fit-for-purpose Base models. Once a PMAP Stage 3 model has been accepted by the MAE there will often be a relatively small amount of work required to complete PMAP.

Future Base models are required for all time periods in PMAP Stage 5a.

The Pedestrian Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing against the Base model results alone.

The model data parameters that should be re-evaluated as part of building Future Base models are:

- Pedestrian demand;
- Bus routes and frequencies, including any changes to bus stops ; and
- Signal timings for all pedestrian crossings.

The MAE will use their knowledge and experience of the area to make informed comments and decisions, and should respond to address any highlighted issues.

7.4.2 PMAP Stage 5a Check Sheet

PMAP Stage 5a has a Check Sheet (**MQA-0544/P5a/L** or **MQA-0544/P5a/V**), which must be completed by the MAE when auditing the models.

A separate PMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

P.501 Future Base Report

Future Base submissions must be accompanied by a written report, containing all the necessary information to allow the accurate assessment of criteria **P.502** – **P.509**.

All assumptions and changes to the MAP Stage 3 approved pedestrian models should be clearly stated along with the reasoning behind those changes. The DE should identify all critical areas, including those areas which experience high pedestrian flows or levels of crowding, or are directly affected by the proposals.

P.502 Pedestrian-Accessible Space Changes

There may be the requirement to adjust the pedestrian-accessible space to represent the Future Base scenario. When layout changes exist between the MAP approved Base model and the Future Base model, the DE should follow the guidance in **P.207** and document the changes in the Future Base Report (**P.501**).

For LEGION models, changes to areas that are inaccessible to pedestrians can be ignored for the sake of simplification. However, any changes to pedestrian-accessible space including footways and pedestrian crossings, should be highlighted.

The DE will need to ensure that any changes that form part of the proposals must remain unchanged when producing Future Base models.

All pedestrian movements, walk speeds and route choices must remain consistent with those passed during PMAP Stage 3, and any inconsistencies should be checked by the MAE.

P.503 Model Objects Changes

There may be the requirement to make minor changes to Objects in the Future Base model, such as relocation and adjustments to shape, as a result of any Future Base schemes within the model area. Any modifications to Objects, should be detailed in the Future Base Report (**P.501**).

Any inclusion of additional Objects within the Future Base models should be detailed by the DE, particularly regarding any variation of how entities are routed from their origin to destinations.

P.504 Pedestrian Demand Changes

The DE should provide updated OD matrices or pedestrian inputs for the Future Base models that utilise the same approach and methodology used in PMAP Stages 2 and 3, but have been amended to reflect the agreed Future Year.

Commentary should be provided in the Future Base Report (**P.501**) explaining the pedestrian demand changes and how they align with the growth rate or otherwise between the Base year and future year.

P.505 Public Transport Changes

The DE should ensure that changes to public transport elements between the Base year and the future year are reflected in the Future Base models and detailed in the Future Base Report (**P.501**).

- Bus routes;
- Bus frequencies;
- Bus boarding and alighting profiles;
- Location and size of bus stops and associated street furniture.

For LEGION models, it is expected that changes to the models brought about by the new bus frequencies, are accompanied by updated LDT files and shared alongside the Future Base model submission.

For Viswalk pedestrian models, amendments to bus frequencies will be included as part of the VMAP (see **V.506**).

Should changes to the location or size of bus stops be required in the Future Base models, the DE should ensure that these are carried out according to P.503. Where amendments have been made to bus stops, the behaviours of entities waiting at and passing bus stops should be checked.

P.506 Signal Timing Changes

Where amendments are made to the signal timings at signalised pedestrian crossings, the DE has a responsibility to incorporate the following into the Future Base model submission, which will be verified by the MAE:

- Cycle times;
- Start of green times; and
- Green durations.

Any changes to the signal timings within the Future Base Pedestrian models should be documented in the Future Base Report (P.501). It is also expected that new signal timings will be taken from an approved MAP Stage 5a LinSig or TRANSYT model submission.

Some pedestrian crossings may be demand-dependent or have variable cycle and stage times. Where this is the case, an alternative methodology to the standard fixed-time approach can be taken, which should replicate the on-street timings as well as possible.

Where signal timing changes are required for Future Base LEGION models, the updated LDT files should be included in the Future Base model submission.

For Viswalk pedestrian models, amendments to signal timings will be included as part of the VMAP (V.504). The MAE should verify that any signal heads and associated detectors are placed accurately on Pedestrian Links, see P.207, in the correct direction of travel.

P.507 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks P.502 – P.506, concerning specific changes to the following areas that should be detailed in the Future Base Report (P.501):

- Pedestrian-accessible space changes;
- Model Object changes;
- Pedestrian demand changes;

- Public Transport changes; and
- Traffic signal timing changes.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved PMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and justify why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

P.508 Model Errors / Warnings

Errors and warning messages should be reviewed and corrected, but it is understood that it is not necessarily possible to achieve best practice modelling, without some warning messages appearing within the modelling. It is recommended that a brief explanation of any error or warning messages present in the modelling is provided as part of the Future Base Report (**P.501**).

P.509 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **P.501** – **P.508**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the PMAP Stage 5a Check Sheet (**MQA-0544/P5a/L** or **MQA-0544/P5a/V**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **P.501** – **P.508**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should

be seen as constructive, to increase the likelihood of model approval following resubmission.

7.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **P.501** – **P.509** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant PMAP Stage 5a Check Sheet (**MQA-0544/P5a/L** or **MQA-0544/P5a/V**).

If the MAE fails the model on any of the checks **P.501** – **P.509**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the PMAP submission and provide completed AMAP Stage 5a Check Sheets (**MQA-0544/P5a/L** or **MQA-0544/P5a/V**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of PMAP Stage 5a

PMAP STAGE 5b

7.5 PMAP Stage 5b, Pedestrian Proposed Model Submission

7.5.1 Introduction

Proposed models should be based on the approved Future Base PMAP Stage 5a models. The DE should save a copy of the approved Future Base PMAP models, and apply the changes required to represent the scheme proposals. The approach and methodology to pedestrian movement should be consistent with the previous stages of PMAP.

Proposed models are required for all time periods in PMAP Stage 5b.

There are likely to be three main changes between the Future Base and Proposed models, which should be detailed by the DE:

- Layout changes; in which case the footways, crossings and all pedestrian-accessible space will need to be changed to reflect the proposals;
- Signal timings may have been changed as part of the proposed option. These changes would normally be represented in an accompanying LinSig or TRANSYT model; and
- Changes to bus services. If modelling includes bus movements or other forms of public transport in scope, then frequencies will need to be amended in line with the Future Year being modelled. If bus stops are relocated as part of the proposals, then consideration of which routes are serving which stops should also be included and incorporate any planned changes as necessary.

In addition to ensuring that the model is correctly developed from a technical point of view, the DE should demonstrate that the proposals can be accommodated without sacrificing acceptable levels of pedestrian flow. There must be some interpretation of the proposed changes, using heat maps or other outputs, with commentary provided alongside an assessment of quantifiable outputs such as crowding levels of service and journey times.

The MAE will use their knowledge and experience of the area to make informed comments and decisions, and should respond to address any highlighted issues. The MAE must highlight any apparent issues or concerns with the proposals. These issues are likely to be in respect of safe, efficient pedestrian movement within the network and current policy / guidelines.

The DE will receive feedback from the MAE and will need to address any issues highlighted.

7.5.2 PMAP Stage 5b Check Sheet

PMAP Stage 5b has a Check Sheet (**MQA-0544/P5b/L** or **MQA-0544/P5b/V**), which must be completed by the MAE when auditing the models.

> A separate PMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

P.551 SAE-Approved Proposed Methods of Control

Before commencing the audit of any Proposed models which involve any new or modified signalised infrastructure, the DE and MAE must ensure that the proposed design has been approved by the SAE and documented on the Traffic Signal Option Selection Review form (**F7356**). This review identifies issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings.

The review is arranged as part of the supporting LMAP, TMAP or VMAP Stage 5b.

> Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from completing PMAP Stage 5b.

P.552 Proposed Model Report

Proposed model submissions must be accompanied by a written report, containing all the necessary information to allow the accurate assessment of criteria **P.553** - **P.562**.

As per the Validated Model Report in PMAP Stage 3 and Future Base Report in PMAP Stage 5a, all assumptions and changes to the models should be clearly stated along with the reasoning behind those changes.

There should be clear comparisons between the results of the Future Base models and the Proposed models for the corresponding periods. The DE should identify all critical areas, including those which experience high pedestrian flows or levels of crowding, or are directly affected by the proposals.

P.553 Pedestrian-Accessible Space Changes

The scheme proposals are likely to require amendments to the pedestrian-accessible space. The changes to pedestrian-accessible space should follow the guidance in **P.207**, and should be documented in the Proposed Model Report (**P.552**)

Proposed LEGION models will require proposed CAD files to be uploaded as the DE is likely to need to amend or input new objects.

For Viswalk models, changes to the road network would be incorporated into VMAP (**V.554**).

All pedestrian movements, walk speeds and route choices must remain consistent with those passed during PMAP Stage 3 and Stage 5a, and any inconsistencies should be checked by the MAE.

P.554 Changes to Model Objects

While the process of model-building for the Proposed models is not as demanding as model-building for the Base models, it is not expected that the DE will simply be able to transfer all objects directly from the Future Base models into the Proposed models. The MAE should expect minor changes to Objects - such as relocation and adjustments to shape - required by the changes to layout between the Future Base models and the Proposed models. More significant modifications regarding the use of Objects, should be detailed in the Proposed Model Report (**P.552**).

The DE should continually aim to make Proposed models as similar as possible to Future Base models in their approach and methodology. Any inclusion of additional Objects within the Proposed models should be detailed by the DE, particularly regarding any variation of how entities are routed from their origin to destinations. The MAE should be able to quickly understand the use of Objects in the Proposed models from their understanding of the Future Base models, and any use of Objects that is not intuitive must be detailed by the DE in the Proposed Model Report (**P.552**).

P.555 Public Transport Changes

The DE should ensure that any changes to public transport elements in the proposals are reflected in the Proposed models and detailed in the Proposed Model Report (**P.552**).

For LEGION models, it is expected that changes to the models brought about by the new bus frequencies, are accompanied by updated LEGION Data Template files and shared alongside the Proposed model submission.

For Viswalk pedestrian models, amendments to bus frequencies will be included as part of the VMAP (**V.557**).

Should changes to the location or size of bus stops be required in the Proposed models, the DE should ensure that these are carried out according to **P.553** and **P.554**. Where amendments have been made to bus stops, the behaviours of entities waiting at and passing bus stops should be checked.

P.556 Signal Timing Changes

It is expected that changes to the layout between the Future Base models and the Proposed models will require new signal timings where signalised crossings are modelled. It is typically expected that new signal timings will be taken from an approved MAP Stage 5b LinSig or TRANSYT model which should be included with the pedestrian Proposed model submission.

As per the Base and Future Base modelling, the DE has a responsibility to incorporate the following into the Proposed Pedestrian model submission, which will be verified by the MAE:

- Cycle times;
- Start of green times; and
- Green durations.

Some pedestrian crossings may be demand-dependent or have variable cycle and stage times. Where this is the case, an alternative methodology to the standard fixed-time approach can be taken, which should be replicate the on-street timings as well as possible.

Any changes to the signal timings within the Proposed Pedestrian models should be documented in the Proposed Model Report (**P.502**)

Where signal timing changes are required for Proposed LEGION models, the updated LEGION Data Template files should be included in the Proposed model submission.

For Viswalk pedestrian models, amendments to signal timings will be included as part of the VMAP (**V.555**). The MAE should verify that any signal heads and associated detectors are placed accurately on Pedestrian Links, see (**P.207**), in the correct direction of travel.

P.557 Flow Consistency Check

Pedestrian flows and movements modelled in the Proposed models should maintain a consistent approach with those modelled in the Future Base models. While some change to pedestrian routing is likely due to the differences in layout between the Future Base and Proposed models, changes made should be intuitive to the MAE and any counter-intuitive movements documented in the Proposed Model Report (**P.552**).

P.558 Other Adjustments from Stage 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **P.553** – **P.557**, concerning specific changes to the following areas resulting from the proposed scheme that should be detailed in the Proposed Model Report (**P.552**):

- Pedestrian-accessible space changes;
- Model Object changes;

- Pedestrian demand changes;
- Public Transport changes; and
- Traffic signal timing changes.

Any other software settings (including the software version) or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved PMAP Stage 5a model.

The DE should highlight any other model changes that have been made to the MAE and justify why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

P.559 Model Errors / Warnings

Errors and warning messages should be reviewed and corrected, but it is understood that it is not necessarily possible to achieve best practice modelling, without some warning messages appearing within the modelling. It is recommended that a brief explanation of any error or warning messages present in the modelling is provided as part of the Proposed Model Report (**P.552**).

P.560 Journey Times

The layout changes brought about within the Proposed models bring material changes that could impact pedestrian walk times. These include:

- changes to the distance between a pedestrian's origin and destination;
- a change to the congestion experienced when walking caused by variance in crowding; or
- a change to pedestrian delay at signalised or non-signalised crossings.

The Proposed Model Report (**P.552**) should contain a comparison of Future Base model and Proposed model journey times, with some commentary regarding the implications of these times upon the pedestrian experience in the local environment. If the pedestrian modelling indicates a negative impact on pedestrian journey times, this should be investigated and discussed by the DE and MAE.

The MAE should report the overall network impact of a proposal in the SIR. The MAE will cite reported changes in saturation flow, degree of saturation, queue lengths, and journey times as justification for any assessment of network impact.

P.561 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see **A2.1**) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

P.562 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **P.551** – **P.561**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the PMAP Stage 5b Check Sheet (**MQA-0544/P5b/L** or **MQA-0544/P5b/V**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **P.551** – **P.561**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

7.5.3 Acceptance / Rejection of the Model

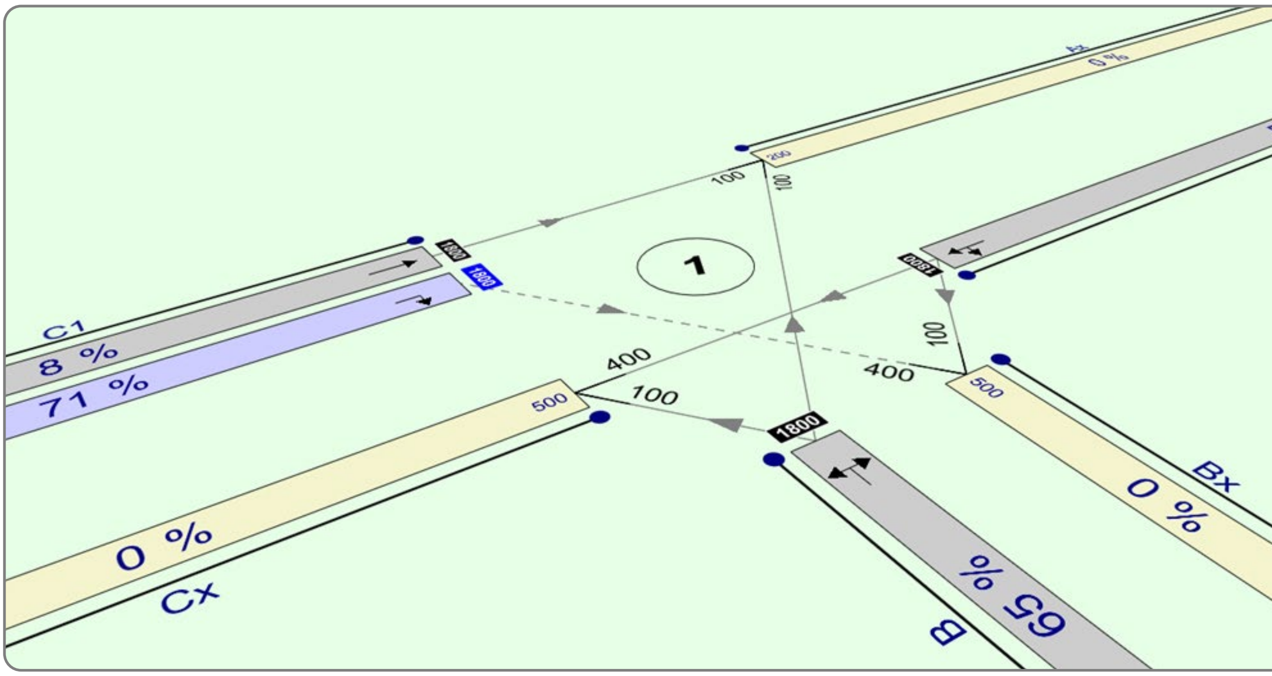
If the MAE passes the model on all of the checks **P.551** – **P.562** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the PMAP Stage 5b Check Sheet (**MQA-0544/P5b/L** or **MQA-0544/P5b/V**).

If the MAE fails the model on any of the checks **P.551** – **P.562**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the PMAP submission and provide completed PMAP Stage 5b Check Sheets (**MQA-0544/P5b/L** or **MQA-0544/P5b/V**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of PMAP Stage 5b

8 TRANSYT MAP (TMAP)



8.1 Scope

TMAP applies to all TRANSYT modelling submitted to TfL Operations for auditing.

TMAP STAGE 2

8.2 TMAP Stage 2, TRANSYT Calibrated Base Model Submission

8.2.1 What is a TRANSYT Calibrated Base Model?

A TRANSYT Calibrated Base model should contain:

- all the signal control data with representative signal timings for the network during the period under consideration, without adjustments to account for the non-appearance of demand-dependent stages; and
- the appropriate link structure, measured cruise times, measured saturation flows, traffic flows and measured link lengths. Traffic

flows should also be included to allow TRANSYT to produce output data; however these will not be checked until TMAP Stage 3.

A single TRANSYT Calibrated Base model is required for TMAP Stage 2.

8.2.2 What is the purpose of a Calibrated TRANSYT Model?

Experience has shown that the submission of one model early in the modelling exercise is a very useful starting point for both the DE and the MAE, and will improve the standard of subsequent model submissions.

The Calibrated Base model submission will provide the DE with an opportunity to demonstrate to the MAE that they have fully understood the UTC data they have been provided with, and have collected relevant knowledge of the network. This is particularly relevant if the MAE has not received any modelling from the DE previously. The initial model submission will ensure that the signal data is correct.

8.2.3 Tasks before looking at the TMAP Stage 2 Check Sheet

- The DE should obtain TfL Signal Timing sheets and Controller Specifications from TfL[20] for all the nodes in the network, as described in Part B of the **Traffic Modelling Guidelines**. TfL Signal Timing Sheets should be checked against relevant Controller Specifications for accuracy. These two documents need to be consistent, the only acceptable differences are those changed directly within the memory of the on-street controller, such as phase delays. These should be listed in the 'Historical Amendments' section at the end of the TfL Signal Timing Sheet. If the TfL Signal Timing Sheet is not consistent with method of control on street, the MAE should detail the changes for the Data and Inspections team in TfL and ask for the TfL Signal Timing Sheet to be up issued.
- The DE should obtain a copy of each of the UTC timing plans from the MAE for all the nodes in the Network for all modelled periods.
- It is recommended that the DE builds a LinSig Skeleton model for each of the junctions included in the Calibrated TRANSYT model to allow for convenient checking of the phase-stage relationship. A

20 TfL Signal Timing Sheets and Controller Specifications can be requested from **AssetOperationsDataLegalRequest@tfl.gov.uk**

LinSig Skeleton model allows the DE and MAE to easily check and confirm correct representation of phases, phase minimums, stages, stage minimums, the stage sequence, intergreens and phase delays against up to date TfL Signal Timing Sheets. If the DE does not provide a LinSig Skeleton model the MAE may ask for one to be provided for auditing or build their own.

- A LinSig Skeleton model does not need to include traffic flows (traffic flows will be included in TRANSYT) and will effectively be a 'control-data-only' model. The stage sequence should be based on the current UTC timing plans, and the cycle time should be reduced within LinSig to the minimum cycle time. It is good practice to name the filename using the UTC junction number and the issue number of the TfL Signal Timing Sheet used, such as '02055_tsheet_iss10.lsgx'.
- There is a 'Junction Information' section in LinSig (accessed from the 'Junction' menu) which the DE is encouraged to complete with the junction location, controller data source (including TfL Signal Timing Sheet / Controller Specification issue number) and purpose of the LinSig model (such as Skeleton model for auditing purposes).
- Since TRANSYT uses 'links' to represent the different traffic streams it is more complicated for both the DE and the MAE to ensure that minimum green and interstage times are correct when using TRANSYT alone. The software package TranEd has a function which allows phase / link intergreen conversion. It is recommended that this is used, however it does not negate the usefulness of LinSig as a tool and it is therefore recommended that the DE uses both. In cases where there are parallel stream stages in separate nodes only LinSig allows the correct representation of the phase-stage relationship. For proposed junction designs it will be necessary to produce LinSig models, therefore providing more reason to generate LinSig models at the beginning of a project.
- It is important that, in developing LinSig Skeleton models, phase minimums are treated as 'controller minimums' rather than 'street minimums'.
- The MAE should audit the interstage durations and stage minimums in the Skeleton model against the UTC System. If there are discrepancies, the MAE should investigate. In cases where data does not correlate but the reason is not obvious, the MAE may require a second opinion from a more experienced colleague as there can be UTC-specific explanations.

