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Finglas to Phibsborough

Draft Transport Modelling Report

November 2020

BUS CONNECTS

SUSTAINABLE TRANSPORT FOR A BETTER CITY.

Project Ireland 2040
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BusConnects Dublin - Core Bus Corridor Infrastructure Works

Project No:	32111200
Document Title:	Draft Transport Modelling Report
Document No.:	Document No.
Revision:	0
Document Status:	Work in Progress
Date:	October 2020
Client Name:	National Transport Authority
Client No:	EIA / TIA
Project Manager:	David King
Author:	Various
File Name:	Finglas to Phibsborough CBC - Draft-WIP Transport Modelling Report v1 FINAL.docx

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
V1	21/10/2020	Work in Progress Draft	Paul Hussey	Ian Byrne	Ian Byrne	David King

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Appendix A - Full Local Area Model Calibration and Validation

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List of Acronyms

Acronym	Definition
AADT	Annual Average Daily Traffic
ATC	Automatic Traffic Counts
CBCs	Core Bus Corridors
CPO	Compulsory Purchase Order
CSA	Census Small Area
DfT	UK Department for Transport
DM	Do Minimum
DS	Do Something
ED	Engineering Design
EIARs	Environmental Impacts Assessment Reports
ERM	East Regional Model
FDM	Full Demand Model
GDA	Greater Dublin Area
GEH	Geoffrey E. Havers statistic
JTC	Junction Turning Counts
LAM	Local Area Model
LGV	Light Goods Vehicles
NDFM	National Demand Forecasting Model
NDP	National Development Plan
NHTS	National Household Travel Survey
NPF	National Planning Framework
NTA	National Transport Authority
OGV	Other Goods Vehicles
PAG	Project Appraisal Guidelines
pcu	passenger car units
PDR	Preliminary Design Report
PMS	People Movement at Signal
PRO	Preferred Route Option
RMS	Regional Modelling System
SAPS	Small Area Population Statistics
TAG	Transport Analysis Guidance
TIA	Transport Impact Assessment
TII	Transport Infrastructure Ireland
TRL	Transport Research Laboratory

1. Introduction

The purpose of this document is to provide a detailed overview of the suite of forecast transport modelling tools that have been developed to support the design development and assessment of the **Finglas to Phibsborough Core Bus Corridor (CBC)** (hereafter referred to as the Proposed CBC). The Proposed CBC is one of the 16 CBCs that make up the BusConnects Dublin – Core Bus Corridor Infrastructure Works (hereafter referred to as the CBC Infrastructure Works). Work regarding examination of environmental impact is under way that may culminate in an Environmental Impact Assessment Report (EIAR) to be prepared or submission as part of a planning application to An Bord Pleanála by the National Transport Authority (NTA) under the Roads Act 1993 (as amended).

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Figure 1-1: Overview of BusConnects Dublin – Core Bus Corridor Infrastructure Works with Finglas to Phibsborough Core Bus Corridor Highlighted

The Proposed CBC is being planned as part of the CBC Infrastructure Works to provide enhanced walking, cycling and bus infrastructure on key access corridors in the Dublin region, which will enable and deliver efficient, safe and integrated sustainable transport movement along these corridors. To achieve this overall objective, the NTA has identified the following objectives:

- Enhance the capacity and potential of the public transport system by improving bus speeds, reliability and punctuality through the provision of bus lanes and other measures to provide priority to bus movement over general traffic movements;
- Enhance the potential for cycling by providing safe infrastructure for cycling, segregated from general traffic wherever practicable;
- Support the delivery of an efficient, low carbon and climate resilient public transport service, which supports the achievement of Ireland's emission reduction targets;
- Enable compact growth, regeneration opportunities and more effective use of land in Dublin, for present and future generations, through the provision of safe and efficient sustainable transport networks;
- Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved sustainable connectivity and integration with other public transport services; and
- Ensure that the public realm is carefully considered in the design and development of the transport infrastructure and seek to enhance key urban focal points where appropriate and feasible.

In line with the above objectives, the transport assessment of the Proposed CBC and the transport modelling outputs are focused on the concept of the "movement of people" rather than, solely, the "movement of vehicles". The emphasis of the design philosophy is on maximising the capacity of the Proposed CBC to move people on sustainable modes whilst providing for the necessary movement of vehicles along the CBC.

The timeline for the Proposed CBC is:

- **Current through early-2021** – Preparation of Statutory Application including selection of the Preferred Route Option, optimised Engineering Design, EIAR, and identification of property requirements and drafting of Compulsory Purchase Order (CPO);
- **2021** – Statutory Process including submission of application to An Bord Pleanála, statutory consultation and Oral Hearing; and
- **2022 to 2027** – In the event of approval by An Bord Pleanála under section 51 of the Roads Act 1993 (as amended) and confirmation of the CPO, carry out property acquisition and construction.

The Emerging Preferred Route Option was published for non-statutory public consultation in November 2018. A second public consultation was held in March 2020 outlining the Draft Preferred Route Option (PRO) taking into account the submissions received from the first public consultation exercise. The second consultation period allowed public submissions until 17 April 2020, however on-site public engagement was suspended due to the introduction of Covid-19 restrictions. To complete this public engagement, the NTA intends to hold a further public consultation in Autumn 2020 prior to finalising the PRO.

Following this and the consideration of submissions received, the preferred route option will be finalised and the Preferred Route Options Report will be completed and published. The environmental impact assessment work including a Transport Impact Assessment (TIA) will be completed. The finalisation and publication of the Preferred Route Options Report, and subsequent detail design, will form part of the statutory submission to An Bord Pleanála for approval under section 51 of the Roads Act 1993 (as amended).

This draft report presents an overview of the transport modelling tools that have been developed for the assessment of the Proposed CBC in relation to traffic and transport. The report will detail the transport model development process, the traffic data inputs used, the calibration, validation and forecast model development for the suite of transport models.

2. Proposed Core Bus Corridor Description

2.1 Description of the Proposed Core Bus Corridor

The Proposed CBC will commence on the R135 Finglas Road at the junction between the R135 Finglas Road and R104 St. Margaret's Road and will be routed along the R135 Finglas Road as far as Hart's Corner in Phibsborough. Priority for buses will be provided along the entire route, consisting of dedicated bus lanes in both directions. Continuous segregated cycle tracks will be provided from Church Street junction in Finglas to Hart's Corner.

For a full description of the Proposed CBC and for maps showing the Preferred Route Option please refer to the Finglas to Phibsborough Core Bus Corridor Public Consultation Brochure which can be found on the BusConnects website at this link https://busconnects.ie/initiatives/core-bus-corridor/.

2.2 Purpose and Structure of This Report

This report presents an overview of the transport modelling tools that have been developed for the assessment of the Proposed CBC in relation to traffic and transport. The transport modelling supports the design development, construction strategy and the traffic and transport impact assessment of the Proposed CBC. The outputs from the transport modelling for the Proposed CBC are used to inform other environmental disciplines including Air Quality, Climate, Noise & Vibration, Population and Human Health. The remainder of the report is structured as follows:

Chapter 3 – Transport Modelling Methodology

Chapter Three provides an overview of the transport modelling methodology including the use of the NTA's East Regional Model (ERM), the development of local area and scheme specific micro-simulation modelling to support the assessment of the Proposed CBC.

Chapter 4 – Transport Modelling Specification

Chapter Four presents information on the specification of the transport modelling tools including the defined model area, demand segmentation, time periods modelled, model software and key assignment parameters.

Chapter 5 – Data Collection

Chapter Five outlines the traffic data collected to support transport model development for the Proposed CBC.

Chapter 6 – Local Area Modelling

Chapter Six describes the development of the local area model (LAM) including the calibration and validation process adopted and the results achieved to ensure that the LAM is meeting relevant Transport Infrastructure Ireland (TII) and NTA guidelines.

Chapter 7 – Micro-simulation Modelling

Chapter Seven describes the development of the micro-simulation model for the Proposed CBC including the calibration and validation process adopted and the results achieved that demonstrate that the micro-simulation model is a suitable and robust tool to be used to assess the impact of the Proposed CBC.

Chapter 8 – Forecast Model Development

Chapter Eight presents the process used for the development of the Do-Minimum and Do-Something (2028 & 2043) suite of transport models, including the process to convert from the ERM to the LAM and in turn the micro-simulation model for the Proposed CBC.

3. Transport Modelling Methodology

3.1 Introduction

The following chapter describes the overall methodology used for developing the various transport modelling tools which are, in turn, used to support the assessment of the Proposed CBC. This assessment in relation to the receiving transport environment will require a qualitative assessment of changes to the transport environment, as well as quantitative analysis that will be undertaken using a suite of multi-modal transport modelling tools which have been developed for the CBC Infrastructure Works.

The assessment of traffic and transport benefits and impacts of the Proposed CBC require a transport modelling approach which can provide information on, for example, the mode share changes along the route, people movement by different modes of transport travelling along the corridor as well as traffic re-routing impacts on the surrounding road network. The modelling approach requires an assessment of bus, pedestrian and cycle operations and bus reliability with a focus on the movement of people along the route.

To enable this a multi-tiered transport modelling approach is being adopted. The NTA's East Regional Model (ERM) will be the primary modelling tool and provides the overarching information on forecast travel demand for each mode of transport. The ERM will be supported by other modelling tools which will provide more granular level traffic information which will allow for detailed and refined modelling at a local network and junction level. For this purpose, it is intended to use a cordoned[1] corridor-wide, road (motorised vehicle only) based Local Area Model (LAM) in combination with a multi-modal corridor micro-simulation model and local junction models which will work in tandem with the NTA's East Regional Model (ERM).

The traffic and transport impact assessment for the Proposed CBC, which will be informed by the suite of modelling tools described above, will be undertaken in accordance with latest guidance including the 'Guidelines on the Information to be contained in Environmental Impact Assessment Reports' (EPA 2017), the 'Traffic and Transport Assessment Guidelines' (TII 2014), the National Cycle Manual (NTA 2011) and the UK Design Manual for Roads & Bridges (DMRB), Volume 11, Section 2, Part 5 (UK Highways Agency 2011).

The traffic and transport assessment will be informed by the following reports which will be included as part of the EIAR:

- **Transport Impact Assessment (TIA)** – will include the comprehensive assessment of the individual CBC covering all transport modes for both Construction and Operational Phases; and
- **Transport Modelling Report (This Report) -** will detail the model development, data inputs, calibration and validation and forecast model development for the suite of models that will be used to support the assessment.

The assessment of traffic and transport benefits and impacts will take account of receptors relevant to the Proposed CBC including:

- Buses;
- Pedestrians / mobility impaired;
- Cyclists;
- General traffic; and
- On-street parking, off-street parking, loading, taxis.

In addition, the following modes of transport will be considered as part of the modelling:

- Public Transport including MetroLink, inter-urban rail, suburban rail, DART, light rail (Luas) and bus;
- Traffic including private car, taxis and goods vehicles;
- Walking; and

[1] Cordoning is the process of creating a smaller area model (network and demand) from a larger model

- Cycling.

The traffic and transport assessments will be carried out in relation to the following scenarios:

1. Existing Baseline Conditions (2020) (Pre-COVID-19) – The existing baseline scenario has been developed based on conditions existing in February 2020. It will be used for the non-modelling-based metrics which rely on qualitative or provision-based assessments.

2. Future 'DoMinimum' ('likely receiving environment') Scenario – For the quantitative assessments (that use modeling outputs), the baseline model will be developed to represent the agreed future design years, without the Proposed CBC in place. Typically, a 'DoMinimum' model includes any known permanent improvements or changes to the road or public transport network that have taken place, been approved or are planned for implementation. These models are important to form the reference case by which to compare the proposal ('DoSomething') models.

3. Future 'DoSomething' ('likely receiving environment') Scenario – This scenario will include the Proposed CBC infrastructure design models, implementing all elements of the design for the Proposed CBC i.e. the 'DoMinimum' conditions with the addition of the Proposed CBC.

Further detail on the design years and the transport schemes that are included in the future 'DoMinimum' models can be found in Chapter 8.

3.2 Movement of People Calculation

To support the 'Objective' led approach to the design of junctions along the Proposed CBC (i.e. with a focus on the movement of people rather than vehicles), a People Movement at Signal (PMS) Calculator has been developed from first principles based on TRL guidance[2].

The 'Objective' led approach involves the prioritisation of people movement, focussing on maximising the throughput of sustainable modes (i.e. Walking, Cycling and Bus modes) in advance of the consideration and management of general vehicular traffic (private car) movements at junctions.

The PMS calculator has been developed to provide an initial estimate of green time allocation for all movements at a typical junction, as proposed in the design guidelines used for the CBC Infrastructure Works, on the basis that sustainable mode movements should be accommodated foremost to maximise people movement with the remaining green time allocated to general traffic movements. The calculations are underpinned by:

- the number of buses required to be accommodated along the Proposed CBC;
- an estimate of peak hour cycling demand based on the provision of a high Level of Service for cyclists at each junction along the Proposed CBC; and
- the pedestrian crossing width and crossing timing requirements based on the provision of a high Level of Service for pedestrians at each junction along the Proposed CBC.

The PMS calculator is based on the junction arrangements as proposed in the design guidelines used for the CBC Infrastructure Works, for both 3 and 4-arm variations. The outputs of the calculator provide the designer with an estimate of the green times and vehicle capacity movements based on designer user inputs and assumptions for each junction along the Proposed CBC. The calculator provides an estimate of the People Movement for the junction in question (by mode) and is used by the designer to adjust their proposals with a view to maximising the total person throughput at each junction along the Proposed CBC.

The Movement of People Calculation and vehicular capacity from this initial exercise will be enhanced further by the Proposed CBC Transport Models described in Section 3.3 below.

[2] UK – Department of Transport Research Report 67 - THE PREDICTION OF SATURATION FLOWS FOR ROAD JUNCTIONS CONTROLLED BY TRAFFIC SIGNALS https://trl.co.uk/sites/default/files/RR067.pdf

3.3 Proposed CBC Transport Models

This section sets out the various transport modelling tools that have been developed and will be used to inform the preparation of the TIA and traffic and transport chapters of the EIARs and to support design decisions. The purpose of each tool is detailed and the use of the tool for each element of the CBC Infrastructure Works is defined.

The modelling tools that have been developed as part of the CBC Infrastructure Works do not work in isolation but instead work as a combined modelling system driven by the ERM as the primary source for multi-model demand and trip growth etc. which is then passed to the cordoned local area model, corridor microsimulation models and junctions models which are refined and calibrated to represent local conditions to a greater level of detail then that contained in the ERM.

Importantly, no one tool can provide the full set of modelling data required to inform both the EIAR and TIA requirements and to support design iterations and decisions e.g. the ERM via the LAM will provide road traffic flow information (for example Annual Average Daily Traffic (AADT) and link speed data which is used to inform Air Quality and Noise models).

The CBC micro-simulation model is the most appropriate tool to provide the end-to-end bus journey times for the CBC based on the detailed interaction of vehicle movements along the proposed CBC. In addition, the LAM has been used directly for supporting design development decisions and to assist with an understanding of the implications of banned turns and potential trip redistribution away from the Proposed CBC during both the construction and operational phases.

3.3.1 CBC Transport Modelling Hierarchy

There are four tiers of transport modelling which are used to assess the Proposed CBC and these are detailed below and shown graphically in Figure 3-1.

- **Tier 1 (Strategic Level):** The NTA's East Regional Model (ERM) is the primary tool used to undertake the strategic modelling of the Proposed CBC and provides the strategic multi-modal demand outputs for the proposed forecast.
- **Tier 2 (Local Level):** A Local Area Model (LAM) has been developed to provide a more detailed understanding of traffic movement at a local level. The LAM is a subset model created from the ERM and is a more refined road network model used to provide consistent road-based outputs to inform the TIA, EIAR and junction design models. This would include information such as AADTs, road network speed data, traffic re-distribution impacts during construction and operation etc. The LAM also provides traffic flow information for the CBC micro-simulation model and junction design models and is used to support junction design and traffic management plan testing.
- **Tier 3 (Corridor Level):** An 'end-to-end' corridor Micro-simulation model has been developed for the Proposed CBC to assist in the operational validation of proposed designs with the visualisation of the potential Proposed CBC impacts and benefits. The CBC micro-simulation model provides information on journey time reliability and also more accurate information on end-to-end bus journey times. 3D Visualisations of sections of the Proposed CBC can be developed from the micro-simulation model.
- **Tier 4 (Junction Level):** Local junction models have been developed, for each junction along the Proposed CBC to support local junction design development. These models are informed by the outputs from the above modelling tiers, as well as the junction designs which are, as discussed above, based on people movement.

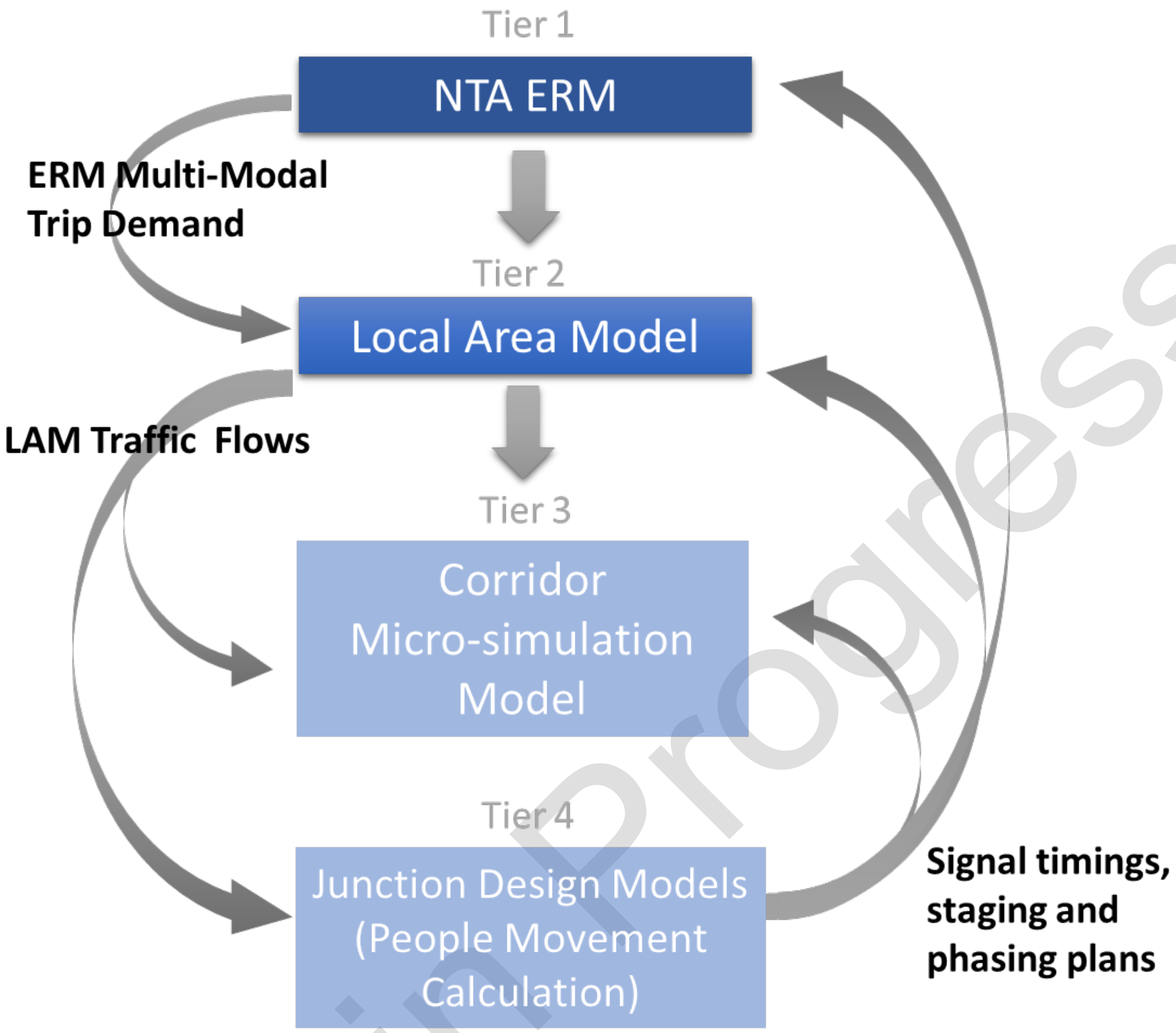

Figure 3-1 Proposed CBC Modelling Hierarchy

The purpose of each of the modelling tools and where each has been used across the various CBC Infrastructure Works elements (EIAR, TIA and Preliminary Design Report (PDR)) is summarised in Table 3.1 below and discussed further in subsequent sections.

Table 3.1: Modelling tool and purpose

Tool	Purpose	Inputs	EIAR	TIA	PDR
NTA ERM	• Forecast Multi-Modal demand impacts Proposed CBC including both area wide and corridor level • Mode share • Policy assessment (e.g. demand management) • Donor Network for LAM • Flows to inform PDR	• NTA Forecast Planning Data (2020,2028,2043) • Future year Proposed CBC information (Traffic signal plans and timings	✓	✓	✓

Local Area Model (LAM)	• General Traffic Redistribution impacts • Link Flows (AADTs) • Link Speeds • Junction turning flows • Construction Strategy and Traffic Management measure testing • Donor network for CBC Micro-sim model	• Traffic surveys • Journey time data • ERM forecast matrices • Proposed CBC designs • Proposed CBC Traffic signal plans and timings	✓	✓	
CBC Micro-sim Model	• Operational features • Design validation • Person delay measurement • Bus journey times • Queue formation • Scheme visualisation	• LAM demand matrices • Proposed CBC designs • Proposed CBC Traffic signal plans and timings	✓	✓	
Junction Design Models / People Movement Calculation	• Junction design tool • Proposed CBC signal plan and timing development • People Movement Calculation	• Junction Turning flows from LAM			✓

The following sections describe in further detail each of the modelling tools and their role within the assessment of the Proposed CBC.

3.3.2 NTA Regional Modelling System (RMS) and East Regional Model (ERM)

The East Regional Model (ERM) is part of the National Transport Authority's (NTA) Regional Modelling System (RMS) for Ireland that allows for the appraisal of a wide range of potential future transport and land use alternatives. The RMS comprises the National Demand Forecasting Model (NDFM); five large-scale, detailed, multi-modal regional transport models; and, a suite of Appraisal Modules. The five regional models comprising the RMS are focussed on the travel to-work areas for Dublin (represented by the aforementioned East Regional Model (ERM)), for Cork (represented by the South West Regional Model (SWRM)), for Limerick (represented by the Mid-West Regional Model (MWRM)), for Galway (represented by the West Regional Model (WRM)) and for Waterford (represented by the South East Regional Model (SERM)).

The key attributes of the five regional models include; full geographic coverage of each region, detailed representations of all major surface transport modes including active modes, road and public transport networks and services, and of travel demand for five time periods (AM, 2 Inter-Peaks, PM and Off-Peak). The RMS encompasses behavioural models calibrated to 2017 National Household Travel Survey[3] data that predict changes in trip destination and mode choice in response to changing traffic conditions, transport provision and/or policies which influence the cost of travel.

Purpose of the RMS

The NTA uses the RMS to help inform decisions required during strategy development and to assess schemes and policy interventions that are undertaken as part of its remit. The RMS has been developed to provide the NTA with the means to undertake comparative appraisals of a wide range of potential future transport and land use options, and to provide evidence to assist in the decision-making process. Examples of how the RMS can assist the NTA include testing new public transport schemes by representing the scheme in the assignment networks, testing demand management measures by, for example, changing the cost of parking or number of

[3] https://www.nationaltransport.ie/wp-content/uploads/2019/01/National_Household_Travel_Survey_2017_Report_-_December_2018.pdf

parking spaces within the regional model or testing the impacts of new land use by changing the planning data assumptions within the NDFM.

The RMS includes the 2016 Census/POWSCAR and 2017 National Household Travel Survey (NHTS) data sets and the NTA has included a range of improvements to the main model components where identified and implemented. These improvements include improving and making changes to such elements as the NDFM, development of the Long-Distance Model, updated zoning, networks, and parking modules; best-practice discrete choice modelling using the NHTS and POWSCAR datasets to estimate the parameters of the behavioural models, improved model runtimes, and general model functionality improvements.

RMS Components

The NTA RMS comprises of the following three main components, namely:

- The National Demand Forecasting Model (NDFM);
- 5 Regional Models (including the ERM); and
- A suite of Appraisal Modules

The NDFM takes input attributes such as land-use data, population etc., and estimates the total quantity of daily travel demand produced by, and attracted to, each of the 18,641 Census Small Areas in Ireland.

The ERM is a strategic multi-modal transport model representing travel by all the primary surface modes – including, walking and cycling (active modes), and travel by car, bus, rail, tram, light goods and heavy goods vehicles, and broadly covers the Leinster province of Ireland including the counties of Dublin, Wicklow, Kildare, Meath, Louth, Wexford, Carlow, Laois, Offaly, Westmeath, and Longford, plus Cavan and Monaghan.

The ERM is comprised of the following key elements:

- **Trip End Integration:** The Trip End Integration module converts the 24-hour trip ends output by the NDFM into the appropriate zone system and time period disaggregation for use in the Full Demand Model (FDM);
- **The Full Demand Model (FDM):** The FDM processes travel demand, carries out mode and destination choice, and outputs origin-destination travel matrices to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved; and
- **Assignment Models:** The Road, Public Transport, and Active Modes assignment models receive the trip matrices produced by the FDM and assign them in their respective transport networks to determine route choice and the generalised cost for each origin and destination pair.

Destination and mode choice parameters within the ERM have been calibrated using two main sources: Census 2016 Place of Work, School or College - Census of Anonymised Records (2016 POWSCAR), and the Irish National Household Travel Survey (2017 NHTS).

The use of the ERM for the Proposed CBC

The NTA's ERM is the most sophisticated modelling tool available for assessing complex multi modal movements within an urban context. This provides a consistent framework for transport assessments. The ERM is the ideal tool to use as a basis for the assessment of the Proposed CBC and to estimate its multi-modal impact. In addition, it provides the platform to forecast future trip demand and distribution.

The NTA ERM is, therefore, the primary high-level modelling tool for the strategic transport assessment of the Proposed CBC, providing the sole source of multi-modal forecast trip / person demand for each of the scenarios to be assessed. The ERM provides the strategic impacts and benefits of the CBC and the outputs from the ERM provide key inputs to the Transport Impact Assessments (TIA) and EIAR.

3.3.3 Local Area Model (LAM)

To support the detailed assessment of the Proposed CBC a more disaggregate urban area traffic model was developed, as a cordoned model from the ERM, that could incorporate the most up to date traffic survey data. The LAM provides the appropriate level of detail required to inform the various disciplines and levels of decision making within the CBC Infrastructure Works e.g. capturing the impact of redistribution of traffic on streets and roads not included within the strategic detail of the ERM. As such, a Local Area Model (LAM) has been developed to support the assessment of the Proposed CBC.

The LAM is compatible with the ERM road network, being a direct extraction from the ERM road model, but with the addition of extra road network and zoning detail. The LAM is calibrated and validated with the most recent 2019/2020 traffic survey data and journey time information, which ensures that the model reflects 'on-the-ground' conditions for the Proposed CBC in February 2020 (e.g. prior to COVID-19 restrictions).

The LAM which is a more refined version of the road network model component of the ERM has been used throughout the CBC Infrastructure Works to provide all road-based outputs to inform the TIA, EIA and junction design models. i.e. AADTs, road network speed data, traffic re-distribution impacts during construction and operation of the Proposed CBC. The LAM also provides traffic flow information for the corridor micro-simulation models and junction design models.

3.3.4 Proposed CBC Micro-simulation Model

A micro-simulation model has been developed for the full continuous 'end-to-end' route of the Proposed CBC. The 'end-to-end' Corridor Micro-simulation model has been developed to assist in the operational validation of the scheme designs and to provide visualisation of scheme operability along with its impacts and benefits.

The term 'end-to-end' refers to the point of model 'entry' (start of Proposed CBC) to the point of model 'exit' (end of Proposed CBC) rather than the actual bus service terminus points which, in most cases, will lie outside of the modelled area. The modelling of the Proposed CBC will show the differences in travel time for buses along the full length of the Proposed CBC, including delay at individual locations.

