London’s Strategic Transport Models

Transport for London
Contents

Introduction ........................................................................................................... 2
Why do we need transport models? ................................................................. 3
TfL’s suite of strategic transport models ......................................................... 4
MoTION .............................................................................................................. 5
LoHAM ............................................................................................................... 8
Railplan ............................................................................................................ 10
Cynemon .......................................................................................................... 12
LonLUTI .......................................................................................................... 14
ONE .................................................................................................................. 16
Which model should I use? ............................................................................ 18
Accreditation and licensing .......................................................................... 20
More information and contacts .................................................................... 21

Introduction

This document introduces a suite of strategic transport models which are owned, maintained and supplied by Transport for London. The document provides:

- An introduction to transport modelling
- An overview of the models
- A summary of each model
- Examples of projects and the appropriate models to use
- Details of how the models can be used by parties internal and external to TfL

Please note all the images in this document are illustrative. For the latest model outputs or for further information please use the contact details found at the end of this document.
**Why do we need transport models?**

Investment in transport can bring about a range of economic, social and environmental benefits. Building new public transport links, providing space for cyclists, improving highways, and changing fares and tolls are all examples of investment that have the potential to make it easier for people to move around, or address the problems of public transport crowding and road congestion.

However, with limited financial resources and a variety of options, how can we tell which transport improvements are the best to invest in? We need to predict the impact of each proposal on people’s travel decisions and the resulting crowding and congestion impacts against a backdrop of changes in population, employment and other economic factors. Transport models are tools which help to provide a robust and consistent evidence base for data and analysis when carrying out these predictions.

The decisions that an individual makes when considering travel options are summarised below. Transport models are mathematical tools developed to predict some or all of these decisions, with different models often combining to provide an overall picture.

TfL’s models represent the behaviour of drivers, passengers, cyclists and pedestrians as they travel on London’s transport network. They cover all the main modes of travel and help TfL and others to plan London’s future transport needs and identify which transport schemes and policies should be implemented to meet the goals set in the Mayor’s Transport Strategy.
TfL’s suite of strategic transport models

Our transport models are described as strategic because they combine to represent the different decisions that an individual makes when planning a journey and are designed to be used for understanding the long-term impacts of schemes and policies over wide areas. TfL also owns and operates other models such as its local and operational models, which are used for assessing local or short-term impacts.
MoTiON

Overview

Model of Travel in London (MoTiON) is a multi-modal strategic transport model of London and the surrounding area. MoTiON can model how many trips there are likely to be, their origins and destinations and their modes of transport. TFL’s previous multi-modal strategic transport model LTS was developed over a number of decades based on extensive data sources. London is a dynamic city of over 9 million people which has been planning and meeting the challenge of growth, however ongoing change in consumer behaviours, lifestyles and travel habits result in uncertainty within forecasting.

To understand key drivers of changing trends, TFL first undertook research into the main factors influencing travel demand, explaining how journey patterns had changed over the last decade. It then commissioned the development of a new analytical framework including MoTiON to enhance forecasting, and Project EDMOND (Estimating Demand from Mobile Network Data) to provide a comprehensive view of travel patterns in London. Complemented by existing TFL datasets such as Oyster smartcard use and the London Travel Demand Survey (LTDS), this helped to achieve a major improvement in the quality of demand data used in strategic modelling.

MoTiON incorporates strategic assignment models, capturing the intelligence from EDMOND data and seeking to predict how personal travel habits in the city may respond to changes in population and employment, transport infrastructure development and policy interventions. It offers a complete refresh of travel behaviour, building on TFL’s previous demand studies, and provides insights into behaviour change by various population groups for all main modes of transport.

Using MoTiON, TFL are able to imitate the impact of changing demographics in potential future scenarios. This could help TFL to plan for an ageing population, with increasing accessibility needs, or to reflect the positive impact of urban regeneration. MoTiON can also help TFL to understand how removing behavioural barriers could unlock more cycle journeys and support better connectivity using public transport. The ability to represent future modes such as CAVs should also enable TFL to assess the impact of such new modes and plan for a future where they complement rather than disrupt the public transport network.

MoTiON is developed to meet ever-changing needs and policy requirements with careful adherence to industry guidelines and the leadership and review of experts in the field of transport modelling. In particular, the Department for Transport’s Transport Analysis Guidance (TAG) has been followed to ensure the model is robust and reliable. Details of the work undertaken have been documented in reports which are available on request.