8.2.4 TMAP Stage 2 Check Sheet

TMAP Stage 2 has a Check Sheet (**MQA-0544/T2**), which must be completed by the MAE when auditing the model.

This section identifies the audit checks that the MAE is required carry out, corresponding to the individual numbered entries on the Check Sheet.

Where examples are given for illustrative purposes, TRANSYT 12 examples are taken from the output (***.prt**) file and TRANSYT 13 examples are from the Report Builder:

T.201 Calibration Report

The DE is required to submit a Calibration Report with the Calibrated Base model which describes the network being modelled and the various input data used, as described in Part B of the **Traffic Modelling Guidelines**. The Calibration Report provides the opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a 'tick box' requirement. It is a technical document and it should be specific to the model it accompanies.

The Calibration Report should contain:

- The stated Purpose of the model as agreed with MAE during MAP Stage 1 and defined in the Modelling Expectations Document (MED);
- A list of all the TfL-referenced nodes in the network with addresses as agreed within MAP Stage 1;
- Clear notes on all site observations, covering both the physical constraints of the network and vehicle behaviour. Where the behaviour is specific to a time of day, this should be noted. It is important to clearly explain how these factors have determined the structure of the model;
- Site datasheets with measured saturation flows;
- Table of Saturation Flows for each link in the network. The table should indicate clearly whether the value has been measured on-site or has been calculated using RR67. Where RR67 has been applied an explanation should be provided as to which site conditions prevented measurement;
- Site datasheets with measured cruise times; and

- The derivation of the signal timings. In the case of Fixed Time junctions the UTC signal plans should be included. For SCOOT junctions, average representative timings should be calculated from M16, M18 and M37 messages.

T.202 Software and Network Data

The software version should be as agreed at MAP Stage 1 and documented in the MED.

Within TRANSYT 12 (T12) or earlier Network Data will be audited via information contained within the data input section of the ***.prt** file (see **Figure 18**). The same data will be audited within TRANSYT 13 (T13) via the Report Builder but, in addition, the DE must ensure that the Traffic Model is set to PDM (Platoon Dispersion Model) with the Cruise Scaling Factor set to 100% (see **Figure 19**). TfL does not currently accept TRANSYT modelling using the Cell Transmission Model (CTM).

For both T12 and T13 the DE and MAE need to ensure that the following are specified correctly:

- **Cycle Time:** matches an agreed on street value for the modelled period;
- **Number of steps per cycle:** the same as the Cycle Time up to 64s cycle and half the Cycle Time thereafter;
- **Time Period:** 60 minutes;
- **Effective Green Displacements:** Start = 2s, End = 3s;
- **Equisat:** 0;
- **Equal Cycle:** 1;
- **Flow Scale:** 100%;
- **Cruise Speeds Card 32:** zero (Times);
- **Optimise:** zero as Base models should not be optimised;
- **Delay Value:** 1420 pence per PCU-hour (T12) or £14.20 per PCU-hour (T13)
- **Stop Value per 100 stops:** 260 pence (T12) or £2.60 (T13);
- **List of Nodes to be optimised:** should be empty for a Base model, however TranEd requires a single node.

```
         DATA INPUT :-
CARD   CARD
 NO.  TYPE
(  1)= TITLE:-
CARD   CARD   CYCLE  NO. OF   TIME EFFECTIVE-GREEN  EQUISAT 0=UNEQUAL FLOW   CRUISE-SPEEDS   OPTIMISE  EXTRA  HILL-   DELAY   STOP
 NO.  TYPE   TIME    STEPS  PERIOD DISPLACEMENTS  SETTINGS  CYCLE    SCALE   SCALE  CARD32   0=NONE   COPIES  CLIMB   VALUE   VALUE
                       PER   1-1200  START    END      0=NO  1=EQUAL  10-200  50-200 0=TIMES  1=O/SET   FINAL  OUTPUT   P PER   P PER
             (SEC)   CYCLE   MINS. (SEC)   (SEC)    1=YES  CYCLE      %       %   1=SPEEDS 2=FULL   OUTPUT  1=FULL  PCU-H    100
  2)=   1      80      40      60      2       3       0       1      100       0       0       0       0       0     1420    260
CARD   CARD                                       LIST  OF  NODES  TO  BE  OPTIMISED
 NO.  TYPE
  3)=   2      0      0      0      0      0      0       0       0       0       0       0       0       0       0       0
```

Figure 18: TRANSYT 12 Card Type 1 and 2 data within the *.prt file

Network Options

Network Timings

Network Cycle Time (s)	Lock Number Of Steps	Number Of Steps	Time Segment Length (min)	Number Of Time Segments	Modelled Time Period (min)
96		48	60	1	60

Signals Options

Use EQUISAT	Optimisation Level	Hill Climb Increments	OUTProfile Accuracy	Use Enhanced Optimisation	Signals Representation Mode	Equal Length Multiple Cycling	Start Displacement (s)	End Displacement (s)
	None				TRANSYT13 Mode	Yes	2	3

Traffic Options

Traffic Model	Generate CTM Cell Data	DOS Threshold (%)	Flow Scaling Factor (%)	Cruise Scaling Factor (%)	Cruise Times Or Speeds	Use Link Stop Weightings	Use Link Delay Weightings	Exclude Pedestrian Links	Random Delay Mode
PDM		90	100	100	Cruise Times	Yes	Yes	Yes	Simplified (TRANSYT 12)

Economics

Unit Of Cost	Monetary Value Of Delay (£ per PCU-hr)	Monetary Value Of Stops (£ per 100 stops)
£	14.20	2.60

Node Optimisation Order

Node Optimisation Order

Node Order

Figure 19: TRANSYT 13 Network Options information within Report

T.203 Stage Minimums

The DE should ensure that the stage minimum is correctly represented as determined by the phase minimums running in the stage. The most transparent method for calculating the stage minimums for any junction is to use a LinSig Skeleton model as described in **B8.2.3**.

The TRANSYT 'Card Type' which corresponds to the stage minimum is Card Type 10. For TRANSYT 12 the Card Type 10 values can be seen in the ***.prt** file, while for TRANSYT 13 they can be seen in the Stages data table within Report Builder.

Before submitting the Calibrated Base model during TMAP Stage 2, the DE should compare the minimum stage times for each TRANSYT node to the LinSig calculated stage minimums to check that the TRANSYT model is correct. The MAE is required to relate the TfL Junction Reference Number to the TRANSYT Node Number and verify that, for the Minimum Stage Sequence in each LinSig Skeleton model, the minimum stage times are correct. At this MAP stage these should all be correct. Special attention should be paid to ensure that stage minimums are derived from LinSig Skeleton models and fixed to ensure that TRANSYT cannot compromise 'controller minimums' during later stages of MAP. Where TranEd has been used to create TRANSYT 12 or earlier models these fixed stage minimums will need to be explicitly defined by the DE.

Figure 20 highlights where minimum stage durations are presented within the TRANSYT 12 or earlier output (*.prt) file. Within TRANSYT 13 the Stages table in the Report Builder contains information labelled Stage Minimum (see **Figure 21**). Note that the Stage Index does not necessarily correspond to the actual on-street stage number and may alter between TRANSYT 13 simulations, so the Display ID column should be used during audit.

CARD NO.	CARD TYPE	NODE NO.	NODE CARDS: MINIMUM STAGE TIMES (WORKING) S1	S2	S3	S4	S5	S6	S7
27)=	10	13	10	11					
28)=	10	14	9	7	1				
29)=	10	15	7	8	5				
30)=	10	16	1	7	10	7			
31)=	10	17	7	5					
32)=	10	18	10	10					
33)=	10	19	7	5					
34)=	10	20	1	7	7				
35)=	10	21	4	7					
36)=	10	22	7	7					
37)=	10	25	7	10					
38)=	10	26	10	7					
39)=	10	27	7	10					
40)=	10	28	10	7					

Figure 20: TRANSYT 12 Card Type 10 data within the *.prt file

Stages

Node	Stage Index	Is Base Stage	Display ID	Links In This Stage	Stage Start (s)	Stage End (s)	User Stage Minimum (s)	Stage Minimum (s)	TRANSYT Stage Start (s)	TRANSYT Minimum Preceding Interstage (s)	TRANSYT Actual Preceding Interstage (s)	TRANSYT Stage Minimum (s
8	**1**	Yes	2	821,852,863,864	0	12	0	6	86	10	10	16
8	**2**	Yes	3	861,862,863,864,865	23	29	0	6	12	11	11	17
8	**3**	Yes	1	811,813,841,843,848	44	86	0	7	29	15	15	22
9	**1**		2	921,933	16	26	0	10	10	6	6	16
9	**2**	Yes	1	911,931	32	58	0	10	26	6	6	16
9	**3**	Yes	2	921,933	64	74	0	10	58	6	6	16
9	**4**		1	911,931	80	10	0	10	74	6	6	16

Figure 21: TRANSYT 13 Stages data table

T.204 Interstage Durations

The interstage duration will be determined by the phases present in the current and previous stages, and the corresponding phase intergreens. The DE should determine the correct interstage durations by creating LinSig Skeleton models.

The TRANSYT 'Card Type' which corresponds to the stage intergreen is Card Type 11. For TRANSYT 12 the Card Type 11 values can be seen in the ***.prt** file (see **Figure 22**), while for TRANSYT 13 they can be seen in the Stages data table listed as 'TRANSYT Actual Preceding Interstage'. Note that for TRANSYT 13 the Stage Index value may not necessarily match the stage number and could change between TRANSYT runs, so the Display ID should be used as the stage reference.

Before submitting the Calibrated Base model during TMAP Stage 2 it is suggested that the DE compares data to the LinSig calculated stage intergreens to check that the model is correct. The MAE needs to relate the TfL junction reference number to the TRANSYT node number and then verify that, for the minimum stage sequence in each LinSig Skeleton model, the preceding interstage times are correct. At this MAP stage these should all be correct.

NODE CARDS: PRECEDING INTERSTAGE TIMES (WORKING)

CARD NO.	CARD TYPE	NODE NO.	S1	S2	S3	S4	S5	S6	S7
41)=	11	13	8	6					
42)=	11	14	7	7	6				
43)=	11	15	8	8	7				
44)=	11	16	10	8	6	12			
45)=	11	17	14	7					
46)=	11	18	7	7					
47)=	11	19	10	6					
48)=	11	20	7	6	7				
49)=	11	21	6	9					
50)=	11	22	7	7					
51)=	11	25	11	6					
52)=	11	26	6	8					
53)=	11	27	11	5					
54)=	11	28	6	8					

Figure 22: TRANSYT 12 Card Type 11 data within the *.prt file

T.205 Stage Change Points

If the modelled network is running under Fixed Time UTC, the stage change points should directly correlate with the UTC plans. At this point, the TRANSYT Model should include the appearance of all demand-dependent stages. If the study network is running under SCOOT Control, the methodology used to derive the stage change points should be agreed with the MAE and documented in the DE's Technical Note.

A common method of modelling SCOOT Control in TRANSYT is by use of SCOOT stage duration messages (M16 and M37) together with offset messages (M18) recorded for a representative day, with no interventions to the weekly timetabled control. A DE or MAE with limited experience may require support from more experienced colleagues, such as the CE or a Principal Network Manager, in order to corroborate that the timings are correct.

When using stage duration messages it is important to note that SCOOT Stages are not always the same as UTC Stages. The DE and MAE should examine the SCOOT background plans to understand the SCOOT stage change points relative to the UTC Stage change points (which are modelled in TRANSYT).

For TRANSYT 12 or earlier, stage change points should be checked using the Card Type 12 data (see **Figure 23**).

For TRANSYT 13 stage change points are listed in the Stages data table under 'TRANSYT Stage Start' (see **Figure 21**). Note that the Stage Index does not necessarily match the stage number and could change between TRANSYT runs, so the Display ID column should be used as the stage reference.

NODE CARDS: STAGE CHANGE TIMES (WORKING)

CARD NO.	CARD TYPE	NODE NO.	Sgl/Dbl Cycled	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
38)=	12	8	1	29	86	12							
39)=	12	9	2	26	58								
40)=	12	87	1	51	13	28							
41)=	12	117	2	23	57								
42)=	12	225	1	64	52								
43)=	12	253	1	33	78	87	24						
44)=	12	346	2	32	65								

Figure 23: TRANSYT 12 Card Type 12 data within the *.prt file

T.206 Link Control Data

The link control data defines the following for each link in the network:

a. The stage in which the link's start of green occurs;
b. The number of seconds into that stage the start of green occurs;
c. The stage in which the link's end of green occurs; and
d. The number of seconds into the stage the end of green occurs.

As in previous sections, a LinSig Skeleton model should be used by the DE to verify that the correct link control information is correctly entered based on the link-phase relationships for every link in the network. This will be verified by the MAE and should be 100% correct at this stage of MAP.

For TRANSYT 12, these parameters can be seen within the ***.prt** file. The MAE should check the node that each link relates to (the fifth column in the Card Type 31 data, as shown in **Figure 24**). In the accompanying LinSig Skeleton model created for that node, the phase that is controlling the link should then be determined. Once the correct phase has been identified, a, b, c and d can be easily verified against columns four to eight within the Card Type 31 data.

In the example shown in **Figure 24**, links 119, 139, 179, 199 and 209 have zeros in columns 5, 6, 7 and 8. This is because they are shared links where the start stage, start lag, end stage and end lag are defined by the main link. Shared links are defined in the card type 7 part of the ***.prt** file, as shown in **Figure 25**. In this example link 20 is a major link that has a shared link 209, so link 209 uses the link control data for link 20 in card type 31.

It is good housekeeping for shared links to have zeros in the Card Type 31 data. However, any link control information will be ignored. Using the Card Type 31 example (**Figure 24**) link 259 is a shared link and will only use control information from link 25, despite having 1, 13, 2, 0 entered.

LINK CARDS: FIXED DATA

CARD	CARD	LINK	EXIT	FIRST GREEN				SECOND GREEN				LINK	STOP	SAT	DELAY	DISPSN
				START		END		START		END						
NO.	TYPE	NO.	NODE	STAGE	LAG	STAGE	LAG	STAGE	LAG	STAGE	LAG	LENGTH	WT.X100	FLOW	WT.X100	X100
40)=	31	10	1	3	12	1	9	0	0	0	0	44	0	1700	0	0
41)=	31	11	1	3	13	1	6	0	0	0	0	44	0	3500	0	0
42)=	31	13	1	2	13	3	5	0	0	0	0	200	0	1800	0	0
43)=	31	14	1	1	14	2	5	0	0	0	0	200	0	1940	0	0
44)=	31	15	1	1	14	2	5	0	0	0	0	200	0	3600	0	0
45)=	31	17	1	1	14	3	8	0	0	0	0	115	0	2200	0	0
46)=	31	19	1	2	13	3	5	0	0	0	0	95	0	3499	0	0
47)=	31	20	2	2	13	1	4	0	0	0	0	200	0	1850	0	0
48)=	31	21	2	2	13	3	2	0	0	0	0	140	0	1900	0	0
49)=	31	22	2	1	8	3	2	0	0	0	0	140	0	2000	0	0
50)=	31	23	2	3	8	1	0	0	0	0	0	107	0	1672	0	0
51)=	31	24	2	3	8	1	0	0	0	0	0	107	0	1672	0	0
52)=	31	25	2	1	9	2	7	0	0	0	0	86	0	3806	0	0
53)=	31	31	3	1	13	2	0	0	0	0	0	90	0	1915	0	0
54)=	31	32	3	1	13	2	0	0	0	0	0	90	0	1915	0	0
55)=	31	33	3	1	13	2	0	0	0	0	0	200	0	2000	0	0
56)=	31	34	3	1	13	2	0	0	0	0	0	200	0	1915	0	0
72)=	31	119	0	0	0	0	0	0	0	0	0	44	0	0	0	0
73)=	31	139	0	0	0	0	0	0	0	0	0	200	0	0	0	0
74)=	31	179	0	0	0	0	0	0	0	0	0	115	0	0	0	0
75)=	31	199	0	0	0	0	0	0	0	0	0	95	0	0	0	0
80)=	31	205	2	1	11	2	0	0	0	0	0	10	0	8000	0	0
81)=	31	209	0	0	0	0	0	0	0	0	0	200	0	0	0	0
82)=	31	219	0	0	0	0	0	0	0	0	0	140	0	0	0	0
83)=	31	229	0	0	0	0	0	0	0	0	0	140	0	0	0	0
84)=	31	259	0	1	13	2	0	0	0	0	0	86	0	0	0	0
85)=	31	429	0	0	0	0	0	0	0	0	0	200	0	0	0	0
86)=	31	619	0	0	0	0	0	0	0	0	0	40	0	0	0	0

Figure 24: TRANSYT 12 Card Type 31 data within the *.prt file

LINKS HAVING SHARED STOP LINES

CARD NO.	CARD TYPE	FIRST SET........................					SECOND SET.......................					THIRD SET.......................				
4)=	7	11	119	0	0	0	0	0	0	0	0	0	0	0	0	0
5)=	7	13	139	0	0	0	0	0	0	0	0	0	0	0	0	0
6)=	7	17	179	0	0	0	0	0	0	0	0	0	0	0	0	0
7)=	7	19	199	0	0	0	0	0	0	0	0	0	0	0	0	0
8)=	7	20	209	0	0	0	0	0	0	0	0	0	0	0	0	0
9)=	7	21	219	0	0	0	0	0	0	0	0	0	0	0	0	0
10)=	7	22	229	0	0	0	0	0	0	0	0	0	0	0	0	0
11)=	7	25	259	0	0	0	0	0	0	0	0	0	0	0	0	0
12)=	7	42	429	0	0	0	0	0	0	0	0	0	0	0	0	0
13)=	7	61	619	0	0	0	0	0	0	0	0	0	0	0	0	0
14)=	7	71	719	0	0	0	0	0	0	0	0	0	0	0	0	0
15)=	7	1997	1996	0	0	0	0	0	0	0	0	0	0	0	0	0
16)=	7	1999	1998	0	0	0	0	0	0	0	0	0	0	0	0	0
17)=	7	2999	3000	0	0	0	0	0	0	0	0	0	0	0	0	0
18)=	7	3999	3998	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 25: TRANSYT 12 Card Type 7 data within the *.prt file

The TRANSYT 13 equivalents to card type 31 parameters are:

e. TRANSYT Starting Stage;
f. TRANSYT Start Lag;
g. TRANSYT Ending Stage; and
h. TRANSYT End Lag.

These can be found in the Link Green Periods data table, as shown in **Figure 26**, while shared links are defined in the Links data table, shown in **Figure 27**.

At this stage of TMAP the columns for Relative Start and End Displacement should be zero. Within TRANSYT 13 the Starting and Ending Stages refer to the Stage Index, which does not necessarily match the stage number. The DE and MAE should refer to the Stages data table (see **Figure 21**) to verify the correct Stage Index using the Display ID as the stage reference, especially as the Stage Index can change between TRANSYT runs.

Link Green Periods

Link	Green Period	Is Base Green Period	Relative Start Displacement (s)	Relative End Displacement (s)	Start Time (s)	End Time (s)	TRANSYT Starting Stage (s)	TRANSYT Ending Stage (s)	TRANSYT Start Lag (s)	TRANSYT Minimum Start Lag (s)	TRANSYT End Lag (s)
811	**1**	Yes	0	0	44	90	3	1	15	15	4
813	**1**	Yes	0	0	37	90	3	1	8	8	4
821	**1**	Yes	0	0	95	12	1	2	9	9	0
841	**1**	Yes	0	0	44	86	3	1	15	15	0
843	**1**	Yes	0	0	44	86	3	1	15	15	0
848	**1**	Yes	0	0	44	86	3	1	15	15	0
852	**1**	Yes	0	0	95	12	1	2	9	9	0
861	**1**	Yes	0	0	23	29	2	3	11	11	0
862	**1**	Yes	0	0	22	29	2	3	10	10	0

Figure 26: TRANSYT 13 Link Green Periods data table

Links

Links

Link	ID	Name	Description	Saturation Flow (PCU/hr)	Length (m)	Link Control Type	Traffic Node	Signals Node	Separate Signals Node	Is Give Way Link	Is Pedestrian Link	Is Minor Shared Link	Major Link
811	811			3369	135.00	Signalised	8	(8)					
812	812			(3369)	135.00	(Signalised)	(8)	(8)				Yes	811
813	813			1617	125.00	Signalised	8	(8)					
814	814			(1617)	125.00	(Signalised)	(8)	(8)				Yes	813
821	821			1956	100.00	Signalised	8	(8)					
822	822			(1956)	200.00	(Signalised)	(8)	(8)				Yes	821
841	841			1964	95.00	Signalised	8	(8)					
842	842			(1964)	95.00	(Signalised)	(8)	(8)				Yes	841
843	843			1617	95.00	Signalised	8	(8)					

Figure 27: TRANSYT 13 Links data table

T.207 Cruise Times

The cruise time for a link in TRANSYT is defined as the average time for a free-flowing vehicle driving in a platoon to travel from the stopline of the upstream link to the stopline of the defined link. Cruise times should be recorded on site by the DE for every link as this is the only way to achieve the required level of accuracy. The **Traffic Modelling Guidelines** provide detailed guidance on how to measure cruise times but the method and approach used should be outlined in **T.201**.

Particular attention should be paid to the accuracy of cruise times in view of the fact that they are based on vehicle speeds which can vary significantly both from network to network and within a network.