Figure 3-2 Proposed CBC Microsimulation Model Network

Role of the Corridor Micro-Simulation Models

The Proposed CBC micro-simulation model will provide key information on journey time reliability in addition to more accurate information on end-to-end bus and car journey times along the CBC which can be fed back into the ERM and LAM models to increase the level of robustness to the change in journey times between the 'DoMinimum' and 'DoSomething' (with CBC scheme) scenarios.

The Proposed CBC micro-simulation model will be supplied traffic flow information from the LAM and will use outputs from the junction design models, in terms of signal plans, green times, staging, phasing and offsets. 3D Visualisations of sections of the CBC can be developed based on the 2D models to help visualise and demonstrate the benefits and impacts of the scheme to stakeholders.

Overall, the Proposed CBC micro-simulation model will provide key transport metric inputs to the TIA in terms of operation features, vehicle interaction, person level delay and bus journey time performance.

3.3.5 CBC Junction Design Models

The fourth tier of modelling in the modelling hierarchy to support the assessment of the Proposed CBC is the individual junction design models that have been developed for junctions along the Proposed CBC. These junction design models are supplied with traffic flow information from the LAM and from the micro-simulation model for the Proposed CBC. The LAM, Corridor Micro-simulation and local junction models will contain consistent design, transport demand, signal phasing and staging information.

Role of the CBC Junction Design Models

The junction design models have been used to inform junction design considerations as part of the formulation of Preliminary Designs for the Proposed CBC. The junction models have been developed for standalone junction assessments and for combinations of secondary (off-line to CBC) junctions. The junction models are used in combination with the CBC micro-simulation model at 'hot-spot' locations for operational testing and 'proof of concept' demonstration of the preferred design for the CBC.

The junction design models are important supporting design tools for analysis of the design proposals and help to inform the development of signal plans and phasing at junctions along the CBC. The junction models are used to inform the LAM and CBC micro-simulation models, with information such as design amendments, signal plans and timings being fed back in the iterative process where appropriate.

The resultant scheme designs are then modelled in the ERM, LAM and corridor models to understand the strategic and corridor specific issues and inform the preparation of the TIAs and EIARs and the planning submissions for the Proposed CBC.

3.3.6 Modelling Interface with Proposed CBC Design Team

Throughout the development of the Preliminary Design for the Proposed CBC there have been various design stages undertaken based on a common understanding of the maturity of the design at a given point in time. Part of this process is to ensure the environmental and transport impacts are mitigated to the greatest extent possible during the design development and to enable information to be provided from the various EIA and TIA disciplines back to the engineering designers for consideration.

Figure 3-3 below illustrates this process whereby the emerging design for the Proposed CBC (which have been developed in line with a set of design objectives / principals with a view to maximising the 'Movement of People' along the Proposed CBC), have been tested using the transport models described above as part of an iterative process. The transport models provide an understanding of the benefits and impacts of the proposals (mode share changes, traffic redistribution, bus performance etc.) with traffic flow information also feeding other environmental disciplines (Air Quality, Noise and Vibration etc.) which in turn feed back to the designers of the Proposed CBC.

The iterative process concludes when the designers are satisfied that the Proposed CBC design meets its required objectives (maximising the people movement capacity of the Proposed CBC) and that the environmental impacts and level of mitigation required are reduced to a minimum level.

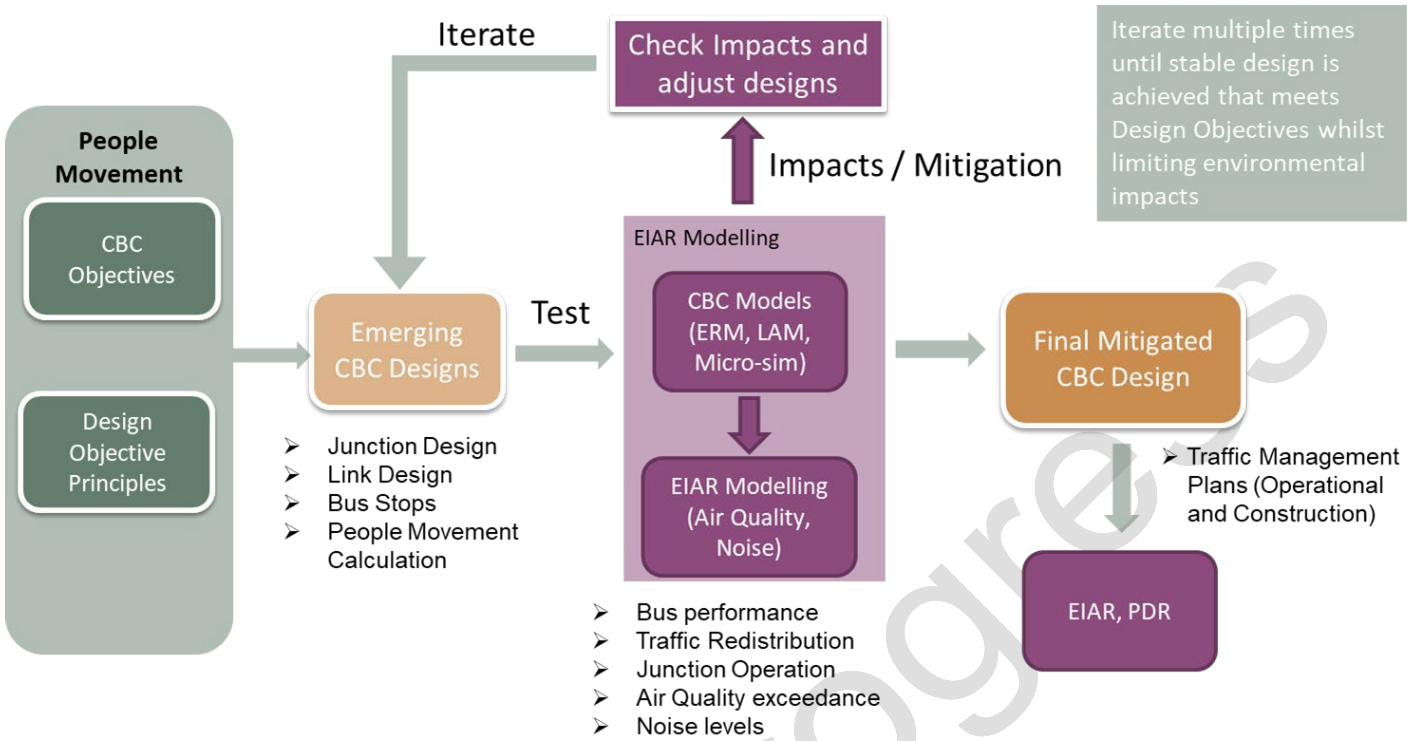

Figure 3-3 CBC Modelling and Design Interaction

3.4 Base Model Development Methodology

The base year for the Proposed CBC models is 2020 (Pre-COVID19) based on the date of traffic surveys undertaken for the CBC Infrastructure Works in November 2019 and February 2020. The following section provides an overview of the ERM, LAM and CBC Micro-simulation base models development methodology. The CBC junction design models (Tier 4) are developed for the Proposed CBC designs and don't require base model development like the Tier 1-3 models.

ERM 2020 Model Development Methodology

A 2020 baseline (existing conditions) ERM run was required for the development of the LAM and subsequent base models for the Proposed CBC. This was done through the following steps:

- Update of Road and Public Transport networks to 2020 conditions;
  - The ERM road network was updated to include road schemes that were implemented to February 2020. In addition, the most recent public transport timetable information was provided from the NTA Journey Planner and updated within the ERM.
- Update of demand data (Trip Ends) to 2020;
  - 2016 Census planning data for population, employment and education was updated to 2020 based on a linear interpolation between the 2016 data and the future reference case forecasts provided by the NTA. This data was passed through the NDFM to generate base year demand which was then run in the NTA ERM along with the updated 2020 networks.

LAM Development Methodology

The methodology for developing the LAM from the ERM is illustrated in Figure 3-4 below.

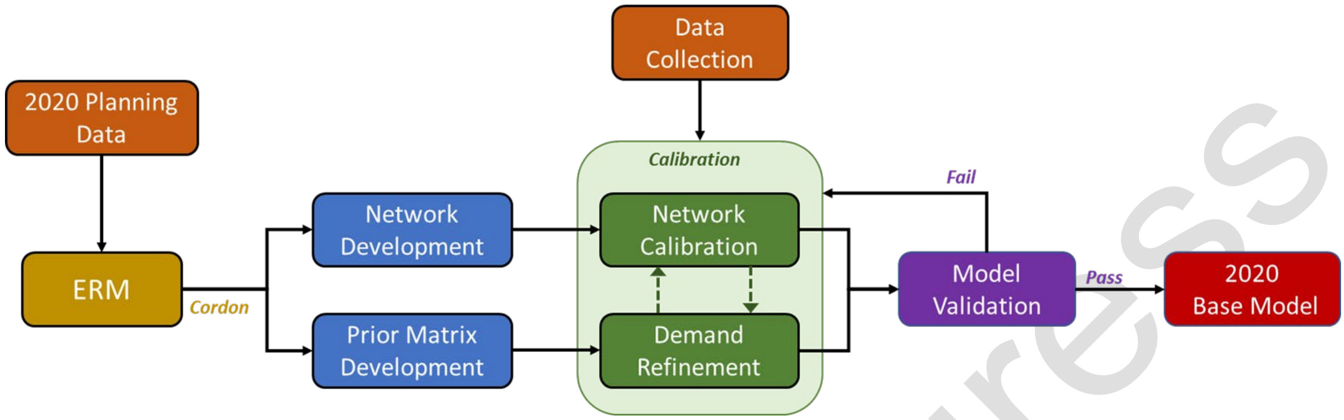

Figure 3-4 LAM Development Methodology

In Summary:

- **ERM Cordon**: The 2020 ERM road assignment was cordoned[4] to extract the initial network and traffic matrix to provide a starting point for the LAM.
- **LAM Network and Prior Matrix Development**: The newly formed LAM was then reviewed in detail which included a review of junction layouts, network speeds, banned turns, missing links etc. The zone system within the LAM was disaggregated, where necessary, to ensure a more accurate representation of traffic loading onto the road network was captured. Further details on the network and zone system development is provided in Chapter 6.
- **Data Collection:** Traffic survey data including link counts, junction turning counts and journey time information was collected and used to calibrate and validate the LAM (refer to Chapter 5 for further information).

The LAM was calibrated in-line with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) and the UK Department for Transport (DfT) TAG guidance, and further information is provided in Chapter 6. The LAM was validated in-line with TII and TAG guidance, and further information is provided in Chapter 7 of this report.

CBC Micro-Simulation Model Development Methodology

The development of the Proposed CBC Micro-simulation model follows a similar process to that of the LAM, but at a more refined and detailed level along the direct extents of the Proposed CBC alignment. For example, both the LAM and the micro-simulation model start with an initial prior matrix based on a cordon of the ERM.

Similarly, to the LAM, the Micro-simulation model was calibrated and validated in-line with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) and the UK Department for Transport (DfT) TAG guidance, and further information is provided in Chapter 7. The micro-simulation model would aim to achieve a higher level of calibration / validation along the Proposed CBC that the LAM which covers a wider area.

[4] Cordoning is the process of creating a smaller area model (network and demand) from a larger model

4. Transport Modelling Specification

4.1 Introduction

This chapter provides an overview of the key parameters that define the Proposed CBC models, with specific reference to the following aspects:

- Model Area;
- Model Time Periods;
- Demand Segmentation;
- Model Software; and
- Modelling Input Parameters.

4.2 Model Area of Proposed CBC Models

This section provides an overview of the model areas for each of the Proposed CBC models, namely the ERM, LAM and CBC Microsimulation model which are shown in Figure 4-1 below

The ERM broadly covers the travel to work area of Dublin city and encompasses the Leinster province of Ireland including the counties of Dublin, Wicklow, Kildare, Meath, Louth, Wexford, Carlow, Laois, Offaly, Westmeath, and Longford, plus Cavan and Monaghan and is shown in Figure 4-1 below. The LAM covers the main urban area of Dublin, which is the study area for the CBC Infrastructure Works. The CBC Micro-simulation modelled area includes the direct alignment of the Proposed CBC and immediate sections of adjoining road networks.

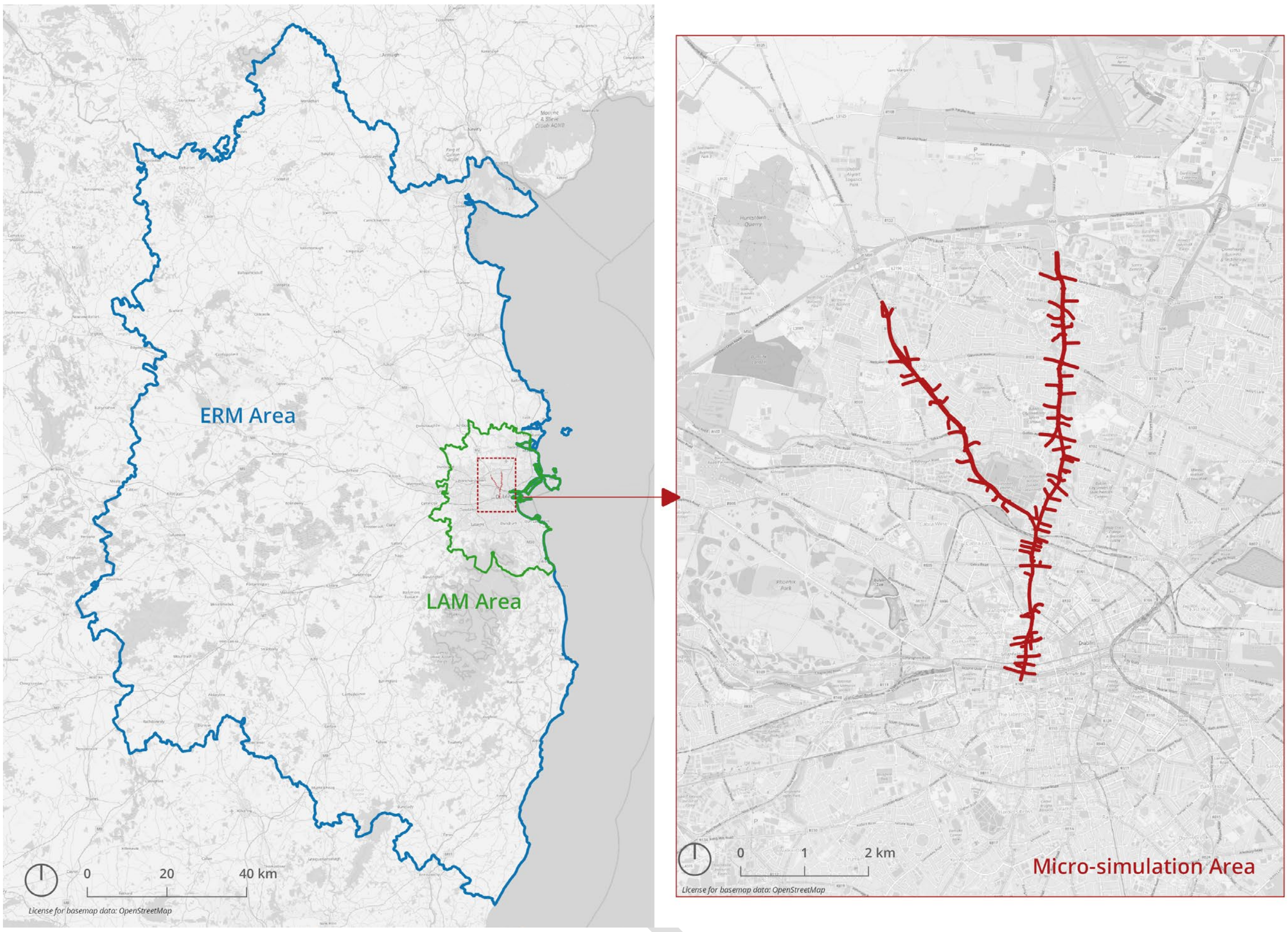

Figure 4-1 ERM, DLAM and Micro-simulation Model Areas

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4.3 Modelled Time Periods

The transport models developed for the Proposed CBC cover all time periods across a typical average weekday. The ERM demand model covers the following time periods with the road and public transport models assigning a representative 1-hour within each of the 3-hr demand periods:

- AM Peak period covering the period between 07.00-10.00;
- Morning Inter-Peak covering the period between 10.00-13.00;
- Afternoon Inter-Peak covering the period between 13.00-16.00;
- PM Peak period covering the period between 16.00-19.00; and
- Off-Peak covering the period between 19.00-07.00.

The LAM covers the 4 peak hour time periods outlined below:

- AM Peak hour covering the period between 08.00-09.00;
- Morning Inter-Peak hour covering the period between 12.00-13.00;
- Afternoon Inter-Peak hour covering the period between 15.00-16.00; and
- PM Peak hour covering the period between 17.00-18.00.

The Proposed CBC Microsimulation Model covers the following periods:

- Weekday AM peak between 07:00 and 10:00; and
- Weekday PM peak between 16:00 and 19:00.

4.4 Demand Segmentation

Different components of the model require the sub-division of travel demand into various classifications with the most prevalent sub-divisions are by demand segment and user class.

Demand segments are used to categorise trips into meaningful segments where there is a notable difference in travel choice primarily relating to mode choice or destination choice. User classes represent combinations of vehicle type, purpose and person type and are more important for route choice in assignment models where a clear difference exists in how they will be modelled such as value of time or free fares.

4.4.1 ERM Demand Segmentation:

The ERM includes 33 different demand purposes which is made up of the following segmentations:

- Home base journey purposes, such as:
  - Commute;
  - Education;
  - Escort to Education;
  - Shopping;
  - Visiting friends/relatives;
  - Employers business; and
  - Other (which combines all trip types not part of the above categories).
- Non-home-based trips, derived from the destinations of home-based trips;

All home-based trips are segmented by car availability, which is a function of household car ownership and competition levels.

4.4.2 LAM User Classes

As outlined previously in Chapter 3, the prior travel demand for the LAM was derived from the NTA's ERM. The ERM road assignment matrices contain the following ten user classes:

- UC1 - Car Employer's Business (in work time)
- UC2 - Car Commute (travel to/from work);
- UC3 - Car Other (other non-work purposes such as shopping, visiting friends, etc.);
- UC4 - Car Education (travel to/from school);
- UC5 - Car Retired;
- UC 6 - Taxi;
- UC7 - Light Goods Vehicles (LGV);
- UC8 - Other Goods Vehicles (OGV1);
- UC9 - OGV2 Permit Holder (5 or more axles and allowed drive in Dublin city centre); and
- UC10 - OGV2 (5 or more axles and not allowed drive in Dublin city centre).

Each user class has its own defined set of generalised cost parameters based on a price per kilometre and a price per minute. To ensure consistency with the larger strategic ERM, the ten user classes and their associated generalised cost parameters were retained for the LAM.

The ten assigned user classes were then grouped in to three broader vehicle classes, based on the availability of disaggregated survey data. The three vehicle classes represented are:

- All Car;
- LGV; and
- All other Goods Vehicles.

4.4.3 CBC Micro-simulation Model Segmentation

The CBC micro-simulation model contains the following 'vehicle classes':

- Taxi (LV);
- Car (LV);
- LGV (LV);
- OGV1 (HV);
- OGV2 (Permit Holder) (HV);
- OGV2 (Other) (HV);
- Bus (HV);
- Tram;
- Cyclist (standard) (Cycles);
- Cyclist (confident) (Cycles);
- Man (Pedestrians); and
- Woman (Pedestrians).

4.5 Model Software

The following section outlines the software in which the Proposed CBC modelling tools have been developed.

ERM Software

The ERM is built within the following transport modelling software packages:

- Road Model is built within SATURN[5] software; and
- NDFM, Public Transport Model and Choice Modelling components are built within the CUBE Voyage software.

LAM Software

The model software used to develop the LAM is the SATURN suite of transportation modelling programs with the model calibrated and validated using release versions 11.4.07 of the software. SATURN has 6 basic functions:

1. As a combined traffic simulation and assignment model for the analysis of road-investment schemes ranging from traffic management schemes over relatively localised networks (typically of the order of 100 to 200 nodes) through to major infrastructure improvements where models with over 1,000 junctions are not infrequent;

[5] SATURN - Simulation Assignment of Traffic to Urban Road Networks

2. As a "conventional" traffic assignment model for the analysis of much larger networks (e.g., up to 6,000 links in the standard PC version, 37,500 in the largest);
3. As a simulation model of individual junctions;
4. As a network editor, data base and analysis system;
5. As a matrix manipulation package for the production of, for example, trip matrices; and
6. As a trip matrix demand model covering the basic elements of trip distribution, modal split, etc.

CBC Micro-simulation Model Software

The Proposed CBC micro-simulation model has been developed using PTV VISSIM 11-09. This represents the latest version of the software at the time of writing.

4.6 Modelling Input Parameters

ERM / LAM Input Parameters

The SATURN application SATNET was used to build the various data files in to an assignable road network (UFN) file.

Matrices were then assigned to the network using the SATALL application, where it iterates through assignment and simulation loops until the user defined levels of convergence are reached (RSTOP and STPGAP), or the model reaches the user defined maximum number of assignment and simulation loops (MASL). SATALL uses a converged equilibrium assignment method to assign the traffic to the road network over successive iterations, until user defined convergence criteria are achieved. The key convergence criteria are presented in Table 4.1 and represent a very tight level of convergence.

Table 4.1: LAM SATURN Convergence Criteria

VARIABLE	DESCRIPTION	VALUE
MASL	Maximum number of assignment / simulation loops.	150
PCNEAR	Percentage change in flows judged to be "near" in successive assignments	1%
RSTOP	The assignment / simulation loops stop if RSTOP % of link flows change by less than PCNEAR % in successive assignments	98%
NISTOP	Number of successive loops which must satisfy the RSTOP criteria for convergence	4
STPGAP	Critical gap value (%) used to terminate assignment / simulation loops	0.05

Micro-simulation Inputs Parameters

The Micro-simulation model includes a range of 'link behaviour types'. For each 'link type', there is a corresponding 'vehicle types' and 'driver behaviour parameter sets'. Further detail on the model parameters are available in the Proposed CBC Micro-simulation Model Development Report.

5. CBC Data Collection

5.1 Introduction

The following chapter provides an overview of the data collection exercise undertaken to facilitate the calibration and validation of the LAM, Proposed CBC micro-simulation and junction models. Existing data sources were reviewed to identify available counts and locate gaps in observed information across the model area. This review was used to define a specification for additional counts which were commissioned for the area. The combination of new commissioned counts, and existing available information, provided a comprehensive dataset for calibration and validation.

5.2 Existing Data Review (GAP Analysis)

A review of existing traffic survey data available for the model area was undertaken from the following sources:

- NTA count database: A mixture of Automatic Traffic Counts (ATC) and Junction Turning Counts (JTC) from previous studies covering a range of years;
- TII Counters: Permanent TII ATCs located on national strategic roads across the network with data publicly available online.

The NTA, Dublin City and the other local authorities undertake periodic counts within their administrative areas in connection with their own local schemes. These surveys are conducted throughout the year and a limited set of data was available within the area of the Proposed CBC. It was decided that due to the scale of the CBC Infrastructure Works, the Proposed CBC required a full set of consistent updated traffic counts for a neutral period e.g. November / February when schools, colleges are in session.

5.3 Commissioned Traffic Survey Data

The information in this chapter presents the methodology adopted to prepare counts as inputs to the model calibration and validation process. The two types of counts used in the study are Junction Traffic Counts (JTCs) and Automatic Traffic Counts (ATCs).

Junction Turning Counts (JTCs)

The JTCs are 24-hour counts broken down into 15 minute segments over a full day. As indicated in Table 5.1 all main junctions along the Proposed CBC have been included and provide information on the volume, and types of vehicles, making turning movements at each location. This data is utilised within the LAM calibration to ensure that the flow of vehicles through the main junctions on the network is being represented accurately.

Automatic Traffic Counts (ATCs)

The ATCs are taken over an entire 2-week period. The ATC data provides information on:

- The daily and weekly profile of traffic within the study area;
- Busiest time periods and locations of highest traffic demand on the network;
- Any issues on the network during the survey period e.g. accidents, road closures etc.; and
- Typical speed of traffic on the network.

Both sets of counts were surveyed by IDASO Ltd. The JTCs were surveyed on the 26th of November 2020. The ATCs were surveyed from the 21st of November to the 4th of December 2019.

Table 5.1 Survey Overview

SURVEY TYPE	COMPANY	NUMBER	DATES
JTC	IDASO LTD	17	26/11/2019
ATC	IDASO LTD	3	21/11/2019 - 4/12/2019

The various components of traffic have different characteristics in terms of operating costs, growth and occupancy. The surveys used the most common categories as defined by COBA; these are:

- Cars (CARS): Including taxis, estate cars, 'people carriers' and other passenger vehicles (for example, minibuses and camper vans) with a gross vehicle weight of less than 3.5 tonnes, normally ones which can accommodate not more than 15 seats. Three-wheeled cars, motor invalid carriages, Land Rovers, Range Rovers and Jeeps and smaller ambulances are included. Cars towing caravans or trailers are counted as one vehicle unless included as a separate class.
- Light Goods Vehicles (LGV): Includes all goods vehicles up to 3.5 tonnes gross vehicle weight (goods vehicles over 3.5 tonnes have sideguards fitted between axles), including those towing a trailer or caravan. This includes all car delivery vans and those of the next larger carrying capacity such as transit vans. Included here are small pickup vans, three-wheeled goods vehicles, milk floats and pedestrian controlled motor vehicles. Most of this group is delivery vans of one type or another.
- Other Goods Vehicles (OGV 1): Includes all rigid vehicles over 3.5 tonnes gross vehicle weight with two or three axles. Also includes larger ambulances, tractors (without trailers), road rollers for tarmac pressing, box vans and similar large vans. A two or three axle motor tractive unit without a trailer is also included.
- Other Goods Vehicles (OGV 2): This category includes all rigid vehicles with four or more axles and all articulated vehicles. Also included in this class are OGV1 goods vehicles towing a caravan or trailer.
- Buses and Coaches (PSV): Includes all public service vehicles and work buses with a gross vehicle weight of 3.5 tonnes or more, usually vehicles with more than 16 seats.

The ATCs were taken for an entire week. In some cases, the ATC counts were repeated for a second week to account for data-collection issues. The categories surveyed are: motorcycles, cars, LGVs, OGV1, OGV2 and PSVs.

5.4 Count Data for Calibration and Validation

Figure 5-1 shows the locations of the 17 JTC counts and 3 ATC counts the Proposed CBC.

Summary information related to the JTC junctions is provided in Table 5.2. The busiest junction in the study area is the North Road/St Margarets Road (48836 daily movements). The next busiest junctions are:

- Old Finglas Road (37195 daily movements)
- Wellmount Road (34277 daily movements)
- Ballyboggan Road (32948 daily movements)
- Tolka Valley Road (31699 daily movements)

The least busy junction in the study area is Finglas Road / North Road Slip Road with 16775 daily movements.

The average weekday ATC flows (all vehicles) are shown in Table 5.3. The highest ATC daily flows are on the North Road north of St Margarets Road. Some ATC counts did not have reliable counts for a full week and were excluded from the dataset.