MoTiON uses five demand modules to forecast trip change and mode shift. It takes land use assumptions, economic and travel behaviour assumptions and planned transport investment and forecasts how many trips will be made, what mode they will use and the resultant crowding and congestion conditions.
The model works in four stages, as illustrated opposite. All stages are carried out in the demand model and the fourth incorporates the strategic assignment models. The transport modes modelled are car driver, car passenger, PHV, public transport (London Bus, National Rail, Underground, Overground, Docklands Light Railway and Tramlink), cycling and walking. MoTiON also models light goods vehicles, other goods vehicles, coaches and taxis.

MoTiON provides new capability to explore travel behaviour:

- Cycling propensity: Understanding how removing behavioural barriers could unlock more journeys by bike
- Bus propensity: Looking at how some users are more captive to the bus than others
- Connected autonomous vehicles: Opportunity and challenge of new private and shared mobility
- London population synthesiser: Representing the changing demographic makeup of London in the future
Outputs

Data extracted from a number of modelled scenarios can be used to assess the impact of a transport scheme or development. Mode share, trip numbers, and road and public transport conditions can be analysed at a regional, sub-regional or borough level. The outputs can be used to develop business cases and as inputs into economic appraisal.

MoTiON overcomes commercial risks and delivers efficiency with integrated assignments. It provides information about trip numbers and their distribution to LoHAM, Railplan and Cynemon. It also provides the transport inputs for LonLUTI.

Modelled years and time periods

MoTiON predicts trips for a typical 24-hour weekday. It also provides information on average conditions for three time periods:

- AM Peak (07:00–10:00)
- Inter Peak (10:00–16:00)
- PM Peak (16:00–19:00)

The current model base year is 2016. Future year models are available in five-year steps from 2026 to 2041.

Software and skills

MoTiON is based in the transport modelling software Cube developed by Citilabs. The assignment models are in Cube (Cynemon), Emme (Railplan) and Saturn (LoHAM)

Using the model requires skills and experience in the use of Cube software and a good understanding of MoTiON methodology, model assumptions, data preparation and interpretation of results.

TfL City Planning runs training courses for TfL staff and accredited consultants who want to learn how to use MoTiON and its application of Cube.

Contact

For MoTiON enquiries please email StrategicModelling@tfl.gov.uk
LoHAM

Overview

LoHAM (London Highway Assignment Model) is a strategic model representing routeing and congestion of motorised highway trips using London’s highway network.

LoHAM has been developed over the past decade to provide a consistent basis for highway modelling and the underpinning of planning across the Capital. The development of LoHAM has been undertaken with careful adherence to industry guidelines, and has been led or reviewed by experts in the field of transport modelling. In particular, the Department for Transport’s Transport Analysis Guidance (TAG) has been followed to ensure LoHAM is robust and reliable. This work has been documented in a model development report and supporting technical notes which are available on request.

The LoHAM base year travel patterns have been estimated using aggregated and anonymised mobile phone data (project Edmond) and the model routes these trips through the highway network based on journey times and distance. It is used to provide an overall impression of the impact of major highway schemes or large residential or employment developments. The model splits highway users into different vehicle types including car, taxi, personal hire vehicles (phv), light goods vehicles and other goods vehicles. The model has the capability to reflect the separate movement of ULEZ compliant vehicles versus non-compliant ones and there are also representations of buses and cycles included to make sure that the road space required by these users is taken into account.

Outputs

Data extracted from a number of modelled scenarios can be used to assess the impact of a scheme or development. Examples of such data are as follows:

- Congestion hotspots
- Total distance or time travelled in the area of interest
- Number of vehicles using a major road of interest
- Origins and destinations of vehicles using a major road of interest
- Average speeds

These outputs and others can be used in support of the development of scheme business cases and for input into economic appraisal.
Modelled years and time periods

Three models, representing key time periods during the day, have been developed for LoHAM. These time periods are:

- **AM Peak (08:00-09:00)**
- **Inter Peak** (an average hour between 10:00 and 16:00)
- **PM Peak (17:00-18:00)**

The model base year is 2016. Future year models are available in line with MoTiON.

Software and skills

LoHAM is based in the transport modelling software SATURN developed by Atkins.