The MAE may wish to discuss with the DE how auditing time is best utilised within **T.207**. If necessary the MAE can identify critical journey times which should be checked for accuracy on-site. Less critical cruise times should be checked to ensure they are at least reasonable based on expected vehicle speeds at individual sites.

For TRANSYT 12, link cruise time information can be found within the TRANSYT 12 ***.prt** file (see **Figure 28**). For TRANSYT 13, the equivalent data is split between two 'Link Sources' tables: one for entry links and one for internal links (see **Figure 29**).

LINK CARDS: FLOW DATA

CARD NO.	CARD TYPE	LINK NO.	TOTAL FLOW	UNIFORM FLOW	ENTRY 1 LINK NO.	ENTRY 1 FLOW	ENTRY 1 CRUISE TIME	ENTRY 2 LINK NO.	ENTRY 2 FLOW	ENTRY 2 CRUISE TIME	ENTRY 3 LINK NO.	ENTRY 3 FLOW	ENTRY 3 CRUISE TIME
114)=	32	811	624	0	8711	270	12	8741	355	12	0	0	0
115)=	32	812	120	0	8712	46	3200	8743	74	3200	0	0	0
116)=	32	813	134	0	8711	94	12	8741	40	12	0	0	0
117)=	32	814	28	0	8712	28	3200	0	0	0	0	0	0
118)=	32	821	296	0	0	0	18	0	0	0	0	0	0
119)=	32	822	64	0	0	0	3200	0	0	0	0	0	0
120)=	32	841	712	0	2535	712	7	0	0	0	0	0	0
121)=	32	842	122	0	2536	122	3200	0	0	0	0	0	0

Figure 28: TRANSYT 12 Card Type 32 data within the *.prt file

Link Sources - default sources for entry links

Link	Entry Source Type	Entry Cruise Time (seconds)	Entry Cruise Speed (kph)	Entry Free Running Speed (kph)	Entry Stationary Time (seconds)	Entry Profile Type	Entry DIRECTFlows (PCU/hr)
821	Normal	18.00	20.00	(N/A)	(N/A)	FLAT	296
822	Buses	(N/A)	(N/A)	32.00	0	FLAT	64
861	Normal	10.00	3.60	(N/A)	(N/A)	FLAT	10
862	Normal	10.00	3.60	(N/A)	(N/A)	FLAT	10

Link Sources - sources for internal links

Link	Source	Source Link	Source Type	Source Flow (PCU/hr)	Cruise Time (seconds)	Cruise Speed (kph)	Free Running Speed (kph)	Stationary Time (seconds)
811	**1**	8741	Normal	355	15.00	40.50	(N/A)	(N/A)
811	**2**	8711	Normal	270	12.00	40.50	(N/A)	(N/A)
812	**1**	8743	Buses	74	(N/A)	(N/A)	32.00	0
812	**2**	8712	Buses	46	(N/A)	(N/A)	32.00	0

Figure 29: TRANSYT 13 Link Sources data tables

T.208 Link Lengths

Link lengths should ideally be physically measured on site, or using up-to-date electronic mapping or aerial photography. The DE should detail the methodology used for link measurement within **T.201**.

The methodology used by the DE should determine the appropriate level of information required during auditing. Depending on availability, the MAE can, ideally, verify link lengths on site with a measuring wheel. Alternatively, the MAE can measure link lengths from available scaled drawings, or using electronic mapping. A practical compromise is to identify critical links and measure those on-site, and then measure non-critical links from available drawings / mapping. **Figure 30** details where this information can be found within the ***.prt** file for TRANSYT 12. The equivalent data for TRANSYT 13 can be found in the Report Builder Links table, as shown in **Figure 31**.

LINK CARDS: FIXED DATA

CARD NO.	CARD TYPE	LINK NO.	EXIT NODE	FIRST GREEN START STAGE	FIRST GREEN START LAG	FIRST GREEN END STAGE	FIRST GREEN END LAG	SECOND GREEN START STAGE	SECOND GREEN START LAG	SECOND GREEN END STAGE	SECOND GREEN END LAG	LINK LENGTH	STOP WT.X100	SAT FLOW	DELAY WT.X100	DISPSN X100
40)=	31	10	1	3	12	1	9	0	0	0	0	44	0	1700	0	0
41)=	31	11	1	3	13	1	6	0	0	0	0	44	0	3500	0	0
42)=	31	13	1	2	13	3	5	0	0	0	0	200	0	1800	0	0
43)=	31	14	1	1	14	2	5	0	0	0	0	200	0	1940	0	0
44)=	31	15	1	1	14	2	5	0	0	0	0	200	0	3600	0	0
45)=	31	17	1	1	14	3	8	0	0	0	0	115	0	2200	0	0
46)=	31	19	1	2	13	3	5	0	0	0	0	95	0	3499	0	0
47)=	31	20	2	2	13	1	4	0	0	0	0	200	0	1850	0	0
48)=	31	21	2	2	13	3	2	0	0	0	0	140	0	1900	0	0
49)=	31	22	2	1	8	3	2	0	0	0	0	140	0	2000	0	0
50)=	31	23	2	3	8	1	0	0	0	0	0	107	0	1672	0	0
51)=	31	24	2	3	8	1	0	0	0	0	0	107	0	1672	0	0
52)=	31	25	2	1	9	2	7	0	0	0	0	86	0	3806	0	0

Figure 30: TRANSYT 12 Card Type 31 Information

Links

Links

Link	ID	Name	Description	Saturation Flow (PCU/hr)	Length (m)	Link Control Type	Traffic Node	Signals Node	Separate Signals Node	Is Give Way Link	Is Pedestrian Link	Is Minor Shared Link	Major Link
811	811			3369	135.00	Signalised	8	(8)					
812	812			(3369)	135.00	(Signalised)	(8)	(8)				Yes	811
813	813			1617	125.00	Signalised	8	(8)					
814	814			(1617)	125.00	(Signalised)	(8)	(8)				Yes	813
821	821			1956	100.00	Signalised	8	(8)					
822	822			(1956)	200.00	(Signalised)	(8)	(8)				Yes	821
841	841			1964	95.00	Signalised	8	(8)					
842	842			(1964)	95.00	(Signalised)	(8)	(8)				Yes	841
843	843			1617	95.00	Signalised	8	(8)					

Figure 31: TRANSYT 13 Links data table

T.209 Saturation Flows

Saturation flows are fundamental to the integrity of a TRANSYT Model. If modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies which may cause problems during later stages of MAP.

Saturation flows should be measured on-site by the DE for all links where possible. If this is not possible, an explanation should be given in the DE's technical note (**T.201**). Where saturation flows have been derived, TRL RR67[21] should be used and the calculations recorded. It may also be acceptable to use default saturation flows (1800pcuh^{-1} per lane) for pelican crossings or non-critical side roads and pedestrian crossings where there is insufficient traffic demand (or queuing) to measure the saturation flows accurately, however this should be agreed with the MAE.

The MAE should identify the critical node(s) and link(s) in the network. Of all the site work relating to auditing, on-site measurement of saturation flows for critical links in the network should be seen as necessary. If critical modelled saturation flows are not accurate, they are likely to result in modelling inaccuracies during later stages of MAP.

The source of saturation flow data is shown in **Figure 30** for TRANSYT 12 and **Figure 31** for TRANSYT 13.

T.210 Link Structure, Bus Links, Flares, Give-Ways

While on-site measuring link lengths, cruise times and/or saturation flows, the DE should observe and record site-specific behaviour in order to construct a representative link structure.

Further details of typical site observations are provided in Part B of the **Traffic Modelling Guidelines** but may include common queuing behaviour, flared approaches, parking / loading issues, bus lane usage and setbacks, right turn behaviour and exit-blocking. This list should not be considered exhaustive however, and other observations may need to be made depending on engineering judgement. As traffic behaviour changes by time of day it may be necessary to observe these phenomena separately for each modelled period. It is essential that the DE has a thorough understanding of the area covered in the modelling they are undertaking.

21 Kimber R M, Macdonald M & Hounsell N B, The Prediction of Saturation Flows for Road Junctions Controlled by Traffic Signals, Transport and Road Research Laboratory, Department of Transport, Research Report 67, 1986

It is advised that DEs or MAEs with limited experience ask for assistance from a more experienced colleague (such as the CE or a Principal Network Manager) to determine key observations. This will provide understanding of more detailed network-specific issues which may be highlighted in later stages of MAP. For example, it may be found that whilst two lanes have been indicated on the site drawing, parking in the nearside lane close to the stopline results in a single lane discharge. Any observed behaviour that impacts on the operation of the network should be reported in **T.201**.

Figure 32 highlights where the Give-Way and Flare information is held within the TRANSYT 12 ***.prt** file, with the bus link information shown in **Figure 28**. TRANSYT 13 retains bus link data within the Link Sources tables (**Figure 29**) whilst Give-Way and Flare data are in separate tables as shown in **Figure 33**.

Flare lengths should be audited with attention to the potential presence of flares which haven't been correctly modelled, such as where a bus lane setback or parking bay creates an effective flare. It is important that all flared approaches are accurately captured at this stage of MAP. If effective flares are not correctly coded the model will overestimate stopline capacity with a consequent impact during model validation.

```
                                                        LINK CARDS:   GIVEWAY DATA
                      PRIORITY LINKS   LINK1 GIVEWAY COEFFS.
 CARD   CARD   LINK     LINK1   LINK2    ONLY      A1       A2                                                   LINK     STOP     MAX   DELAY
DISPSN
 NO.   TYPE     NO.      NO.     NO.  % FLOW     X100     X100                                               LENGTH WT.X100   FLOW  WT.X100
X100
  45)=  30     848      811       0       0       50        0       0       0       0       0       20        0     1000       0
0

                         LINK CARDS : FLARE SATURATION FLOW DATA
                         ..LANE  1..      ..LANE  2..      ..LANE  3..
        CARD   LINK    SAT.      CAPAC  SAT.      CAPAC  SAT.      CAPAC
        TYPE    NO.    FLOW       VEH.  FLOW       VEH.  FLOW       VEH.
 182)=  33     821     1600        3       0        0       0        0
 183)=  33     841     1800        5       0        0       0        0
 184)=  33    8711     1800        3       0        0       0        0
```

Figure 32: TRANSYT 12 Card Types 30 and 33 data within the *.prt file

Give-Way Data

Link	Controlling Link 1	Controlling Link 2	Percentage Opposed (%)	Opposed By Link 1 Only (%)	Max Flow At Give Way (PCU/hr)	A1 Coefficient	A2 Coefficient	Use RR67 Opposed Right-Turn Model	Number Of Storage Spaces	Radius Of Turn (m)
848	811		100	(N/A)	1000	0.50	(N/A)		(N/A)	(N/A)
849	812	832	100	60	699	0.22	0.19		(N/A)	(N/A)

Flares

Link	Description	Saturation Flow	Effective Storage (Vehs)
821		1600	3
841		1800	5
8711		1800	3

Figure 33: TRANSYT 13 Give-Way and Flares data tables

T.211 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in T.201 – T.210.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the TMAP Stage 2 Check Sheet (**MQA-0544/T2**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in T.201 – T.210.

These additional issues may include project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

8.2.5 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks T.201 – T.211 and there are no other issues the MAE will approve the model and authorise the TMAP Stage 2 Check Sheet (**MQA-0544/T2**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the TMAP submission and provide a completed AMAP Stage 2a Check Sheet (**MQA-0544/T2**), which should be copied to NMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of TMAP Stage 2

8.2.6 Stage 2 to Stage 3, Demand-Dependent Stage Count Information

In order to model the frequency of demand-dependent stages at a signalised node, the DE or MAE needs to retrieve data from the UTC system. Demand dependency data must be collected for the same time as other traffic surveys and should be recorded separately for each modelled period. If a junction is able to alternate between single cycling or double cycling, careful consideration should be given the interpretation of the demand dependency data.

TMAP STAGE 3

8.3 TMAP Stage 3, TRANSYT Validated Base Model Submission

8.3.1 What is a TRANSYT Validated Base Model?

TMAP defines that a TRANSYT Validated Base model should be based on the TMAP Stage 2 approved Calibrated Base model (see **B8.2.1**) where the frequency of demand-dependent stage appearance has been defined.

Validation in TRANSYT is completed by comparing modelled degrees of saturation (DoS) with those recorded on-site. Queue lengths may also be examined but are not considered compulsory criteria that determine the validation of a model.

Validated TRANSYT models are required for all time periods in TMAP Stage 3.

8.3.2 TMAP Stage 3 Check Sheet

TMAP Stage 3 has a Check Sheet (**MQA-0544/T3**), which must be completed by the MAE when auditing the model.

A separate TMAP Stage 3 Check Sheet must be completed for all time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

T.301 Validation Report

Validated Base model submissions must be accompanied by a Validation Report, as described in Part B of the **Traffic Modelling Guidelines**.

The DE should include the following information in the report:

- Detail on the traffic flows:
    - When were the traffic surveys done and by who?
    - What data was collected during the traffic surveys?

- Demand dependency calculations:
    - Explanation on how the frequency of demand-dependent stages has been accounted for by comparing Calibrated Base model timings to the Validated Base model timings;
    - UTC data should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be used in conjunction with a UTC log. The output of the UTC log should be included in the report;

- Evidence of validation, including comparison between on street data and TRANSYT results;
- Flare usage observed on-site;
- Flashing amber usage at pelicans; and
- Queue lengths (if surveyed).

T.302 Adjustments from Stage 2 Model

There should be few changes in the Validated Base model as compared to the Accepted Stage 2 Calibrated Base model, other than modification for peak-specific signal timings, the addition of flows, and the inclusion of public transport.

Where any other changes have been made, the DE should identify what was changed and why the change was considered necessary within the Validation Report. The DE should specifically document any changes to the following data that was previously checked during TMAP Stage 2, and the MAE will need to check any changes that have been made.

- **T.202** Software and Network Data;
- **T.203** Stage Minimums;
- **T.204** Interstage Durations;
- **T.205** Stage Change Points;
- **T.206** Link Control Data;
- **T.207** Cruise Times;
- **T.208** Links Lengths;

- **T.209** Saturation Flows; and
- **T.210** Link Structure, Bus Links, Flares, Give-Ways.

T.303 Appropriate Peak-Specific Signal Timings

The stage information that was specified in TMAP Stage 2 during **T.205** and **T.206** should be repeated for each time-specific TRANSYT Base model to ensure that appropriate Base signal timings have been applied to the period being modelled.

Note that the timings may have been affected by adjustments for Demand Dependency (**T.304**) and Underutilised Green Time (**T.309**) but these modifications from the Base timings should be clearly marked within the DE's technical note.

T.304 Demand-Dependent Stage Adjustments

The DE should adjust traffic signal control information to account for the non-appearance of demand-dependent stages over the modelled period, and fully document these adjustments. All demand-dependent stages within the network should show a frequency matching on street observations, , which must be verified by the MAE.

The preferred method for modelling demand dependency in TRANSYT 12 is to adjust appropriate links by modifying start and/or end lags. If the TRANSYT 12 model is constructed using TranEd, the DE should use the 'Bonus Greens' facility to adjust the start and end lags as these differentiate modelling adjustments from the original interstage design. In TRANSYT 13 these adjustments to the effective green time should be modelled using Relative Start and End Displacements.

Demand-dependent stage frequency can vary by time of day to directly influence link capacity. It is recommended that the DE and MAE confirm that the modelled adjustments provide appropriate green times for critical links within the modelled network. As an example, if a junction has been modelled with a pedestrian stage being called every cycle, when on site this situation occurs for 50% of signal cycles, then the model is likely to underestimate the capacity of one or more of the major movements.

T.305 Base Flows

TRANSYT models are usually constructed using stopline flows from manual classified traffic surveys. The DE should calculate a common peak hour for the entire modelled network as agreed in MAP Stage 1. The peak hour for all junctions in the model should be demonstrated by the DE via a graph showing the sum of the total flows at each junction over the survey period, typically divided into 15-minute segments, thereby illustrating the peak hour for all junctions in the model.

As most traffic surveys are carried out manually, there will be human counting errors. It is not expected that neighbouring survey counts will match, and in cases where they do, this warrants closer inspection as they may have been manually adjusted.

If it is necessary to adjust the surveyed flow data to reduce inconsistencies, the DE should make adjustments and detail the changes in the Validation Report. Normally it would be expected that where two flows do not balance the higher of the two should be used and the lower flows manually increased to match. Problems with model validation can often be caused by use of incorrect flow data. Careful checking of flow data by the CE is recommended before submitting the Validated Base model for approval at TMAP Stage 3.

Where there is a discrepancy in flows on a modelled link, the MAE should examine the flow data used in the model to confirm that the highest of the two flow counts has been applied. If this does not correspond and resolve any concerns, the MAE may conduct a sample spot count on site and discuss a method to resolve discrepancies with the DE. To get an accurate count, it is recommended that the flow is recorded over a whole number of cycles, during a section of the modelled peak, for example start and end timings should be from the start of green on the movement being measured.

Where multiple upstream links feed two links downstream, the DE should provide evidence that they have recorded the percentage split of flow from each of the origin links to each of the destination links.

The preferred method for flow entry in TRANSYT is to use direct data entry for each link. TRANSYT 13 contains an option for flow allocation to be based upon Origin-Destination (OD) traffic flows specified in a matrix. Flows are placed onto links according to paths between different zones. This methodology for flow allocation is only supported by TMAP for smaller models that have minimal route choice available. When using OD flow allocation, the DE and MAE must ensure that unrealistic routes do not exist by disabling the allocation type, and that lane usage is accurately represented (flows on specific routes can be manually fixed where necessary). The use of OD traffic flows in TRANSYT 13 models should be agreed in advance with the MAE.

T.306 Public Transport Modelling

The MAE should examine the following public transport elements of the model:

- Bus flows, routes and frequencies;
- Bus lanes;
- Location of bus stops;
- Bus stop dwell times; and
- Influence on general traffic.

The DE should calculate bus flows, routes and their frequencies as described in the Traffic Modelling Guidelines, based on available data which should be provided to the MAE for auditing. Bus lanes, hours of operation and vehicle type restrictions should also be checked against on-street data to ensure that bus lane usage is accurately represented.

Buses should be modelled using minor links where they share the carriageway with general traffic or using major links for dedicated bus lanes.

Where a bus stop exists on a link, the 'Mean Stopped Time' on the upstream Connector should be set to the average bus stop dwell time that has been determined. Where more than one bus stop exists, the dwell times should be added together with an additional delay added to reflect the time lost slowing down and accelerating for the additional bus stop(s).

Bus link cruise speeds are to be entered in kph, regardless of whether cruise times or cruise speeds have been selected in **T.202**.

The purpose and scope of the TRANSYT model agreed in MAP Stage 1 will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a public transport-related scheme, the DE should ensure that all relevant public transport elements have been modelled in detail. This may include detailed on-street measurement of dwell times per bus stop and per time period. In models where public transport is considered less of a priority the use of default dwell times may be satisfactory.

As mentioned in **T.210**, the influence of public transport on general traffic often can have a significant impact on network capacity and performance, such as the creation of effective flares for general traffic in the case of bus lane setbacks and funnelling at bus lane entries. The DE should provide in the accompanying Validation Report any notes on site observations to demonstrate that any influences on capacity due to public transport are accurately represented. Site visits can be undertaken by the MAE to observe behaviour and ensure they have been accurately reflected in the submission.

T.307 Degrees of Saturation

The correct recording of on-street DoS is essential to the validation of a model. The **Traffic Modelling Guidelines** outline the preferred approach for surveying DoS, however it is strongly recommended that the DE contacts the MAE prior to surveys being undertaken to discuss the approach to be used. It may also be appropriate for the MAE to accompany the DE on an initial site visit to observe and/or measure DoS.

DoS recorded on-street and in the model should correlate, especially on links operating close to their practical reserve capacity (90%+ DoS). Links close to practical reserve capacity should be given particular attention during auditing.

The following criteria should be used to indicate validation of Base TRANSYT models:

- Degrees of saturation within 5% of observed values;
- Degree of saturation for links upstream of pedestrian crossings within 10% of observed values; and
- Observed Cyclic Flow Profiles (CFP) for critical links showing similar peaks, dispersion and spacing.

It is important to note that, for models built using stopline counts, by definition, the degree of saturation cannot be over 100%. This is because a stopline count is the traffic that has cleared the stopline rather than the demand. For models with link DoS above 100%, model discrepancies may exist for one or more of the following: saturation flows, link structure, green times, and/or stopline flows.

Another consideration is that, although the signal timings in the model are accurate, the timings that were in operation during the traffic surveys may have been different to the modelled average signal timings, such as where contingency plans were in operation. This is possible but unusual if sufficient checks were made during TMAP Stage 2. If the MAE suspects this may have occurred it is appropriate to investigate UTC logs for the date of the traffic surveys. If in doubt, a sample traffic count during the modelled period (as detailed in **T.305**) is advisable.

Flare usage should be represented correctly in each model and fully documented in the DE's Validation Report (**T.301**), based on observed measurements recorded in each peak. If flare usage has not been documented then the MAE should request clarification from the DE with regards to the impact on degrees of saturation.

It is possible that Underutilised Green Time may have occurred on-street and has not been fully applied within the submitted model. In these cases, the DoS in the model will be lower than those surveyed on-street. In these cases the MAE should refer to **T.309** for guidance.