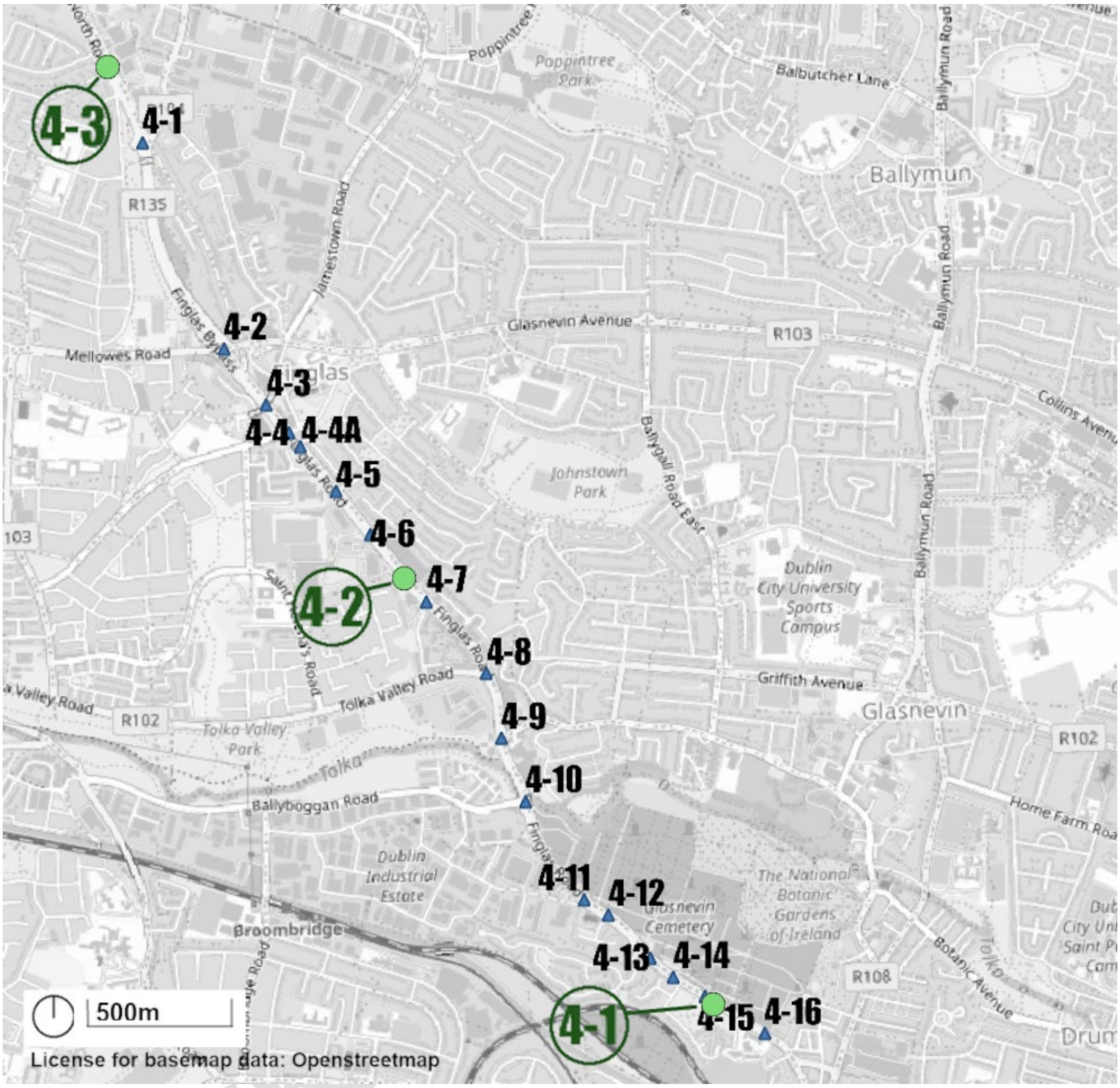


Figure 5-1 ATC and JTC Traffic counts location

Table 5.2 JTC Locations

JUNCTION IDENTIFIER	JUNCTION NAME	TYPE	DAILY MOVEMENTS	AM MOVEMENTS	PM MOVEMENTS
4-1	North Road/St Margarets Road	Priority	48836	3357	3667
4-2	Finglas Road/Mellowes Road	Signals	16775	1206	1139
4-3	Finglas Road/Church St	Priority	29499	1854	2021
4-4	Finglas Road/Wellmount Road	Priority	34277	2440	2400
4-4A	Finglas Road/Wellmount Road	Priority	30829	2277	2106

JUNCTION IDENTIFIER	JUNCTION NAME	TYPE	DAILY MOVEMENTS	AM MOVEMENTS	PM MOVEMENTS
4-5	Finglas Road/Finglas Place	Priority	30692	2127	2047
4-6	Finglas Road/Glenhill Road	Priority	31471	1918	2064
4-7	Finglas Road/Ardmore Lodge	Signals	26077	1638	1636
4-8	Finglas Road/Tolka Valley Road	Signals	31699	2240	2106
4-9	Finglas Road/Old Finglas Road	Signals	37195	2648	2650
4-10	Finglas Road/Ballyboggan Road	Signals	32948	2149	2344
4-11	Finglas Road/Slaney Road	Signals	27990	1487	1897
4-12	Finglas Road/The Willows	Priority	23803	1253	1645
4-13	Finglas Road/Claremont Cres	Priority	24047	1274	1656
4-14	Finglas Road/Cemetery Exit	Priority	23075	1201	1604
4-15	Finglas Road/Cemetery Exit	Priority	22303	1145	1536
4-16	Finglas Road/St Vincents	Priority	22309	1116	1537

Table 5.3 ATC Locations

ATC IDENTIFIER	ATC LOCATION	DIRECTION	DAILY MOVEMENTS	AM MOVEMENTS	PM MOVEMENTS
4-1A	Finglas Road at Glasnevin Cemetery	Southbound	12899	622	966
4-1B		Northbound	excluded	excluded	excluded
4-2A	Finglas Road north of Tolka Road	Southbound	excluded	excluded	excluded
4-2B		Northbound	excluded	excluded	excluded
4-3A	North Road north of St Margarets Road	Southbound	16172	1155	1173
4-3B		Northbound	17535	1150	1346

Private cars and taxis were aggregated as a single vehicle type for input to the LAM model. The OGV1 and OGV2 categories were also aggregated as HGVs. PSVs are modelled as fixed routes with a specific frequency in the model and as such were not included in the model inputs. PCL counts are not included in the model inputs. Separate input files were prepared for the following time periods.

- AM: 0800-0900;
- LT: 1200-1300;
- SR: 1500-1600;
- PM: 1700-1800; and
- OP: 2000-2100.

The JTCs were merged into a 'flat format' database which permits the extraction of counts grouped by modelled hour (AM, LT, SR or PM) and modelled vehicle category (Car, LGV or HGV). Turn count records were given a unique movement identifier (AB, AC, AD etc). These identifiers were then associated with their respective nodes in the LAM. In some cases, there is a unique one-to-one relationship between the turn counts and the SATURN network as shown in Figure 5-2 below.

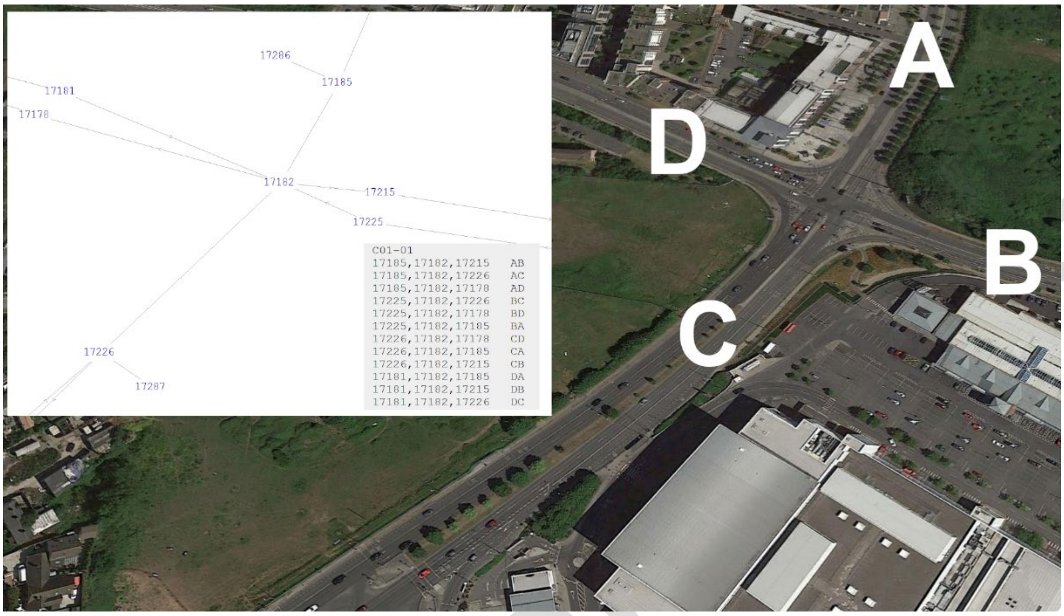


Figure 5-2 –Bus Connects LAM Node Matching (Junction C01-01)

The flows for complex junctions were obtained by combining certain turning movement flows. An example of this is junction C01-02 on the Malahide Road, Figure 5-3 below.

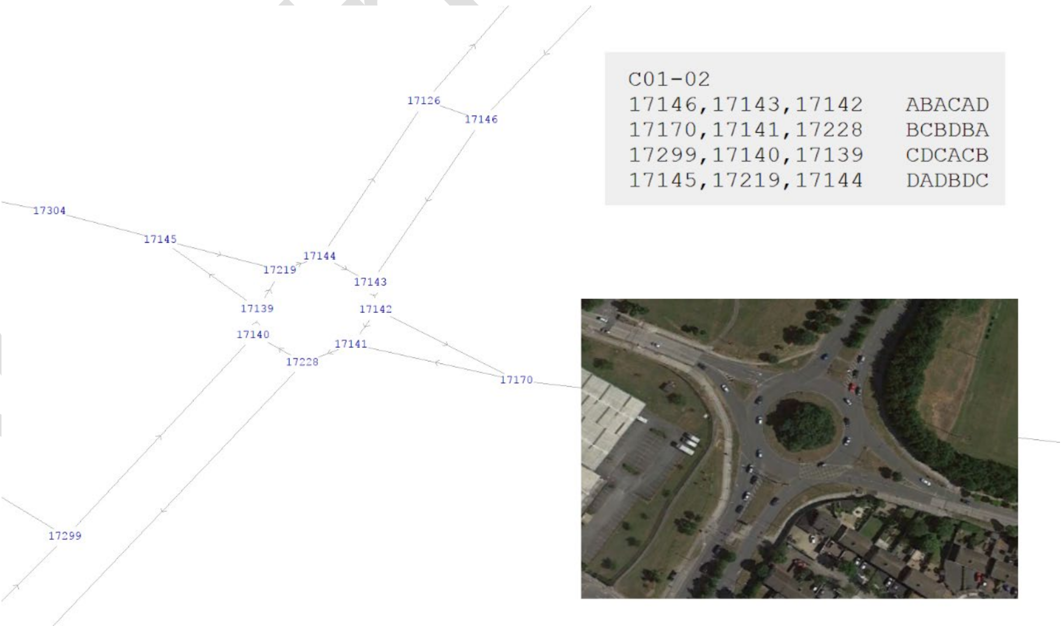


Figure 5-3 – Bus Connects LAM Node Matching (Junction C01-02)

5.5 Road Journey Time Data

5.5.1 TomTom Data Summary

Journey time data for the Proposed CBC models has been sourced from TomTom, who calculate journey times using vehicle position data from GPS-enabled devices and provide this on a commercial basis to a number of different users. The NTA purchased a license to access the Custom Area Analysis dataset through the TomTom TrafficStats portal. The NTA has an agreement with TomTom to provide travel time information covering six areas of Ireland and for certain categories of road.

Data is provided based on the area specified by the agreement; however, the date and time range of the data can be specified by the user. For the development of the LAM the following query on the data was applied:

- 2019 weekdays (Monday to Thursday) from mid-January until end of November, excluding all bank holidays and days close to those dates.

The data is provided in the form of a GIS shapefile and accompanying travel time database file. The shapefile contains topographical details for each road segment, which is linked to the travel time database via a unique link ID. The database file then contains average and median travel time, average and median speed, the standard deviation for speed, the number of observations and percentile speeds ranging from 5 to 95 for each link.

5.5.2 TomTom Data Processing

In order to compare the journey times of specific links and routes between the TomTom data and the road assignment models, the two datasets need to be linked. After importing both the road assignment model and TomTom networks into the GIS environment, ensuring both datasets are in the same coordinate system, the selected routes can then be linked using a spatial join functionality.

Before applying the data to the models, it was checked to ensure that it was fit for purpose. The review included checks of the number of observations that form the TomTom average and median times and checks of travel times against Google Maps travel times.

The TomTom Custom Area Analysis dataset was processed to provide observed journey times against which the LAM and Micro-simulation model could be validated along the Proposed CBC.

5.5.3 TomTom Data Application

The processed journey time data was used to validate the LAM and the micro-simulation models at an end-to-end travel time level, with intermediate segment travel times used to inform the calibration of both models. Further information about the journey time validation process can be found in Chapter 6 and 7 of this report for the LAM and micro-simulation models respectively.

6. Local Area Modelling

6.1 Introduction

To support the detailed assessment of the Proposed CBC a more disaggregate urban area traffic model was developed, as a cordoned Local Area Model (LAM) model from the ERM, that incorporates the most up to date traffic survey data. The LAM provides the appropriate level of detail to capture the impact of redistribution of traffic on streets and roads not included within the strategic detail of the ERM.

The LAM is a direct extraction from the ERM road model with the addition of extra road network and zoning detail. The LAM is calibrated and validated with the most recent 2019/2020 traffic survey data and journey time information, which ensures that the model reflects 'on-the-ground' conditions for the Proposed CBC in February 2020 (e.g. prior to COVID-19 restrictions).

The following chapter provides a detailed overview of the development of the LAM for the Proposed CBC. It describes the model development (network and zoning) process and the calibration and validation results in the specific area of the Proposed CBC. Further information on the calibration and validation of the full LAM can be found in Appendix A.

6.2 LAM Network and Zone System Development

6.2.1 Introduction

This chapter provides an overview of the network and zone system developed for the LAM. As noted in Chapter 2 previously, a cordon of the 2020 ERM run was used to generate the initial network and zone system. Further detail was then added to provide a more accurate representation of traffic loading within the model area of the Proposed CBC.

6.2.2 Network Development

The LAM road network, extracted from a cordon of the ERM, is illustrated in Figure 6-1. A review was undertaken of all model coding in the study area using digital mapping systems such as Google Earth to ensure it represented, as accurately as possible, the existing road network. This included aspects such as network speed limits, availability of bus lanes, junction layouts, pedestrian crossing points etc.

Junction capacities and saturation flows were adopted from the ERM standards[6] developed for the NTA as part of the RMS development, and were further reviewed during the calibration process. Where required, additional detail was added to ensure that traffic was loading onto the road network at the correct locations.

Along the Proposed CBC, side roads adding more than 50 vehicles per hour in the AM or PM peak hours were identified using traffic survey data and added within the model. Any existing signalised junctions not within the model along the Proposed CBC were also added. Particular attention was given to the addition of road links that form potential rat-runs through residential streets as pictured in Figure 6.2 below. In total 117 new links were identified and coded into the LAM to compliment the network already contained within the ERM donor network.

As illustrated in Figure 6-1, the LAM provides a detailed representation of all significant roads within the study area. To ensure full network coverage and route choice, all roads have been considered, from national primary routes to minor residential streets. The short dead-end links in Figure 6.2 are "spigots[7]" used to load traffic from the zones accurately onto the network and reflect the further developed zone system that is outlined in section 6.2 below.

[6] NTA RMS - TN11 Regional Model Coding Guide

[7] A small link representing either a single or amalgamation of local roads coded specifically to allow for the connection of a zone into the network in a logical location and allow for modelled junction interactions with the larger road the spigot connects to.

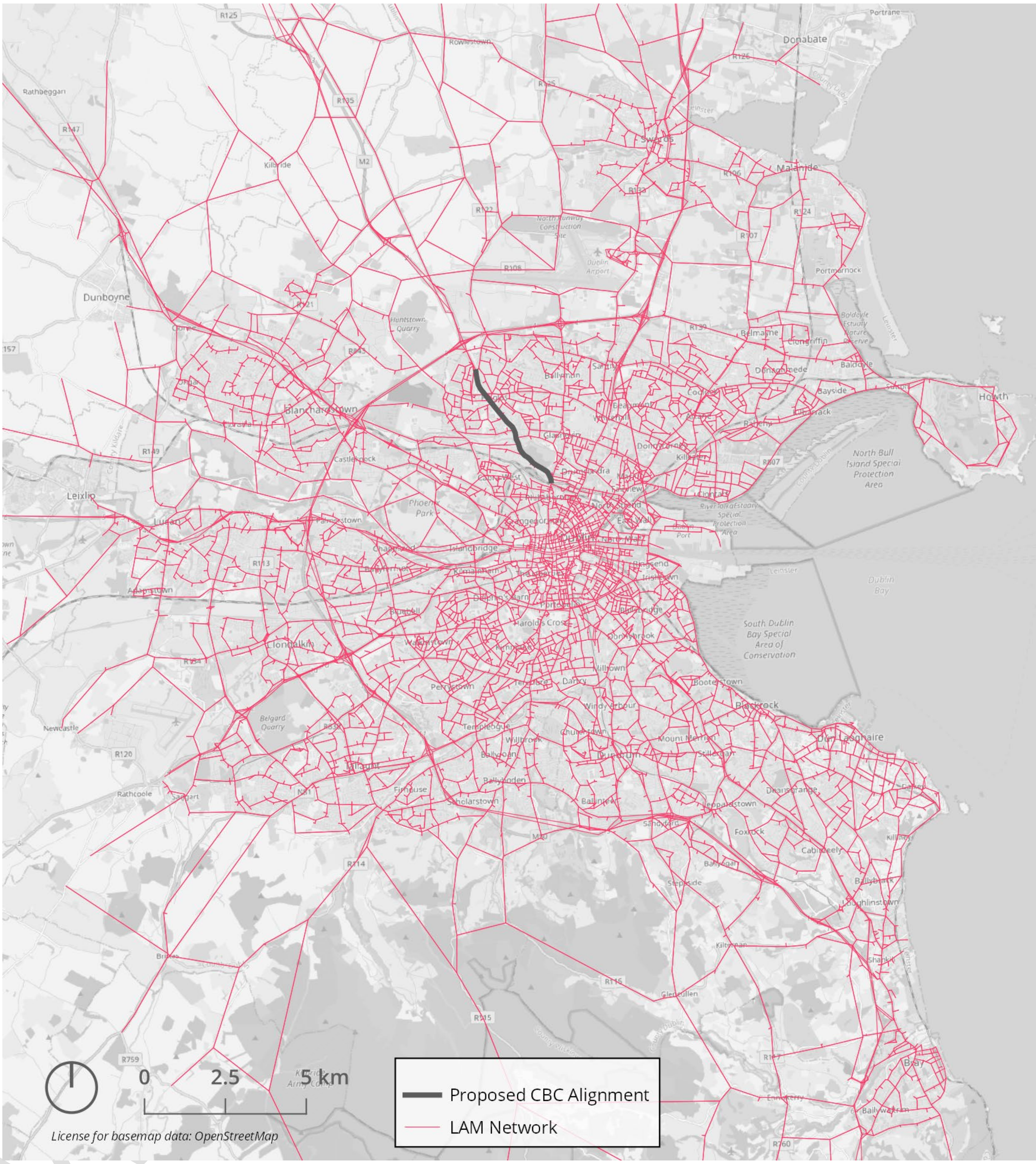


Figure 6-1 LAM Network and Proposed CBC Alignment

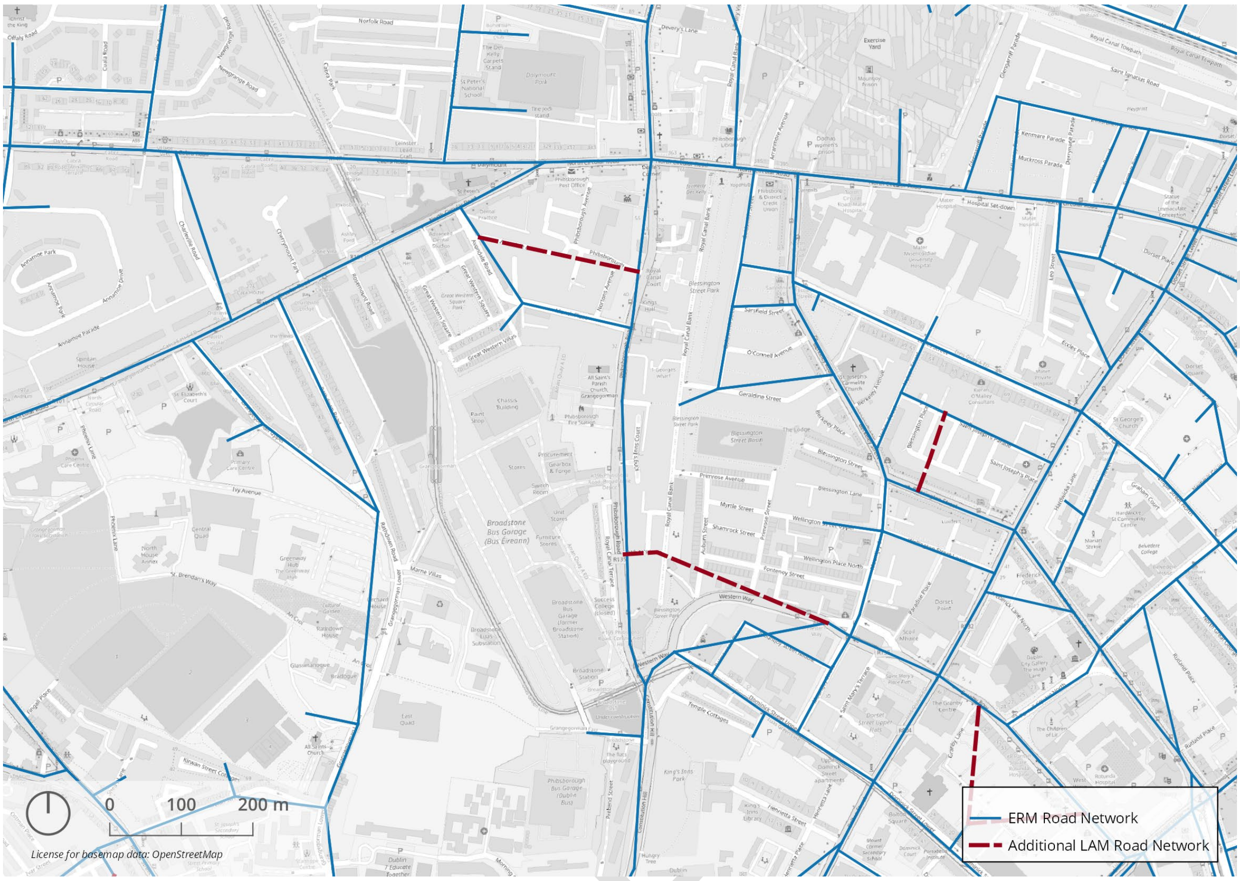


Figure 6-2 Example of additional network detail within LAM

6.2.3 LAM Zone System Development

Similar to the road network described previously, the LAM zone system was adopted from the ERM. The ERM zone system was developed using the Census Small Area Population Statistics (SAPS) and Place of Work, School or College Census of Anonymised Records (POWSCAR) to get detailed information on population, employment and education locations across the model area. Other data sources such as MyPlan[8] and Geo Directory[9] were also used to obtain information on specified land-use zoning and the locations of commercial development. The following rules were applied in generating the zone system:

- **Population, Employment and Education** – the number of zones with values of population, number of jobs and persons in education above a certain threshold (~ 2000) should be minimised;
- **Activity Levels** – the number of zones with activity levels that have very low or very high levels of trips should be minimised;
- **Intra-zonal Trips** – threshold values should be applied to the proportion of intra-zonal trips within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- **Land Use** – zones should be created with homogeneous land use and socio-economic characteristics where possible;

[8] MyPlan is a web map portal providing spatial information relevant to the planning process in Ireland. This site is an initiative of the Department of Housing, Local Government and Heritage in conjunction with Irish Local Authorities.

[9] GeoDirectory is An Post's database of 2.2million commercial and residential property addresses

- **Zone Size/Shape** – zone size and the regularity of zone shape should be considered in order to avoid issues with inaccurate representation of route choice;

- **Political Geography** – it should be possible to aggregate all zones to ED level i.e. zone boundaries do not intersect ED boundaries; and

- **Special Generators/Attractors** – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. should be allocated to separate zones.

Figure 6-3 below illustrates the LAM Zone System covering the study area.

A detailed review was undertaken of all ERM zoning and centroid connectors in the study area. A number of zone splits, illustrated in red in Figure 6-4, as well as the addition of centroid connectors were applied to the ERM zone system in order to provide a more accurate representation of traffic loading onto the road network. Some ERM zones have been split according to the following criteria:

- Zones crossed the Proposed CBC have been split along the CBC aligment.

- Zones with multiple accesses to the Proposed CBC have been split if the accesses are significant (signalized junction or access adding more than 50 vehicles on the Proposed CBC in the morning ro evening peak hour)

These criterias led to the creation of 100 new LAM zones split from the ERM zone system, giving a total number of LAM zones as 1294.

Figure 6-3 LAM Zone System

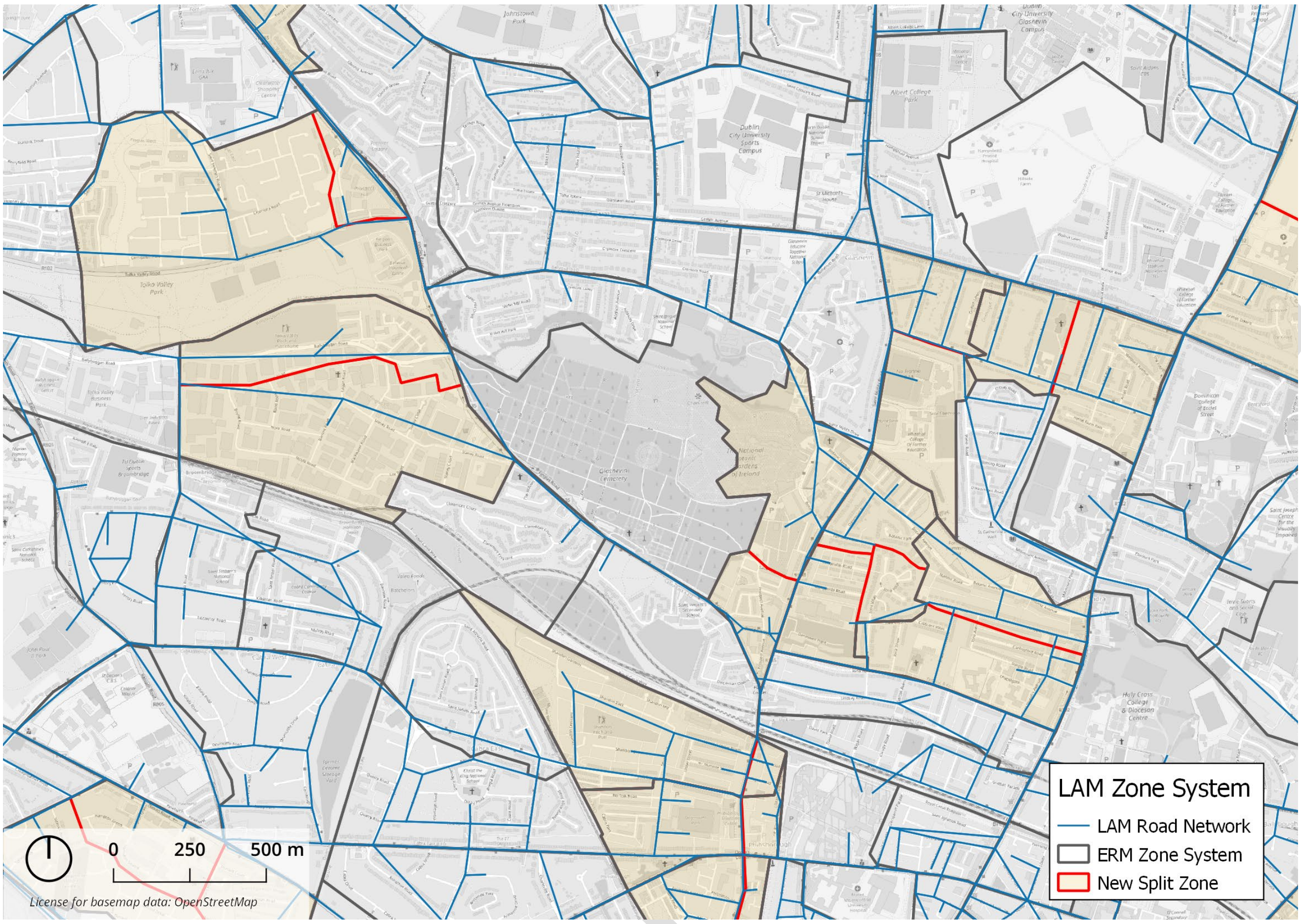


Figure 6-4 LAM Zone System – Split zones

6.2.4 LAM Network Adjustments

The LAM was coded based on best practice approaches developed during the NTA RMS development, and as such, the model provided an accurate and up-to date representation of the existing road network.