Using the model requires skills and experience in the use of SATURN and a good understanding of the HAM Modelling Guidance, which is available on request.

Contact

For LoHAM enquires please email StrategicModelling@tfl.gov.uk
Railplan

Overview

Railplan is a strategic public transport model for London and the south-east. Railplan models the likely route and service choices of public transport users, and the resulting levels of crowding on public transport networks in and around London.

Railplan has been developed over a number of decades with careful adherence to industry guidelines and the leadership and review of experts in the field of transport modelling. In particular, the Department for Transport’s Transport Analysis Guidance (TAG) has been followed to ensure the model is robust and reliable.

Railplan allocates the public transport trips generated by MoTiON to the following public transport modes:

- London Bus
- National Rail
- Underground
- Overground
- Docklands Light Railway
- Tramlink

Railplan also includes an extensive walk network to represent access to the public transport system and transfer between services. Railplan can predict the rerouting and crowding effects of new services or stations and changes to service frequencies or vehicle speeds.

Outputs

Railplan is commonly used to compare data extracted from a number of modelled scenarios to assess the impact of a transport scheme or development. Examples of the wide range of information that can be extracted are as follows:

- The number of people getting on and off at stops and stations
- Passenger numbers to and from different locations
- Crowding levels on services of interest
- The number of passengers interchanging at stations
- Total passenger travel time and distance travelled by mode

Crowding levels on the central section of the London Underground network in the 2016 morning peak from Railplan
These outputs and others can be used in support of the development of scheme business cases and for input into economic appraisal. Railplan also provides journey time information for display in TfL’s connectivity tool, WebCAT.

**Modelled years and time periods**

Railplan represents average weekday conditions for three key time periods during the day. The periods are:

- **AM Peak (07:00−10:00)**
- **Inter Peak (10:00−16:00)**
- **PM Peak (16:00−19:00)**

The model base year is 2016. Future year models are available in five-year steps from 2026 to 2041 in line with MoTiON. The models for these years include up-to-date plans for infrastructure schemes and the latest population, employment and economic forecasts.

**Software and skills**

Railplan is based in the transport modelling software Emme developed by Inro.

Operating the model requires skills and experience in the use of Emme and a good understanding of Railplan’s methodology, public transport networks, model assumptions, data preparation and interpretation of results.

**Contact**

For Railplan enquires please email [StrategicModelling@tfl.gov.uk](mailto:StrategicModelling@tfl.gov.uk)
Cynemon

Overview

Cynemon is a new innovative strategic cycling model which estimates the number of cyclists and their routes and journey times across London. Cynemon has been developed as a mechanism to model and visualise cyclist route choice, as well as provide the inputs for cycle connectivity mapping.

There has been significant investment in cycling in London in recent years and with more planned there is a need to justify this investment with robust appraisal. This calls for better tools to estimate the impact of new cycling schemes and so Cynemon has been developed to meet this need. Its development was based on TfL count and travel diary data sources combined with mobile phone app data and bespoke research.

Cynemon is designed to address the questions related to the routes that cyclists choose as they travel around London, taking into account aspects such as gradient, road type, cycle lanes and other traffic. It gives the user the ability to quantify the impacts of investment in cycling infrastructure and identify the locations where cycle infrastructure should be considered.

Outputs

Cynemon is able to:

- Show where the busiest cycling corridors are in London
- Output average cycling journey times between places of interest
- Show the impact of the expected growth in cycling in the future
- Show the origins and destinations of cyclists on particular routes
- Indicate the choice of routes available between places of interest
- Show the rerouting effects of new infrastructure

These outputs and others can be used in support of the development of scheme business cases and for input into economic appraisal.
**Modelled years and time periods**

Three models, representing key time periods during an average weekday, have been developed for Cynemon. These time periods are:
- AM Peak (08:00-09:00)
- Inter Peak (an average hour between 10:00 and 16:00)
- PM Peak (17:00-18:00)

The model base year is 2016. Future year models are available for 2021, 2031 and 2041.

**Software and skills**

Cynemon is based in the transport modelling software Cube developed by Citilabs.

Using the model requires skills and experience in the use of Cube and a good understanding of the Cynemon model setup.