T.308 Queue Lengths

TRANSYT calculates the Mean Maximum Queue (MMQ) for each link as the average of the maximum queue that occurs throughout the signal cycle. This can be measured on-street where platoon arrival patterns are observed to be regular and distinct. However, if vehicle arrival patterns are less pronounced then the MMQ can be difficult to accurately survey. If queue data has been surveyed, it is the responsibility of the DE to provide this data for auditing by the MAE.

Modelled queue lengths should not exceed the link length as they cannot physically do so on street. Excess queuing is indicated by a '+' in the 'Average Excess Queue' column in the TRANSYT 12 output (***.prt)** file, and by a '+' in the 'Mean Max Queue' column in the TRANSYT 13 Report Builder.

If queues in a model exceed link lengths, the DE and MAE have to consider whether the green times, offsets, saturation flows and flows for the links are correct. If these parameters have been correctly modelled, it may be useful to consider the advice in **T.309**' for guidance. A model will undergo further scrutiny by the MAE if an excess queue is indicated within modelled results.

T.309 Modelling of Underutilised Green Time

Where fully saturated traffic appears to discharge at a rate less than the saturation flow (for example, due to driver behaviour or exit-blocking), this should not be accounted for by changing the saturation flow in a model. Instead, it is recommended that Underutilised Green Time (UGT) is used to quantify this behaviour. UGT can commonly occur during periods of congestion within networks operating at or over capacity. At times traffic may only be travelling marginally slower than would be the case during unrestricted saturation flow. This may not be noticeable to an on-street observer but its impact will be captured by UGT during data processing. UGT is fully described within Part B of the **Traffic Modelling Guidelines**.

UGT is calculated to quantify situations where congestion-related issues prevent fully saturated discharge. Where UGT is measured on street during the modelled period, it needs to be accounted for with manual adjustments during validation. The DE should calculate the average amount of green time that is lost due to UGT (such as wasted green due to exit-blocking) and adjust the link control data accordingly. For TRANSYT 12, adjustments to effective green time should be made via appropriate start and end lags. Where the model is built in TranEd, the bonus green facility may be used as it differentiates modelling adjustments from interstage design. In TRANSYT 13 these adjustments to the effective green time should be modelled using Relative Start and End Displacements.

The MAE will be required to audit data to verify that this aspect of modelling has been addressed correctly.

T.310 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **T.301** – **T.309**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the TMAP Stage 3 Check Sheet (**MQA-0544/T3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **T.301** – **T.309**.

These additional issues may relate to project specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should

be seen as constructive, to increase the likelihood of model approval following resubmission.

8.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **T.301** – **T.310** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant TMAP Stage 3 Check Sheet (**MQA-0544/T3**).

If the MAE fails the model on any of the checks **T.301** – **T.310**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided

The MAE should inform the P, DE and CE of the Approval or Rejection of the TMAP submission and provide completed TMAP Stage 3 Check Sheets (**MQA-0544/T3**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of TMAP Stage 3

TMAP STAGE 5a

8.4 TMAP Stage 5a, TRANSYT Future Base Model Submission

8.4.1 Introduction

MAP Stage 5a is an optional MAP stage dependant on whether the scheme assessment is following the Three Stage Modelling Process. The scope of the scheme assessment agreed in the MAP Stage 1 meeting will determine the requirement for Future Base models and a MAP Stage 5a audit.

The majority of the work, both in terms of creating and auditing a TRANSYT Model, is completed when generating fit for purpose Base modelling. Once TMAP Stage 3 is complete there will often be a relatively small amount of work required to complete TMAP. The DE should make a copy of the TMAP Stage 3 accepted Base models and input Future Base traffic flows. Where any likely future network changes, excluding the scheme being assessed, fall within the TRANSYT model boundary amendments will be required to reflect the new methods of control and/or lane structure.

The Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing against the Base model results alone.

> Future Base models are required for all time periods in TMAP Stage 5a.

8.4.2 TMAP Stage 5a Check Sheet

TMAP Stage 5a has a Check Sheet (**MQA-0544/T5a**), which must be completed by the MAE when auditing the model.

> A separate TMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

T.501 Future Base Report

Future Base model submissions must be accompanied by a Future Base Report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to assess criteria **T.502** – **T.509**, together with an assessment of the likely operation of the future year network. All changes to the models should be clearly stated along with the reasoning behind the changes and any required supporting information or data.

There must be a comparison between the results of the Validated Base models and the Future Base models for the corresponding periods. The inclusion of comparisons for all links which are deemed critical is required.

It is the responsibility of the DE to identify critical links. Normally (but not exclusively) critical links would be those which experience high traffic flows, are close to capacity and/or those links which are affected by the proposals.

T.502 Physical Layout / Signal Changes

There may be the requirement to make adjustments to the Network Layout and/or signal control to represent the Future Base scenario. The changes from the approved Base model may include:

- Inclusion of any likely future network layout changes that fall within the boundary of the TRANSYT modelling;
- Changes to junction control, including give-way parameters, method of control and signal timings as a result of future network changes;
- Amendments to demand dependency and UGT assumptions; and
- The model will have been optimised following the pathway detailed in the **Traffic Modelling Guidelines**, including the application of any mitigation strategies, in which case the signal timings may have been modified. It should be noted that the signal timings in a Future Base model are likely to have undergone an iterative process with a highway assignment model and the model submitted for MAP Stage 5a audit should represent the final signal timings

All amendments should be detailed by the DE within the Future Base Report (**T.501**) and checked by the MAE. It is important that no changes that form part of the proposals are included in the Future Base model. These should only be introduced in MAP Stage 5b.

T.503 Future Base Flows

The methodology to determine and apply Future Base general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Future Base model may be determined by applying manual changes to existing Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Future Base traffic flows.

Where the Future Base flows have been supplied from iterations with tactical modelling, the submitted Future Base TRANSYT model should represent the flows from the agreed assignment of the corresponding Future Base tactical model. The DE should provide outputs from the tactical modelling and the MAE should check the application with in the TRANSYT model. It should be noted that for entry links into a TRANSYT model, queue lengths from the tactical model should be added to turning count outputs and entered onto the approach links.

T.504 Demand-Dependent Stage Frequencies

The DE's Future Base Report (**T.501**) should comment on the frequency of the appearance of demand-dependent stages in the Base model and whether any assumptions regarding demand have been made for the Future Base model, according to the guidance provided in in Part B of the **Traffic Modelling Guidelines**. The assumptions should be audited by the MAE.

T.505 Model Optimisation Strategy

The optimisation strategy to be used for the Proposed modelling should be agreed with the MAE and documented by the DE in the Future Base Report (**T.501**). The choice of optimisation strategy is likely to depend on the nature and purpose of the Proposed modelling.

Factors to consider include the following:

- Demand dependency adjustments may need to be:
    - Left unchanged in the case of capacity assessment;
    - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
- Underutilised Green Time adjustments may need to be:
    - Included if the cause of the UGT is likely to remain in the Future Base scenario;
    - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
    - Removed if the cause of the UGT is likely to be removed in the Future Base scenario;
- Network control strategies:
    - Discussion with Network Managers to determine any factors that may impact or place restrictions on the optimisation of signal timings, for example the requirement to prioritise public transport movements at certain locations; and
- Iterative optimisation and flow adjustment:
    - A dedicated assignment model may be used in conjunction with a Future Base TRANSYT model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the TRANSYT model area. This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 Validated Base TRANSYT model are clearly identified and justified, with any calculations used to produce estimated values included.

T.506 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **T.502 – T.505**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**T.501**):

- Physical layout changes;
- Traffic signal changes; and
- Expected traffic flow changes.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved TMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

T.507 Degrees of Saturation

The Future Base Report (**T.501**) should contain a quantitative comparison of Base and Future Base degrees of saturation and the implications for the operation of the network. The MAE will need to be satisfied that the Future Base model degrees of saturation are acceptable.

The report does not necessarily have to contain a comparison of every link in the model, but it is the responsibility of the DE to include all links which are considered as critical to the model or the proposal. The DE should ensure that any adjustments to saturation flows, effective flare lengths or traffic flows on links that exhibit changes in DoS have been fully documented. If any changes have not been highlighted then the MAE should approach the DE to explain their impact on degrees of saturation.

T.508 Queue Lengths

The DE's Future Base Report (**T.501**) should contain a quantitative comparison of Base and Future Base queue lengths and the implications for the operation of the network, in a similar manner to the analysis undertaken in **T.507** for DoS. Excess queuing is indicated by a '+' in the 'Average Excess Queue' column in the TRANSYT 12 output (***.prt)** file, and by a '+' in the 'Mean Max Queue' column in the TRANSYT 13 Report Builder.

Particular attention should be paid to links with limited stacking capacity for queued traffic. If short links operate at or near physical capacity the network can be susceptible to cross junction exit-blocking and loss of capacity. Consideration should be given to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network if queue lengths on critical links are at, or close to, the link length.

T.509 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **T.501** – **T.508**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the TMAP Stage 5a Check Sheet (**MQA-0544/T5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **T.501** – **T.508**.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

8.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **T.501** – **T.509** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant TMAP Stage 5a Check Sheet (**MQA-0544/T5a**).

If the MAE fails the model on any of the checks **T.501 – T.509**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed TMAP Stage 5a Check Sheets (**MQA-0544/T5a**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of TMAP Stage 5a

TMAP STAGE 5b

8.5 TMAP Stage 5b, TRANSYT Proposed Model Submission

8.5.1 Introduction

Proposed models must be based on approved TMAP Stage 3 Base models, or when following the Three Stage Modelling process (see **A2.3.2**) the approved TMAP Stage 5a Future Base models.

Proposed models are required for all time periods in TMAP Stage 5b.

The Proposed models should be based on the Validated Base approved TMAP Stage 3 model., or when following the Three Stage Modelling process the approved Future Base TMAP Stage 5a model. The DE should make a copy of the accepted Base or Future Base models and input the new methods of control and/or link structure in line with the proposals. Proposed TRANSYT models are required for all time periods in TMAP Stage 5b.

In addition to ensuring that the model is correctly developed from a technical point of view the DE has the responsibility of demonstrating that the proposals can be accommodated within the network without jeopardising the day to day operation of the network. This will include maintaining acceptable levels of DoS and queue lengths as well as sufficient provision for pedestrian demand.

In common with the preceding stages, the MAE will need to consider all the technical data and their implications. However, an important additional responsibility of the MAE at Stage 5b is to make a judgement of whether they agree that the network is likely to operate satisfactorily on a day-to-day basis.

As a representative of the TfL Traffic Manager who will have a duty to manage the new network (if the proposal is given the go-ahead by NIST), the MAE should highlight any issues and concerns with the proposals. These issues are likely to be in respect of safe, efficient network operation and current policy / guidelines.

The DE will receive feedback from MAE and will need to address any issues highlighted. The MAE can use their operational experience in making informed comments and decisions.

If required by the model scope the proposed timings must be suitable to be used as controller held background timings for new methods of control. This means that the MAE's audit is implicitly asking the DE:

> 'Are you satisfied that, if observing on-site when these proposals are commissioned, the timings in each of the submitted TRANSYT models would provide appropriate network operation under local control and that the network impacts would be as described in the SIR?'

8.5.2 TMAP Stage 5b Check Sheet

TMAP Stage 5b has a Check Sheet (**MQA-0544/T5b**), which must be completed by the MAE when auditing the model.

A separate TMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

T.551 SAE-Approved Proposed Methods of Control

Before submitting any Proposed modelling, the DE must submit proposed drawings and methods of control to the MAE. The MAE must ensure that the proposed methods of control and drawings reflect the proposals identified in the MED. Once the MAE has confirmed the details are correct, they can arrange for an Engineering Service Request (ESR) to be undertaken. The SAE will undertake a review to identify issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings.

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE. The MAE must confirm that SAE approval has been received for any new or modified signalised infrastructure prior to auditing.

Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from proceeding with TMAP Stage 5b.

T.552 Proposed Model Report

Proposed model submissions must be accompanied by a report, as described in the Traffic Modelling Guidelines. The report needs to contain all necessary information and paperwork in order to assess criteria **T.553** - **T.561**, together with an assessment of the likely impact of the proposals.

There must be a comparison between the results of the Validated Base models and Future Base models, if required, and the Proposed models for the corresponding periods. The inclusion of comparisons for all links which are deemed critical is required.

It is the responsibility of the DE to identify critical links. Normally (but not exclusively) critical links would be those which experience high traffic flows, are close to capacity and/or those links which are affected by the proposals.

T.553 Physical Layout / Signal Changes

There are likely to be network and signal control changes to represent the scheme proposals. The changes from the Base or Future Base models may include:

- Changes to the network layout;
- Changes to junction control, including give-way parameters, method of control, and signal timings as a result of the proposed scheme;
- Amendments to demand dependency and UGT assumptions; and
- The model will have been optimised following the pathway detailed in the Traffic Modelling Guidelines, in which case the signal timings may have been modified. It should be noted that the signal timings in a Proposed model may have undergone an iterative process with a highway assignment model and the model submitted for MAP Stage 5b audit should represent the final signal timings

All amendments should be detailed by the DE within the Proposed Model Report (**T.552**) and checked by the MAE.

T.554 Proposed Flows

The methodology to determine and apply Proposed general traffic flows will have been discussed and agreed at the MAP Stage 4 meeting and documented in the Modelling Expectations Document.

Traffic flows within a Proposed model may be determined by applying manual changes to existing Base or Future Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or informed from tactical modelling to capture wider network influence. The DE should provide the MAE with the detailed methodology, assumptions and all other relevant information used for the calculation and application of the Proposed traffic flows.

Where the Proposed traffic flows have been supplied from iterations with tactical modelling, the submitted TRANSYT model should represent the flows from the agreed assignment of the corresponding Proposed tactical model. The DE should provide outputs from the tactical modelling and the MAE should check the application with in the TRANSYT model.

T.555 Demand-Dependent Stage Frequencies

The Proposed Model Report (**T.552**) should comment on the frequency of the appearance of demand-dependent stages in the Base or Future Base models and whether any assumptions regarding demand have been made for the proposed network, according to the guidance provided in Part B of the **Traffic Modelling Guidelines**. The assumptions should be audited by the MAE.

T.556 Model Optimisation Strategy

The optimisation strategy to be used for the Proposed modelling should be agreed with the MAE and documented by the DE in the Proposed Model Report (**T.552**). The choice of optimisation strategy is likely to depend on the nature and purpose of the Proposed modelling.

Factors to consider include the following:

- Demand dependency adjustments may need to be:
    - Left unchanged in the case of capacity assessment;

    - Modified if any flows demanding demand-dependent stages are expected to change significantly, for example due to additional development traffic or growth;
    - Removed to preserve offsets if the model is to be used to produce controller-held signal timings using offset-only optimisation;

- Underutilised Green Time adjustments may need to be:
    - Included if the cause of the UGT is likely to remain in the Proposed scenario;
    - Recalculated if a change in UGT can be predicted and estimated based on the existing UGT value, for example due to a change in cycle time; or
    - Removed if the cause of the UGT is likely to be removed following the proposal implementation, which may in fact be one of the goals of the proposal;

- Network control strategies:
    - Discussion with Network Managers to determine any factors that may impact or place restrictions on the optimisation of signal timings, for example the requirement to prioritise public transport movements at certain locations; and

- Iterative optimisation and flow adjustment:
    - A dedicated assignment model may be used in conjunction with a Proposed TRANSYT model to iteratively adjust flows and signal timings in both models until convergence is achieved, to account for wider traffic reassignment outside the TRANSYT model area. This may be the case where traffic management strategies are to be employed or to take account of other scheme changes in a wider area.

Whichever decisions are agreed between the DE and MAE regarding the optimisation strategy, it is important that they are documented and that any changes from the Stage 3 Validated Base or Stage 5a Future Base TRANSYT model are clearly identified and justified, with any calculations used to produce estimated values included.

T.557 Other Adjustments from Stage 3 / 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **T.553** – **T.556**, concerning specific changes to the following areas resulting from the proposed scheme that should be detailed in the Proposed Model Report (**T.552**):

- Physical layout changes;
- Traffic signal changes; and
- Expected traffic flow changes.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved TMAP Stage 3 / 5a model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable.

T.558 Degrees of Saturation

The Proposed Model Report (**T.552**) should contain a quantitative comparison of Base or Future Base and Proposed degrees of saturation and the implications for the operation of the network. The MAE will need to be satisfied that the proposed scheme degrees of saturation are acceptable.

The report does not necessarily have to contain a comparison of every link in the model, but it is the responsibility of the DE to include all links which are considered as critical to the model or the proposal. The DE should ensure that any adjustments to saturation flows, effective flare lengths or traffic flows on links that exhibit changes in DoS have been fully documented. If any changes have not been highlighted then the MAE should approach the DE to explain their impact on degrees of saturation.

It is important to note that it is not possible to provide a datum at which DoS becomes significant. In some cases a small change in DoS or even relatively low values of DoS can cause problems, for example on the circulatory carriageway of a roundabout or at staggered junctions.

The MAE must be satisfied that the proposed scheme degrees of saturation are acceptable. Degrees of saturation are affected by cycle time, available green time, traffic flow and saturation flow. Therefore, care must be taken to ensure techniques such as adjusting saturation flows or flows on a link have not been used in order to manipulate degrees of saturation. Particular attention should be paid to short links with modest stacking capacity, such as signalised roundabouts or within staggered junctions. The MAE should expect these short links to have spare capacity nearer to 20-30% (in essence a degree of saturation less than 70-80%), to prevent exit-blocking onto upstream links.

T.559 Queue Lengths

The DE's Proposed Model Report (**T.552**) should contain a quantitative comparison of Base or Future Base queue lengths and Proposed queue lengths and the implications for the operation of the network, in a similar manner to the analysis undertaken in **T.558** for DoS. Excess queuing is indicated by a '+' in the 'Average Excess Queue' column in the TRANSYT 12 output (***.prt**) file, and by a '+' in the 'Mean Max Queue' column in the TRANSYT 13 Report Builder.

Particular attention should be paid to links with limited stacking capacity for queued traffic. If short links operate at or near physical capacity the network can be susceptible to cross junction exit-blocking and loss of capacity. Consideration should be given to whether signal timings can be manipulated to place queued traffic into less sensitive areas of the network if queue lengths on critical links are at, or close to, the link length.

T.560 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see

A2.1) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

T.561 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in T.551 – T.560.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the TMAP Stage 5b Check Sheet (**MQA-0544/T5b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in T.551 – T.560.

These additional issues may relate to project specific agreements formalised during MAP Stage 4, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

8.5.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **T.551** – **T.561** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the relevant TMAP Stage 5b Check Sheet (**MQA-0544/T5b**).

If the MAE fails the model on any of the checks **T.551** – **T.561**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE, CE and SAE of the Approval or Rejection of the submission and provide completed TMAP Stage 5b Check Sheets (**MQA-0544/T5b**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of TMAP Stage 5b

9 Vissim MAP (VMAP)

9.1 Scope

VMAP applies to all Vissim modelling submitted to TfL Operations for auditing.

Where detailed pedestrian modelling is required and included within a Vissim model, a PMAP audit needs to be carried out in parallel with the VMAP audit to ensure that pedestrian modelling elements are fit for purpose. Each MAP stage will require joint PMAP / VMAP approval.

9.1.1 Supporting Modelling

It is common practice, and highly recommended, that Base, Future Base and Proposed Vissim models are developed for networks which already have supporting MAP-approved modelling using traffic signal optimisation software such as LinSig or TRANSYT. This allows for signal optimisation of the proposal and easier auditing of signal timings and saturation flows in Vissim.

LinSig Skeleton models, although not covered by MAP, may also be useful for the purpose of auditing signal timings and controller behaviour in addition to any MAP-approved models.

VMAP STAGE 2

9.2 VMAP Stage 2, Vissim Calibrated Base Model Submission

9.2.1 What is a Vissim Calibrated Base Model?

A VMAP Stage 2 Vissim Calibrated Base model is a partially calibrated Vissim model that is intended to provide the MAE with an early opportunity to review development of the model prior to the introduction of traffic.

It is recommended that a TfL Vissim Template file is used for developing new models, which is available on request. It contains recommended settings, driving behaviour and parameters that include:

- Simulation Parameters;
- Model Units;
- Background;
- Functions;
- Desired Speed Distributions;
- Vehicle Data;
- Driving Behaviour Parameters; and
- Link Types.

The Vissim software version used must match the version agreed at the MAP Stage 1 meeting and recorded in the Modelling Expectations Document (MED).

It is important that the MAE and DE agree fundamental Vissim modelling parameters prior to model development, calibration, and validation. Once a model has been validated, changing these basic parameter sets may significantly impact the model performance and require the model to be revalidated.

Calibrated Base models are required for all time periods in VMAP Stage 2.

9.2.2 VMAP Stage 2 Check Sheet

VMAP Stage 2 has a Check Sheet (**MQA-0544/V2**), which must be completed by the MAE when auditing the model.

A separate VMAP Stage 2 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on the Check Sheet.

V.201 Calibration Report

VMAP Stage 2 Vissim Calibrated Base model submissions must be accompanied by a Calibration Report, as described in Part B of the **Traffic Modelling Guidelines**.