When the traffic survey data was processed and analysed, the network coding was re-checked with the following edits undertaken where there was a clear justification for doing so:

- **Junction Capacity:** The SATURN software flags an error where a junction has insufficient modelled capacity to achieve the observed traffic flow. All these instances were reviewed in detail and remedial action was taken where required. This included:
    - Adjusting Signal Timings (mostly synthesised within the model area);
    - Adding/removing flared lanes;
    - Adding/removing approach lanes; and
    - Adjusting saturation flows through junctions.
- **Network Speeds:** The capacity and speeds of modelled links were checked to ensure they were broadly in line with survey information;

- **Zone Connectors:** A review was undertaken on the location of zone connectors in close proximity to count sites to ensure they were providing an accurate representation of traffic loading onto the road network.

6.3 LAM Prior Matrix Development

As noted previously in Section 2.2, the ERM Full Demand Model (FDM) carries out mode and trip destination choice for all zones within the ERM. The FDM has been calibrated using Census data, and hence, provides a robust and accurate representation of trip distributions across the model network. In order to generate prior matrices for the LAM, a cordon was extracted from a run of the 2019/2020 ERM scenario (described in section 3.4). The cordon function within SATURN, facilitates the extraction of trip matrices for a subset area of the ERM whilst still maintaining route and destination choice from the full model.

A bespoke Cube Voyager module was created to disaggregate the cordoned ERM matrices to each of the LAM zones. This tool used available data on population, employment, and education places by Census Small Area, to split trips to/from each ERM zone between the more detailed LAM zoning system. This allowed for a consistent split of demand within the study area, whilst maintaining consistency with the ERM matrix.

A set of simplifying assumptions, as outlined in Table 6-1, were used to assign the ERM demand by User Class to each of the LAM zones.

Table 6-1 Method of Disaggregation

TIME PERIOD	USER CLASS	ORIGIN	DESTINATION	NOTES
AM	Taxi	Pop + Emp	Pop + Emp	** Taxis could originate from places of work or people travelling from home*
AM	Employers Business	Emp	Emp	** assumed travelling from one employment location to another*
AM	Commute	Pop	Emp	** assume travel from home to work in the AM*

TIME PERIOD	USER CLASS	ORIGIN	DESTINATION	NOTES
AM	Education	Pop	Edu	* *assume travel from home to school in the AM*
AM	Other	Pop	Emp + Edu	* *includes escort to education and one-way commute - distribute based on pupil and job numbers*
AM	LGV	Emp	Emp	* *assumed deliveries from one business to another*
AM	OGV1	Emp	Emp	* *assumed deliveries from one business to another*
AM	OGV2	Emp	Emp	* *assumed deliveries from one business to another*
AM	OGV2_NP	Emp	Emp	* *assumed deliveries from one business to another*
PM	Taxi	Pop + Emp	Pop + Emp	* *Taxis could originate from places of work or people travelling from home*
PM	Employers Business	Emp	Emp	* *assumed travelling from one employment location to another*
PM	Commute	Emp	Pop	* *assume travel from work to home in PM*
PM	Education	Edu	Pop	* *assume travel from school to home in PM*
PM	Other	Pop + Emp	Pop + Emp	* *includes shopping, visiting friends etc. - assume split based on total resident and job numbers*
PM	LGV	Emp	Emp	* *assumed deliveries from one business to another*
PM	OGV1	Emp	Emp	* *assumed deliveries from one business to another*
PM	OGV2	Emp	Emp	* *assumed deliveries from one business to another*
PM	OGV2_NP	Emp	Emp	* *assumed deliveries from one business to another*

** Note: Pop = Population, Emp = Employment & Edu = Education*

Figure 6-5 provides an indicative example of how the disaggregation process is undertaken in the Cube Voyager module for the Commute user class in the AM peak.

The overall commute trips between Zone 1 and Zone 2 is extracted from a cordon of the ERM. Zone 1 is disaggregated into two LAM zones, namely Zone A and Zone B. Whilst Zone 2 is also disaggregated into two LAM zones, Zone C and Zone D.

As outlined in Table 6-1, commute trips in the AM are assumed to be travelling from home to work. As such, the origin trips for ERM Zone 1 are split between the LAM zones based on the population numbers in each zone. Likewise, the destination trips to ERM Zone 2 are split between their LAM zones based on the level of employment in each zone.

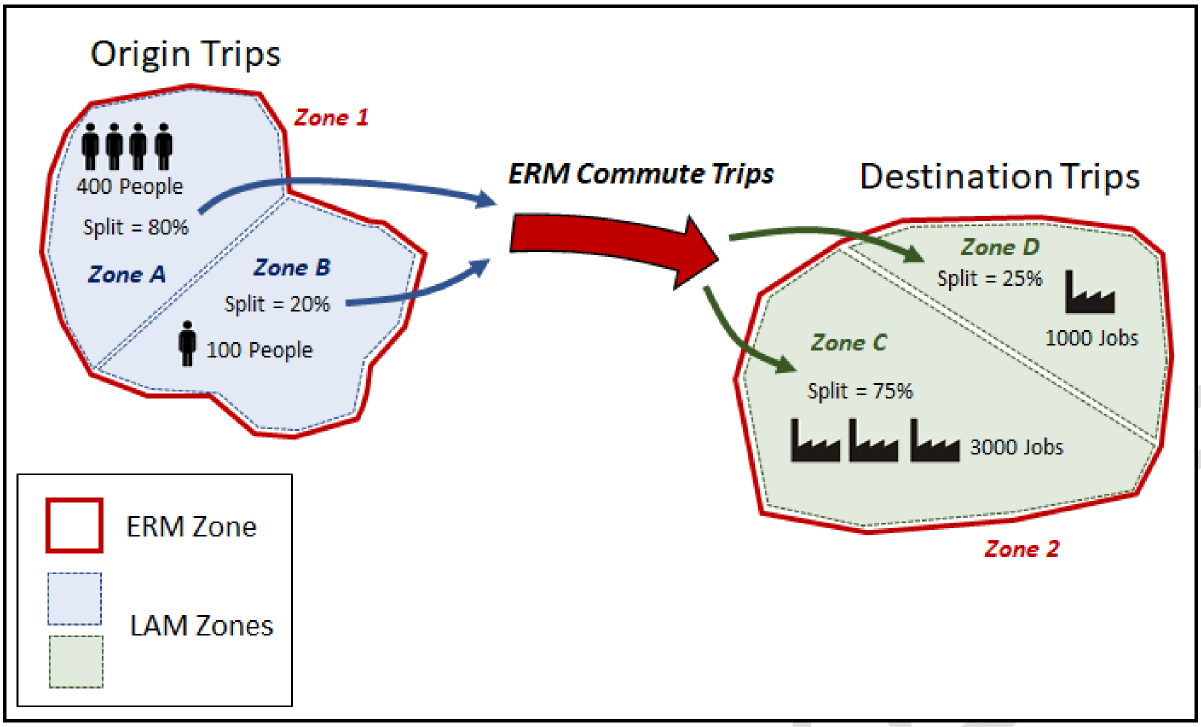


Figure 6-5 LAM Disaggregation Example – AM Peak Commute Trips

Detailed checks were undertaken at various stages to ensure that no demand from the ERM was lost throughout the disaggregation process. Table 6-2 to Table 6-5 below outline the matrix totals by user class before and after the disaggregation process indicating that all ERM cordoned demand is represented in the LAM matrices for the AM and PM peaks.

Table 6-2 AM Matrix Total Comparison

User Class	ERM Cordon	LAM Matrix	% Difference
Car Emp Business	13,489	13,489	0%
Car Commute	88,898	88,898	0%
Car Other	54,258	54,258	0%
Car Education	1530	1530	0%
Car Retired	2,078	2,078	0%
Taxi	5,372	5,372	0%
LGV	15,256	15,256	0%
OGV1	12905	12905	0%
OGV2 Permit Holders	34	34	0%
OGV2 Non Permit Holders	401	401	0%

Table 6-3 LT Matrix Total Comparison

User Class	ERM Cordon	LAM Matrix	% Difference
Car Emp Business	10,987	10,987	0%
Car Commute	17,581	17,581	0%
Car Other	56,301	56,301	0%
Car Education	365	365	0%
Car Retired	9,948	9,948	0%
Taxi	5,728	5,728	0%
LGV	16,199	16,199	0%
OGV1	14854	14854	0%
OGV2 Permit Holders	33	33	0%
OGV2 Non Permit Holders	412	412	0%

Table 6-4 SR Matrix Total Comparison

User Class	ERM Cordon	LAM Matrix	% Difference
Car Emp Business	8,204	8,204	0%
Car Commute	28,940	28,940	0%
Car Other	57,558	57,558	0%
Car Education	886	886	0%
Car Retired	6,139	6,139	0%
Taxi	5,398	5,398	0%
LGV	15,442	15,442	0%
OGV1	12043	12043	0%
OGV2 Permit Holders	27	27	0%
OGV2 Non Permit Holders	390	390	0%

Table 6-5 PM Matrix Total Comparison

User Class	ERM Cordon	LAM Matrix	% Difference
Car Emp Business	12,067	12,067	0%
Car Commute	77,452	77,452	0%
Car Other	55,998	55,998	0%
Car Education	1247	1247	0%
Car Retired	3,930	3,930	0%
Taxi	5,029	5,029	0%
LGV	14,841	14,841	0%
OGV1	7500	7500	0%
OGV2 Permit Holders	15	15	0%
OGV2 Non Permit Holders	259	259	0%

6.4 LAM Calibration and Validation Criteria

6.4.1 Introduction

Calibration is the process of adjusting the LAM network and demand to ensure that it provides a robust estimate of assignment when compared to 2019/2020 observed traffic characteristics. Generally, the components of the model that may be adjusted on the demand side are trip distribution and trip production/generation levels, and this usually involves trip 'Matrix Estimation'.

On the supply side (network), modelled junction and link characteristics may be altered if sufficient new information is available to justify changes to the existing network.

The LAM was calibrated and validated in accordance with Transport Infrastructure Ireland's (TII) *Project Appraisal Guidelines (PAG) for National Roads Unit 5.1 – Construction of Transport Models (October 2016)*. This is a widely accepted standard in Ireland that provides robust calibration and validation criteria to which certain types of highway models should adhere. Additionally, the LAM development has followed guidance from the UK's Department for Transport's Transport Analysis Guidance (TAG) unit M3-1, particularly in terms of matrix estimation controls.

The method for the calibration of the LAM is illustrated in Figure 6-6 overleaf, and comprises of the following key elements:

- **Network and Zone System Development:** The initial LAM network and zone system is derived from the ERM with further detail added where necessary to provide an accurate representation of existing conditions;
- **Network Adjustments:** A detailed review is undertaken of the road network coding taking cognisance of surveyed traffic volumes and network speeds with adjustments made where necessary;
- **Prior Matrix:** The initial prior matrix is extracted from a cordon of the ERM and disaggregated to the LAM zone system based on population, employment and education planning data;
- **Prior Matrix Factoring:** The prior matrix from the ERM is compared to observed counts at screenlines capturing key movements within the model area. Where there are large discrepancies between modelled and observed flows, factoring is undertaken to ensure that the prior matrix better represents observed travel patterns;
- **Calibration Criteria Check:** The LAM is then assessed against guideline calibration criteria in terms of modelled versus observed traffic volumes;
- **Matrix Estimation:** If the model is not passing the initial calibration check, a process known as 'Matrix Estimation' is undertaken to adjust the trip demand in order to provide an improved correlation between counts and modelled flows;
- **Post-Estimation Calibration Check:** The model is then re-tested against the calibration criteria with a focus on correlation between modelled and observed flows, along with an analysis of the demand changes introduced by 'Matrix Estimation'; and
- **Validation:** Once all the calibration criteria have been achieved, the model is passed forward for validation.

The following sections of this chapter provide an overview of the steps outlined above along with the calibration guidelines for LAM development.

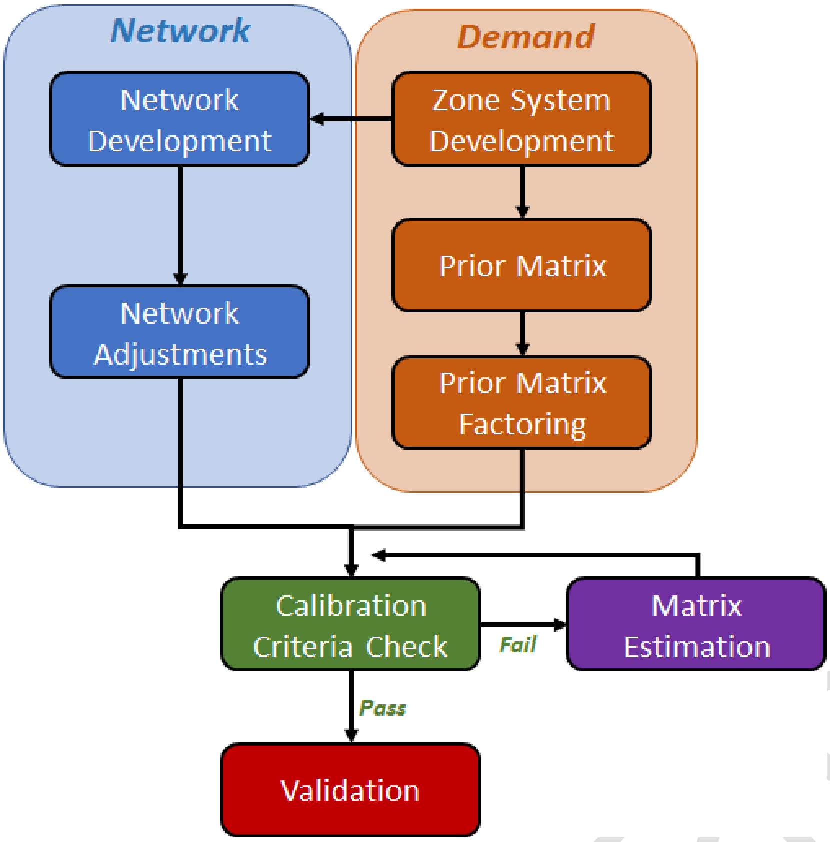


Figure 6-6 LAM Calibration Process

6.4.2 Calibration Criteria Details

Traffic Flow Calibration

Table 6-6 outlines the TII PAG criteria for permissible differences between observed and modelled traffic flows. The guidelines are measured as absolute and percentage differences at various link flows, and also make use of the Geoffrey E. Havers (GEH) statistic.

The GEH statistic is a measure that considers both absolute and proportional differences in flows. Thus, for high levels of traffic volumes a low GEH may only be achieved if the percentage difference in flow is small. For lower flows, a low GEH may be achieved even if the percentage difference is relatively large. GEH is formulated as:

$$GEH = \sqrt{\frac{(Observed - Modelled)^2}{0.5\ X\ (Observed + Modelled)}}$$

The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows. For example, an absolute difference of 100 passenger car units per hour (pcu/h) may be considered a big difference if the flows are of the order of 100 pcu/h, but would be unimportant for flows in the order of several thousand pcu/h. Equally a 10% error in 100 pcu/h would not be important, whereas a 10% error in, say, 3000 pcu/h might mean the difference between adding capacity to a road or not.

In general, the GEH parameter is less sensitive to the above statistical biases since it would be reasonable to consider that an error of 20 in 100 would be roughly as bad as an error of 90 in 2,000, and both would have a GEH statistic of roughly 2.

As a rule of thumb in comparing assigned volumes with observed flows, a GEH parameter of 5 or less would be an acceptable fit, while GEH parameters greater than 10 would require closer attention.

Table 6-6 Model Flow Calibration Criteria

CRITERIA	ACCEPTABILITY GUIDELINE
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases
Individual flows within 15% for flows between 700 & 2,700 v/h	
Individual flows within 400 v/h for flows greater than 2,700 v/h	
Individual flows – GEH < 5	>85% of cases

Screenline Analysis

Screenlines represent an amalgamation of count sites that capture key movements across the model network. TII guidelines suggest that an additional check on the quality of trip matrices should be undertaken by comparing modelled and observed flows across screenlines by vehicle type and modelled time period using the following criteria:

Table 6-7 Screenline Calibration Criteria

CRITERIA	ACCEPTABILITY GUIDELINE
Total screen line flows (> 5 links) to be within 5%	> 85% of cases
GEH statistic: screenline totals < 4	> 85% of cases
Notes: Screenlines containing high flow routes (such as motorways) should be presented both with and without such routes	

Analysis of Trip Matrix Changes

Regression Analysis

As noted previously, 'Matrix Estimation' was used to adjust the prior trip matrix in order to provide a better correlation between modelled and observed flows. However, both TII and TAG guidance suggest that caution should be taken when using estimation, and that the changes introduced should be monitored to ensure that the original matrices are not overly distorted, thus providing irregular movement patterns.

Table 6-8 outlines the matrix estimation change criteria, as specified in WebTAG Unit M3-1, Section 8.3, Table 5. The guidelines use regression analysis to identify the correlation/relationship between the demand pre and post 'Matrix Estimation', and suggest careful monitoring by the following means:

- Scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values); and
- Scatter plots of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values).

Table 6-8 Significance of Matrix Estimation Changes

MEASURE	SIGNIFICANCE CRITERIA
Matrix zonal cell value	Slope within 0.98 and 1.02; Intercept near zero; R^2 in excess of 0.95
Matrix zonal trip ends	Slope within 0.99 and 1.01; Intercept near zero; R^2 in excess of 0.98.

Tripe Length Distribution Analysis

A further calibration step recommended by TII guidance is to compare trip length distributions for the prior and post calibrated matrices to ensure they have not been overly distorted by the 'Matrix Estimation' process.

'Matrix Estimation' can sometimes generate increased short distance trips to match count information, thus distorting the profile of trip making on the network. PAG suggests that the coincidence ratio[10] should be used to compare trip length distributions before and after estimation, with a desirable range between 0.7 and 1.0

A coincidence ratio can be used to compare two distributions by examining the ratio of the total area of those distributions that coincide. The coincidence ratio is defined as:

$$CR = \frac{\sum\{\text{Min}\ (\text{TLDs}, \text{TLDf})\}}{\sum\{\text{Max}\ (\text{TLDs}, \text{TLDf})\}}$$

Where TLDs is the source trip length frequency and TLDf is the final trip length frequency. A desirable range for the coincidence ratio is between 0.7 and 1.0 where a ratio of 1.0 suggests an identical distribution.

Figure 6-7 Coincidence Ratio Calculation – TII PAG Page 20

6.4.3 Validation Criteria Details

The validation of the model uses additional comparative measures against which the robustness of the calibrated model may be judged. Calibration and validation are separate concepts, however, in reality these two elements are part of an iterative process. If the results of the validation checks are not satisfactory, thenthe inputs and coding within the model are reviewed and adjusted as required in order to achieve a better representation of reality.

It is important that the information used in calibrating the model, including count data for matrix estimation, is kept separate from that used for validation if it is to be a true independent test of the model. As such two main data sources were used in the validation of the LAM:

- Junction turning counts not utilised during model calibration; and
- Observed journey times on key routes as illustrated below in Figure 6-8

[10] The coincidence ratio is a calculation used to examine the how the total area under different distributions coincide, with a value of 1 representing an identical distribution.

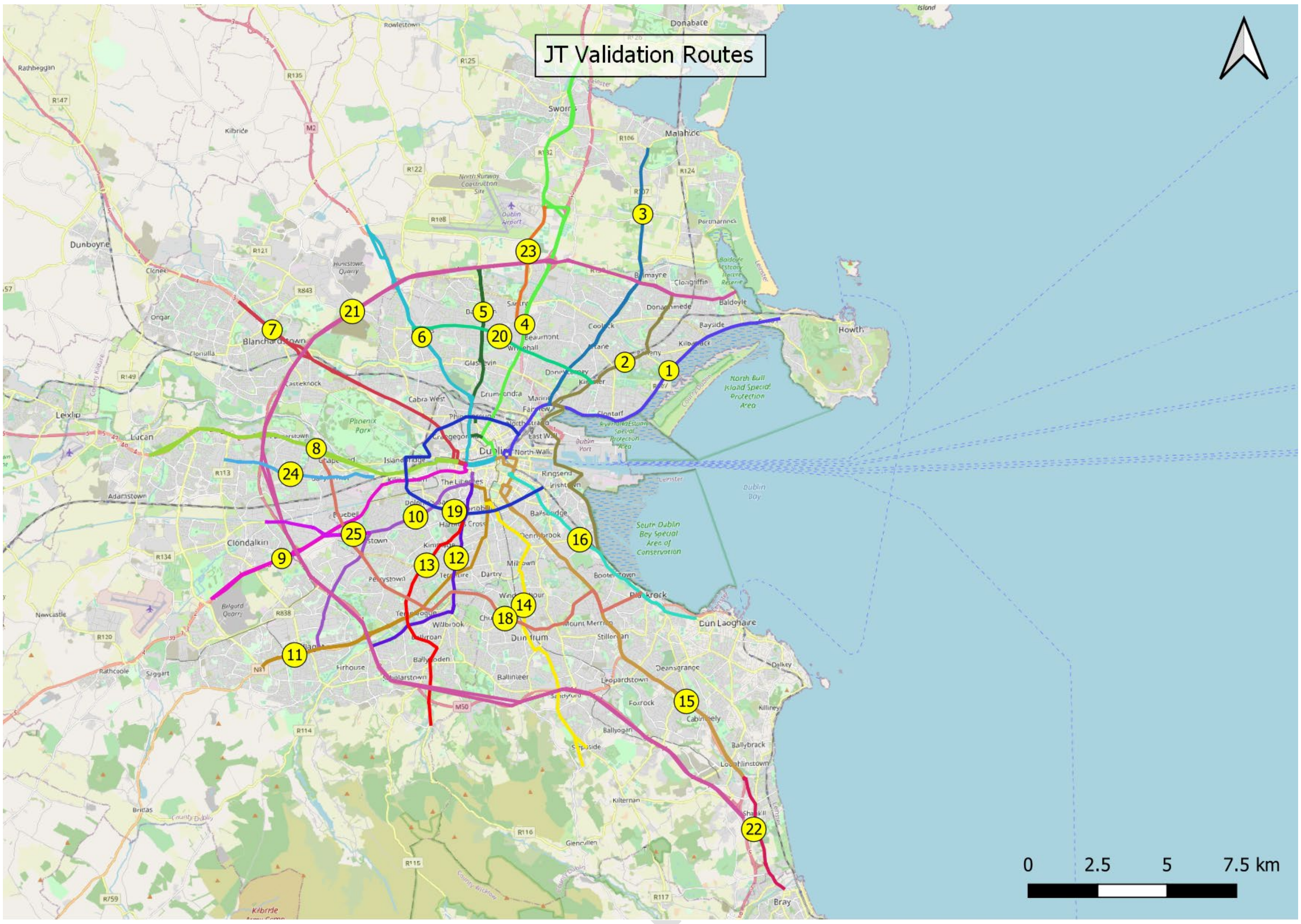


Figure 6-8 Journey Time Validation Routes

The guidelines for model validation are very similar to those described previously for calibration in Section 6.2 and are outlined in Table 6-9.

Table 6-9 Validation Criteria[11]

CRITERIA	ACCEPTABILITY GUIDELINE
Assigned hourly flows compared with observed flows	
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases
Individual flows within 15% for flows between 700 & 2,700 v/h	
Individual flows within 400 v/h for flows greater than 2,700 v/h	
Individual flows – GEH < 5	>85% of cases
Modelled journey times compared with observed times	
Times within 15% or 1 minute if higher	>85% of cases

[11] Table 5.1.5 (pg 23) TII *Project Appraisal Guidelines for National Roads Unit 5.1 - Construction of Transport Models*

Mean and Median Road Speeds

Note that on review of the processed journey time results, it became clear that there was a significant difference between the mean and median journey time results. This indicates that the data is likely to be not normally distributed and is skewed. Access to the raw data behind the TomTom results is not available as part of the license agreement and so more detailed investigation for discrepancies/outliers or a subsequent cleaning of the raw data was not possible.

As TomTom data is collected over a long period, it is likely to include periods of disruption caused by roadworks and accidents. These types of incidents are not captured within the base year model congested speeds, so cognisance of this should be taken when comparing the modelled data against that recorded by TomTom. Following a review of mean and median travel times across the TomTom network, it was felt that the median time would likely underestimate congestion impacts, as some of the most severe congestion would potentially be under represented. Whereas the mean times would potentially over estimate congestion as they would also reflect network disruption, such as roadworks and accidents (where the modelling is required to compare against 'average' journey times with no network disruption.

Comparisons with Google Map times showed that the mean of the TomTom data was on average a lot slower in the peak hours, however it matched well with the interpeak journey times.

Following on from this analysis, early comparisons with the model highlighted that although the interpeak periods (LT ad SR) matched relatively well against the TomTom mean, the AM and PM were significantly different, which the AM being closer to the median and the PM not matching well with either. This largely reflects the results of the full ERM model where the LT and SR results are notably better than the AM and PM when compared to guidance.

Given the difficulty this presents in terms of providing a consistent target observed value in order to check the validation of the modelled journey times against, a 50/50 blend of the median and mean has been created to provide a consistent target to measure all time periods against. This provides a more balanced and appropriate set of journey times to compare against the modelled data.

Journey time reporting will highlight the performance of the modelled times against the mean, median and 50/50 blend in order to give a full appreciation of the variation of the observed data and the models performance against this.

6.5 Full LAM Model Calibration and Validation

Details on the calibration and validation results for the full LAM are provided within Appendix A

6.6 Proposed CBC Calibration and Validation Summary

6.6.1 Introduction

This section details the calibration and validation of the model within the specific vicinity of the Proposed CBC and highlights the performance of the model against guidance in these key areas.

6.6.2 Turning Calibration/Validation

The turning count calibration/validation results along the route of the proposed scheme in presented in this section. Along the route of the proposed scheme there are 75 turns across 22 junctions, the location of which are displayed below in Figure 6-9.

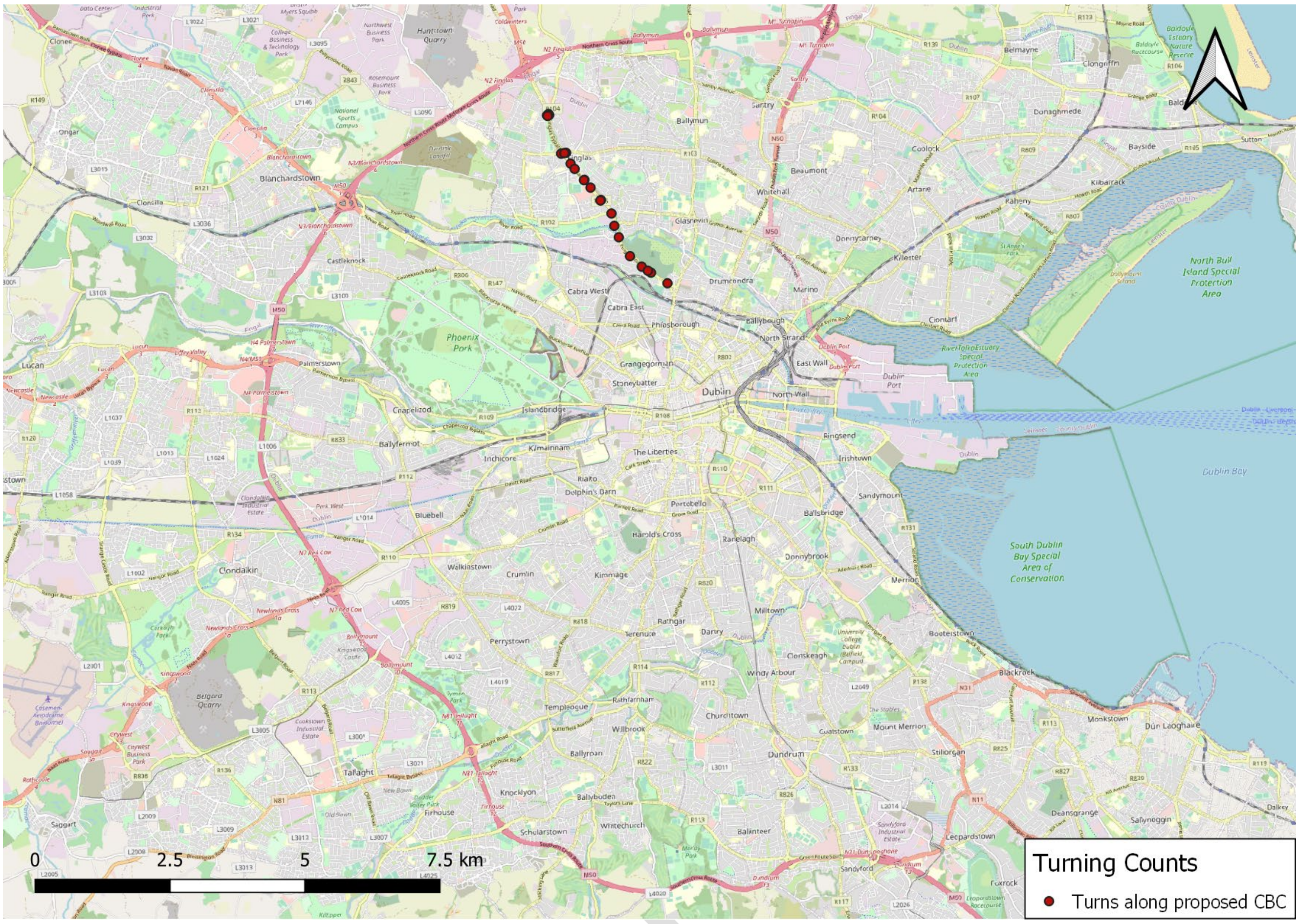


Figure 6-9 Turning counts along route of proposed scheme

The performance of these turns against guidance is detailed below in Table 6-10

Table 6-10 Turning Flow Calibration – Proposed CBC – Cars

Time Period	Total Number on Route	Individual Flow Criteria	GEH <5	DMRB or GEH <5	GEH <10	Prop within 10%
AM	75	83%	69%	83%	92%	84%
LT	75	99%	79%	99%	96%	97%
SR	75	89%	76%	89%	91%	92%
PM	75	92%	75%	93%	96%	92%

The above table shows a good fit along the Proposed CBC, with the lunch-time (LT), school-run (SR) and evening (PM) time periods meeting the required TII/TAG guidance for absolute/percentage difference and the morning (AM) being just below this at 83%. The guidance compared to GEH is significantly lower, but a comparison at GEH=10 shows that results are within guidance. The numbers of turns within 10% of the observed proportions is all either above or close to 85%, indicating the distribution of the flow across the arms is sufficiently accurate.