**Contact**

For Cynemon enquires please email [StrategicModelling@tfl.gov.uk](mailto:StrategicModelling@tfl.gov.uk)
LonLUTI

Overview

The London Land-use and Transport Interaction Model (LonLUTI) can assess the land-use impact of transport schemes and provide analysis of the demographic, economic and transport outcomes of land-use proposals. The term ‘land-use’ in this context refers mainly to activities that use space – in particular, where people live and work.

LonLUTI has been developed over the past decade with careful adherence to industry guidelines and the leadership and review of experts in the field of transport modelling. In particular, the Department for Transport’s Transport Analysis Guidance (TAG) has been followed to ensure the model is robust and reliable. Experts from consultancies and TfL staff formed a team of experienced modellers that focused on delivering LonLUTI to the highest standards possible.

LonLUTI covers London as well as east and south-east England. The model consists of four components: the economic, urban and migration models form LonLUM (the land-use model), which is linked to LTS (the predecessor of MoTiON).

- LTS predicts travel by highway and public transport using demand inputs from the economic and urban models. In doing so, it estimates the time and cost of travel between locations, allowing for congestion and crowding effects.
- The economic model predicts the growth (or decline) of sectors of the economy in each of the areas modelled. The predictions by sector and area are influenced by transport costs from LTS, and consumer demand for goods and services, with property costs from the urban model.
- The urban model predicts the location of households and jobs which are influenced by the supply of floorspace, accessibility and environmental variables. Households are influenced by access to workplaces and services. Jobs are influenced by access to potential workers and customers.
- The migration model predicts migration between regions in the model (movement within each region is predicted in the urban model). The inputs to this model include job opportunities and housing costs from the urban model.

LonLUTI will be updated during 2021 to use the MoTiON in place of LTS.

Comparison of employment distribution resulting from two transport investment scenarios
Outputs

LonLUTI is able to provide outputs such as:

- Total population (split down into groups e.g. children, resident workers, non-working adults and retired people)
- Total households
- Total jobs
- Total floorspace

These are available by area and land-use and along with other outputs can be used in support of the development of scheme business cases and for input into economic appraisal, in particular the Wider Economic Impacts (WEIs).

Modelled years and time periods

The model base year is 2011. Future year land-use outputs are available in annual increments, whereas transport outputs are available in five-year steps from 2021 to 2041. The transport model years include up-to-date plans for infrastructure schemes.

Software and skills

The land-use model element of LonLUTI uses the DELTA package developed by David Simmonds Consultancy.

The transport model element of LonLUTI is LTS. Refer to the LTS chapter of this document for further information.

Operating LonLUTI requires skills and experience in DELTA and Cube, and a good understanding of LonLUTI’s methodology, model assumptions, data preparation and interpretation of results.

Contact

For LonLUTI enquires please email StrategicModelling@tfl.gov.uk
ONE

Overview

The Operational Network Evaluator (ONE) Model is a tactical highway assignment model built in the VISUM software environment. The model is built as a simplified representation of the real world at a particular moment in time. The initial version covers all of London within and including the M25 and was calibrated to reflect observed traffic volumes and journey times in October / November 2014. The latest version of the ONE model has been refined predominantly in Central London area to reflect 2016/17 traffic network conditions. The scope and scale of the model is in line with TAG guidance.

The ONE Model can inform micro-simulation and network optimisation models of route choice changes when new junctions are signalised or when existing signal timings are reviewed.

The model can be used to assess the impact of signal schemes before they are introduced so that appropriate mitigation action is planned in time to deal with congestion that is likely to develop elsewhere in the network as a result of traffic reallocation.

The model can be used to make operational decisions as a response to planned events in the network such as long-term road works and road closures, or state events.

The demand contained in the ONE Model is fixed for each of the Base and Forecast years. Over time, individuals may decide to reduce their mobility or use alternative modes – effects which are not represented in the ONE Model.

The demand in the ONE Model is based on estimates calculated by Transport for London City Planning and the London Transport Study (LTS) model. Whilst in reality demand origins and destinations can be anywhere on the highway network, this behaviour is too complex to represent in a tactical model. Consequently trips are grouped into zones and load onto or exit from the network at designated locations. The point at which trips are loaded onto the network influences the routes vehicles take through the network and every effort is made to locate these points in logical locations.