The Calibration Report provides an opportunity for the DE to outline the way in which the model has been set up. It should not be treated as simply a 'tick box' requirement. It is an engineering document and it should be specific to the models it accompanies. Key elements include:

- The scope and purpose of the Vissim models, as agreed at MAP Stage 1 and defined in the MED;
- Extent of the agreed model area;
- List of all agreed TfL-referenced traffic signals in the network, with physical addresses;
- Agreed modelled time periods, including details of how peaks have been determined. Corresponding Vissim Scenarios should be identified where Scenario Management is used;
- Details of any variation from default Vissim parameters defined within the TfL Vissim template, with supporting justification;
- Details of the source of any background imagery used for network calibration;
- Details of how the routing methodology agreed at MAP Stage 1 and documented in the MED is to be implemented in Vissim;
- Site observation notes, detailing physical constraints within the network and vehicle behaviour. Where behaviour is specific to a time of day, this should be described. The DE should explain how these observations have determined the modelled network structure;

- List of all modelled stoplines with accompanying saturation flow measurements. Any that could not be measured or that will not be validated at VMAP Stage 3 should be identified, with reasoning;
- Sources of data used for public transport modelling, including bus / tram routes, stops and stands, bus / tram lanes and their hours of operation.
- The TfL signal Timing Sheets used for Signal Controller calibration, together with the source of data used for traffic signal timings:
    - For VAP-controlled junctions without accompanying MAP Stage 3-approved LinSig or TRANSYT models:
        - For Fixed Time junctions the UTC signal plans should be included; and
        - For SCOOT junctions, average representative timings should be calculated using an approved method and clearly presented.
    - For UTC-Vissim controlled junctions the associated traffic cell(s) should be provided;
- Details of any other modelling issues, assumptions or technical challenges.

V.202 Software, Units and Network Settings

The software version should be as agreed at MAP Stage I and documented in the MED.

The model's Network Settings should be set as follows:

- **Vehicle Behavior / Traffic regulations:** must be set to 'Left-hand traffic' for UK models;
- **Units / Distance:** mm, m and km are recommended;
- **Units / Speed:** m/s and miles per hour are recommended, for comparison with local speed limits; and
- **Units / Acceleration:** m/s^2 is recommended.

V.203 Scenarios

Scenario Management in Vissim provides the ability to manage multiple modelled scenarios within a single modelling project, which can be helpful during model development. Where Scenario Management is used, individual scenarios should be named appropriately so that the purpose of each scenario is clear. It is particularly important to identify which modelled scenario is being submitted for auditing so that the audit can proceed.

To avoid ambiguity, the **Traffic Modelling Guidelines** describes a recommended method to export individual scenarios from Scenario Management as standalone Vissim models prior to model submission. When doing so, it is important to check that any necessary external files such as signal control and background files are included with the model submission and referenced correctly so that no errors are encountered.

Use of Scenario Management, and whether submissions should be exported as standalone models, should be discussed and agreed with the MAE. It should be noted that TfL's UTC-Vissim interface is not compatible with Scenario Management.

The MAE must confirm that where Scenario Management has been used:

- Submitted scenarios have been successfully exported as standalone Vissim models for auditing, without any errors and including any necessary external files; or
- Use of Scenario Management has been agreed for model submission, all scenarios are named appropriately to clearly describe their purpose and the specific scenario being submitted for auditing has been identified.

V.204 Simulation Parameters

The DE must ensure the following Simulation Parameters in the Vissim model are appropriate, which will be checked by the MAE:

- **Simulation resolution:** should be set to 5 steps per simulation second (resulting in 0.2 seconds per time step) unless a higher value is justified, such as when modelling autonomous vehicles. Lower values must not be used.
- **Simulation start date:** should be set to a date that is representative for the model, typically coinciding with collection of flow, signal

and/or validation data. For UTC-Vissim models this is essential so that signal timings reflect correct operation for the specified day;

- **Simulation start time:** must be set to a time before the start of the modelled peak period, allowing for a suitable warm-up period to populate the network with representative traffic flows and queues prior to the start of the peak;
- **Simulation period:** must cover the warm-up period, the whole of the modelled evaluation period and a cool-down period if required, as defined within the **Traffic Modelling Guidelines**.

V.205 Background

The DE must ensure that any background imagery used is up to date, representative for the network being modelled and scaled correctly, which will be checked by the MAE.

The **Traffic Modelling Guidelines** recommends that TfL Site Layout Diagrams (SLDs) are used as the primary source of background data for areas surrounding signalised junctions, which can be supplemented by aerial photography and topographical drawings.

Vissim uses a generic Cartesian coordinate system rather than a particular map projection. At TfL the British National Grid (BNG) coordinate system is used for SLDs and Vissim modelling, therefore background imagery should also use this system. For SLDs that are saved in Model View the scaling should automatically be set when used in Vissim, however this should always be checked. As an additional safeguard it is suggested that a known reference scale marker is included on background imagery, which is recommended to be at least 100m in length.

Although Vissim has the capability to load mapping from online sources such as Bing Maps, this is not recommended as it does not use BNG coordinates and the imagery changes over time, so references used to calibrate the Vissim network may be lost.

If a background lacks detail or is not scaled correctly, it will result in the development of a Vissim network to incorrect dimensions that will potentially lead to erroneous model results.

V.206 Functions

The TfL Vissim Template referred to in **B9.2.1** contains several pre-defined functions that have been calibrated for different Vehicle Types. These include profiles for:

- Maximum acceleration;
- Desired acceleration;
- Maximum deceleration; and
- Desired deceleration.

The DE must ensure, and MAE verify, that should functions in a model differ from these default template values any differences must be justified, fully documented within the Calibration Report (**V.201**) and supported by suitable observed data or TfL advice.

V.207 Desired Speed Distributions

Details of speed limits present within the modelled network should be specified in the DE's Calibration Report (**V.201**). The DE should ensure that appropriate speed distributions have been defined for:

- Different speed limits in the study area;
- Different vehicle types, as specified in the MED, which may include:
  - Light vehicles;
  - Buses and heavy vehicles; and
  - Cyclists.
- A range of reduced speeds for turns, depending on turning radii; and
- A range of reduced speeds for saturation flow calibration.

Since models contain no traffic at VMAP Stage 2, all that needs to be checked at this stage is that the defined distributions are named appropriately and appear sensible.

The TfL Vissim Template includes a range of speed distributions for different vehicle types and UK road speed limits. These are based on data from the Department for Transport and TfL, together with research carried out by TRL. Any changes to these speed distributions must be justified, fully documented within the Calibration Report (**V.201**) and supported by suitable observed data or TfL advice.

V.208 Vehicle Data

The DE should specify, and MAE verify, that vehicle data is as listed below:

- **Vehicle Model:** correct 3D models have been selected for additional vehicles such as taxis, buses and other vehicle types;
- **Vehicle Types:** have been correctly identified and defined. A common error is for incorrect desired and maximum acceleration / deceleration profiles to be selected for Vehicle Types. This may have an impact upon network performance and journey times during later stages of model development. Any variation of the following parameters from default values should therefore be reported or highlighted for discussion between the DE and MAE:
    - Vehicle Category;
    - Vehicle Model; and
    - Acceleration / deceleration profiles; and
    - Colours.
- **Vehicle Classes:** all relevant Vehicle Classes have been defined.

V.209 Driving Behaviour

Default driving behaviour parameters are available in the TfL Vissim Template. Parameter values should not be changed from those contained within the template unless supported by site observation. Where driving behaviour parameters are changed from default values it should be explicitly documented and justified, applied at specific locations only and labelled appropriately with '(ADDED)' appearing at the end of the name to distinguish them from TfL template values.

The DE should specify appropriate values for the following parameters, which will be checked by the MAE:

- Following:
    - **Look ahead distance (min and max):** when combined with 'observed vehicles', these determine how vehicles react to other vehicles either in front or to the side. Where lateral behaviour is important (in essence for overtaking) the 'min look ahead distance' can be increased from zero;
    - **Observed vehicles:** determines how well vehicles predict and react to other network elements and vehicle movements.

Increasing this value can be necessary where multiple network elements occur within a short distance;
   - **Look back distance (min and max):** determines how far a vehicle can see backwards in order to react to approaching vehicles. Where lateral behaviour is important (in essence for overtaking), the 'min look back' distance can be increased;
   - **Standstill distance:** defines the average desired distance between stopped cars. It is recommended to set this value to 1.2m; and
   - **Additive and multiplic. parts of safety distance:** impact upon link saturation flow and should remain as default values. The **Traffic Modelling Guidelines** recommend the use of Reduced Speed Areas for saturation flow calibration.

- Lane Change:
   - The Lane Change values should remain at the default values in the TfL Vissim Template. Changes to these values should be supported by DE justification within the Calibration Report (**V.201**); and
   - The MAE should check if cooperative lane changing has been applied, and any use should be justified by the DE in the Calibration Report (**V.201**).

- Lateral:
   - Should be left at default values for motorised vehicles, with desired position at free-flow set to 'Middle of the Lane', unless 'overtaking on the same lane' is to be enabled in the model. If 'overtaking on the same lane' is to be active in the Vissim model, additional Link Behaviour Types may be defined using the Urban (motorized) parameter set as a base, as described in **V.210**; and
   - When modelling cyclists, refer to the TfL Vissim Template guidance note for advice on lateral behaviour parameters.

- Signal Control:
   - **Reaction to amber signal:** should remain at default with the decision model set to 'Continuous Check'; and
   - **Behavior at red / amber signal:** should be 'Stop (same as red)'.

V.210 Link Behaviour Types

The DE must ensure that Link Behaviour Types correspond to the correct Driving Behaviours, which will be checked by the MAE. The number of Link Behaviour Types in any model should be kept to a minimum where possible. The default Link Behaviour Types should not be changed without good reason and supporting evidence. The creation of additional Link Behaviour Types may sometimes be necessary, however supporting evidence explaining their use must be presented in the Calibration Report (**V.201**).

It is recommended that different Display Types are used to help identify and distinguish specific Link Behaviour Types in the modelled network, however the MAE must still check that Link Behaviour Types have been applied to links appropriately since any Display Type can be applied to any link.

V.211 Route Assignment Methodology

The DE must ensure, and MAE verify, that the correct traffic assignment choice (static assignment) has been used as agreed during MAP Stage 1.

The **Traffic Modelling Guidelines** advise against use of Dynamic Assignment models. In instances where traffic assignment is necessary, a dedicated assignment model should be used, such as TfL's ONE Model.

For most models, it will be most appropriate for static routes to originate from a cordon of TfL's ONE Model, where a Base Review has been undertaken in accordance with IMAP (see **B6.2**). Use of other models such as LoHAM may be appropriate where the required forecast year is beyond the horizon of ONE.

The DE should explain in reporting how the zoning system of the supporting strategic model has been mapped to the Vissim link structure.

V.212 Network Structure

The initial modelled network structure should be accurate and consistent with the layout on-street. The **Traffic Modelling Guidelines** contains advice concerning appropriate link / connector structures.

Key elements of the network in the model that will be checked by the MAE are:

- Link Structure:
    - Number of lanes;
    - Link lengths;
    - Bus / tram / cycle lanes and lane closures;
    - Lane change restrictions;
    - Pedestrian / cyclist links; and
    - Presence of flared approaches.
- Connectors:
    - All possible movements;
    - Lane to lane structure;
    - Connector lengths; and
    - Bus / tram lanes and connector closures.

It is recommended that a single connector be used when modelling lane gain or loss, rather than multiple lane-to-lane connectors which enforce strict lane change behaviour. 'Lane Change' and 'Emergency Stop' distances for connectors should be carefully specified as they play a key role in lane changing behaviour on upstream links.

There can be different ways of structuring the network to obtain similar results. It is recommended that advice is sought from an experienced Vissim modeller if there is any doubt regarding the effectiveness of a specific network structure.

V.213 Speed Restrictions

In Vissim, changes to a vehicle's desired speed are controlled using:

- Desired Speed Decisions (DSDs), for permanent changes to the vehicle's desired speed; and
- Reduced Speed Areas (RSAs), for temporary changes within a defined area.

DSDs are principally used for controlling desired vehicle speeds based on the local prescribed speed limit.

DSDs must be placed across all lanes where speed limits change within the modelled network, and are recommended near the beginning of entry links. Appropriate Desired Speed Distributions must be used for each relevant Vehicle Class. Where Vehicle Compositions are solely used to enforce speed limits on entry links, this should be mentioned in the Calibration Report (**V.201**).

RSAs are used in Vissim models for a variety of purposes, but most importantly to:

- Replicate lower speeds used by turning vehicles within the model;
- Represent localised changes in speeds due to network geometry or driver psychology; and
- Calibrate saturation flows at junction stoplines.

The DE must place RSAs wherever they are considered necessary within the network, with reasonable initial parameters assumed for each relevant Vehicle Class.

It is recommended in the **Traffic Modelling Guidelines** that RSAs should be placed on approaches to stoplines, turning movements at junctions, bends, corners, road humps and in areas of poor visibility. They can also be placed on approaches to zebra crossings and Priority Rules where appropriate.

DSDs can be used in place of RSAs to represent reduced speeds through more complex modelled network areas such as at roundabouts or gyratory systems, as advised in the **Traffic Modelling Guidelines**.

The MAE must check that RSAs have been placed at all locations they consider necessary, that initial RSA calibration appears appropriate and is correctly applied for relevant Vehicle Classes. RSAs can be further refined during VMAP Stage 3 when traffic flows are introduced.

V.214 Saturation Flow Measurements

The DE must provide a table listing all stoplines in the model, indicating which are proposed for saturation flow validation during VMAP Stage 3.

The table should identify, for each stopline:

- The site number, phase and lane number;
- Vissim link and lane number;
- The RSA that will be used to calibrate the Saturation Flow;
- The measured saturation flow value for validation, indicating whether it was surveyed on site or estimated from RR67; and
- Explanation and justification if a stopline is not to be validated.

The MAE must be satisfied that measured / calculated saturation flows appear reasonable, that saturation flows will be validated for all critical stoplines and that any justifications for not measuring or validating saturation flows are considered acceptable. The DE must provide the MAE with any survey data or calculations used to determine measured saturation flow values.

V.215 Public Transport Modelling

The purpose and scope of the Vissim model, as agreed during MAP Stage 1 and documented in the MED, will determine the level of detail required for public transport modelling. For example, if the models are being prepared to assess the impacts of a scheme on bus / tram journey times, the DE should ensure all public transport elements have been modelled in detail.

For a VMAP Stage 2 model submission the DE should ensure that the following public transport network elements are correctly calibrated, which will be checked by the MAE:

- Bus / tram routes;
- Bus / tram lanes; and
- Location and size of bus / tram stops and bus stands.

Bus / tram lanes, hours of operation and vehicle type restrictions should be checked against on-street data to ensure correct restrictions are active where necessary during the modelled period.

V.216 Traffic Signals

Prior to modelling traffic signals in Vissim, the DE should obtain relevant TfL Signal Timing Sheets and Controller Specifications from TfL[22] for all Signal Controllers in the network, as described in Part B of the **Traffic Modelling Guidelines**. TfL Signal Timing Sheets should be checked against relevant Controller Specifications for accuracy. These documents need to be consistent, the only acceptable differences are those changed directly within the on-street controller, for example Phase Delays, which would typically be listed on the TfL Signal Timing Sheet under 'Historical Amendments'.

22 TfL Signal Timing Sheets and Controller Specifications can be requested from **AssetOperationsDataLegalRequest@tfl.gov.uk**

The DE should also obtain from the MAE signal timing plans and demand dependency logs for all UTC-controlled junctions, for each of the periods being modelled. The relevant Network Manager should be consulted for correct interpretation of SCOOT plans and associated messages to derive average SCOOT timings. For non-UTC junctions dedicated signal timing surveys may be necessary.

It is common practice for MAP-approved LinSig or TRANSYT models to be submitted with Base Vissim models. If not the case, the DE must produce, and provide to the MAE, LinSig Skeleton models for more complex junctions to facilitate auditing of signal data in Vissim as outlined in section **B9.1.1**. These LinSig Skeleton models need to contain signal data, though no flow data is required. If Base LinSig or TRANSYT models have been submitted with Vissim models, it is essential that these are approved MAP Stage 3 models.

At VMAP Stage 2 it is expected that Signal Heads are placed in the modelled network. These should be positioned on links rather than connectors, and at least two metres upstream of the end of the link / start of the connector.

The **Traffic Modelling Guidelines** recommends that VAP is used for implementing signal control logic and timings in Vissim (including Fixed Time), unless more detailed UTC-Vissim modelling is required.

VAP signal control should be structured and implemented by the DE. The MAE should therefore understand VAP in order to audit the signal control logic (***.vap**) and interstage files (***.pua**). All VisVAP (***.vv**) files must be provided by the DE to aid the auditing process. The recommended method for modelling demand-dependent stages is further described in the **Traffic Modelling Guidelines**.

Where TfL's UTC-Vissim interface is used, both the model and traffic cell(s) must be set up correctly, including:

- In the Vissim model:
    - Signal Controllers, Signal Heads and Detectors configured and named appropriately. Note that changing the filename of the Vissim (***.inpx**) file or use of Scenario Management may corrupt the signal configuration (***.cfg**) files.

- In the traffic cell(s):
    - The MAE should consult with the relevant TfL Network Manager within NPD to ensure that traffic cells are properly configured, including:
        - Junction configuration data;
        - Plans;
        - Timetables;
        - Procedures;
        - Gating / System Activated Strategy Selection (SASS); and
        - SCOOT configuration data.

Once Signal Controllers, Signal Heads, Detectors and signal timing plans have been implemented in Vissim, the DE must check, and MAE confirm, that signals are operating correctly and correspond to the signal data provided. At VMAP Stage 2, the following need to be checked:

- Controller configurations;
- Cycle times;
- Stage change points;
- Stage durations;
- Interstage design:
    - Phase intergreens;
    - Phase delays;
- Critical signal offsets;
- Demand dependency Detectors (if used);
- Bus / tram Detectors and Bus / Tram Priority (if present); and
- SCOOT and SASS Detectors (for UTC-Vissim).

The DE and MAE should use the Signal Times Table Window in Vissim to verify the operation of modelled Signal Controllers. This allows intergreens, phase durations and stage change points to be visualised. Although traffic flows are not required at VMAP Stage 2, demand-dependent operation can either be checked with dummy flows or using Vissim's interactive test functionality to manually trigger Detector demands.

Signal timings will be further checked at VMAP Stage 3 to ensure correct calibration of demand-dependent stage demands, and additional checks may be necessary where traffic flows are expected to further influence signal behaviour.

V.217 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in V.201 – V.216.

The DE should take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the VMAP Stage 2 Check Sheet (**MQA-0544/V2**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in V.201 – V.216.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

9.2.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks V.201 – V.217 and there are no other issues the MAE will approve the model and authorise the relevant VMAP Stage 2 Check Sheet (**MQA-0544/V2**). If the MAE fails the model on any of these checks, or has highlighted other significant issues with the model, it will be rejected with the reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed VMAP Stage 2 Check Sheets (**MQA-0544/V2**), which should be copied to NMSchemeAssessments@TfL.gov.uk.

If there are fundamental flaws within the model, the MAE may organise a meeting with the DE. At the MAE's discretion, the P may also be invited as they are often the budget holders for the DE's work and may need to discuss if the quality of work is as agreed in the project brief.

End of VMAP Stage 2

VMAP STAGE 3

9.3 VMAP Stage 3, Vissim Validated Base Model Submission

9.3.1 What is a Vissim Validated Base Model?

VMAP specifies that a Vissim Validated Base model should be based on an approved VMAP Stage 2 model (see **B9.2**). In addition, the DE will be required to demonstrate that the models have been validated against on-street data that is independent of data used for model calibration.

The **Traffic Modelling Guidelines** provide guidance to support Vissim model validation, including validation of saturation flows and the use of random seeds to demonstrate model stability. For this reason validation should be conducted using a minimum of twenty seed values, although more may be required in highly variable models, and results presented as a mean average of all simulation runs. The seed values used should be detailed in the Validation Report and should use a common seed increment, in essence there should be no 'cherry picking' of seed values.

> Validated Base models are required for all time periods in VMAP Stage3.

9.3.2 VMAP Stage 3 Check Sheet

VMAP Stage 3 has a Check Sheet (**MQA-0544/V3**), which must be completed by the MAE when auditing the models.

> A separate VMAP Stage 3 Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

V.301 Validation Report

Validated Base model submissions must be accompanied by a Validation Report, as described in Part B of the Traffic Modelling Guidelines.

The DE should ensure that the following information is provided:

- Detail on modelled traffic flows:
  - When the traffic surveys were carried out and by whom;
  - What data was collected during the traffic surveys; and
  - Vehicle Inputs and Compositions used in Vissim.
- Implementation of the agreed routing methodology described at VMAP Stage 2. This should include details of the source data, how it has been processed, associated Vehicle Classes / Routing Decisions and any significant refinements made during model calibration;
- Any site observations or assumptions used for the calibration of give-ways, yellow boxes, priority junctions and roundabouts;
- Observation and refinement of network operation, including:
  - Flare usage and behaviour observed on-site;
  - Observed network bottlenecks;
  - Parking / loading restrictions and behaviour; and
  - Adjustments to RSAs checked at VMAP Stage 2.
- Evidence of stopline saturation flow validation against observed measurements reported in VMAP Stage 2;
- Details of public transport modelling, including data sources for timetable frequencies, dwell times and travel times;
- Details of cyclist and pedestrian modelling;
- Traffic signal operation and demand dependency adjustments:
  - Appropriate traffic signal operation with traffic flows present;
  - UTC demand dependency data and any site observations; and
  - Explanation of how demand-dependent stage frequencies have been calibrated and demonstrated to be representative.
- Random seed parameters used for model results and validation;
- Details of any other adjustments from VMAP Stage 2 model;
- Queue length analysis and commentary, including details of observed congestion or recorded Underutilised Green Time (UGT).
- Evidence of journey time validation for agreed vehicles and routes; and

- Details of any other modelling issues, assumptions or technical challenges.