Table 6-11 Turning Flow Calibration – Proposed CBC – LGV

Time Period	Total Number on Route	Individual Flow Criteria	GEH <5	DMRB or GEH <5	GEH <10	Prop within 10%
AM	75	100%	92%	100%	100%	81%
LT	75	100%	81%	100%	100%	80%
SR	75	100%	88%	100%	100%	88%
PM	75	100%	93%	100%	100%	87%

The above table for LGV turns shows a good fit along the Proposed CBC, with AM, SR and PM time periods meeting the TII/TAG guidance for both GEH and % difference. The LT periods meets guidance for % difference and falls just below guidance for GEH at 81%. For turns within 10% of the observed proportions, the results are not quite as high, with the suggested guidance not met for AM and LT. This is due to the lower levels of flow for LGV results in a wider range of proportions percentages and less dominant individual movements compared to cars, however the results are close with 81% and 80% respectively

Table 6-12 Turning Flow Calibration – Proposed CBC - HGV

Time Period	Total Number on Route	Individual Flow Criteria	GEH <5	DMRB or GEH <5	GEH <10	Prop within 10%
AM	75	100%	99%	100%	100%	88%
LT	75	100%	97%	100%	100%	88%
SR	75	100%	100%	100%	100%	92%
PM	75	100%	100%	100%	100%	84%

The above table for HGV turns shows a good fit along the Proposed CBC, with all time periods meeting the TII/TAG guidance for both GEH and % difference. AM, LT and SR time periods meet the suggested guidance compared to observed proportions with PM at 84%

6.6.3 Journey Time Validation

The following sections highlight the level of validation for each individual journey time route and for each of the four time periods and then present a graph showing the full modelled vs observed journey time profile for journey time route 6 which relates best to the Proposed CBC.

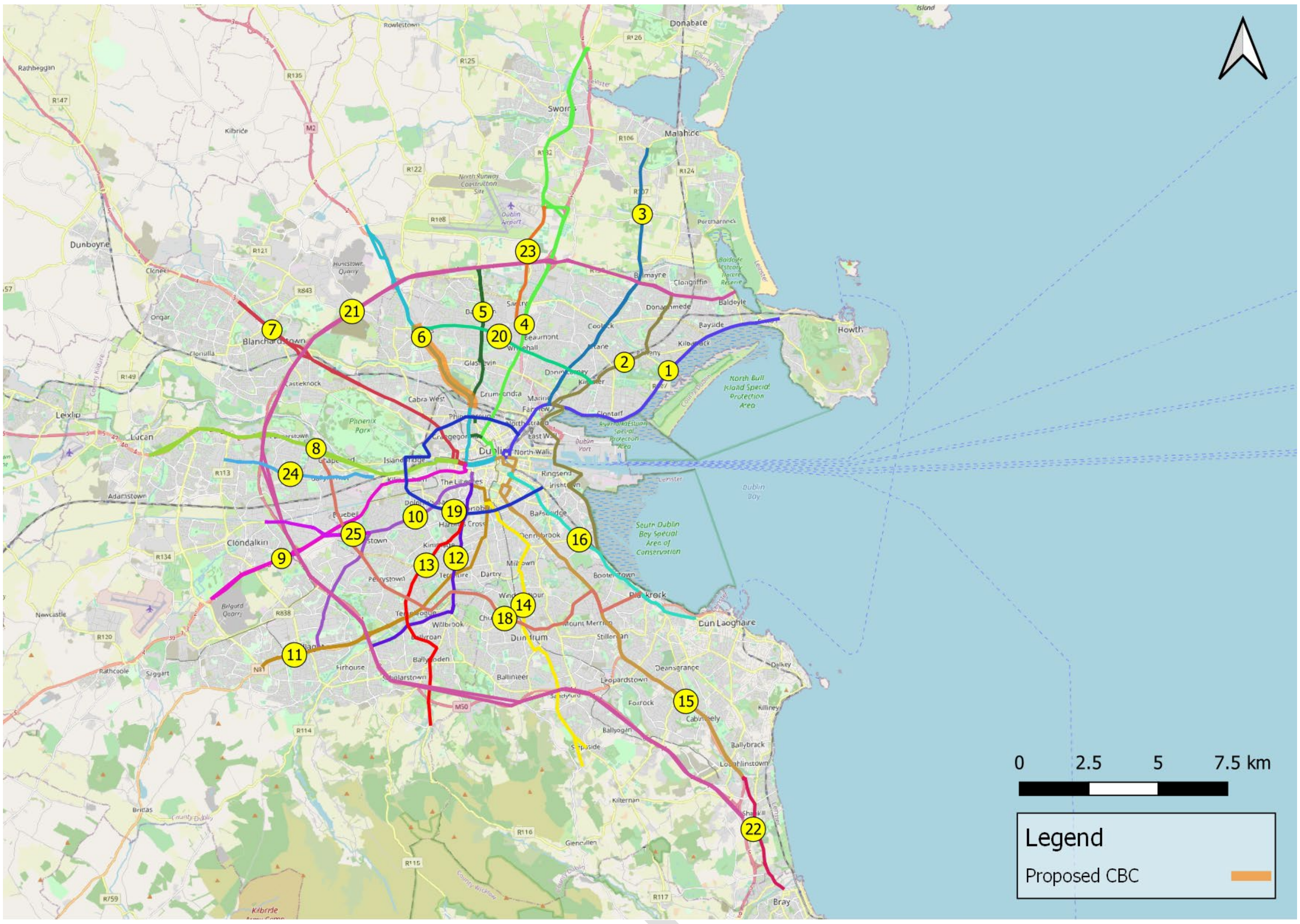


Figure 6-10 Journey Time Routes

6.6.3.1 AM Results

The following graphs highlight the routes which relate to the Proposed CBC in detail to show how the modelled cumulative profile of time in seconds against distance travelled compares to the observed along the journey route. The key journey time route is 6 and the graphs for this are shown below for the AM period.

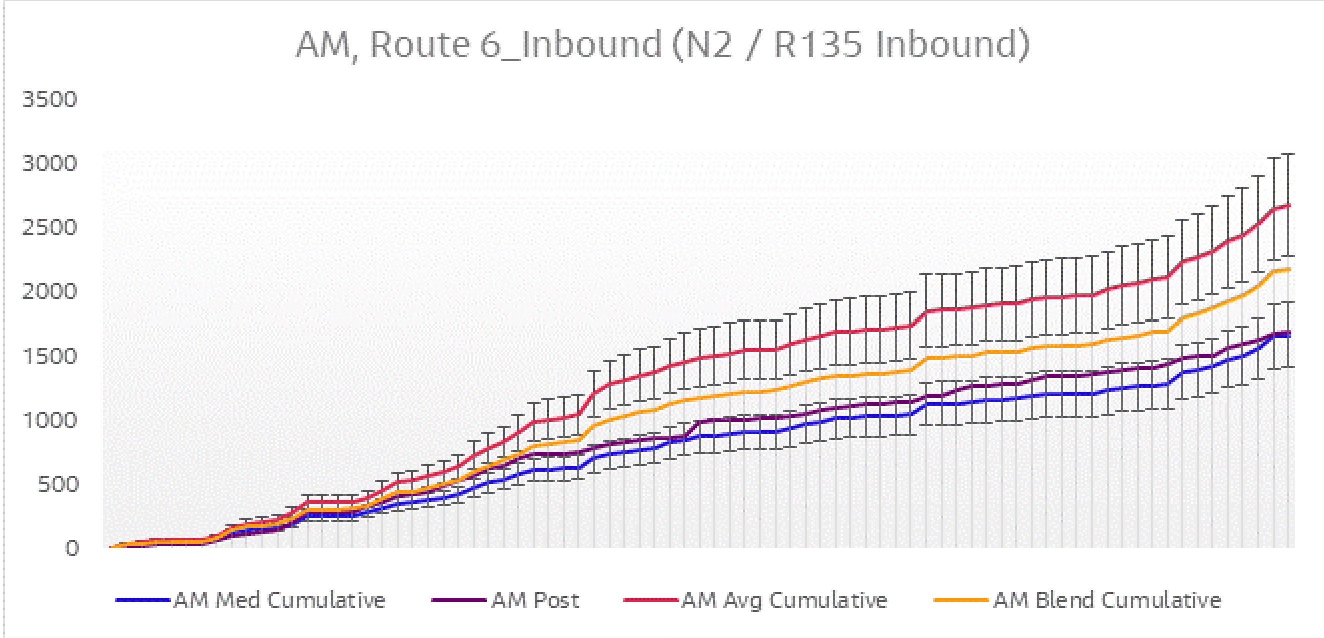


Figure 6-11 Journey Time Validation Plot - Route 6 Inbound AM

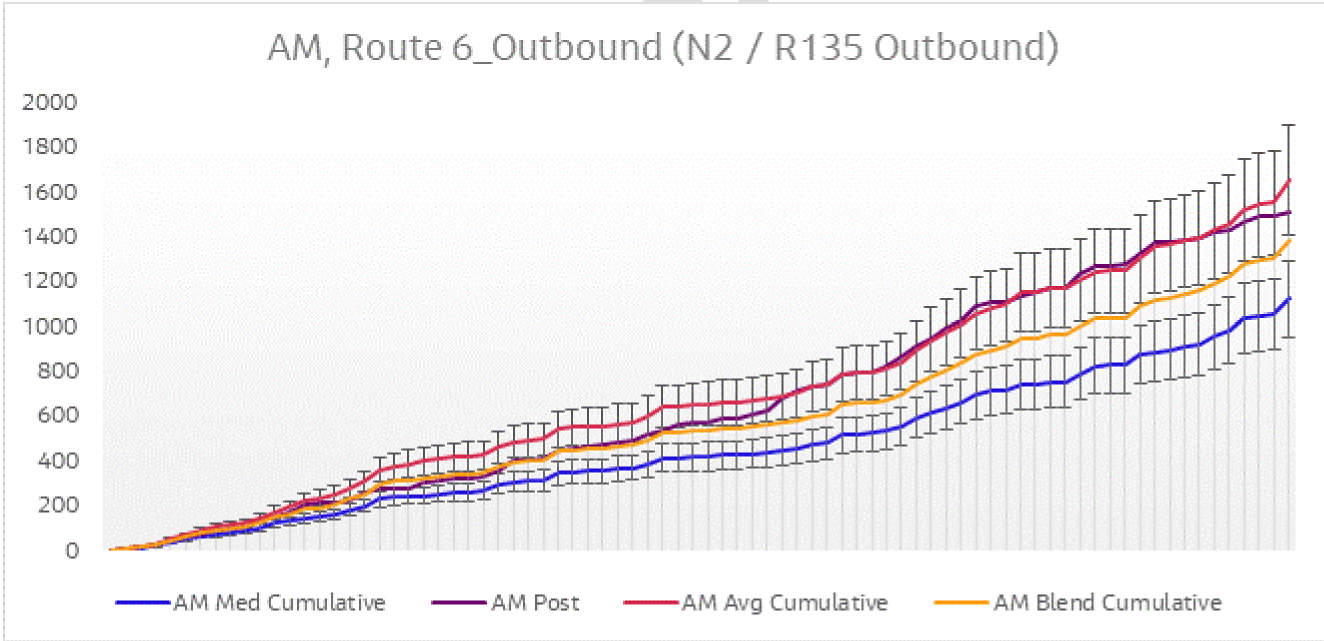


Figure 6-12 Journey Time Validation Plot – Route 6 Outbound AM

The above figures show a good match between the profile of the 50/50 blend of the median and mean observed times and the modelled times for JT Route 6 for both directions. The outbound movement meets the 15% guidance compared to the 50/50 blend of the observed. The inbound falls just outside of guidance at 21.8% difference although matches very closely to the median observed time.

6.6.3.2 LT Results

The following graphs highlight the routes which relate best to the Proposed CBC in detail to show how the modelled profile compares to the observed along the journey route. The key journey time route is 6 and the graphs for this are shown below for the LT period.

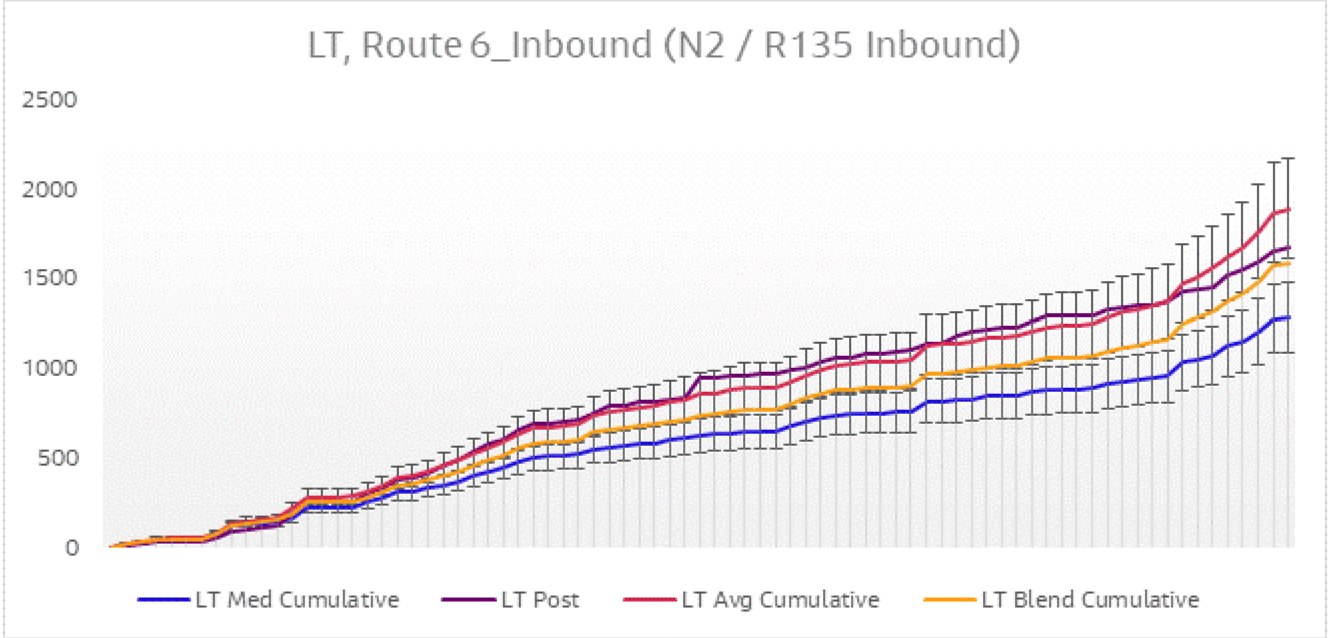


Figure 6-13 Journey Time Validation Plot - Route 6 Inbound LT

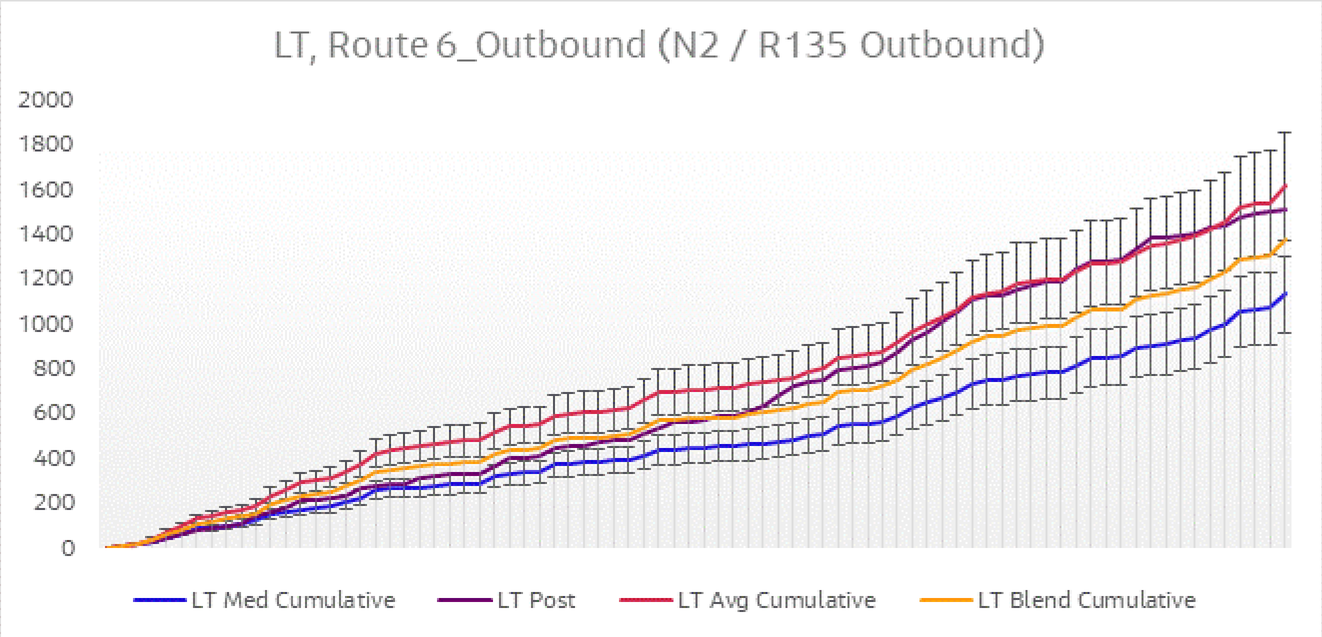


Figure 6-14 Journey Time Validation Plot - Route 6 Outbound LT

The above figures show that model generally matches the cumulative profile of observed journey time routes well with similar peaks and troughs along the route. The 15% guidance compared to the 50/50 blend of mean and median observed times is met in both directions.

6.6.3.3 SR Results

The following graphs highlight the routes which relate best to the Proposed CBC in detail to show how the modelled profile compares to the observed along the journey route. The key journey time route is 6 and the graphs for this are shown below for the SR period.

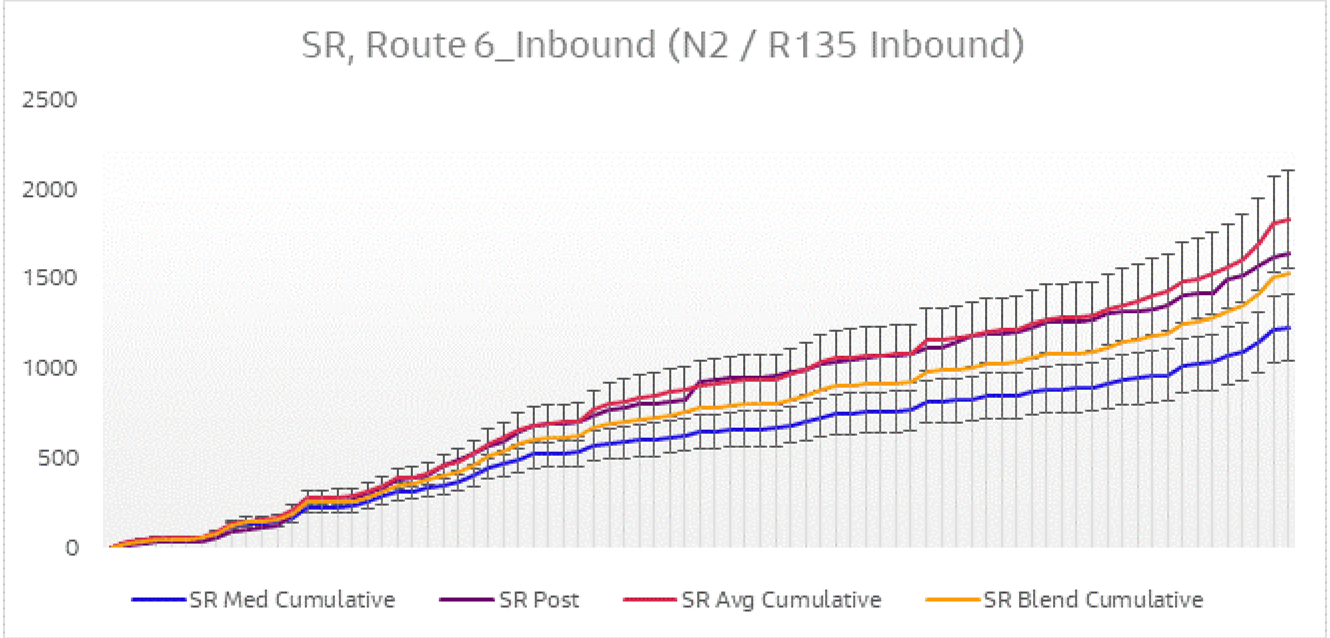


Figure 6-15 Journey Time Validation Plot - Route 6 Inbound SR

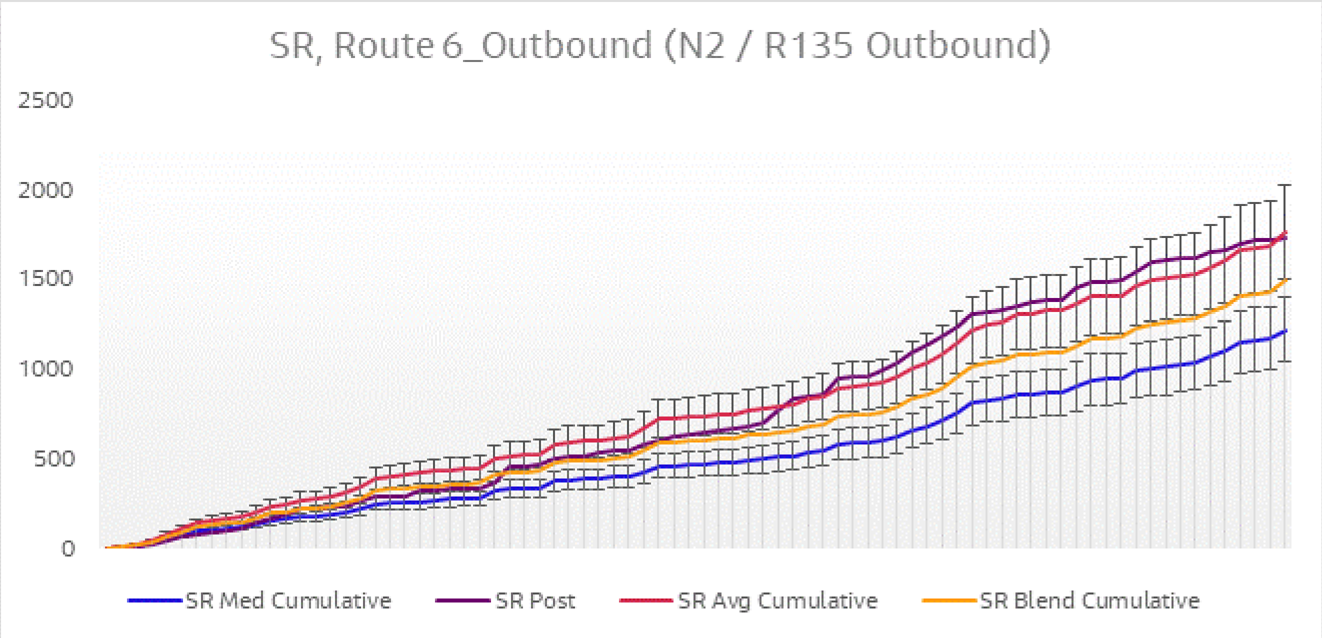


Figure 6-16 Journey Time Validation Plot - Route 6 Outbound SR

As with the LT period, the SR generally matches the cumulative profile of observed journey time routes well and matches the 15% guidance for the inbound direction. The outbound is slower compared to the 50/50 blend of mean/median and falls just outside of guidance at 16.8% difference however matches very closely to the mean observed time.

6.6.3.4 PM Results

The following graphs highlight the routes which relate best to the Proposed CBC in detail to show how the modelled profile compares to the observed along the journey route. The key journey time route is 6 and the graphs for this are shown below for the PM peak period.