The ONE Model utilises an equilibrium assignment methodology wherein it assigns trips between all origins and destinations to their least cost path and assumes that drivers have perfect network knowledge when selecting routes.
Outputs

Data extracted from a number of modelled scenarios can be used to assess the impact of a scheme or development. One is able to provide information such as:

- Congestion hotspots, node saturation and link speed plots
- Total distance or time travelled in the area of interest
- Number of vehicles using a road of interest
- Origins and destinations of vehicles using a road of interest
- Average speeds and Network delay statistics – the change in vehicular delay i.e. delay per km across the boroughs and study area

These outputs and others can be used in support of the development of scheme business cases and for input into economic appraisal.

Modelled years and time periods

The model base year is 2014, updated in Central London to 2016, while the Future year model represents a 2021 forecast (this includes all ‘committed’ schemes planned for implementation and demand growth between 2014 and 2021).

The AM period covers one hour from 8.00 to 9.00 and the PM peak is defined as 17.00 to 18.00.

Software and skills

The model runs in the VISUM software package developed by PTV AG; the most up to date model in Version 16 and its predecessor in Version 12.5. Using the model requires skills and experience in the use of VISUM and a good understanding of the ONE Modelling Guidance, which is available on request.

Contact

For ONE model enquiries please email StrategicModelling@tfl.gov.uk
Which model should I use?

When choosing which model to use, it is perhaps important to first recognise that all models have limitations, and strategic transport models are no exception to this. Strategic transport models cannot represent accurately every journey made by every individual by every mode and route. They are also not precise in the way they replicate specific individual behaviour and the interaction between individuals. There are many factors that impact on people’s travel behaviour and the day-to-day variation in congestion and crowding which are random and impossible to predict.

Understanding the limitations of a model is key to making best use of it and taking advantage of its strengths. The reasonable level of expectation from the models is that they are able to estimate the likely route choice of transport users, and the resulting average levels of congestion and crowding, on London’s strategic transport network. It is advised that whenever a model is used for a new project, it should be reviewed and refined to ensure it is fit for the purposes required for that project and that models should be developed as a project is taken forward.

**It should be noted that LoHAM and ONE are both strategic highway traffic assignment models. The ONE model is mainly to be used for schemes and assessments that require closer relation with micro-simulation and considers interventions up to 3 years ahead. LoHAM is able to provide both short and long term forecasts, traffic impact and economic benefits.**

The table below presents a range of studies and the most appropriate models for each.