V.302 Vehicle Inputs

The DE must add Vehicle Inputs for every significant entry link in the model to load traffic on to the network. Vehicle inputs are normally expected to be informed by recent traffic surveys and should cover the vehicle classifications agreed at MAP Stage 1 and documented in the MED.

Vehicle inputs should be entered using 'Exact' volumes of vehicles rather than 'Stochastic' volumes and are usually entered in 15-minute time increments to capture observed traffic profiles. Since Vissim expects vehicular flows to be entered in hourly flow figures, each 15-minute vehicle count must be multiplied by four to define an equivalent 15-minute Vehicle Input in vehicles per hour.

While Vehicle Inputs should match observed flows during the modelled peak period, they can be adjusted during the warm-up period to ensure that modelled queues are representative of observed conditions at the start of the peak. If a cool-down period is used Vehicle Inputs can similarly be adjusted depending on the purpose of any cool-down analysis, while ensuring data collection during the peak period is unaffected (see **V.317**).

Each Vehicle Input must be associated with a corresponding Vehicle Composition, describing the proportion of different Vehicle Types the Vehicle Input applies to. The **Traffic Modelling Guidelines** recommends the use of pre-defined Vehicles Compositions for each Vehicle Type, with separate Vehicle Inputs used on every entry link for each modelled Vehicle Type to simplify data entry from traffic surveys. Alternatively, a single Vehicle Input can be used on each link with appropriate Vehicle Compositions defined to represent observed Vehicle Type proportions.

As well as specifying the proportion of Vehicle Types, Vehicle Compositions also associate each Vehicle Type with a Desired Speed Distribution that is used to allocate vehicle speeds on model entry. This must also be checked for each Vehicle Type to ensure it is appropriate, which should typically reflect the speed limit in force at each entry link (unless DSDs have been placed at the beginning of entry links for this purpose, as advised in **V.213**).

V.303 Vehicle Routing

Vehicle routes must be coded using the routing assignment methodology agreed at MAP Stage I, documented in the MED and checked during VMAP Stage 2. Vehicle Classes are used to group similar Vehicle Types in Vissim for routing purposes, and these should be detailed in the routing methodology.

Static routes should typically be used to route modelled vehicles from model entry to model exit. This routing information is usually derived from tactical modelling, which is a requirement when following the Three Stage Modelling Process (see **A2.3.2**). For smaller models, or for specific Vehicle Classes such as cyclists, the MAE may consider local static routing derived from junction turning counts to be acceptable.

All entries to the model will require at least one static Routing Decision covering entering vehicles, with a separate Routing Decision used for each Vehicle Class agreed in the routing methodology.

Routing Decision starting points should be placed sufficiently upstream of any junction to allow vehicles to get into the appropriate lanes. Where local Routing Decisions are used at each junction this can be further accommodated using the 'Vehicle Routing Decisions Look Ahead' Lateral Driving Behaviour and the 'Combine Static Routing Decisions' property of the relevant Routing Decision. Alternatively, the MAE may require that local Routing Decisions are permanently merged using the 'Combine Routes' feature.

All static Routing Decisions should have sensible link-connector sequences, and any use of Partial Routes should be appropriately justified. Vehicle behaviour should be observed by the DE and MAE to ensure compliance with Routing Decisions and that no unrouted vehicles exist within the network.

For each Routing Decision, relative flows on each route should correspond with the source agreed in the routing methodology, with any significant adjustments during calibration recorded and justified. Further guidance on routing in Vissim can be found in the **Traffic Modelling Guidelines**.

V.304 Priority Rules / Conflict Areas

TfL recommends the use of Priority Rules for most give-way conflicts. This is because they are individually placed within the road network, which gives them more flexibility to replicate observed conditions.

Priority Rules have an impact on both congestion and vehicle journey times, especially in networks with give-way junctions and opposed movements at signalised junctions. It is important that the DE calibrates Priority Rules correctly in Vissim when replicating observed behaviour. Site visits, observation notes and video footage should be used as a guide when determining the operation of give-ways and Conflict Areas.

For Priority Rules the DE and MAE should ensure that the following are appropriate:

- The position of yielding markers;
- Priority between different streams of traffic;
- Operation of the Priority Rules;
- Headways (time and distance); and
- Keep Clear / Yellow Box areas.

With respect to Conflict Areas, the DE must ensure that movement priority, visibility, gaps and safety distance factors are specified to accurately reflect on-street observations, which will be checked by the MAE. The use of Conflict Areas is most suited to locations such as zebra or signalised crossings, where the area of conflict is clearly defined.

There may be some instances where Priority Rules are used to model complex behaviour such as courtesy behaviour for traffic leaving side roads, vehicles forcing themselves out of side-roads or buses given priority at off-line bus stops. Where possible, the modelling of complex behaviour should be supported with photo or video footage.

V.305 Speed Refinement

At VMAP Stage 2, DSDs and RSAs were placed within the modelled network with assumed Desired Speed Distributions, however traffic flows were not present. At VMAP Stage 3, DSDs and RSAs should therefore be checked to confirm expected behaviour with traffic present, and further refined where necessary.

Appropriate Desired Speed Distributions should be associated with each DSD and RSA, which will be checked by the MAE. Where separate distributions are applied to different Vehicle Classes, the DE should ensure that each Vehicle Class uses an appropriate Desired Speed Distribution. For DSDs, these should be based on the predefined Vehicle Classes and distributions within the TfL Vissim Template for relevant speed limits, which should not be changed unless justified by supporting data.

It is important to ensure that DSDs and RSAs are not used to artificially influence journey times and thereby manipulate journey time validation.

It is also recommended in the **Traffic Modelling Guidelines** that RSAs are not used to generate artificial queuing, but instead that the cause of any observed queuing is replicated where possible if it falls within the model boundary.

V.306 Network Operation

The initial network structure was defined during VMAP Stage 2, however it is not until traffic is simulated that the structure of the modelled network can be fine-tuned by the DE. The DE's experience, with guidance from the CE and MAE, will help inform the optimum network structure to deliver the most appropriate representation of on-street behaviour and ensure the modelled network is 'fit for purpose'.

The DE should ensure that the following are correctly modelled and reported:

- Network changes from the approved VMAP Stage 2 model;
- Lane / flare utilisation by appropriate vehicles and traffic movements;
- Lane changing behaviour;
- Traffic stream merges / diverges;
- Exit-blocking;
- Bottlenecks in the network;
- Queuing;
- Notable network observations; and
- Overtaking.

The DE should maintain an active dialogue with the MAE throughout **V.306** as this allows the DE to explain the techniques used, for approval by the MAE. Techniques may not be approved if they achieve certain behaviour at the cost of unrealistically representing on-street conditions.

Queue lengths and locations should be representative of on-street conditions. It is strongly recommended that the DE carries out site visits and records evidence of behaviour calibrated in the Vissim model, including photos and videos. The MAE may ask for evidence to corroborate model behaviour against observed on-street conditions.

V.307 Saturation Flows

The DE must ensure that junction stopline saturation flows in Vissim are validated against the data previously measured and submitted during **V.214**. Saturation flows can be measured from Vissim in several ways, but the three preferred approaches are:

- Using Discharge Record Evaluation (***.dis**) output files, as described in the Vissim manual. A TfL spreadsheet is available that can assist with analysing these files against measured saturation flow data;
- By producing output from a VAP routine that reports saturated vehicle headways; or
- By manually counting vehicles across stoplines and recording simulation times, replicating the way that saturation flows are collected on site. This method, although time-consuming, may be required in certain circumstances, particularly in the presence of cyclists.

Comparison of the observed and modelled saturation flows is required during model validation as it provides a measure of the capacity of signal-controlled approaches.

Where RSAs are applied to turning movements near stoplines, the turning movements can significantly affect stopline saturation flows. In these situations, priority should therefore be given to calibration of the ahead movements at stoplines before the turning movements.

Saturation flows may be observed to vary between peaks in saturation flow surveys or associated MAP Stage 3-approved LinSig or TRANSYT models, for example due to tidal flow movements. Where this is the case those saturation flows should be validated separately in Vissim for each peak.

All observed and modelled saturation flows should be tabulated and the percentage error between the two values reported.

> Modelled saturation flow values must be within 10% of observed values, or values used in any corresponding approved LinSig or TRANSYT modelling.

V.308 Public Transport Modelling

The purpose and scope of the Vissim model, as agreed during MAP Stage 1 and documented in the MED, will determine the level of detail required for public transport modelling.

The DE should ensure that the following public transport service elements are correctly calibrated in addition to those in VMAP Stage 2, which will be checked by the MAE:

- Service frequencies;
- Route offsets;
- Dwell times for stops and stands;
- Interference with other traffic.

The DE should provide the MAE with details and sources of all data used to calibrate public transport routes and their frequencies, to allow necessary audit checks. Data collection may also involve measurement of dwell times per route and time period, as well as passenger numbers boarding or alighting at each stop. Journey time data and dwell times for TfL bus routes can be obtained via TfL's iBus system, as referenced in the **Traffic Modelling Guidelines**.

The interaction between public transport and general traffic can have a significant impact on network performance. Site visits should therefore be carried out by the CE and DE to ensure that any disruptive behaviour that influences junction or link capacity has been modelled correctly, which should be detailed in the Validation Report (**V.301**). Site visits should also be undertaken by the MAE, which can include the DE and CE, to observe behaviour and ensure it is accurately reflected in the submission.

Public transport journey times should be validated in **V.317** for each route in the same manner as for general traffic. Modelled journey times for whole routes and individual route segments should be averaged over multiple seeds (minimum twenty) and be within 15% of observed journey times. Any grouping of routes for reporting or validation purposes must be justified and agreed with the MAE. It may not be considered necessary to validate journey times for individual routes that are particularly short or contain fewer than 2 modelled bus stops within the model, but this must be confirmed with the MAE.

V.309 Cyclist Modelling

The purpose and scope of the Vissim model, as agreed during MAP Stage I and documented in the MED, will determine the level of detail required for cyclist modelling. Cyclist behaviour can be complex, vary considerably by location / situation, and can significantly impact overall network performance. It is therefore important to ensure that where cyclists are included, they are modelled appropriately.

Where present, cyclist-specific infrastructure such as segregated cycle lanes and stoplines, mandatory / advisory cycle lane markings, Advanced Stop Lines (ASLs), early release cycle signals and two-stage turn junction layouts should be checked for accuracy. Saturation flow calibration should take account of cyclist influence where it is observed to be significant, following advice in Part C of the **Traffic Modelling Guidelines**.

Since cyclists and other two-wheelers typically filter through queuing traffic and have significantly different performance characteristics to other vehicles, overtaking and lateral behaviour are particularly important. The TfL Vissim Template includes pre-defined behaviours that should be used as a starting point for cyclist modelling, along with an accompanying guidance note. Part C of the **Traffic Modelling Guidelines** includes further guidance on cyclist modelling in microsimulation models.

Driving behaviour parameters from **V.209** that are important for cyclist modelling and may need to be varied include:

- Following:
    - Look ahead distance (min and max);
    - Observed vehicles; and
    - Look back distance (min and max).
- Lateral:
    - When modelling cyclists, refer to the TfL Vissim Template guidance note for advice on lateral behaviour parameters.

Modelled cyclist flows should be compared to observed counts for turns at junctions in the same way as for other vehicles in **V.315**, averaged over a minimum of twenty different simulation runs.

It is possible to validate journey times for cyclists using either GPS data or floating survey techniques, but whether it is a requirement to do so will depend on the model purpose and scope. Where it is considered appropriate to do so, the routes to use for cyclist journey time validation must be agreed and documented in the MED.

Journey time validation criteria are as for other vehicles in **V.317**, averaged over a minimum of twenty different simulation runs. However, the exact methodology may vary, which must be agreed with the MAE and documented in the MED. Part C of the **Traffic Modelling Guidelines** includes further guidance on cyclist journey time validation.

Where cyclist journey times have not been validated, assessments of cyclist performance should not be reported in detail, however limited reporting can be included for indicative purposes only.

V.310 Pedestrian Modelling

The purpose and scope of the Vissim model, as agreed during MAP Stage 1 and documented in the MED, will determine the level of detail required for pedestrian modelling.

Where detailed pedestrian modelling is required, it will be covered by a separate PMAP audit covering pedestrian modelling elements (see Chapter **B7**). In this case MAP Stage 3 requires joint PMAP / VMAP approval.

There are other situations in a Vissim model where pedestrian calibration may be required, even if pedestrians are not being modelled in detail. These include:

- Calibration of demand-dependent stages using pedestrian inputs and Detectors. This is particularly important for Toucan crossings where cyclists are modelled, and stages that are demanded by both pedestrians and vehicles; and
- Zebra crossings or informal crossings.

The DE must ensure, and MAE verify, that any modelled pedestrian activity is appropriate with respect to the model purpose, calibrated correctly and representative of observed conditions.

V.311 Traffic Signals and Demand Dependency

At VMAP Stage 2 the modelled traffic signal timings and operation of demand-dependent stages were checked in the absence of traffic. At VMAP Stage 3, they should be rechecked to confirm that signal timings are appropriate and that demand-dependent stages are operating correctly with traffic present.

UTC demand dependency data, where available, should be recorded to confirm any site observations. If pedestrian counts are taken, the frequency of demand can be recorded on-site but should be supported by UTC data.

The DE should ensure that demand-dependent stages within the network show a frequency that is within 10% of that observed on-street. The DE should show evidence of this in the Validation Report (**V.301**), supplying any supporting files to the MAE for auditing such as any VAP trace (***.trc**) files generated during simulation runs.

The DE should provide a table comparing modelled appearances of demand-dependent stages against observed data. It is recommended that the table should include:

- Signal Controller;
- Stage Number;
- Controller type (VAP / UTC-Vissim);
- Detector Port Number(s);
- Observed frequency;
- Average modelled frequency;
- Difference (Modelled - Observed); and
- Any additional comments, and justification if a demand-dependent stage is forced.

V.312 Random Seeds

As explained in the **Traffic Modelling Guidelines**, randomness is used in Vissim to represent daily variation, such as in vehicle arrival patterns and the characteristics of individual vehicles and drivers. By performing multiple simulation runs with differing random seeds, an average can be obtained that is considered more representative of 'typical' conditions than a single simulation run.

It is good practice to vary the random seed during model development so that calibration is not just based on observation from a single seed. When carrying out multiruns to collect model results it is similarly advisable to observe behaviour during different runs. When averaging model results over multiple seeds it can also be helpful to investigate variability across runs to determine if a particular seed has an issue.

When submitting a VMAP Stage 3 Vissim Validated Base model, the DE must specify the random seed parameters used to generate the reported model results, as described in B9.3.1. The following should therefore be documented in the Validation Report (V.301):

- **Random seed:** can be any positive integer;
- **Random seed increment:** can be set to any reasonable value; and
- **Number of runs:** should set to a minimum of twenty, although a higher value may be required for highly variable models.

Once a model is validated the above parameter values must not be changed when reporting model results.

By using the reported seed parameters the MAE can reproduce model results during auditing, and ensure that future modelling assessments only evaluate the impact of deliberate changes to the model rather than the effects of random variation.

It is important that the random seeds used for individual simulation runs use a common seed increment and are not 'cherry picked' to artificially improve model validation. The MAE should therefore be able to repeat model results in a single continuous multirun using the reported simulation parameters without discarding any seeds considered 'unsuitable'.

V.313 Other Adjustments from Stage 2 Model

The main changes expected in the VMAP Stage 3 modelling are likely to have been covered by MAP checks V.302 – V.312, relating to specific changes that should be detailed in the Validation Report (V.301).

Any other software settings or model parameters checked at MAP Stage 2 that are not covered by the above checks should typically remain unaltered.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked at MAP Stage 2, or that any changes made have been explained with suitable justification and are considered reasonable.

V.314 Model Errors / Warnings

Vissim and VAP error (***.err**) files are generated at the end of a simulation. These files should be interrogated by the DE and MAE as they may indicate significant errors that may not otherwise be obvious, including:

- Vehicles or buses / trams removed from the network;
- Vehicles or buses / trams unable to follow their prescribed route;
- Not all vehicles being loaded onto the network during the simulation;
- Vehicles or buses / trams following circular paths;
- Minimum green and/or minimum stage length violations; and
- Unusual signal changes.

Ideally, no error files should be produced at the end of simulation runs in a model submission. However, small error files with non-critical error messages are acceptable. The DE must seek further advice from the CE or MAE if unsure about the type of errors that have been produced.

> Large numbers of model errors can indicate significant issues with the model.

For models with many error file entries, and for simultaneous checking of error files from multiple seeds, a macro-enabled spreadsheet is available from TfL to aid the process of error file analysis.

Details of errors in the model submission must be reported. The MAE must be satisfied that all significant model errors have been resolved and that any remaining are small in number and/or considered non-critical.

V.315 Base Traffic Flow Comparison

The Validation Report (**V.301**) should contain evidence comparing modelled traffic flows and turning counts against flows and turning counts recorded on-site.

The DE must ensure that modelled traffic flows and turning counts closely match surveyed data, which will be verified by the MAE. The GEH statistic should be used for flow comparison, which is detailed within the **Traffic Modelling Guidelines**. GEH is used as a standard measure of the 'goodness of fit' between observed and modelled flows. Unlike flow comparison using percentage differences, the GEH statistic places more emphasis on larger flows than on smaller flows.

When comparing modelled flows to observed flow volumes, GEH values less than five are required for each routed Vehicle Class and for the total traffic flow. However, GEH values less than three are required for all critical or important links within the model area. Results should be presented in the Validation Report (**V.301**), showing all observed and modelled flows together with calculated GEH values. Modelled flows should be averaged over multiple seeds, as described in **B9.3.1**. Significant discrepancies between modelled and actual traffic flows may suggest an error or that further refinement is required, which should be highlighted and discussed with the MAE.

> All entry links into the network should show modelled flows within 5% of observed flows. This requirement should be achievable since vehicle flows are direct input values for entry links.

If necessary, entry links should be extended so that all vehicles are able to enter the network. Consideration should be given to whether future demand or proposals are likely to increase queuing when assessing entry link lengths. Entry links should be long enough so that a journey time marker can be placed beyond the back of any queue in the Base, Future Base and Proposed models.

V.316 Queue Length Analysis

Comparison of modelled queue lengths to observed queues is a common method of calibration. However, it is not considered suitable for validation purposes in Vissim models since queue measurement can be subjective, and queue comparison for entry links will be flawed if any latent demand is not accounted for.

Modelled queues should, however, correlate reasonably with observed queuing behaviour from site visits and aggregated onboard GPS-sourced datasets. Significant discrepancies may indicate that areas within the model require further calibration. The MAE must be satisfied that queues appear reasonable and that there are no indications of unusual queuing behaviour.

It is possible that queue length output data will be required for proposal assessment, which should be specified in the MED. Queue length comparison can provide an indication whether queues have grown longer or shorter as a result of modelled proposals, but should not be used as a prediction of exact queue length.

If turning count traffic surveys have been used to determine model input flows, then no significant queues should exist on model entry links as the survey data represents flows crossing the stopline. However, queues may occur at the start of the peak hour due to high traffic demand during the warm-up period, and small queues may also form due to fluctuation in vehicle arrival patterns.

V.317 Journey Time Validation

Journey time validation is typically regarded as the most reliable measure of validation for a Vissim model. Journey times must be validated for all agreed vehicles and routes, which will be documented in the MED and may include critical arterial routes, key traffic movements likely to be affected by proposals, public transport routes and cyclists.

> Modelled journey times should be averaged over multiple seeds (minimum twenty, as described in **B9.3.1** and be within 15% of surveyed on-street journey times. Journey time output should be measured for vehicles originating from the start of the route, and be presented as the cumulative journey time for individual journey time segments as well as the total journey time for the complete route.

Travel time measurements should be configured in Vissim to be aggregated 'by time of passing the destination section', as described and illustrated in the **Traffic Modelling Guidelines**, so that journey time measurements are not affected whether a cool-down period is included in model runs. It may also be necessary to restrict journey time measurements from Vissim to the same vehicle type that the site measurements were based on, such as private vehicles, buses, taxis or cyclists.

The MAE will need to be satisfied that journey time validation has been demonstrated according to the principles set out in Part B of the Traffic Modelling Guidelines. If the MAE is not satisfied that the model has been validated satisfactorily, it will not be approved at VMAP Stage 3.

V.318 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **V.301 – V.317**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the VMAP Stage 3 Check Sheet (**MQA-0544/V3**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **V.301 – V.317**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

9.3.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **V.301 – V.318** and there are no other issues then, referring back to the model purpose, as agreed at MAP Stage 1 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the VMAP Stage 3 Check Sheet (**MQA-0544/V3**).