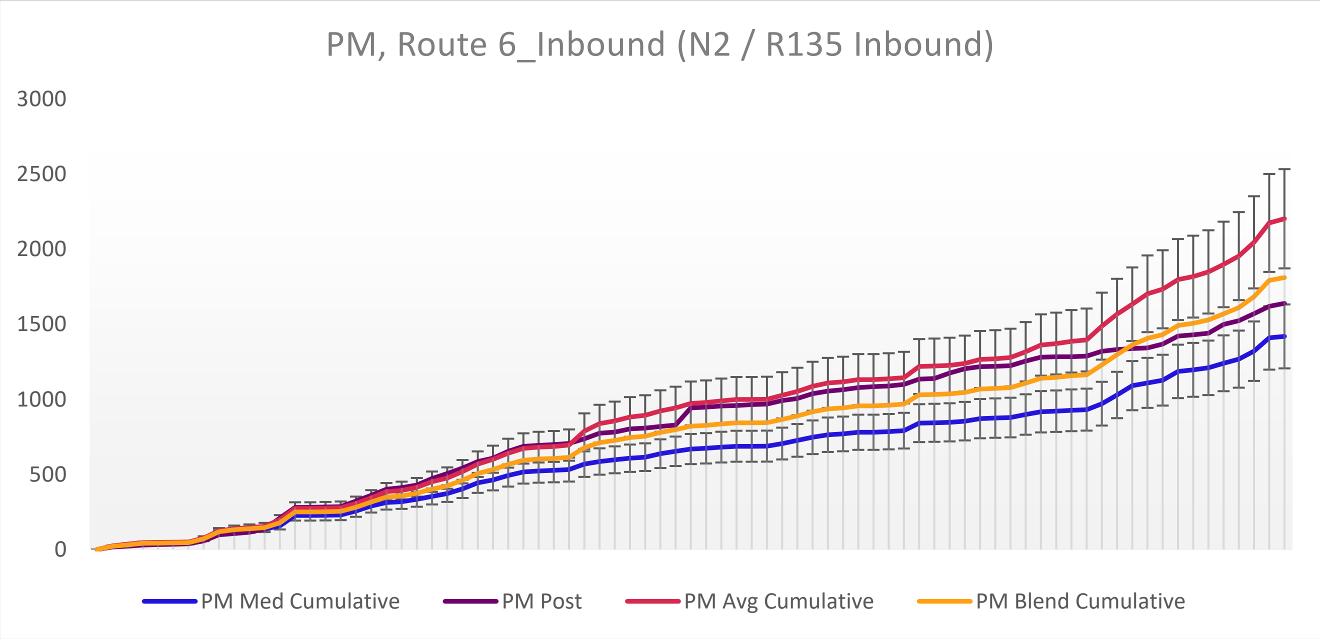


Figure 6-17 Journey Time Validation Plot - Route 6 Inbound PM

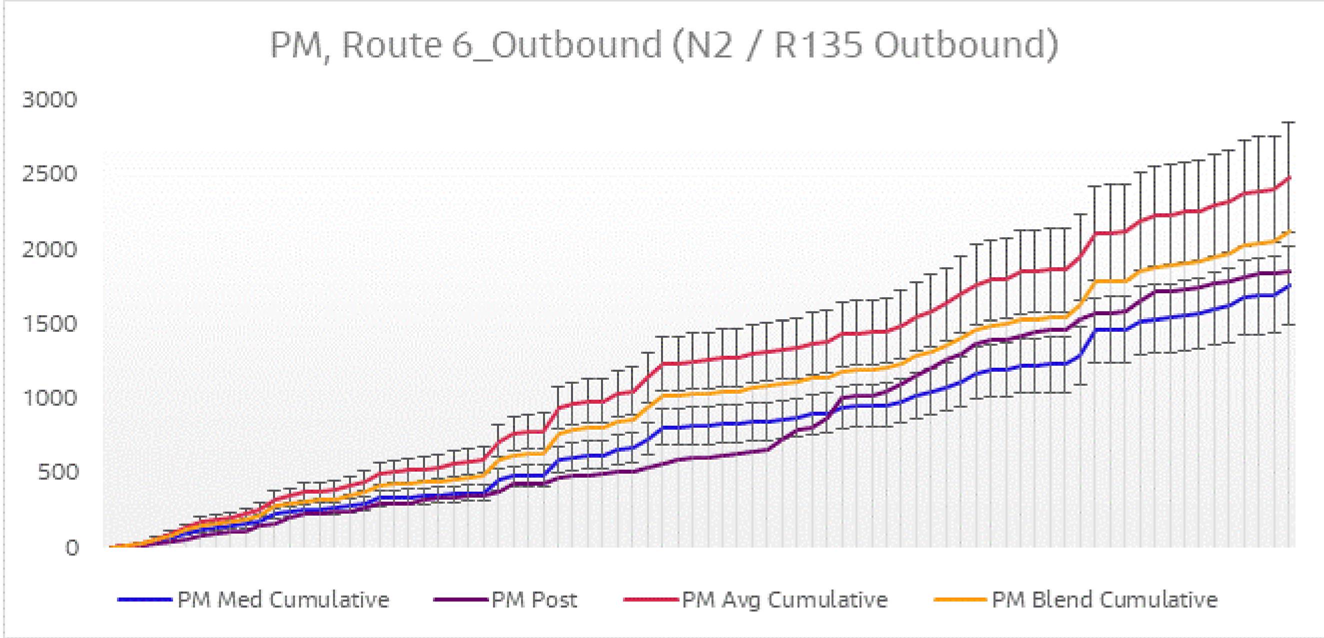


Figure 6-18 Journey Time Validation Plot - Route 6 Outbound PM

The above figures show that model generally matches the cumulative profile of observed journey time routes well within the PM peak period and the 15% guidance compared to the 50/50 blend of mean and median observed times is met in both directions.

6.6.4 Summary

The summary of the performance of the LAM in the vicinity of the Proposed CBC route is detailed below:

- The LAM calibrates and validates well against turning counts for all time periods.
- The modelled journey times from the LAM in the vicinity of the Proposed CBC is representative of observed journey times, with the cumulative journey time profiles matching well for all time periods.

7. Micro-simulation Modelling

7.1 Introduction

A micro-simulation model has been developed for the full continuous ‘end-to-end’ route of the Proposed CBC. The ‘end-to-end’ micro-simulation model has been developed to assist in the operational validation of the scheme designs and to provide a visualisation of scheme operability along with its impacts and benefits. The modelling of the Proposed CBC using the micro-simulation model will show the differences in travel time for buses as well as general traffic along the full length of the Proposed CBC, including delay at individual locations. The Proposed CBC Micro-simulation model network is shown in Figure 7-1 below

Figure 7-1 Proposed CBC Microsimulation Model Network

7.2 Micro-simulation Model Building

7.2.1 Background Mapping

The Proposed CBC model has been built on a topographical survey which includes all lane markings, street furniture, visible services, utility covers and boundary information.

Background mapping has been supplemented by video footage of the Proposed CBC. This has been used to better reflect how drivers treat yellow-box/hatched markings and (in the case of left-turning vehicles) other features such as the end sections of bus lanes.

7.2.2 Vehicle Types

The Proposed CBC model includes a range of vehicle and pedestrian types as outlined in Table 7-1.

Table 7-1 Vehicle and Pedestrian Types

Type Number	Type Name
101	Taxi
201	Car
301	LGV
401	OGV1
402	OGV2 (permit holder)
403	OGV2 (other)
501	Bus
502	Tram
601	Cyclist (standard)
602	Cyclist (confident)
701	Pedestrian (man)
702	Pedestrian (woman)

7.2.3 Vehicle Speeds

7.2.3.1 Desired Speed Distributions

The Proposed CBC model includes a range of 'desired speed distributions' as outlined in Table 7-2. All speeds shown are in kph and are industry standard.

Table 7-2: Desired Speed Distributions

Number	Name	Lower Bound	Upper Bound
1001	30 km/h – LV	25	35
1002	30 km/h – HV	20	30
2001	40 km/h – LV	35	45
2002	40 km/h – HV	30	40
3001	50 km/h – LV	45	55
3002	50 km/h – HV	40	50
3501	60 km/h – LV	55	65
3502	60 km/h – HV	50	60
4001	80 km/h – LV	75	85
4002	80 km/h – HV	70	80
5001	100 km/h – LV	88	130
5002	100 km/h – HV	75	110

6001	Standard Cyclist	9	15
6002	Confident Cyclist	14	20

7.2.3.2 Reduced Speed Distributions

The Proposed CBC model includes a range of 'reduced speed distributions' as outlined in Table 7-3. Within the model, 'reduced speed areas' have been coded to reflect 'turns' at junctions and also to control the saturation flow for 'ahead' movements. All speeds shown are kph.

Table 7-3: Reduced Speed Distributions

Number	Name	Lower Bound	Upper Bound
8001	15 km/h - 1550 Sat flow	15	20
8002	20 km/h - 1750 Sat flow	20	25
8003	25 km/h - 1900 Sat flow	25	30
8004	30 km/h - 1950 Sat flow	30	35
8005	40 km/h - 2050 Sat flow	40	45

7.2.4 Signal Control

The Proposed CBC model utilises fixed-time signal plans based on the average of historical SCATS/SCOOT/MOVA log data. Where necessary, green-times have been adjusted to better reflect the timings in operation on the day of traffic data collection.

7.3 Micro-simulation Model Calibration and Validation

[The Proposed CBC micro-simulation model is currently being calibrated and validated using the traffic survey and journey time data described in Chapter 5 in line with Project Appraisal Guidelines for National Roads Unit 5.1 - Construction of Transport Models – Transport Infrastructure Ireland (PE-PAG-02015). The calibration and validation process is still underway at the time of writing.]

The GEH statistic has been adopted as the main indicator of the extent to which modelled flows match the corresponding observed values. In keeping with PE-PAG-02015, GEH values of less than 5 will be targeted in at least 85% of cases. Attempts will be made to far exceed this guidance to ensure that the micro-simulation model is as accurate as possible in terms of traffic turning movements and journey times along the Proposed CBC. This will ensure the model is fit for purpose to model the impacts and benefits of the Proposed CBC infrastructure measures.

8. Forecast Model Development

8.1 Introduction

The following chapter describes the process to develop the future year forecast models for the assessment of the Proposed CBC. The chapter presents detail on the forecast years for the opening and design years as well as the assumptions on background schemes that are anticipated to be in place in these forecast years. The chapter also presents the assumptions on the future year growth which uses forecast year runs of the ERM.

8.2 Proposed CBC Forecast Assessment Years

The opening year for the scheme is assumed to be 2028, with a design year (opening + 15 years) assumed to be 2043. Transport modelling will therefore be undertaken for the base and two future years: 2028 and 2043.

- Base Year –**2020**
- Opening Year – **2028**
- Design Year – Opening Year plus 15 Year Forecast – **2043**

The assessments within the TIA and EIAR will be carried out in relation to the following scenarios:

1. Future "DoMinimum" ('likely receiving environment') Scenario – For the quantitative assessments, a 2020 baseline model will be developed to represent the agreed future design years (2028 and 2043), without the Proposed CBC in place. Typically, a "DoMinimum" model includes any known permanent improvements or changes to the road or public transport network that have taken place, been approved or are planned for implementation. These models are important to form the reference case by which to compare the proposal ('DoSomething') models.

2. Future "DoSomething" ('likely receiving environment') Scenario – These models will include the Proposed CBC infrastructure design models in 2028 and 2043, implementing all elements of the design for the Proposed CBC i.e. the 'DoMinimum' conditions with the addition of the Proposed CBC.

8.3 DoMinimum Network

The following section contains the approach to the development of the 2028 and 2043 'DoMinimum' reference case models which is included within the transport modelling process (i.e. within the four tiers of modelling, presented in Chapter 3, the ERM, LAM, Micro-simulation and junction models) against which the Proposed CBC will be assessed.

The core 'DoMinimum' scenario is based on the Greater Dublin Area (GDA) Transport Strategy 2016-2035[12] proposals (hereafter referred to as the GDA Strategy). The opening year (2028) assumes a partial implementation of the GDA Strategy in line with the investment proposals contained within the Project Ireland 2040 National Development Plan[13] (NDP) 2018-2027.

The GDA Strategy provides a robust basis for the 'DoMinimum' scenario for the assessment of the Proposed CBC for the following reasons:

- The GDA Strategy is an approved statutory plan for the region, providing a framework for investment in transport within the region up to 2035;
- The Strategy provides a consistent basis for the 'likely' future receiving environment that is consistent with Government plans and Policies (Project Ireland 2040 National Planning Framework (NPF) and NDP;

[12] https://www.nationaltransport.ie/planning-and-investment/strategic-planning/greater-dublin-area-transport-strategy/
[13] https://www.gov.ie/en/policy-information/07e507-national-development-plan-2018-2027/

- The implementation of the Strategy will provide for substantial modal shift from private car to sustainable modes, compared to a future 'DoNothing'[14] scenario, resulting in lower levels of private vehicle road traffic and reduced levels of mitigation required for displaced traffic arising from the Proposed CBC; and
- In 2043 the GDA Strategy would represent a reasonable likely scenario.

8.4 DoSomething Network

The 'DoSomething' Network includes only for the infrastructure elements associated with the Proposed CBC in addition to those elements included within the 'DoMinimum' network.

8.5 2028 and 2043 Forecast Year Scheme Definition

Table 8.1 below outlines the schemes that are included in the 2028 and 2043 'DoMinimum' and 'DoSomething' forecast year scenarios.

Table 8.1: GDA Strategy / NDP Schemes

GDA Strategy / NDP Schemes		2028		2043	
Scheme Reference	Description	DoMin	DoSom	DoMin	DoSom
	Heavy Rail Infrastructure				
HR1	DART+ Programme (non-tunnel elements) including additional stations at Cabra, Pelletstown, Woodbrook, Kylemore and Glasnevin	✓	✓	✓	✓
HR2	DART+ Tunnel Element (Kildare Line to Northern Line)	X	X	✓	✓
	Light Rail Infrastructure				
LR1	MetroLink (to Charlemont)	✓	✓	✓	✓
LR2a	LUAS Cross City incorporating LUAS Green Line Capacity Enhancement - Phase 1	✓	✓	X	X
LR3	LUAS Green Line Capacity Enhancement - Phase 2	X	X	✓	✓
LR4	Finglas LUAS (Green Line extension Broombridge to Finglas)	X	X	✓	✓
LR5	Extension of LUAS Green Line to Bray	X	X	✓	✓
LR6	Lucan LUAS	X	X	✓	✓
LR7	Poolbeg LUAS	X	X	X	X
LR8	Metro South (MetroLink extension Charlemont to Sandyford on LUAS Green Line alignment)	X	X	X	X
	BusConnects				

[14] A 'DoNothing' scenario represents a future scenario with no changes from the existing situation other than travel demand growth

GDA Strategy / NDP Schemes		2028		2043	
Scheme Reference	Description	DoMin	DoSom	DoMin	DoSom
BC1	Radial Proposed Core Bus Corridor (CBC)	X	✓	X	✓
BC2	BusConnects Fares / Ticketing Proposals	✓	✓	✓	✓
BC3	BusConnects Newtork Redesign (Routes and Services)	✓	✓	✓	✓
BC4	Orbital Core Bus Corridors (CBC)	X	X	X	X
Park and Ride					
PR1	Rail and Bus based P&R provision (partial implementation by 2028)	✓	✓	✓	✓
Cycling					
CY1	Greater Dublin Area Cycle Network Plan (excluding Radial Core Bus Corridor elements)	✓	✓	✓	✓
CY2	Greater Dublin Area Cycle Network Plan (including Radial Core Bus Corridor elements)	X	✓	X	✓
National Roads					
NR1	Reconfiguration of the N7 from its junction with the M50 to Naas, to rationalise junctions and accesses in order to provide a higher level of service for strategic traffic travelling on the mainline	X	X	✓	✓
NR2	Junction upgrades and other capacity improvements on the M1 motorway, including additional lanes south of Drogheda, where required	X	X	✓	✓
NR3	Widening of the M7 between Junction 9 (Naas North) and Junction 11 (M7/M9) to provide an additional lane in each direction	✓	✓	✓	✓
NR4	Widening of the M50 to three lanes in each direction between Junction 14 (Sandyford) and Junction 17 (M11) plus related junction and other changes	X	X	✓	✓
NR5	Reconfiguration of the N4 from its junction with the M50 to Leixlip to rationalise accesses and to provide additional capacity at the Quarryvale junction	X	X	✓	✓

GDA Strategy / NDP Schemes		2028		2043	
Scheme Reference	Description	DoMin	DoSom	DoMin	DoSom
NR6	Capacity enhancement and reconfiguration of the M11/N11 from Junction 4 (M50) to Junction 14 (Ashford) inclusive of ancillary and associated road schemes, to provide additional lanes and upgraded junctions, plus service roads and linkages to cater for local traffic movements	✓	✓	✓	✓
NR7	Enhancements of the N2/M2 national route inclusive of a bypass of Slane, to provide for additional capacity on the non-motorway sections of this route, and to address safety issues in Slane village associated with, in particular, heavy goods vehicles	X	X	✓	✓
NR8	Widening of the N3 between Junction 1 (M50) and Junction 4 (Clonee), plus related junction and necessary changes to the existing national road network	X	X	✓	✓
NR9	Development of a road link connecting from the southern end of the Dublin Port Tunnel to the South Port area, which will serve the South Port and adjoining development areas	X	X	✓	✓
Regional and Local Roads					
RR1	N3 Castaheany Interchange Upgrade	✓	✓	✓	✓
RR2	N3–N4: Barnhill to Leixlip Interchange	✓	✓	✓	✓
RR3	North-South Road – west of Adamstown SDZ linking N7 to N4 and on to Fingal	✓	✓	✓	✓
RR4	Glenamuck District Distributor Road	✓	✓	✓	✓
RR5	Leopardstown Link Road Phase 2	✓	✓	✓	✓
RR6	Porterstown Distributor Link Road	✓	✓	✓	✓
RR7	R126 Donabate Relief Road: R132 to Portrane Demesne	✓	✓	✓	✓
RR8	Oldtown-Mooretown Western Distributor Link Road	✓	✓	✓	✓
RR9	Swords Relief Road at Lord Mayors	✓	✓	✓	✓
RR10	Poolbeg development roads	✓	✓	✓	✓
RR11	Cherrywood development roads	✓	✓	✓	✓
RR12	Clonburris development roads	✓	✓	✓	✓
Demand Management					

GDA Strategy / NDP Schemes		2028		2043	
Scheme Reference	Description	DoMin	DoSom	DoMin	DoSom
DM1	Dublin City Centre Parking Constraint	✓	✓	✓	✓
DM2a	M50 Demand Management Measures - Variable Speed Limits	✓	✓	✓	✓
DM2b	M50 Demand Management Measures - Multi-point tolling	X	X	✓	✓
DM3	Implement demand management measures to address congestion issues on the radial national routes approaching the M50 motorway	X	X	✓	✓
DM4	Further demand management measures that ensure that all future growth in travel demand is facilitated by sustainable modes / max. 45% car commuter mode share	X	X	✓	✓

8.6 Forecast Travel Demand

Transport demand is a key input to the modelling process, which is directly related to the land-use data fed into the NTA ERM at the outset of the modelling process. Population, Employment and Education attractions must be prepared and defined at the Census Small Area (CSA) level to be input to the RMS.

The NTA has defined a 2040 National Planning Framework (NPF) planning sheet, based on 2016 Census data, regional growth projections and their knowledge of Local Authority development plans. Population, Employment and Education attraction growth are located in areas that are likely to be developed between now and 2040.

The NTA has provided the necessary planning sheets for the forecast assessment years (2028, 2043), which has been derived by linear interpolation between the 2016 Census data and the NTA's 2040 NPF reference case planning sheet. It has been assumed that the demand forecasts are fixed with no change in distribution for scenario testing.

Forecast reference case scenarios have been created for the agreed forecast years for the CBC Infrastructure Works. The scheme opening year (2028) is based on the investment priorities contained within the National Development Plan (NDP), whilst the Design Year (2043 – Opening year plus 15) is based on the full implementation of the GDA Strategy measures.

8.6.1 LAM Forecast Matrix Development

Prior forecast trip matrices for the LAM in 2028 and 2043 are developed based on a cordon of the Proposed CBC ERM 2028 and 2043 DM and DS models. To produce the LAM forecast year matrices, the trip end growth between the 2020 and 2028 / 2043 ERM cordoned matrices has been applied to each of the LAM time period (AM, LT, SR, PM) calibrated base models to produce the equivalent 2028 and 2043 matrices. Figure 8-1 below gives a graphical overview of the approach to creating the 2028 LAM demand matrices for the Proposed CBC. The 2043 matrices are created in the same manner using 2043 runs of the ERM.

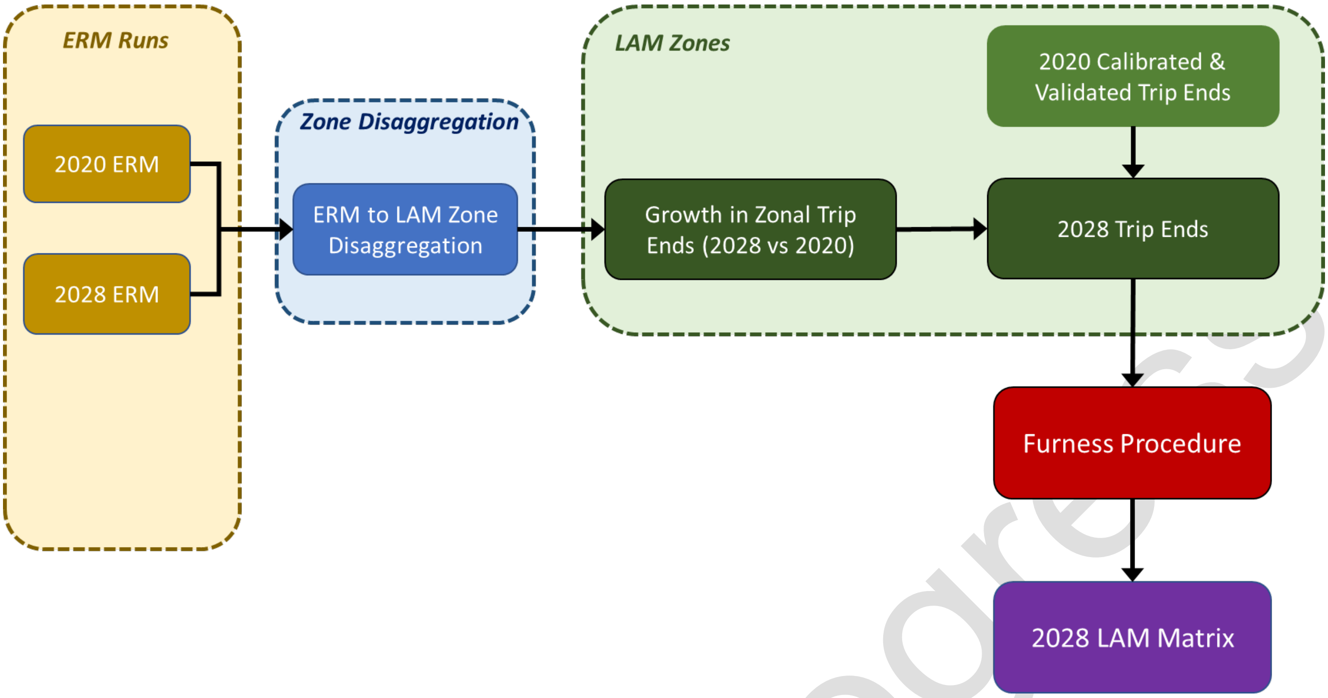


Figure 8-1 LAM Forecast Matrix Development Process

8.6.2 Microsimulation Forecast Matrix Development

8.6.2.1 Overview

Forecast trip matrices for the CBC micro-simulation model in 2028 and 2043 have been developed based outputs from the LAM.

8.6.2.2 Do-Minimum Scenario

In the case of the DM Scenario, cordon matrices have been extracted from the 2020 base and 2028/2043 DM LAM for the areas covered by the CBC micro-simulation model. Cordon matrices have been 'unstacked' and converted from pcus into vehicles before being compressed/expanded to match the zone structure in the CBC micro-simulation models. Based on this, a 2020-2028 and 2020-2043 LAM/CBC DM delta (or difference) has been derived for the 08:00-09:00 and 17:00-18:00 hours.

Rather than assigning the forecast LAM flows directly in the CBC micro-simulation model, the LAM/CBC DM delta has instead been added to the flows within the CBC micro-simulation base model. Using the Furness[15] method, origin and destination trips ends in the CBC micro-simulation base model have been adjusted to reflect the 'CBC micro-simulation base plus LAM/CBC DM delta' target. In the event that adding the LAM/CBC DM delta resulted in a 'negative' trip end, CBC micro-simulation model DM targets have been capped to zero.

Hourly demand for the CBC micro-simulation model 'shoulder' hours has been derived by factoring up or down the 08:00-09:00 and 17:00-18:00 furnessed DM matrices based on the relative number of trips simulated in each of the hours within the 2020 base year CBC micro-simulation model.

[15] A process used to calculate balancing factors in trip distribution. Following the initial calculation of trips using trip distribution, the total number of trips travelling from each origin and to each destination zone are unlikely to match the trip ends for the respective zones. Balancing factors for each origin and destination zone (designated A_i and B_j) must be calculated. The A factors then need to be recalculated, taking into account the B factors and this process is repeated iteratively until the total number of trips both from and to each zone "matches" the respective origin or destination trip ends.

With hourly 2028/2043 DM demand matrices for each of the hours simulated by the CBC micro-simulation models derived, demand has been disaggregated into 15-minute arrivals using the profiles from the 2020 base year CBC micro-simulation model.

In the case of cyclists, which are not modelled in the LAM, 'global' uplifts will be applied to movements in the 2020 base year CBC micro-simulation model to reflect the 2028 and 2043 DM scenario.

8.6.2.3 Do-Something Scenario

Development of the 2028 and 2043 DS CBC micro-simulation demand follows a similar process to that of the DM.

In this case, cordon matrices have been extracted from the 2028/2043 DM and DS LAM for the areas covered by the CBC micro-simulation model before being converted into vehicles and compressed into a consistent zone structure.

The resulting 2028 and 2043 LAM/CBC DS delta for 08:00-09:00 and 17:00-18:00 has then been added to the flows within the CBC micro-simulation DM model. Using the same Furness method, origin and destination trips ends in the CBC micro-simulation DM model have been adjusted to reflect the 'CBC micro-simulation DM plus LAM/CBC DS delta' target. Production of demand for the CBC micro-simulation DS shoulder hours and use of 15-minute profiles from the CBC micro-simulation base model has been applied as per the DM.

With regards to cyclists, 'global' uplifts will be applied to movements in the 2020 base year CBC micro-simulation model to reflect the 2028 and 2043 DM scenario

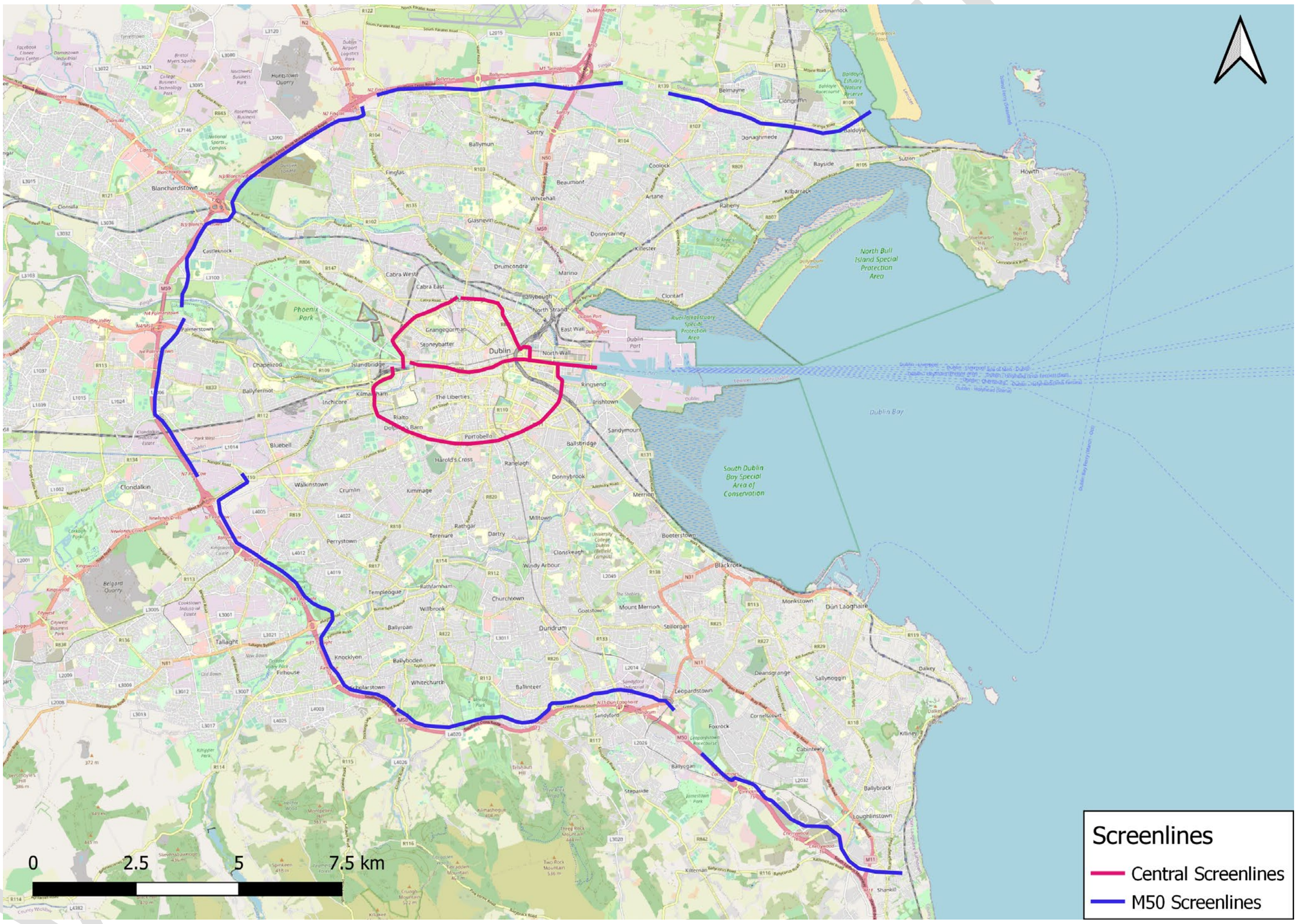
Appendix A. Full Local Area Model Calibration and Validation

A.1 Introduction

This appendix provides further details on the calibration and validation process and results for the full Local Area Model which covers most of the urban area of Dublin.