<table>
<thead>
<tr>
<th>Assessing the impact of:</th>
<th>Appropriate model(s)</th>
<th>Other information</th>
<th>Other tools to consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>An Opportunity Area Planning Framework (OAPF)</td>
<td>All</td>
<td>MoTIoN would be used to assess the demand impact of the proposed development with this being fed into LoHAM, Railplan and Cynemon for the analysis of congestion and crowding impacts as well as any associated rerouteing. LonLUTI could be used to assess the regeneration impacts</td>
<td>Local models, TRICS, TRAVL</td>
</tr>
<tr>
<td>Forecast changes in population, employment or economic factors</td>
<td>All</td>
<td>MoTIoN would be used to assess the demand impact of the changes with this being fed into LoHAM, Railplan and Cynemon for the analysis of congestion and crowding impacts as well as any associated rerouteing</td>
<td>Local models, TRICS, TRAVL</td>
</tr>
<tr>
<td>A new residential or employment development</td>
<td>MoTIoN, LoHAM, ONE, Railplan</td>
<td>MoTIoN would be used to assess the demand impact of the proposed development with this being fed into LoHAM, ONE** and Railplan for the analysis of congestion and crowding impacts as well as any associated rerouteing</td>
<td>Local models, TRICS, TRAVL</td>
</tr>
<tr>
<td>A new policy such as ‘car-lite’ development</td>
<td>MoTIoN</td>
<td>MoTIoN can predict the impact of lower car ownership and other policies, and the knock-on effect on highway and public transport trip levels. Changes to modelling assumptions and other work should be supported with other research</td>
<td>Spreadsheet assessment, behavioural surveys</td>
</tr>
<tr>
<td>Assessing the impact of:</td>
<td>Appropriate model(s)</td>
<td>Other information</td>
<td>Other tools to consider</td>
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<tr>
<td>A new strategic highway scheme</td>
<td>MoTiON, LoHAM, ONE</td>
<td>MoTiON can simulate demand impacts and the effect on highway is passed to LoHAM or ONE** which are designed to assess the rerouting impacts. Impacts on minor streets and turning movement flows should not be relied upon without further model development.</td>
<td>Local models</td>
</tr>
<tr>
<td>Introducing a toll on an existing highway</td>
<td>MoTiON, LoHAM</td>
<td>MoTiON would simulate the demand impacts with the effect on highway trips being passed to LoHAM where route choice and congestion impacts could be estimated if good inputs on the propensity to pay the toll were available for various groups. The modelling of new tolls requires some surveys and preparatory work to be undertaken before considering the modelling aspect.</td>
<td>Spreadsheet assessment</td>
</tr>
<tr>
<td>A new rail or Tube scheme</td>
<td>MoTiON, Railplan</td>
<td>MoTiON would simulate any change in mode choice due to the scheme and pass this to Railplan which is designed to assess rerouting and crowding impacts</td>
<td>Local models</td>
</tr>
<tr>
<td>Policies to encourage the use of public transport</td>
<td>MoTiON, Railplan</td>
<td>MoTiON would simulate any change in mode choice due to the policy and pass this to Railplan which is designed to assess rerouting and crowding impacts. Small changes may not be well represented</td>
<td></td>
</tr>
<tr>
<td>Applying new public transport fares</td>
<td>MoTiON, Railplan</td>
<td>MoTiON would simulate any change in mode choice due to the fare changes and pass this to Railplan which is designed to assess rerouting and crowding impacts</td>
<td></td>
</tr>
<tr>
<td>Revised traffic arrangements in a town centre</td>
<td>LoHAM, ONE, Cynemon</td>
<td>LoHAM or ONE would assess the rerouting and congestion impacts although turning movement flows should not be relied upon without further model development. The impact on cycling route choice would be assessed by Cynemon</td>
<td>Local models</td>
</tr>
<tr>
<td>A new cycle superhighway</td>
<td>Cynemon, LoHAM, ONE</td>
<td>Cynemon would assess the rerouting impact of the new scheme and an estimate of the potential new cycling trips that would be generated. The new cycle flows and general traffic capacity impacts of the scheme could then be assessed in LoHAM or ONE**.</td>
<td></td>
</tr>
<tr>
<td>Land-use regulation policies</td>
<td>LonLUTI</td>
<td>LonLUTI can provide an assessment of how policies would affect development and transport for different population and employment groups. It can estimate impacts of developments and redevelopments, likely impacts on households or jobs, and household density and vacancy rates</td>
<td></td>
</tr>
<tr>
<td>A major transport scheme on land-use</td>
<td>LonLUTI</td>
<td>LonLUTI can assess how transport improvements or changes in travel costs would shift the distribution of activities in an urban area</td>
<td></td>
</tr>
</tbody>
</table>
Accreditation and licensing

The models are available for use in appropriate studies commissioned by all types of organisation including the London boroughs, other public authorities and private developers, as well as all TfL departments.

An accreditation and licensing arrangement controls the use of some of the models outside TfL. This is to ensure users have the appropriate expertise to enhance and run the models and interpret the results. The roles and responsibilities relating to model accreditation and licensing are illustrated and explained below.

**Accreditation**

Any individual or organisation wishing to obtain access to the models to undertake modelling for their own purposes or on behalf of another party will need to be accredited. Accreditation is open to anyone with the experience and expertise required to use the models and relevant software. The accreditation, which is subject to a fee, is renewed at the start of each financial year.

A list of all consultants accredited to use the models is available from StrategicModelling@tfl.gov.uk. Accredited bodies are required to attend and contribute to regular model forums, follow best practice guidance and to share any updates they produce for input to the control versions of a model.

**Licensing**

When a strategic model is required for a project, both the study sponsor (the business or organisation that commissions the work) and the appointed accredited consultant need to be licensed to use the model.

There is a fee to use our strategic models. The fee is only for access to the model and does not include any advice or enhancement costs. Details of our current model access fees are available from StrategicModelling@tfl.gov.uk.

The study sponsor will be provided with a license agreement that must be completed and signed by the study sponsor and the accredited consultant. The agreement will also need to be signed by TfL after which a copy will be returned to the study sponsor. The accredited user will then have access to the requested models.
More information and contacts

For queries about the models, please contact the Strategic Analysis team in TfL City Planning – StrategicModelling@tfl.gov.uk.