If the MAE fails the model on any of the checks **V.301 – V.318**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed VMAP Stage 3 Check Sheets (**MQA-0544/V3**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of VMAP Stage 3

VMAP STAGE 5a

9.4 VMAP Stage 5a, Vissim Future Base Model Submission

9.4.1 Introduction

MAP Stage 5a is an optional MAP stage that is required when the scheme assessment is following the Three Stage Modelling Process (see **A2.3.2**). The need for Future Base models and corresponding MAP Stage 5a audits is typically initially discussed during the MAP Stage 1 Base Scoping Meeting and confirmed at MAP Stage 4.

Much of the work, both in terms of creating and auditing a Vissim Model, is completed when generating fit for purpose Base modelling. Once VMAP Stage 3 has been passed there is often a relatively small amount of work required to complete the remaining stages of VMAP. In many cases there will be no difference to the network structure and the Future Base scenario will only require changes to the traffic flows and any signal optimisation.

> Future Base models are required for all time periods in VMAP Stage 5a.

The DE should make a copy of the MAP-approved Base models and use them as a starting point for Future Base model development, updating them to reflect expected changes in the future year as agreed at the MAP Stage 4 meeting. These should include all future schemes considered likely to have been implemented but excluding the specific scheme under assessment. These schemes may have existing modelling available to help inform Future Base model development. Changes that may need to be considered include:

- **Demand changes** – due to background growth, development flows, or reassignment resulting from other schemes. These will require changes to Vehicle Inputs and Routing Decisions;
- **Network changes** – physical layout changes within the model boundary resulting from schemes other than the one being assessed. These will typically involve changes to link structure and RSA calibration using estimated saturation flows; and

- **Signal timing changes** – within the model boundary resulting from background growth, the influence of other schemes or associated mitigation measures. This may involve changes to Signal Controller configurations, VAP logic, methods of control and phase or stage timings.

The Future Base model results will be used as a reference to compare the Proposed model results against, which is considered more meaningful than comparing against the Base model results alone.

It is common practice that tactical or strategic models (such as ONE / LoHAM), and signal optimisation models (such as LinSig or TRANSYT) are produced along with Vissim models during scheme assessment, which will be separately audited. The input growth, vehicle routes and signal timings from these models are typically incorporated into Vissim models, and manually fine-tuned where necessary. If signal timings are subsequently fine-tuned in Vissim, the DE should be aware that all sources of signal timing information must be in agreement within the final submission. Part B of the **Traffic Modelling Guidelines** contains a suggested strategy for traffic signal optimisation.

9.4.2 VMAP Stage 5a Check Sheet

VMAP Stage 5a has a Check Sheet (**MQA-0544/V5a**), which must be completed by the MAE when auditing the models.

> A separate VMAP Stage 5a Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

V.501 Future Base Report

Future Base model submissions must be accompanied by a Future Base Report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria **V.502** – **V.514**, together with an assessment of the likely operation of the Future Base network.

As for the Validation Report in VMAP Stage 3, it is vital that the DE communicates all their assumptions relating to the Future Base modelling. All changes to the models should be clearly stated, including the reasoning behind the changes and any supporting information.

Clear comparisons must be made between the Validated Base model results and the Future Base model results for the corresponding periods, including analysis of any differences and commentary on impacts to network operation.

V.502 Scenarios

Where Scenario Management is used, individual scenarios should be named appropriately so that the purpose of each scenario is clear. It is particularly important to identify which modelled scenario is being submitted for auditing so that the audit can proceed.

To avoid ambiguity, the **Traffic Modelling Guidelines** describes a recommended method to export individual scenarios from Scenario Management as standalone Vissim models prior to model submission. When doing so, it is important to check that any necessary external files such as signal control and background files are included with the model submission and referenced correctly so that no errors are encountered.

Use of Scenario Management, and whether submissions should be exported as standalone models, should be discussed and agreed with the MAE.

The MAE must confirm that where Scenario Management has been used:

- Submitted scenarios have been successfully exported as standalone Vissim models for auditing, without any errors and including any necessary external files; or
- Use of Scenario Management has been agreed for model submission, all scenarios are named appropriately to clearly describe their purpose and the specific scenario being submitted for auditing has been identified.

V.503 Physical Layout Changes

The Future Base modelling must be updated to reflect any physical layout changes expected in the future year that fall within the boundary of the

Vissim modelling, excluding the scheme under assessment. This may include:

- Changes to the network structure (links and connectors);
- Changes to DSDs, reflecting new speed limits;
- Changes to RSAs, including calibration of predicted saturation flows;
- Changes to Priority Rules or Conflict Areas;
- Changes to public transport stop locations and bus / tram lanes (including hours of operation); and
- Localised changes to routing due to banned traffic movements.

Any supporting data that is used to calibrate physical layout changes in Vissim should be provided, including any background imagery or CAD drawings.

The Future Base Report (**V.501**) should identify where saturation flows are expected to change from the Base model as a result of layout changes and how estimated saturation flows have been determined. Evidence should also be presented to demonstrate that RSAs have been suitably calibrated in Vissim to be representative of the predicted saturation flows, meeting the criteria previously defined in **V.307**.

The MAE must be satisfied that any predicted saturation flows are reasonable, and that they have been calibrated in Vissim correctly. Any model adjustments that impact lane usage or queuing should also be reviewed.

V.504 Traffic Signal Changes

The Future Base modelling must be updated to reflect any traffic signal controller or timing changes expected in the future year that fall within the boundary of the Vissim modelling, excluding the scheme under assessment. This may include:

- Changes to Signal Controllers or Signal Heads;
- Changes to traffic signal methods of control or controller logic;
- Changes to traffic signal phases, stages, intergreens, phase / stage minimums or phase delays;
- Changes to stage timings or cycle times, due to changes in demand or mitigation measures. Where signal timings are changed care should be taken to ensure critical offsets are maintained;

- Changes to Detectors for demand-dependent stage operation, bus / tram priority, SCOOT or SASS; and
- Adjustments to account for assumed changes in pedestrian demands.

The Future Base Report (**V.501**) should comment on any changes to the frequency of demand-dependent pedestrian stages from the Base model. Where any assumptions or estimates are used they should be detailed for the MAE to review.

The MAE will audit stage timings in Vissim to ensure they correlate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design. If signal timings are subsequently fine-tuned in Vissim, the DE should be aware that all sources of signal timing information must be in agreement within the final submission.

V.505 Future Base Traffic Flows

The methodology to derive and apply Future Base traffic flow inputs and routing will have been discussed and agreed at the MAP Stage 4 meeting and documented in the MED. There are different approaches that could be taken depending on the purpose of the model and the agreed modelling methodology. These may include manual changes to existing Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or more detailed adjustments informed from tactical modelling to capture wider network influence.

The DE should provide the MAE with the detailed methodology, assumptions, spreadsheets and other supporting data used to determine and implement the Future Base traffic flow inputs and routing.

The Vissim model traffic flow outputs for the Base and Future Base models must be compared for the MAE to review.

V.506 Public Transport Modelling

The Future Base modelling must be updated to reflect any public transport changes expected in the future year, excluding the scheme under assessment, that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Bus / tram routes and service frequencies;
- Bus / tram stop and stand locations

- Bus / tram stop dwell times;
- Bus / tram lanes (including hours of operation); and
- Bus interaction with other traffic, including overtaking and lane or flare usage in the vicinity of bus stops and bus lanes.

The Future Base Report (**V.501**) should provide details of any modelling amendments relating to public transport, along with supporting data.

The DE should analyse the model results and provide a commentary summarising changes in journey times for all agreed public transport routes in each modelled time period.

V.507 Cyclist Modelling

The Future Base modelling must be updated to reflect any changes in cyclist activity or infrastructure expected in the future year, excluding the scheme under assessment, that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Cyclist numbers and their routing, either due to background growth or as a result of specific schemes expected to influence cyclist activity;
- Cycle lanes (with or without segregation);
- Cyclist phases, ASLs and two-stage turns at traffic signals;
- Cyclist influence on general traffic behaviour, including assumed lane or flare usage in the vicinity of cycle lanes and at junctions.

The DE should provide details of any modelling amendments relating to cyclists or cycle infrastructure in the Future Base Report (**V.501**). Saturation flow calibration for cyclists should follow the advice in Part C of the **Traffic Modelling Guidelines**.

Where Base cyclist journey times were not validated, assessments of cyclist performance should not be reported in detail, however limited reporting can be included for indicative purposes only.

V.508 Pedestrian Modelling

The purpose and scope of the Future Base model, as agreed during MAP Stage 4 and documented in the MED, will determine the level of detail required for pedestrian modelling.

Where detailed pedestrian modelling is required, it will be covered by a separate PMAP audit covering pedestrian modelling elements (see Chapter **B7**). In this case MAP Stage 5a requires joint PMAP / VMAP approval.

The Future Base model must allow for sufficient appearance of pedestrian demand-dependent stages. Any assumptions on future pedestrian activity should be documented and reviewed by the MAE to ensure they are reasonable. Where future pedestrian activity is uncertain, sensitivity analysis may be required, or pedestrian stages modelled as fully demanded to assess a 'worst case' scenario.

V.509 Random Seeds

When submitting a VMAP Stage 5a Future Base model, the DE must document the random seed parameters used to generate model results in the Future Base Report (**V.501**) and confirm they have not been changed from the VMAP Stage 3 Validated Base model.

By using the reported seed parameters the MAE can reproduce model results during auditing, and ensure that any modelling assessments only evaluate the impact of deliberate changes to the model rather than the effects of random variation.

Model runs should be observed using different seeds, and error (***.err**) files from all runs analysed in **V.511**, to identify significant model issues in individual model runs. When averaging model results over multiple seeds it can also be helpful to investigate variability across runs to determine if a particular seed has an issue.

V.510 Other Adjustments from Stage 3 Model

The main changes expected in the Future Base modelling are likely to have been covered by MAP checks **V.502 – V.508**, concerning specific changes to the following areas that should be detailed in the Future Base Report (**V.501**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes; and
- Public transport / cyclist / pedestrian modelling.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

> The software version used must remain unchanged from the approved VMAP Stage 3 model.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The 'Compare and Transfer Networks' menu option can be used to create a Model Transfer file (***.trax**) to identify specific changes between Vissim models.

V.511 Model Errors / Warnings

Vissim and VAP error (***.err**) files are generated at the end of a simulation. These files should be interrogated by the DE and MAE as they may indicate significant errors that may not otherwise be obvious, including:

- Vehicles or buses / trams removed from the network;
- Vehicles or buses / trams unable to follow their prescribed route;
- Not all vehicles being loaded onto the network during the simulation;
- Vehicles or buses / trams following circular paths;
- Minimum green and/or minimum stage length violations; and
- Unusual signal changes.

Ideally, no error files should be produced at the end of simulation runs in a model submission. However, small error files with non-critical error messages are acceptable. The DE must seek further advice from the CE or MAE if unsure about the type of errors that have been produced.

> Large numbers of model errors can indicate significant issues with the model.

For models with many error file entries, and for simultaneous checking of error files from multiple seeds, a macro-enabled spreadsheet is available from TfL to aid the process of error file analysis.

Details of errors in the model submission must be reported. The MAE must be satisfied that all significant model errors have been resolved and that any remaining are small in number and/or considered non-critical.

V.512 Queue Lengths

The Future Base Report (**V.501**) should contain a comparison of Base and Future Base queue lengths and any implications for network operation. This should include all areas of the network identified as critical in the MAP Stage 4 meeting and documented in the MED.

The DE should analyse the model results and provide a commentary summarising changes in network performance for each modelled time period. This should include any issues of concern relating to queue lengths, such as queues exceeding available storage space, blocking issues within junctions or queues reaching to / from neighbouring junctions or other significant locations.

Where pedestrian crossings are present any changes to modelled queues resulting from modelled pedestrian demands should also be reported and commented on.

If Vissim indicates a negative impact on queue lengths these should be investigated by the DE and discussed with the MAE.

V.513 Journey Times

The Future Base Report (**V.501**) must contain a comparison of Base and Future Base journey times for all agreed vehicles and routes, as documented in the MED. The DE should analyse the model results and provide a commentary summarising changes in journey times for all agreed routes and vehicles in each modelled time period.

If Vissim indicates a negative impact on journey times these should be investigated by the DE and discussed with the MAE.

Journey time output should be measured for vehicles originating from the start of the route, and be presented as the cumulative journey time for individual journey time segments as well as the total journey time for the complete route.

Travel time measurements should be configured in Vissim to be aggregated 'by time of passing the destination section', as described and illustrated in the **Traffic Modelling Guidelines**, so that journey time measurements are not affected whether a cool-down period is included in model runs. It may also be necessary to restrict journey time measurements from Vissim to the same vehicle type that the site measurements were based on, such as private vehicles, buses, taxis or cyclists.

V.514 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **V.501** – **V.513**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the VMAP Stage 5a Check Sheet (**MQA-0544/V5a**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **V.501** – **V.513**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

9.4.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **V.501** – **V.514** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the VMAP Stage 5a Check Sheet (**MQA-0544/V5a**).

If the MAE fails the model on any of the checks **V.501** – **V.514**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE and CE of the Approval or Rejection of the submission and provide completed VMAP Stage 5a Check Sheets (**MQA-0544/V5a**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of VMAP Stage 5a

VMAP STAGE 5b

9.5 VMAP Stage 5b, Vissim Proposed Model Submission

9.5.1 Introduction

Proposed models must be based on approved VMAP Stage 3 Base models, or when following the Three Stage Modelling process (see **A2.3.2**) the approved VMAP Stage 5a Future Base models. The DE should update the models to reflect proposed changes as agreed at the MAP Stage 4 meeting. Changes that may be required include:

- **Demand changes** – due to the proposed scheme, which will require changes to Vehicle Inputs and Routing Decisions;
- **Network changes** – physical layout changes resulting from the proposed scheme. These will typically involve changes to link structure and RSA calibration using estimated saturation flows; and
- **Signal timing changes** – resulting from the proposed scheme or associated mitigation measures. This may involve changes to Signal Controller configurations, VAP logic, methods of control and phase or stage timings.

Proposed models are required for all time periods in VMAP Stage 5b.

During scheme assessment, Proposed model results will be compared against Future Base model results (or Base model results if appropriate), as agreed at MAP Stage 4 and documented in the MED.

It is common practice that tactical or strategic Proposed models (such as ONE / LoHAM) and signal optimisation Proposed models (such as LinSig or TRANSYT) are produced along with Vissim Proposed models during scheme assessment, which are separately audited. The input changes, vehicle routes and signal timings from these models are typically incorporated into the Proposed Vissim models, and manually fine-tuned where necessary. If signal timings are subsequently fine-tuned in Vissim, the DE should be aware that all sources of signal timing information must be in agreement within the final submission.. The **Traffic Modelling Guidelines** contain a strategy for traffic signal optimisation.

Proposed models should reflect the likely operation of the proposed network and should not include unrealistic changes to the initial calibration of the network that was undertaken in VMAP Stages 2, 3 and 5a. Optimising driver behaviour or network operation to obtain overly optimistic levels of saturation and queue lengths should be avoided.

In addition to ensuring that the models are correctly developed from a technical point of view the DE is responsible for demonstrating that the proposals can be accommodated without jeopardising normal day to day operation of the network. This includes maintaining acceptable levels of DoS and queues as well as sufficient provision for expected pedestrian demand.

As a representative of the TfL Traffic Manager, who will have a duty to manage the network if the proposal is implemented, the MAE must decide whether they agree the network is likely to operate satisfactorily on a day-to-day basis. They must therefore highlight any apparent issues or concerns with the proposals, which will prioritise safe, efficient network operation together with relevant TfL / Mayoral policies and guidance.

The DE will receive feedback from MAE and will need to address any highlighted issues. The MAE will use their operational experience and knowledge of the network in making informed comments and decisions.

If required by the model scope the proposed timings within the Vissim model must be suitable to be used as controller-held background timings. This means that the MAE's audit is implicitly asking the DE:

> 'Are you satisfied that, if observing on-site when these proposals are commissioned, the timings in each of the submitted Vissim models would provide appropriate network operation under local control and that the network impacts would be as described in the SIR?'

9.5.2 VMAP Stage 5b Check Sheet

VMAP Stage 5b has a Check Sheet (**MQA-0544/V5b**), which must be completed by the MAE when auditing the models.

> A separate VMAP Stage 5b Check Sheet must be completed for each of the modelled time periods.

This section identifies the audit checks that the MAE is required to carry out, corresponding to individual numbered entries on each Check Sheet.

V.551 SAE-Approved Proposed Methods of Control

Before submitting any Proposed modelling, the DE must submit proposed drawings and methods of control to the MAE. The MAE must ensure that the proposed methods of control and drawings reflect the proposals identified in the MED. Once the MAE has confirmed the details are correct, they can arrange for an Engineering Service Request (ESR) to be undertaken. The SAE will undertake a review to identify issues affecting the legality, maintainability and buildability of the proposals, including safety-critical timings.

Following the review, the SAE will return approved Traffic Signal Option Selection Review forms (**F7356**) to the P, DE and MAE. The MAE must confirm SAE approval has been received for any new or modified signalised infrastructure prior to auditing.

> Lack of an approved Traffic Signal Option Selection Review form for any of the methods of control changes will prevent the MAE from proceeding with VMAP Stage 5b.

V.552 Proposed Model Report

Proposed model submissions must be accompanied by a Proposed Model Report, as described in the **Traffic Modelling Guidelines**. The report needs to contain all necessary information and paperwork in order to allow the accurate assessment of criteria **V.553** – **V.566**, together with an assessment of the likely impact of the proposals.

All assumptions and changes to the models should be clearly stated along with the reasoning behind those changes. There should be clear comparisons between the Base / Future Base model results and the Proposed model results for the corresponding periods.

Comparisons are required for all areas of the network that are deemed critical. The classification of critical and non-critical links within the model should have been identified by the MAE or Network Manager and documented within the MED. If the MAE believes that the DE has not included links in the comparison which are critical then they will ask the DE to amend the report accordingly.

V.553 Scenarios

Where Scenario Management is used, individual scenarios should be named appropriately so that the purpose of each scenario is clear. It is particularly important to identify which modelled scenario is being submitted for auditing so that the audit can proceed.

To avoid ambiguity, the **Traffic Modelling Guidelines** describes a recommended method to export individual scenarios from Scenario Management as standalone Vissim models prior to model submission. When doing so, it is important to check that any necessary external files such as signal control and background files are included with the model submission and referenced correctly so that no errors are encountered.

Use of Scenario Management, and whether submissions should be exported as standalone models, should be discussed and agreed with the MAE.

The MAE must confirm that where Scenario Management has been used:

- Submitted scenarios have been successfully exported as standalone Vissim models for auditing, without any errors and including any necessary external files; or
- Use of Scenario Management has been agreed for model submission, all scenarios are named appropriately to clearly describe their purpose and the specific scenario being submitted for auditing has been identified.

V.554 Physical Layout Changes

The Proposed modelling must be updated to reflect any physical layout changes proposed as part of the scheme under assessment. Where these include changes to signalised infrastructure, proposed drawings will first need to be submitted to the MAE for SAE approval (see **V.551**) before the model audit can proceed.

Physical layout changes may include:

- Changes to the network structure (links and connectors);
- Changes to DSDs, reflecting new speed limits
- Changes to RSAs, including calibration of predicted saturation flows;
- Changes to Priority Rules or Conflict Areas;

- Changes to public transport stop locations and bus / tram lanes (including hours of operation); and
- Localised changes to routing due to banned traffic movements.

Any supporting data that is used to calibrate physical layout changes in Vissim should be provided, including any background imagery or CAD drawings.

The Proposed Model Report (**V.552**) should identify where saturation flows are expected to change from the Base / Future Base model as a result of layout changes and how estimated saturation flows have been determined. Evidence should also be presented to demonstrate that RSAs have been suitably calibrated in Vissim to be representative of the predicted saturation flows, meeting the criteria previously defined in **V.307**.

The MAE must be satisfied that any predicted saturation flows are reasonable, and that they have been calibrated in Vissim correctly. Any model adjustments that impact lane usage or queuing should also be reviewed.

V.555 Traffic Signal Changes

The Proposed modelling must be updated to reflect any traffic signal controller or timing changes included as part of the scheme under assessment. Where these include changes to signalised infrastructure, proposed drawings will first need to be submitted to the MAE for SAE approval (see **V.551**) before the model audit can proceed.

Traffic signal changes may include:

- Changes to Signal Controllers or Signal Heads;
- Changes to traffic signal methods of control or controller logic;
- Changes to traffic signal phases, stages, intergreens, phase / stage minimums or phase delays;
- Changes to stage timings or cycle times, due to changes in demand or mitigation measures. Where signal timings are changed care should be taken to ensure critical offsets are maintained;
- Changes to Detectors for demand-dependent stage operation, bus / tram priority, SCOOT or SASS; and
- Adjustments to account for assumed changes in pedestrian demands.

The Proposed Model Report (**V.552**) should comment on any changes to the frequency of demand-dependent pedestrian stages from the Base / Future Base model. Where any assumptions or estimates are used they should be detailed for the MAE to review.

The MAE will audit stage timings in Vissim to ensure they correlate with any other submitted modelling, contain appropriate stage minimums and demonstrate accurate interstage design. If signal timings are subsequently fine tuned in Vissim, the DE should be aware that all sources of signal timing information must be in agreement within the final submission.