A.2 LAM Prior Matrix Factoring

An initial step in the calibration of the LAM is to adjust the prior trip matrix provided from the ERM to better represent observed trip patterns at a strategic level to more recent traffic survey data. The disaggregated prior matrix extracted from the ERM was assigned to the LAM road network. Modelled flows were then compared to observed count data at identified screenlines[16] to establish whether the model was accurately representing key movements within the study area. These screenlines represent two cordons, an outer cordon around the M50 and an inner cordon around the central canal area (bounded generally by the Grand Canal and Royal Canal). The coverage of the screenlines is detailed below in Figure A-1.



Apx Figure A-1 Calibration Screenline Coverage

This coverage consists of 13 individual screenlines which have been identified for the LAM calibration, namely:

- Canal North

[16] A screenline is a set of count locations that have been grouped together to form a line of counts. It is used to understand trip patterns at a more aggregate level

- Canal Northeast
- Canal Northwest
- Canal Southeast
- Canal Southwest
- M50 N Cordon
- M50 NE Cordon
- M50 NW Cordon
- M50 S Cordon
- M50 SE Cordon
- M50 SW Cordon
- M50 W Cordon
- River Liffey

Apx Table A-1 outlines the comparison between modelled and observed traffic flows at each of the screenlines for the disaggregated ERM matrix. The results indicate a significant difference in flows, in particular, for movements entering/exiting the model via the western boundary, and traffic exiting to the north and entering from the east.

Apx Table A-1 AM ERM Disaggregated Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1874	2250	20%	8.3
Canal North - Outbound	1289	1766	37%	12.2
Canal Northeast - Inbound	2346	2779	18%	8.5
Canal Northeast - Outbound	1712	1327	22%	9.9
Canal Northwest - Inbound	3176	3600	13%	7.3
Canal Northwest - Outbound	1758	2440	39%	14.9
Canal Southeast - Inbound	4053	4848	20%	11.9
Canal Southeast - Outbound	3012	3625	20%	10.6
Canal Southwest - Inbound	5288	5266	0%	0.3
Canal Southwest - Outbound	3324	4168	25%	13.8
M50 N Cordon - Inbound	6727	5412	20%	16.9
M50 N Cordon - Outbound	4929	4763	3%	2.4
M50 NE Cordon - Inbound	3337	3445	3%	1.8
M50 NE Cordon - Outbound	2438	2627	8%	3.8
M50 NW Cordon - Inbound	5991	6596	10%	7.6
M50 NW Cordon - Outbound	5209	5032	3%	2.5
M50 S Cordon - Inbound	7107	6342	11%	9.3
M50 S Cordon - Outbound	4541	4561	0%	0.3
M50 SE Cordon - Inbound	5759	5411	6%	4.7
M50 SE Cordon - Outbound	3355	3195	5%	2.8
M50 SW Cordon - Inbound	9219	7644	17%	17.2
M50 SW Cordon - Outbound	6628	6300	5%	4.1
M50 W Cordon - Inbound	4864	4730	3%	1.9

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 W Cordon - Outbound	2993	3614	21%	10.8
River Liffey - Northbound	4453	5021	13%	8.3
River Liffey - Southbound	6019	6781	13%	9.5

Apx Table A-2 LT ERM Disaggregated Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1545	1658	7%	2.8
Canal North - Outbound	1419	1717	21%	7.5
Canal Northeast - Inbound	1895	1908	1%	0.3
Canal Northeast - Outbound	1651	1623	2%	0.7
Canal Northwest - Inbound	2077	2141	3%	1.4
Canal Northwest - Outbound	1911	2051	7%	3.1
Canal Southeast - Inbound	3200	3414	7%	3.7
Canal Southeast - Outbound	2923	3083	5%	2.9
Canal Southwest - Inbound	3604	3548	2%	0.9
Canal Southwest - Outbound	3581	4451	24%	13.7
M50 N Cordon - Inbound	4541	4083	10%	7.0
M50 N Cordon - Outbound	4880	4509	8%	5.4
M50 NE Cordon - Inbound	2419	2394	1%	0.5
M50 NE Cordon - Outbound	2513	2315	8%	4.0
M50 NW Cordon - Inbound	3923	4071	4%	2.3
M50 NW Cordon - Outbound	3673	3851	5%	2.9
M50 S Cordon - Inbound	3859	3931	2%	1.1
M50 S Cordon - Outbound	3643	3986	9%	5.6
M50 SE Cordon - Inbound	2470	2765	12%	5.8
M50 SE Cordon - Outbound	2611	2824	8%	4.1
M50 SW Cordon - Inbound	6511	5722	12%	10.1
M50 SW Cordon - Outbound	5601	5397	4%	2.8
M50 W Cordon - Inbound	2981	3162	6%	3.3
M50 W Cordon - Outbound	3213	3254	1%	0.7
River Liffey - Northbound	4329	5109	18%	11.4
River Liffey - Southbound	4750	5473	15%	10.1

Apx Table A-3 SR ERM Disaggregated Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1417	1578	11%	4.2
Canal North - Outbound	1661	1793	8%	3.2

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal Northeast - Inbound	1898	1767	7%	3.1
Canal Northeast - Outbound	1991	2019	1%	0.6
Canal Northwest - Inbound	2134	2133	0%	0.0
Canal Northwest - Outbound	2500	2468	1%	0.6
Canal Southeast - Inbound	3077	3485	13%	7.1
Canal Southeast - Outbound	3244	3274	1%	0.5
Canal Southwest - Inbound	3355	3409	2%	0.9
Canal Southwest - Outbound	4532	4944	9%	6.0
M50 N Cordon - Inbound	4685	4250	9%	6.5
M50 N Cordon - Outbound	5469	5389	1%	1.1
M50 NE Cordon - Inbound	2724	2490	9%	4.6
M50 NE Cordon - Outbound	3191	2524	21%	12.5
M50 NW Cordon - Inbound	4192	4430	6%	3.6
M50 NW Cordon - Outbound	4501	4877	8%	5.5
M50 S Cordon - Inbound	4080	3802	7%	4.4
M50 S Cordon - Outbound	4641	4822	4%	2.6
M50 SE Cordon - Inbound	2936	2772	6%	3.1
M50 SE Cordon - Outbound	3249	3514	8%	4.6
M50 SW Cordon - Inbound	6794	5872	14%	11.6
M50 SW Cordon - Outbound	7107	6347	11%	9.3
M50 W Cordon - Inbound	3021	3077	2%	1.0
M50 W Cordon - Outbound	3866	3538	8%	5.4
River Liffey - Northbound	4690	5733	22%	14.5
River Liffey - Southbound	4628	5258	14%	9.0

Apx Table A-4 PM ERM Disaggregated Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1476	1679	14%	5.1
Canal North - Outbound	1630	2101	29%	10.9
Canal Northeast - Inbound	1999	2014	1%	0.3
Canal Northeast - Outbound	2458	2303	6%	3.2
Canal Northwest - Inbound	2202	2385	8%	3.8
Canal Northwest - Outbound	3407	3230	5%	3.1
Canal Southeast - Inbound	3191	3889	22%	11.7
Canal Southeast - Outbound	3631	3992	10%	5.9
Canal Southwest - Inbound	3317	3510	6%	3.3
Canal Southwest - Outbound	5194	5796	12%	8.1
M50 N Cordon - Inbound	5417	5277	3%	1.9
M50 N Cordon - Outbound	6300	6198	2%	1.3
M50 NE Cordon - Inbound	2726	2525	7%	3.9
M50 NE Cordon - Outbound	3237	3075	5%	2.9

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 NW Cordon - Inbound	4927	4978	1%	0.7
M50 NW Cordon - Outbound	6011	6307	5%	3.8
M50 S Cordon - Inbound	4843	4631	4%	3.1
M50 S Cordon - Outbound	6085	6155	1%	0.9
M50 SE Cordon - Inbound	3360	3409	1%	0.8
M50 SE Cordon - Outbound	4393	4262	3%	2.0
M50 SW Cordon - Inbound	6527	5719	12%	10.3
M50 SW Cordon - Outbound	7013	7163	2%	1.8
M50 W Cordon - Inbound	2779	3360	21%	10.5
M50 W Cordon - Outbound	4811	5185	8%	5.3
River Liffey - Northbound	5396	5980	11%	7.8
River Liffey - Southbound	4942	5289	7%	4.9

In order to provide a better starting point for model calibration, the disaggregated ERM matrix was factored at a screenline level to better represent observed traffic volumes. Two-week ATC data was available at all roads entering the M50 and canal screenline boundaries, and as such, give a good representation of average traffic flows entering/exiting the model area in the AM, LT, SR and PM peak hours.

Select link analysis was undertaken to identify origin-destination (OD) movements passing each screenline, and factors were applied to closer align total modelled screenline flows with observed movement patterns.

The results of the screenline factoring process are presented in Apx Table A-5 to Table A-8. The results indicate a significant improvement in correlation between modelled and observed flows when compared to the pre-factoring results in Apx Table A-1 to Table A-4. Whilst the results represent an improvement, there are still some differences at some screenlines. However, the factored matrix provides an improved representation of observed traffic movements to/from the model area, and as such, was taken forward to the next stages in the calibration process.

Apx Table A-5 AM Post-Factoring Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1874	2195	17%	7.1
Canal North - Outbound	1289	1720	33%	11.1
Canal Northeast - Inbound	2346	2524	8%	3.6
Canal Northeast - Outbound	1712	1377	20%	8.5
Canal Northwest - Inbound	3176	3478	10%	5.2
Canal Northwest - Outbound	1758	2306	31%	12.2
Canal Southeast - Inbound	4053	4449	10%	6.1
Canal Southeast - Outbound	3012	3407	13%	7.0
Canal Southwest - Inbound	5288	5254	1%	0.5
Canal Southwest - Outbound	3324	3975	20%	10.8
M50 N Cordon - Inbound	6727	5635	16%	13.9
M50 N Cordon - Outbound	4929	4539	8%	5.7
M50 NE Cordon - Inbound	3337	3408	2%	1.2
M50 NE Cordon - Outbound	2438	2430	0%	0.2
M50 NW Cordon - Inbound	5991	6667	11%	8.5

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 NW Cordon - Outbound	5209	5094	2%	1.6
M50 S Cordon - Inbound	7107	6710	6%	4.8
M50 S Cordon - Outbound	4541	4525	0%	0.2
M50 SE Cordon - Inbound	5759	5682	1%	1.0
M50 SE Cordon - Outbound	3355	3185	5%	3.0
M50 SW Cordon - Inbound	9219	8249	11%	10.4
M50 SW Cordon - Outbound	6628	6342	4%	3.5
M50 W Cordon - Inbound	4864	4975	2%	1.6
M50 W Cordon - Outbound	2993	3495	17%	8.8
River Liffey - Northbound	4453	4700	6%	3.7
River Liffey - Southbound	6019	6416	7%	5.0

Apx Table A-6 LT Post-Factoring Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1545	1676	8%	3.3
Canal North - Outbound	1419	1720	21%	7.6
Canal Northeast - Inbound	1895	1959	3%	1.5
Canal Northeast - Outbound	1651	1650	0%	0.0
Canal Northwest - Inbound	2077	2140	3%	1.4
Canal Northwest - Outbound	1911	2062	8%	3.4
Canal Southeast - Inbound	3200	3421	7%	3.8
Canal Southeast - Outbound	2923	3122	7%	3.6
Canal Southwest - Inbound	3604	3520	2%	1.4
Canal Southwest - Outbound	3581	4468	25%	14.0
M50 N Cordon - Inbound	4541	4234	7%	4.6
M50 N Cordon - Outbound	4880	4648	5%	3.4
M50 NE Cordon - Inbound	2419	2438	1%	0.4
M50 NE Cordon - Outbound	2513	2352	6%	3.3
M50 NW Cordon - Inbound	3923	4091	4%	2.6
M50 NW Cordon - Outbound	3673	3927	7%	4.1
M50 S Cordon - Inbound	3859	3966	3%	1.7
M50 S Cordon - Outbound	3643	4063	12%	6.8
M50 SE Cordon - Inbound	2470	2777	12%	6.0
M50 SE Cordon - Outbound	2611	2853	9%	4.6
M50 SW Cordon - Inbound	6511	5817	11%	8.8
M50 SW Cordon - Outbound	5601	5617	0%	0.2
M50 W Cordon - Inbound	2981	3186	7%	3.7
M50 W Cordon - Outbound	3213	3311	3%	1.7
River Liffey - Northbound	4329	5109	18%	11.4
River Liffey - Southbound	4750	5556	17%	11.2

Apx Table A-7 SR Post-Factoring Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1417	1517	7%	2.6
Canal North - Outbound	1661	1746	5%	2.1
Canal Northeast - Inbound	1898	1733	9%	3.9
Canal Northeast - Outbound	1991	1796	10%	4.5
Canal Northwest - Inbound	2134	2072	3%	1.4
Canal Northwest - Outbound	2500	2402	4%	2.0
Canal Southeast - Inbound	3077	3187	4%	2.0
Canal Southeast - Outbound	3244	3222	1%	0.4
Canal Southwest - Inbound	3355	3287	2%	1.2
Canal Southwest - Outbound	4532	4850	7%	4.6
M50 N Cordon - Inbound	4685	4527	3%	2.3
M50 N Cordon - Outbound	5469	5691	4%	3.0
M50 NE Cordon - Inbound	2724	2582	5%	2.7
M50 NE Cordon - Outbound	3191	2768	13%	7.7
M50 NW Cordon - Inbound	4192	4383	5%	2.9
M50 NW Cordon - Outbound	4501	4861	8%	5.3
M50 S Cordon - Inbound	4080	3955	3%	2.0
M50 S Cordon - Outbound	4641	4819	4%	2.6
M50 SE Cordon - Inbound	2936	2940	0%	0.1
M50 SE Cordon - Outbound	3249	3432	6%	3.2
M50 SW Cordon - Inbound	6794	6162	9%	7.8
M50 SW Cordon - Outbound	7107	6574	7%	6.4
M50 W Cordon - Inbound	3021	3099	3%	1.4
M50 W Cordon - Outbound	3866	3663	5%	3.3
River Liffey - Northbound	4690	5304	13%	8.7
River Liffey - Southbound	4628	5116	11%	7.0

Apx Table A-8 PM Post-Factoring Matrix Screenline Comparison

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1476	1600	8%	3.2
Canal North - Outbound	1630	2055	26%	9.9
Canal Northeast - Inbound	1999	1948	3%	1.1
Canal Northeast - Outbound	2458	2152	12%	6.4
Canal Northwest - Inbound	2202	2210	0%	0.2
Canal Northwest - Outbound	3407	3130	8%	4.8
Canal Southeast - Inbound	3191	3611	13%	7.2
Canal Southeast - Outbound	3631	3692	2%	1.0
Canal Southwest - Inbound	3317	3308	0%	0.2
Canal Southwest - Outbound	5194	5502	6%	4.2
M50 N Cordon - Inbound	5417	5279	3%	1.9

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 N Cordon - Outbound	6300	6046	4%	3.2
M50 NE Cordon - Inbound	2726	2523	7%	4.0
M50 NE Cordon - Outbound	3237	3179	2%	1.0
M50 NW Cordon - Inbound	4927	4793	3%	1.9
M50 NW Cordon - Outbound	6011	6367	6%	4.5
M50 S Cordon - Inbound	4843	4778	1%	0.9
M50 S Cordon - Outbound	6085	6087	0%	0.0
M50 SE Cordon - Inbound	3360	3594	7%	4.0
M50 SE Cordon - Outbound	4393	4201	4%	2.9
M50 SW Cordon - Inbound	6527	6126	6%	5.0
M50 SW Cordon - Outbound	7013	7060	1%	0.6
M50 W Cordon - Inbound	2779	3398	22%	11.1
M50 W Cordon - Outbound	4811	5175	8%	5.1
River Liffey - Northbound	5396	5550	3%	2.1
River Liffey - Southbound	4942	4993	1%	0.7

A.2.1 Pre-estimation Calibration Check

The factored prior matrix was assigned to the pre-calibration LAM road network to determine how well the LAM replicated observed traffic volumes. The results of this are outlined in Apx Table A-9.

Apx Table A-9 Traffic Count Calibration Statistics (pre Matrix Estimation)

Criteria		Individual flows within 100 v/h for flows less than 700 v/h	Individual flows within 15% for flows between 700 & 2,700 v/h	Individual flows within 400 v/h for flows greater than 2,700 v/h	Individual flows – GEH < 5
AM	**Car**	65%			60%
	LGV	98%			86%
	HGV	99%			92%
LT	**Car**	74%			63%
	LGV	99%			88%
	HGV	98%			90%
SR	**Car**	71%			64%
	LGV	99%			87%
	HGV	98%			92%
PM	**Car**	60%			56%
	LGV	98%			85%
	HGV	99%			95%

The results indicate a good performance in terms of flow criteria and GEH for both LGV and HGVs in the prior demand. However, the car demand is slightly outside of guideline recommendations. In particular, the percentage of total traffic at all count locations with a GEH less than 5 is modest in the AM and PM peaks at 60% and 56% respectively. The LT and SR peaks fare a little better when looking at GEH<5, at 63% and 64% respectively. The

LT and SR have a slightly better match against the observed when looking at the absolute/% difference criteria with 74% and 71% of links matching respectively.

Based on the above, it was decided that further calibration adjustments including 'Matrix Estimation' were required for AM, LT, SR and PM prior matrices to improve the fit between model flows and observed traffic volumes.

A.2.2 Matrix Estimation

'Matrix Estimation' is a process used to adjust trip demand so that there is an improved correlation between counts and modelled flows. The base prior matrix is fed into a SATURN programme called SATME2. SATME2 then adjusts origin-destination patterns to produce a trip demand matrix that better replicates traffic counts when assigned to the network.

The prior matrix is adjusted only after all options for improving the network are exhausted. Any matrix adjustment must significantly improve the match between observed and modelled flows, and not introduce more trips into a zone than could realistically be expected. Controls are placed on zones to ensure that the trip demand generated is sensible and in line with census population and employment statistics and that the donor trip distribution provided by the ERM is not adjusted too much to maintain direct compatibility between the ERM and LAM.

The algorithm driving the SATME2 estimation process tends to reduce long trips in place of chains of short trips, especially when counts are spread over the entire area, which may not fully reflect reality. Constraints are therefore placed on the adjustment process to protect the number of movements and distribution of the trips contained within the original car trip matrix.

A.2.3 Post-estimation Calibration

The post 'Matrix Estimation' model was then re-tested against the TII and TAG calibration criteria to assess performance. This was undertaken in an iterative process, with adjustments made to the road network where necessary to facilitate a better correspondence between model and observed flows e.g. altering junction capacity to facilitate count demand, fixing routing issues and rat-running etc.

A calibration and validation dashboard was created to identify areas of the network requiring adjustment/improvement that was not meeting the calibration guidelines. Once all options for network improvement were exhausted, 'Matrix Estimation' was re-run to try and achieve a better match between modelled and observed flows. The iteration between network alterations and 'Matrix Estimation' was carried out until the calibration criteria had been achieved.

A.2.4 Traffic Flow and GEH Calibration Results

Apx Table A-10 summarizes the traffic flow and GEH calibration results for the LAM after the matrix estimation process, for each of the modelled time periods.

Apx Table A-10 Traffic Count Calibration Statistics (Post Matrix Estimation)

Criteria		Individual flows within 100 v/h for flows less than 700 v/h	Individual flows within 15% for flows between 700 & 2,700 v/h	Individual flows within 400 v/h for flows greater than 2,700 v/h	Individual flows – GEH < 5
AM	Car	80%			77%
	LGV	98%			88%
	HGV	99%			94%
LT	Car	86%			77%
	LGV	98%			93%
	HGV	99%			92%
SR	Car	82%			77%

Criteria		Individual flows within 100 v/h for flows less than 700 v/h	Individual flows within 15% for flows between 700 & 2,700 v/h	Individual flows within 400 v/h for flows greater than 2,700 v/h	Individual flows – GEH < 5
	LGV	98%			91%
	HGV	98%			92%
PM	Car	77%			73%
	LGV	98%			88%
	HGV	99%			98%

The results in Apx Table A-10 demonstrate that a good calibration has been achieved across the four modelled times periods at the individual link level. All criteria is met for LGV and LGV for both absolute/percentage difference and GEH. For private cars, the LT meets the required 85% of cases criteria for the absolute/percentage difference and the other times periods are close to guidance with 80% for AM, 82% for SR and 77% for PM. GEH criteria results are in the high 70s for each time period and vehicle class

Screenline Flows

As noted in previously, counts have been grouped into screenlines covering movements into/out of the LAM from the North, West and South as well as a similar cordon within Dublin city centre.

The comparison between modelled and observed traffic flows at each of the screenlines is presented in Apx Table A-11 to Apx Table A-14 for the AM, LT, SR and PM peak hours.

Apx Table A-11 AM Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1874	1876	0%	0.1
Canal North - Outbound	1289	1525	18%	6.3
Canal Northeast - Inbound	2346	2175	7%	3.6
Canal Northeast - Outbound	1712	1374	20%	8.6
Canal Northwest - Inbound	3176	2826	11%	6.4
Canal Northwest - Outbound	1758	1968	12%	4.9
Canal Southeast - Inbound	4053	4053	0%	0.0
Canal Southeast - Outbound	3012	2988	1%	0.4
Canal Southwest - Inbound	5288	5292	0%	0.1
Canal Southwest - Outbound	3324	3280	1%	0.8
M50 N Cordon - Inbound	6727	6328	6%	4.9
M50 N Cordon - Outbound	4929	4301	13%	9.2
M50 NE Cordon - Inbound	3337	3228	3%	1.9
M50 NE Cordon - Outbound	2438	2399	2%	0.8
M50 NW Cordon - Inbound	5991	5945	1%	0.6
M50 NW Cordon - Outbound	5209	4989	4%	3.1
M50 S Cordon - Inbound	7107	6533	8%	6.9
M50 S Cordon - Outbound	4541	4356	4%	2.8
M50 SE Cordon - Inbound	5759	5615	2%	1.9
M50 SE Cordon - Outbound	3355	3243	3%	1.9
M50 SW Cordon - Inbound	9219	8508	8%	7.6

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 SW Cordon - Outbound	6628	6197	7%	5.4
M50 W Cordon - Inbound	4864	4974	2%	1.6
M50 W Cordon - Outbound	2993	3076	3%	1.5
River Liffey - Northbound	4453	4287	4%	2.5
River Liffey - Southbound	6019	5128	15%	11.9

Apx Table A-12 LT Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1545	1562	1%	0.4
Canal North - Outbound	1419	1560	10%	3.6
Canal Northeast - Inbound	1895	1701	10%	4.6
Canal Northeast - Outbound	1651	1325	20%	8.5
Canal Northwest - Inbound	2077	2102	1%	0.5
Canal Northwest - Outbound	1911	1936	1%	0.6
Canal Southeast - Inbound	3200	3110	3%	1.6
Canal Southeast - Outbound	2923	2797	4%	2.3
Canal Southwest - Inbound	3604	3856	7%	4.1
Canal Southwest - Outbound	3581	3562	1%	0.3
M50 N Cordon - Inbound	4541	4172	8%	5.6
M50 N Cordon - Outbound	4880	4322	11%	8.2
M50 NE Cordon - Inbound	2419	2337	3%	1.7
M50 NE Cordon - Outbound	2513	2428	3%	1.7
M50 NW Cordon - Inbound	3923	3811	3%	1.8
M50 NW Cordon - Outbound	3673	3643	1%	0.5
M50 S Cordon - Inbound	3859	3800	2%	0.9
M50 S Cordon - Outbound	3643	3628	0%	0.2
M50 SE Cordon - Inbound	2470	2541	3%	1.4
M50 SE Cordon - Outbound	2611	2604	0%	0.1
M50 SW Cordon - Inbound	6511	5956	9%	7.0
M50 SW Cordon - Outbound	5601	5049	10%	7.6
M50 W Cordon - Inbound	2981	2972	0%	0.2
M50 W Cordon - Outbound	3213	3159	2%	1.0
River Liffey - Northbound	4329	4329	0%	0.0
River Liffey - Southbound	4750	4561	4%	2.8

Apx Table A-13 SR Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1417	1471	4%	1.4
Canal North - Outbound	1661	1755	6%	2.3

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal Northeast - Inbound	1898	1696	11%	4.8
Canal Northeast - Outbound	1991	1667	16%	7.6
Canal Northwest - Inbound	2134	2080	2%	1.2
Canal Northwest - Outbound	2500	2576	3%	1.5
Canal Southeast - Inbound	3077	2931	5%	2.7
Canal Southeast - Outbound	3244	3155	3%	1.6
Canal Southwest - Inbound	3355	3460	3%	1.8
Canal Southwest - Outbound	4532	4454	2%	1.2
M50 N Cordon - Inbound	4685	4328	8%	5.3
M50 N Cordon - Outbound	5469	5110	7%	4.9
M50 NE Cordon - Inbound	2724	2522	7%	4.0
M50 NE Cordon - Outbound	3191	3050	4%	2.5
M50 NW Cordon - Inbound	4192	4206	0%	0.2
M50 NW Cordon - Outbound	4501	4685	4%	2.7
M50 S Cordon - Inbound	4080	3999	2%	1.3
M50 S Cordon - Outbound	4641	4642	0%	0.0
M50 SE Cordon - Inbound	2936	2912	1%	0.4
M50 SE Cordon - Outbound	3249	3277	1%	0.5
M50 SW Cordon - Inbound	6794	6392	6%	5.0
M50 SW Cordon - Outbound	7107	6504	8%	7.3
M50 W Cordon - Inbound	3021	3077	2%	1.0
M50 W Cordon - Outbound	3866	3675	5%	3.1
River Liffey - Northbound	4690	4665	1%	0.4
River Liffey - Southbound	4628	4422	4%	3.1

Apx Table A-14 PM Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
Canal North - Inbound	1476	1516	3%	1.0
Canal North - Outbound	1630	1915	18%	6.8
Canal Northeast - Inbound	1999	1917	4%	1.8
Canal Northeast - Outbound	2458	1992	19%	9.9
Canal Northwest - Inbound	2202	2219	1%	0.4
Canal Northwest - Outbound	3407	3339	2%	1.2
Canal Southeast - Inbound	3191	3188	0%	0.1
Canal Southeast - Outbound	3631	3616	0%	0.3
Canal Southwest - Inbound	3317	3388	2%	1.2
Canal Southwest - Outbound	5194	5030	3%	2.3
M50 N Cordon - Inbound	5417	5243	3%	2.4
M50 N Cordon - Outbound	6300	5879	7%	5.4
M50 NE Cordon - Inbound	2726	2740	1%	0.3
M50 NE Cordon - Outbound	3237	3212	1%	0.4

Screenline	Observed Flow	Modelled Flow	% Difference	GEH
M50 NW Cordon - Inbound	4927	4805	2%	1.7
M50 NW Cordon - Outbound	6011	6188	3%	2.3
M50 S Cordon - Inbound	4843	4898	1%	0.8
M50 S Cordon - Outbound	6085	5678	7%	5.3
M50 SE Cordon - Inbound	3360	3300	2%	1.0
M50 SE Cordon - Outbound	4393	4244	3%	2.3
M50 SW Cordon - Inbound	6527	6218	5%	3.9
M50 SW Cordon - Outbound	7013	6687	5%	3.9
M50 W Cordon - Inbound	2779	2847	2%	1.3
M50 W Cordon - Outbound	4811	4427	8%	5.7
River Liffey - Northbound	5396	4991	8%	5.6
River Liffey - Southbound	4942	4658	6%	4.1

Apx Table A-15 Screenline Calibration Criteria Check

Criteria	Acceptability GUIDELINE	AM	LT	SR	PM
Total screen line flows (> 5 links) to be within 5%	> 85% of cases	58%	69%	69%	73%
GEH statistic: screenline totals < 4	> 85% of cases	62%	73%	77%	73%
Either 5% or GEH < 4	> 85% of cases	69%	81%	88%	77%

The screenline results show AM, LT, SR and PM generally perform well against the TII/TAG guidance criteria when looking at passing either via 5% or GEH < 4. As can be seen when looking at the individual screenlines there is not much in the way of extreme outliers with those not fully meeting guidance generally being relatively close.

For the AM the largest outliers are '*M50 SW Cordon – Inbound'* with an 8% difference and GEH of 7.6 and '*River Liffey – Southbound'* with a 15% difference and GEH of 11.9. All other screenlines that do not fully meet guidance are generally close to the guideline targets.

For the LT period the largest outliers are '*Canal Northeast – Outbound'* with a difference of 20% and GEH of 8.5 and '*M50 N Cordon – Outbound'* with a difference of 11% and GEH of 8.2. All other screenlines that do not fully meet guidance are generally close to the guideline targets.