V.556 Proposed Traffic Flows

The methodology to derive and apply Proposed model traffic flow inputs and routing will have been discussed and agreed at the MAP Stage 4 meeting and documented in the MED. There are different approaches that could be taken depending on the purpose of the model and the agreed modelling methodology. These may include manual changes to existing Base / Future Base model flows (such as the application of agreed growth factors or assumed localised rerouting due to banned turns), or more detailed adjustments informed from tactical modelling to capture wider network influence.

The DE should provide the MAE with the detailed methodology, assumptions, spreadsheets and other supporting data used to determine and implement the Proposed model traffic flow inputs and routing.

The Vissim model traffic flow outputs for the Base / Future Base and Proposed models must be compared for the MAE to review.

V.557 Public Transport Modelling

The Proposed modelling must be updated to reflect any public transport changes proposed as part of the scheme under assessment that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Bus / tram routes and service frequencies;
- Bus / tram stop and stand locations
- Bus / tram stop dwell times;
- Bus / tram lanes (including hours of operation); and

- Bus interaction with other traffic, including overtaking and lane or flare usage in the vicinity of bus stops and bus lanes.

The Proposed Model Report (**V.552**) should provide details of any modelling amendments relating to public transport, along with supporting data.

The DE should analyse the model results and provide a commentary summarising changes in journey times for all agreed public transport routes in each modelled time period.

V.558 Cyclist Modelling

The Proposed modelling must be updated to reflect any changes in cyclist activity or infrastructure proposed as part of the scheme under assessment that fall within the modelling scope agreed at MAP Stages 1 and 4. This may include changes relating to:

- Cyclist numbers and their routing, due to proposal changes that are expected to influence cyclist activity;
- Cycle lanes (with or without segregation);
- Cyclist phases, ASLs and two-stage turns at traffic signals;
- Cyclist influence on general traffic behaviour, including assumed lane or flare usage in the vicinity of cycle lanes and at junctions.

The DE should provide details of any modelling amendments relating to cyclists or cycle infrastructure in the Proposed Model Report (**V.552**). Saturation flow calibration for cyclists should follow the advice in Part C of the **Traffic Modelling Guidelines**.

Where Base cyclist journey times were not validated, assessments of cyclist performance should not be reported in detail, however limited reporting can be included for indicative purposes only.

V.559 Pedestrian Modelling

The purpose and scope of the Proposed model, as agreed during MAP Stage 4 and documented in the MED, will determine the level of detail required for pedestrian modelling.

Where detailed pedestrian modelling is required, it will be covered by a separate PMAP audit covering pedestrian modelling elements (see **B7**). In this case MAP Stage 5b requires joint PMAP / VMAP approval.

The Proposed model must allow for sufficient appearance of pedestrian demand-dependent stages. Any assumptions on pedestrian activity under the proposals should be documented and reviewed by the MAE to ensure they are reasonable. Where pedestrian activity under the proposals is uncertain, sensitivity analysis may be required, or pedestrian stages modelled as fully demanded to assess a 'worst case' scenario.

V.560 Random Seeds

When submitting a VMAP Stage 5b Proposed model, the DE must document the random seed parameters used to generate model results in the Proposed Model Report (**V.552**), and confirm they have not been changed from the VMAP Stage 3 / 5a models.

By using the reported seed parameters the MAE can reproduce model results during auditing, and ensure that any modelling assessments only evaluate the impact of deliberate changes to the model rather than the effects of random variation.

Model runs should be observed using different seeds, and error (***.err**) files from all runs analysed in **V.562**, to identify significant model issues in individual model runs. When averaging model results over multiple seeds it can also be helpful to investigate variability across runs to determine if a particular seed has an issue.

V.561 Other Adjustments from Stage 3 / 5a Model

The main changes expected in the Proposed modelling are likely to have been covered by MAP checks **V.553** – **V.559**, concerning specific changes to the following areas that should be detailed in the Proposed Model Report (**V.552**):

- Physical layout changes;
- Traffic signal changes;
- Expected traffic flow changes; and
- Public transport / cyclist / pedestrian modelling.

Any other software settings or model parameters checked in previous MAP stages that are not covered by the above checks should typically remain unaltered.

The software version used must remain unchanged from the approved VMAP Stage 3 / 5a models.

The DE should highlight any other model changes that have been made to the MAE and provide justification why they are considered necessary. The MAE should confirm that no changes have been made to the software settings and model parameters checked in previous MAP stages, or that any changes made have been explained with suitable justification and are considered reasonable. The 'Compare and Transfer Networks' menu option can be used to create a Model Transfer file (***.trax**) to identify specific changes between Vissim models.

V.562 Model Errors / Warnings

Vissim and VAP error (***.err**) files are generated at the end of a simulation. These files should be interrogated by the DE and MAE as they may indicate significant errors that may not otherwise be obvious, including:

- Vehicles or buses / trams removed from the network;
- Vehicles or buses / trams unable to follow their prescribed route;
- Not all vehicles being loaded onto the network during the simulation;
- Vehicles or buses / trams following circular paths;
- Minimum green and/or minimum stage length violations; and
- Unusual signal changes.

Ideally, no error files should be produced at the end of simulation runs in a model submission. However, small error files with non-critical error messages are acceptable. The DE must seek further advice from the CE or MAE if unsure about the type of errors that have been produced.

Large numbers of model errors can indicate significant issues with the model.

For models with many error file entries, and for simultaneous checking of error files from multiple seeds, a macro-enabled spreadsheet is available from TfL to aid the process of error file analysis.

Details of errors in the model submission must be reported. The MAE must be satisfied that all significant model errors have been resolved and that any remaining are small in number and/or considered non-critical.

V.563 Queue Lengths

The Proposed Model Report (**V.552**) should contain a comparison of Base / Future Base and Proposed queue lengths and any implications for network operation. This should include all areas of the network identified as critical in the MAP Stage 4 meeting and documented in the MED.

The DE should analyse the model results and provide a commentary summarising changes in network performance for each modelled time period. This should include any issues of concern relating to queue lengths, such as queues exceeding available storage space, blocking issues within junctions or queues reaching to / from neighbouring junctions or other significant locations.

Where pedestrian crossings are present any changes to modelled queues resulting from modelled pedestrian demands should also be reported and commented on.

If Vissim indicates a negative impact on queue lengths these should be investigated by the DE and discussed with the MAE.

V.564 Journey Times

The Proposed Model Report (**V.552**) must contain a comparison of Base / Future Base and Proposed journey times for all agreed vehicles and routes, as documented in the MED. The DE should analyse the model results and provide a commentary summarising changes in journey times for all agreed routes and vehicles in each modelled time period.

If Vissim indicates a negative impact on journey times these should be investigated by the DE and discussed with the MAE.

Journey time output should be measured for vehicles originating from the start of the route, and be presented as the cumulative journey time for individual journey time segments as well as the total journey time for the complete route.

Travel time measurements should be configured in Vissim to be aggregated ‘by time of passing the destination section’, as described and illustrated in the **Traffic Modelling Guidelines**, so that journey time measurements are not affected whether a cool-down period is included in model runs. It may also be necessary to restrict journey time measurements from Vissim to the same vehicle type that the site measurements were based on, such as private vehicles, buses, taxis or cyclists.

V.565 Operational Assessment

It is important for the DE to ensure that the traffic models delivered for the scheme are fit for purpose (in essence the Base, Future Base and Proposed models give an accurate reflection of the likely network conditions) and have been approved by the MAE. The DE also has to demonstrate that the proposed scheme could be accommodated without risk to wider network resilience. TfL's Network Management Duty (see **A2.1**) requires the MAE and Network Manager to consider the operation of the network after the scheme has been delivered.

The DE and MAE may find it useful during the design process to consider arranging meetings with the Network Manager, who may be able to provide advice on acceptable network operation and the possibility for wider mitigation strategies.

The Network Manager must be satisfied that any operational concerns have been addressed as far as possible. Should this not be the case the MAE will fail this check and feed back suggested refinements on the proposals to the DE. The approach should be for the DE, P, MAE, SAE and Network Manager to work through these design issues in order that the final design is practical. This will save time for all stakeholders when the scheme is being prepared for submission of the SIR.

If the MAE passes this check, it does not constitute scheme approval or that the design is operationally sound, just that operational concerns have been taken into consideration and acted upon where possible. The MAE will outline any unresolved capacity or operational impacts in the SIR. It is ultimately the P and the DE's responsibility to provide a workable design and remains their choice whether to submit the SIR to NIST.

V.566 Other Modelling Issues

The DE should provide details of any notable issues, assumptions or technical challenges relating to the modelling that have not been captured in **V.551** – **V.565**.

The DE must take note of any comments provided by the MAE in the 'Other Modelling Issues' section of the VMAP Stage 5b Check Sheet (**MQA-0544/V5b**) and address them. This details any concerns the MAE may have with the model that have not already been covered by the checks in **V.551** – **V.565**.

These additional issues may relate to project-specific agreements formalised during MAP Stage 1, or the MAE may wish to report concerns regarding the modelling methodology to the DE. These comments should be seen as constructive, to increase the likelihood of model approval following resubmission.

9.5.3 Acceptance / Rejection of the Model

If the MAE passes the model on all of the checks **V.551 – V.566** and there are no other issues then, referring back to the model purpose as agreed at MAP Stage 4 and documented in the MED, the MAE will approve the model as fit for purpose and authorise the VMAP Stage 5b Check Sheet (**MQA-0544/V5b**).

If the MAE fails the model on any of the checks **V.551 – V.566**, or has highlighted other significant issues with the model, then it is not considered fit for purpose and will be rejected, with reasoning provided.

The MAE should inform the P, DE, CE and SAE of the Approval or Rejection of the submission and provide completed VMAP Stage 5b Check Sheets (**MQA-0544/V5b**), which should be copied to **NMSchemeAssessments@TfL.gov.uk**. If the submission has been approved, the MAE must upload the models and associated files to the TfL Model Library.

End of VMAP Stage 5b

10 MAP Completion

MAP Stage 6

10.1 Introduction

MAP Stage 6 is the final stage of MAP. At this stage the MAE will provide a modelling assessment to the P and DE and a scheme can then progress in the following ways:

- The modelling is considered fit to proceed for scheme approval, and an SIR is required;
- The modelling is considered fit to proceed, but an SIR is not required. An SIR may not be required for Planning Model Audits and Borough schemes where there is no impact on the TLRN or SRN; and
- The scheme is not considered viable due to negative outcomes. Either an SIR is produced, if required, but is not submitted to NIST, or the scheme undergoes a redesign.

When an SIR is not required, or the P decides not to submit the SIR to NIST, MAP is considered complete at this point. Where the P decides not to submit the SIR, the P, DE or CE should provide written confirmation of this to the MAE and copied to **NMSchemeAssessments@TfL.gov.uk**. Where an SIR is required, but the scheme being redesigned, the scheme assessment will revert back to MAP Stage 4. Where a significant amount of time has passed, or the model scope is impacted, it may be necessary to go back to MAP Stage 1.

Where the SIR is required and the P intends to proceed with scheme approval, MAP is not considered complete until the SIR is submitted (**B10.2**).

10.2 Scheme Impact Report

The SIR allows the P to provide all the required information identifying the impact of a scheme on the network to NIST. This allows the NIST team to make an informed decision on the scheme under the TMA.

The key tasks to complete the SIR are as follows:

- The P and MAE initiate the SIR;
- The SAE completes the Safety Checks section, in accordance with the buildability and maintainability review undertaken during the Traffic Signal Option Selection Review;
- The MAE, in conjunction with the relevant Network Manager, completes the remaining sections to inform on the integrity of the modelling and network impact; and
- Once complete, the SIR is handed back to the P who will submit the SIR to NIST for approval and copied to **NMSchemeAssessments@TfL.gov.uk**.

If the P, DE or CE have any issues with the contents of the SIR they can query the content and the MAE and/or SAE can choose whether it is necessary to redraft the report.

If they deem it appropriate to do so, the P will submit the SIR to NIST. If the proposals are submitted to NIST at a later date, the road network should be reviewed by the DE and MAE to ensure that the network has not undergone significant changes prior to submission of the SIR.

End of MAP Stage 6

Glossary

Term	Description
IMAP	ONE Model Auditing Process (Chapter **B6**)
Aimsun	Developer of Aimsun Next, formerly TSS (Chapter **B3**)
Aimsun Next	Advanced Interactive Microscopic Simulator for Urban and non-urban Networks – modelling software developed by Aimsun (Chapter **B3**)
AMAP	Aimsun (Next) Model Auditing Process (Chapter **B3**)
ARCADY	Assessment of Roundabout Capacity And DelaY – modelling software developed by TRL (Chapter **B4**)
ASL	Advanced Stop Line – area in front of the main traffic stopline so cyclists can wait in front of other vehicles (Chapter **B9**)
CAD	Computer-Aided Design – using computer software to record or design something, in modelling it usually refers to vector drawings of the layout of a particular junction
CE	Checking Engineer – key role in MAP (Chapter **A3**)
CFP	Cyclic Flow Profile – a feature of deterministic modelling that displays a graph of the arrival pattern of vehicles at a stopline (sections **B5.3.2** and **B8.3.2**)
CTM	Cell Transmission Model – a traffic model used in TRANSYT that accounts for exit-blocking (Chapter **B8**)
DE	Design Engineer – key role identified in MAP (Chapter **A3**)
DfT	The Department for Transport
DoS	Degree of saturation – measure used to determine how busy a stopline is by looking at the percentage of the capacity that is used
DSD	Desired Speed Decision – used in Vissim modelling to set speed limits (section **B9**)
EQUISAT	A TRANSYT feature that provides an initial set of signal timings prior to optimisation, based on equal saturation of critical conflicting links (section **B8.2.4**)

GIS	Geographic Information System – computer program that works with spatial data and mapping
GPS	Global Positioning System – a satellite-based navigation system that provides location and time information
HGV	Heavy Goods Vehicle – vehicle classification including all goods vehicles with three or more axles
ICA	Intersection Capacity Analysis – used in Visum modelling to estimate the capacity of intersections (Chapter **B6**)
JCT	JCT Consultancy Ltd – developer of LinSig and TranEd (Chapters **B5** and **B8**)
JMAP	Junctions Model Auditing Process (Chapter **B4**)
Junctions	Deterministic modelling software, developed by TRL (Chapter **B4**)
LMAP	LinSig Model Auditing Process (Chapter **B5**)
LEGION	Pedestrian modelling software, developed by Bentley (Chapter **B7**)
LDT	LEGION Data Template – file containing the input data for a LEGION model (Chapter **B7**)
LGV	Light Goods Vehicle – vehicle classification including all goods vehicles up to 3,500kg gross vehicle weight
LinSig	Deterministic modelling software developed by JCT (Chapter **B4**)
LTA	Local Traffic Authority – the body responsible for local roads (section **A2.1**)
M&V	Modelling & Visualisation Team (section **A2.1**)
MAE	Model Auditing Engineer – key role identified in MAP (Chapter **A3**)
MAP	Model Auditing Process – TfL's framework which leads all interested parties through model development, submission and auditing
MED	Modelling Expectations Document – document created in MAP Stage 1, and updated in MAP Stage 4, which summarises the agreed modelling requirements (sections **B2.2.2** and **B2.3.2**)
MGV	Medium Goods Vehicle – vehicle classification including all goods vehicles with 2 axles over 3,500kg gross vehicle weight

MMQ	Mean Maximum Queue – the average of the maximum queue lengths in each cycle, used in deterministic modelling (sections **B5.3.2** and **B8.3.2**)
MTS	Mayor's Transport Strategy – a document published by the Mayor of London, which sets out the Mayor's policies and proposals to reshape transport in London over the next two decades (section **A2.1**)
NAE	Network Assurance Engineer – key role identified in MAP (Chapter **A3**)
NIST	Network Impact Specialist Team – team within TfL that works on behalf of the Traffic Manager to ensure that the NMD has been fully complied with in the development, design and implementation of highway scheme proposals impacting on London's major roads (section **A2.1**)
NM&R	Network Management & Resilience, formerly Network Management (NM) (**About the Authors** and section **A2.1**)
NMD	Network Management Duty – under the TMA, requires an authority to manage all their activities in such a way as to maximise the efficiency of movement on their road network and minimise unnecessary delay (section **A2.1**)
NP	Network Performance (within NM&R), formerly Urban Traffic Control (UTC) (**About the Authors** and section **A2.3.1.2**)
OD	Origin-Destination – a matrix used to input traffic flows into a model, with the origins as rows and the destinations as columns
ONE	Operational Network Evaluator – TfL's tactical model which covers Greater London and is used to assess schemes and investigate the implications of local network changes on the wider network (Chapter **B6**)
P	Promoter – key role identified in MAP (Chapter **A3**)
PCAM	Process for Commercial Access to Modelling – TfL's cost recovery process for requests for TfL support or model asset access (see **A2.3.1.2**)
PCU	Passenger Car Unit – a common unit used to represent general traffic where vehicle types are assigned a conversion factor to the equivalent number of cars based on the amount of road space they take up
PDM	Platoon Dispersion Model – the traditional traffic model used in TRANSYT (Chapter **B8**)

PICADY	Priority Intersection Capacity And DelaY – modelling software developed by TRL (Chapter **B4**)
PMAP	Pedestrian Model Auditing Process (Chapter **B7**)
POV	Point-of-View imagery, typically taken from a pedestrian, cyclist, driver or vehicle's perspective
Prior Matrix	The result of the matrix building process, including the use of observed data, data cleaning and infilling methods (such as a with a gravity model). This stage of development occurs before the final matrix adjustments during calibration and validation.
PTV	Planung Transport Verkehr (PTV) AG – developer of Vissim, Visum and Viswalk (Chapters **B6**, **B7** and **B9**)
RFC	Ratio of Flow to Capacity – measure used to determine how busy an approach is at an unsignalised junction (Chapter **B4**)
RR67	Research Report 67 – publication by TRL describing a methodology for the prediction of saturation flows
RSA	Reduced Speed Area – used in Vissim modelling to implement changes in speed due to road geometry or factors that cannot be directly modelled (Chapter **B9**)
RSPRG	Road Space Performance Review Group – TfL approval plenary for schemes, if required, following review by NIST (see **A2.3.1.2**)
RTO	Real Time Optimiser – the traffic signal control system that will replace TfL's Urban Traffic Control (UTC) system
SAE	Signals Appraising Engineer – key role identified in MAP (Chapter **A3**)
SASS	System Activated Strategy Selection – an automated method of adjusting on-street signal timings based on particular traffic flow criteria (Chapter **B9**)
SCOOT	Split, Cycle and Offset Optimisation Technique – technology that controls and optimises signal timings across London, developed by TRL
SIR	Scheme Impact Report (formerly TSSR, Traffic Signal Supplementary Report) – a report on the impact of schemes which enables NIST to ensure that TfL is meeting the NMD (section **A2.3.1.3**)
SLD	Site Layout Drawing – diagram showing the layout of junctions including the locations of all street furniture and ducting (section **B9.2.2**)

SQA-8448	TfL Junction Traffic Signal Design Sheet – produced by TfL Engineering & Asset Strategy during Concept (formerly **SQA-0448**) (section **A2.3.1.2**)
SRN	Strategic Road Network – borough roads comprised of 500km of routes which are considered to have a strategic importance in terms of network operation, including major bus routes (section **A2.1**)
SVD	Selective Vehicle Detection – used in systems like iBus to give priority to specific types of vehicle
TAG	DfT Transport Analysis Guidance (formerly WebTAG) (section **B6.3.2**)
TfL	Transport for London
TLRN	Transport for London Road Network – a network of nearly 580km of London's roads which makes up 5% of the roads but carries 30% of London's traffic and is the responsibility of TfL under the TMA (section **A2.1**)
TMA	Traffic Management Act 2004 – places a Network Management Duty (NMD) on all Local Traffic Authorities (LTAs) in England (section **A2.1**)
TMAP	TRANSYT Model Auditing Process (Chapter **B8**)
TranEd	Software developed by JCT to provide an improved graphical user interface for TRANSYT versions 12 and earlier (Chapter **B8**)
TRANSYT	TRAffic Network StudY Tool – modelling software developed by TRL (Chapter **B8**)
TRL	TRL Ltd (formerly the Transport Research Laboratory) – developer of ARCADY, Junctions, OSCADY, PICADY, SCOOT and TRANSYT (Chapters **B4** and **B8**)
UGT	Underutilised Green Time – time where there are vehicles trying to cross the stopline but they are unable to do so at full speed due to queuing or other obstructions
UTC	Urban Traffic Control – the central computer system which controls a lot of the signalised junctions in London
VAP	Vehicle Actuated Programming – a method used in Vissim modelling to control signal timings (section **B9**)
VDF	Volume Delay Function – used in Visum modelling to estimate the delay on links or turns (Chapter **B6**)

Vissim	Verkehr In Städten – SIMulation (meaning: Traffic In Towns – SIMulation) – modelling software developed by PTV (Chapter **B9**)
Visum	Verkehr In Städten – UMlegung (meaning: Traffic In Towns – Assignment) – modelling software developed by PTV (Chapter **B6**)
Viswalk	Verkehr In Städten – walk (meaning: Traffic In Towns – Walk) – pedestrian modelling software developed by PTV (section **B7**)
VMAP	Vissim Model Auditing Process (Chapter **B9**)