For the SR period the only large outlier is the *'Canal Northeast – Outbound'* with a difference of 16% and GEH of 7.6. All other screenlines that do not fully meet guidance are very close to the guideline targets.

For the PM period the only large outlier again is the '*Canal Northeast – Outbound' screenline* with a difference of 19% and GEH of 9.9, all other screenlines that do not fully meet guidance are very close to the guideline targets.

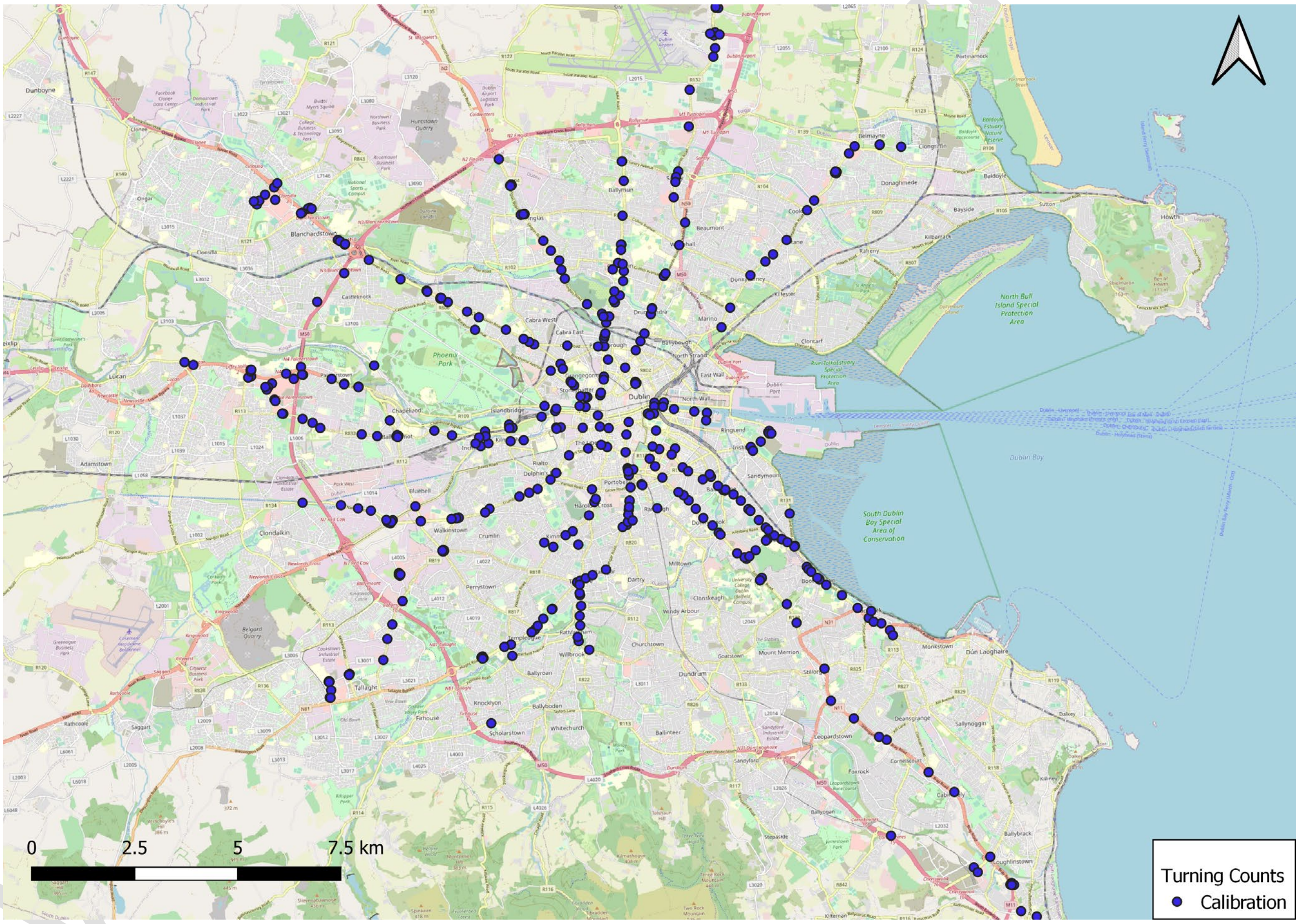
Turning Flows

The model calibration takes into account not only link calibration but also turning movements at key junctions within the LAM network. The guidance for link calibration is used to compare observed and modelled turning flows.

This is an improvement on solely relying on the ERM calibration which only considered link calibration. It was deemed appropriate to calibrate at a turning movement level for the purposes of the CBC Infrastructure Works to add additional robustness to the performance of the LAM in the vicinity of the Proposed CBC.

In addition to this guidance, presented below is also a comparison of the turning proportions at each junction to show that the model is correctly replicating the distribution of traffic across each arm and not just total demand at a particular junction. This is not an officially designed set of guidance and so a target has been assumed of 85% of turns matching within 10% of the observed proportion at each junction.

The turning counts used in the calibration process are outlined below in Apx Figure A-2 and consists of 2,201 turns across 441 junctions



Apx Figure A-2 Turning counts used in Calibration

Note that due to the large number of calibration and validation turning counts (4,226), there has been no smoothing process applied to ensure that any 1 day turning counts were directly comparable to observed link counts nearby that were undertaken in either November 2019 or February 2020. Due to greater accuracy of the link count data collected with regards to the duration over which counts are collected (2-week ATCs), they are prioritized within the matrix estimation process. Given this, the turning distribution may be the better metric in some cases, when comparing observed vs modelled turning flows.

Apx Table A-16 Turning Flow Calibration

Criteria		Individual flows within 100 v/h for flows less than 700 v/h	Individual flows within 15% for flows between 700 & 2,700 v/h	Individual flows within 400 v/h for flows greater than 2,700 v/h	Individual flows – GEH < 5	Turning proportion within 10% of observed
AM	Car	87%			68%	90%
	LGV	100%			91%	79%
	HGV	100%			98%	74%
LT	Car	88%			69%	89%
	LGV	100%			89%	83%
	HGV	100%			97%	78%
SR	Car	86%			66%	89%
	LGV	100%			90%	83%
	HGV	100%			98%	77%
PM	Car	85%			67%	89%
	LGV	100%			91%	78%
	HGV	100%			99%	67%

Table A-16 shows that full TII/TAG guidance is met in all times periods with regards to the absolute/percentage difference individual link criteria. GEH criteria is satisfied for LGV and HGV in all time periods with the results being in the high 60% region for private cars, for all time periods. For the turning proportions at each junction, private cars fully meet the suggested targets while LGV's and HGV's generally just below the car levels.

Analysis of Trip Matrix Changes - Regression

As noted in previously, both TII and TAG model development guidance recommend that care is taken when applying 'Matrix Estimation', and stringent checks should be carried out to ensure that the model demand is not overly distorted.

Pre and Post 'Matrix Estimation' matrices were plotted and the slope, and R^2 measure of goodness of fit were calculated. The results of this analysis are outlined in Table A-17 to Table A-19 below, and Figure A-3 overleaf.

Within the ERM, the Goods Vehicle matrices are not calculated as accurately as for car trips as they are not generated directly by the Full Demand Model. As such, SATME2 was allowed to make more changes to the prior LGV and HGV matrices to match traffic count data.

Apx Table A-17 Matrix Zonal Cell Regression Analysis

Measure	Significance Criteria	AM	LT	SR	PM
R^2	R^2 in excess of 0.95	0.86	0.89	0.88	0.85
Slope	Within 0.98 and 1.02	0.73	0.76	0.73	0.72
Intercept	Intercept near zero	0.03	0.02	0.02	0.03

Apx Table A-18 Matrix Trip End Regression Analysis – Origins

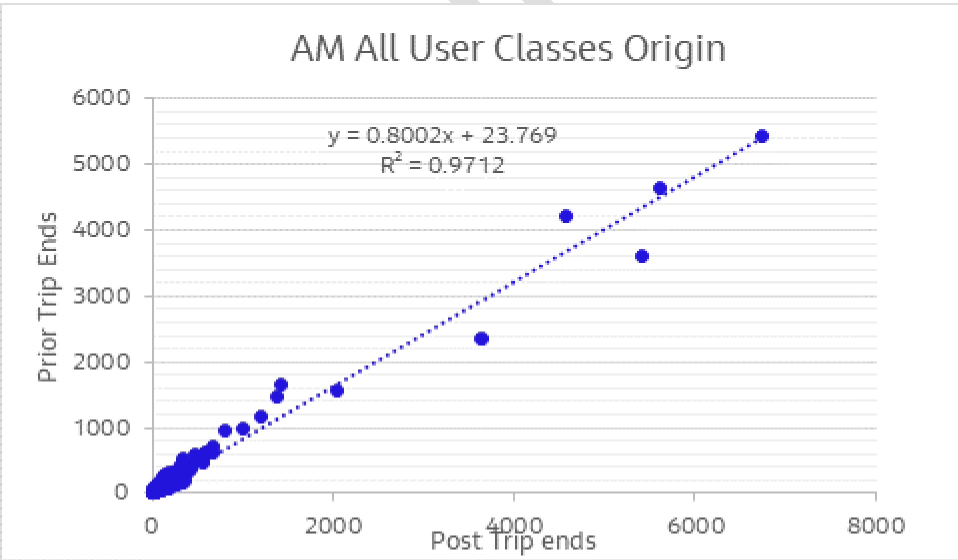
Measure	Significance Criteria	AM	LT	SR	PM
R^2	R^2 in excess of 0.95	0.97	0.98	0.98	0.96
Slope	Within 0.98 and 1.02	0.80	0.79	0.79	0.79
Intercept	Intercept near zero	23.77	19.28	24.20	26.64

Apx Table A-19 Matrix Trip End Regression Analysis – Destinations

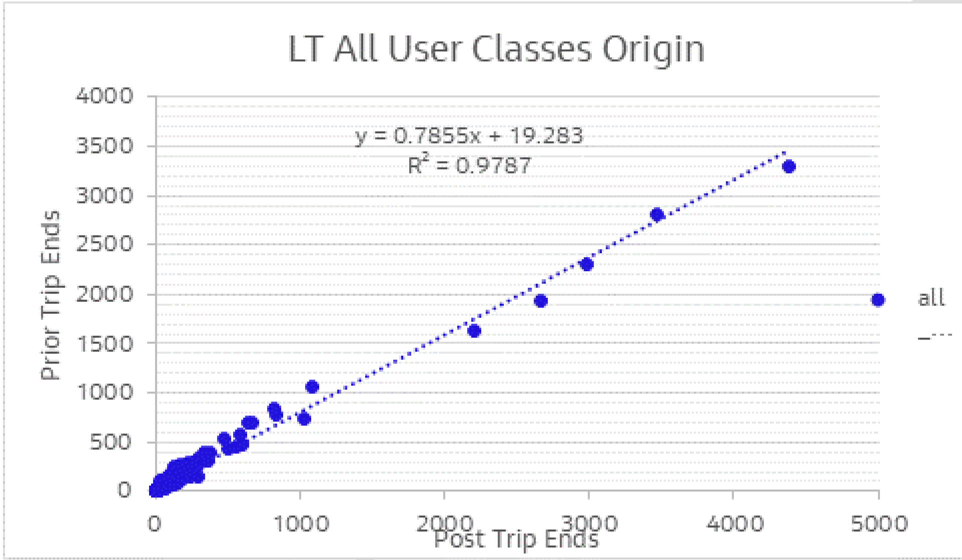
Measure	Significance Criteria	AM	LT	SR	PM
R^2	R^2 in excess of 0.95	0.96	0.98	0.99	0.97
Slope	Within 0.98 and 1.02	0.78	0.82	0.89	0.81
Intercept	Intercept near zero	27.40	15.80	14.12	0.97

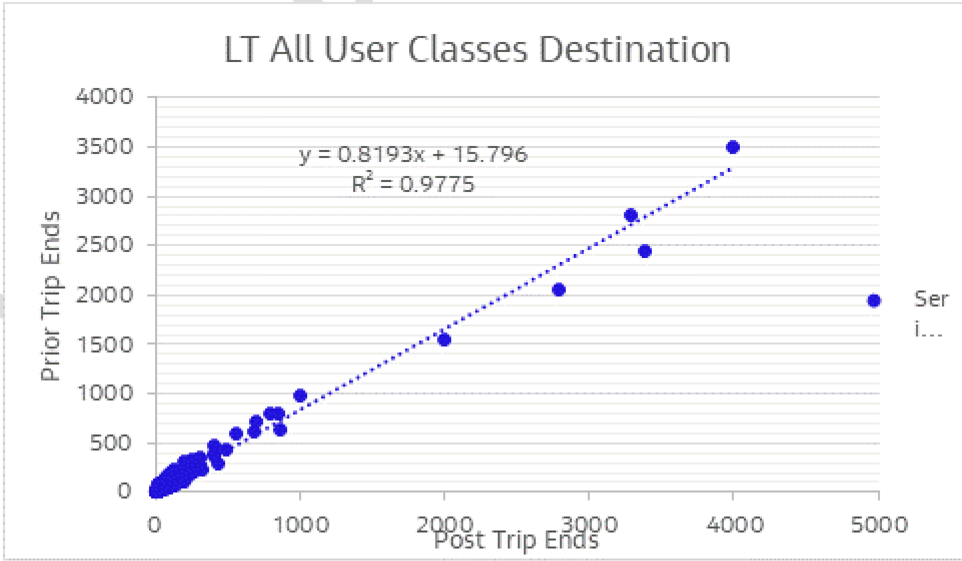
The regression statistics indicate that there is a good correlation between the post calibrated and prior matrices for the R^2 value, with full TII TAG guidance being met. Guidance is not quite met for the Slope and Intercept criteria although this is comparable with similar results from the full ERM model[17]. The results provide confidence that 'Matrix Estimation' has not made significant changes to the prior matrices derived from the ERM, except where it was deemed prudent based on available traffic count data.

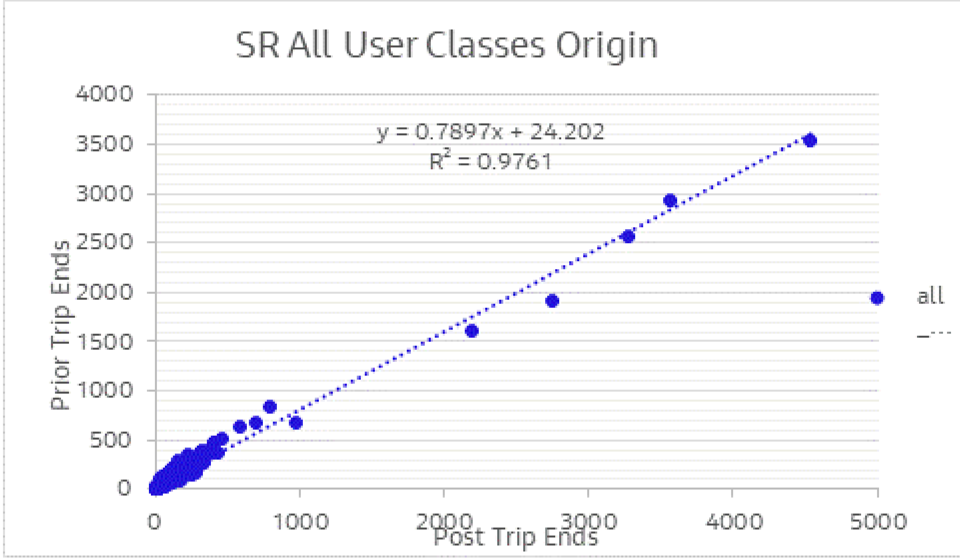
Apx Figure A-3 Regression Analysis of Matrix Estimation Changes

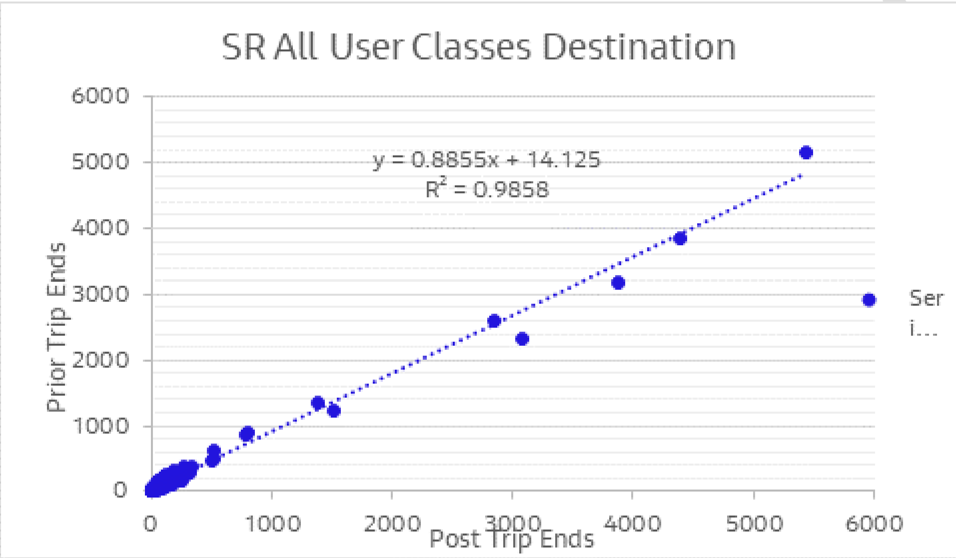


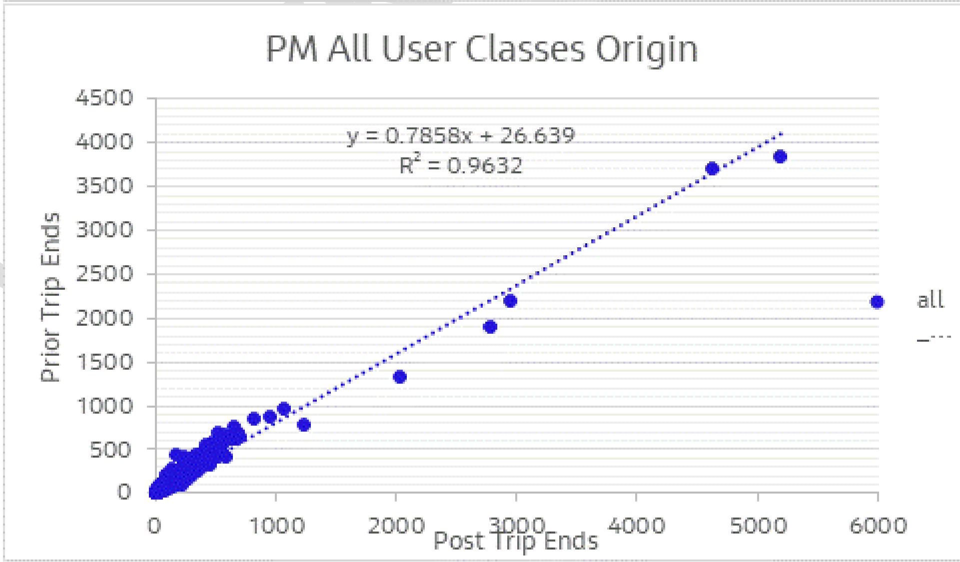
[17] https://www.nationaltransport.ie/wp-content/uploads/2018/06/ERM_Road_Model_Development_Report_Final-2.pdf

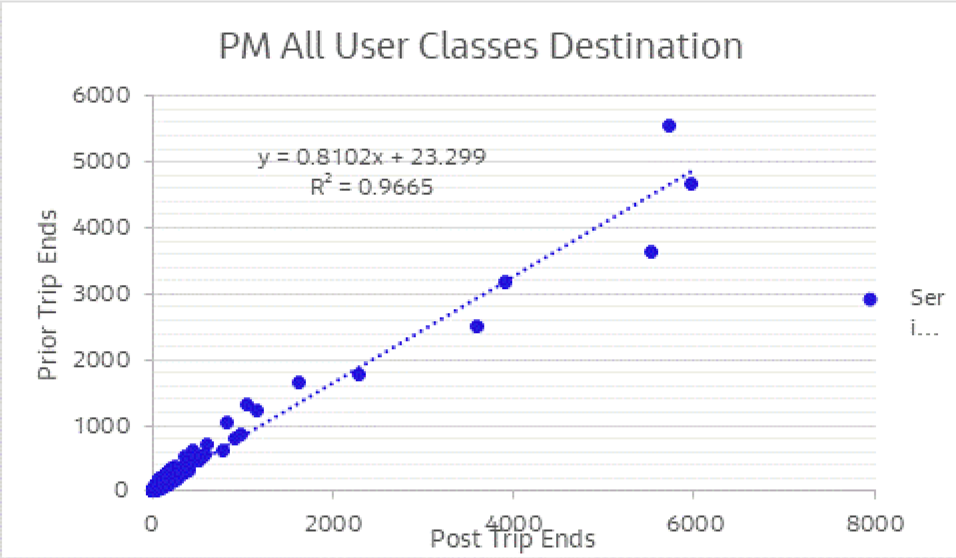

LT All User Classes Origin
y = 0.7855x + 19.283
R² = 0.9787
Prior Trip Ends
Post Trip Ends
0
500
1000
1500
2000
2500
3000
3500
4000
0
1000
2000
3000
4000
5000
all


LT All User Classes Destination
y = 0.8193x + 15.796
R² = 0.9775
Prior Trip Ends
Post Trip Ends
0
500
1000
1500
2000
2500
3000
3500
4000
0
1000
2000
3000
4000
5000
Ser
i...


SR All User Classes Origin
y = 0.7897x + 24.202
R^2 = 0.9761
Prior Trip Ends
Post Trip Ends
all
4000
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000


SR All User Classes Destination
y = 0.8855x + 14.125
R^2 = 0.9858
Prior Trip Ends
Post Trip Ends
Ser
i...
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000


PM All User Classes Origin
y = 0.7858x + 26.639
R^2 = 0.9632
Prior Trip Ends
Post Trip Ends
all
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
1000
2000
3000
4000
5000
6000



Analysis of Trip Matrix Changes – Trip Length Distribution

TII guidance recommends comparing trip length distributions for the prior and post calibrated matrices to ensure they have not been overly distorted by the 'Matrix Estimation' process.

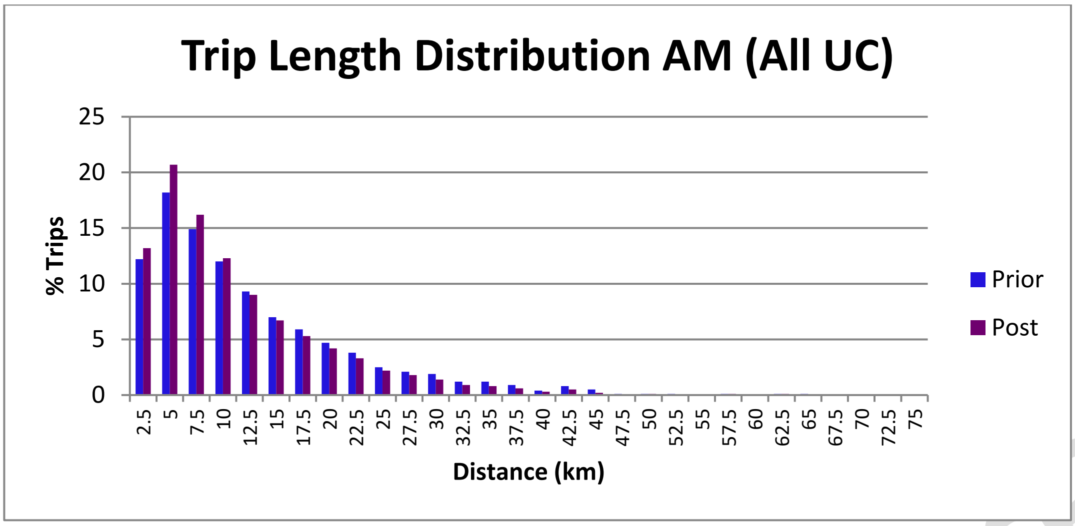
The 'Matrix Estimation' programme SATME2 can sometimes generate increased short distance trips to match count information, thus distorting the profile of trip making on the network. PAG suggests that the coincidence ratio should be used to compare trip length distributions before and after estimation, with a desirable range between 0.7 and 1.0.

Apx Table A-20 below outlines the coincidence ratios for each of the calibrated LAM time periods. The coincidence ratios suggest that there has been some minor distortion of trip lengths but that it is within acceptable bounds.

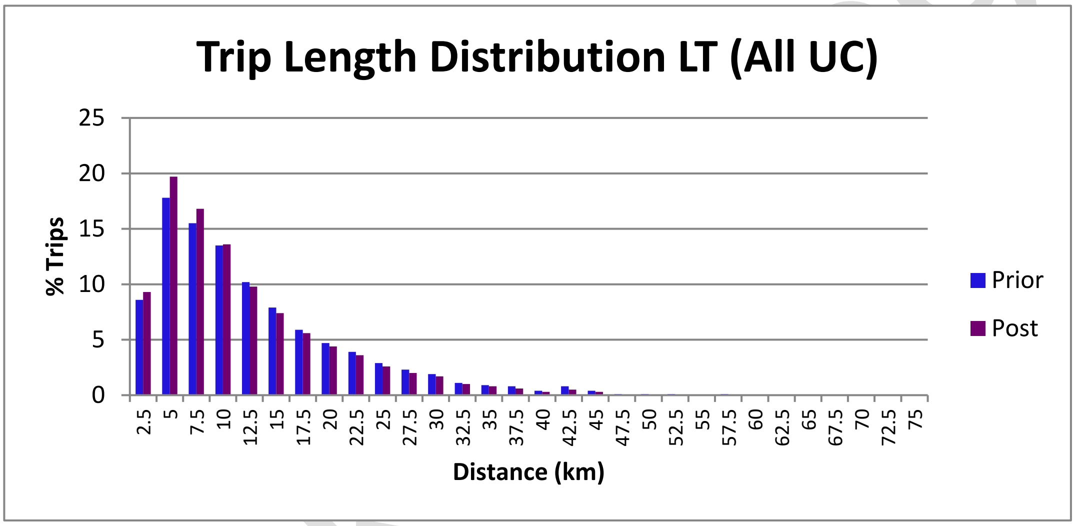
Apx Table A-20 Trip Length Analysis - Coincidence Ratios

Measure	Significance Criteria	AM	LT	SR	PM
Coincidence Ratio	Between 0.7 and 1.0	0.91	0.92	0.92	0.92

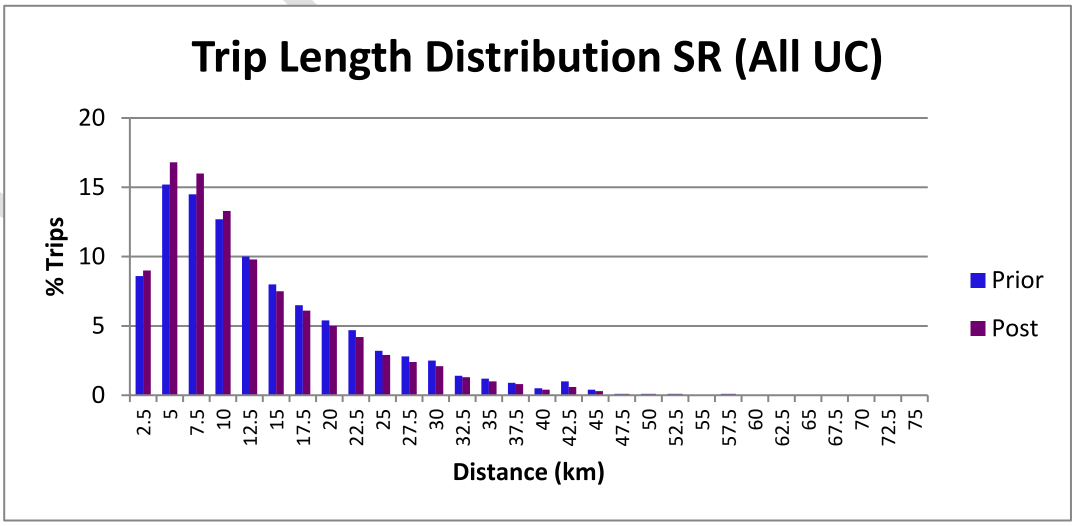
The trip length distributions illustrated from Figure A-4 to Figure A-7 below display the proportion of trips travelling various distances for both the pre and post estimation matrices. The results indicate that there have been some changes, however, the general shape of the distributions is similar. The changes overall are not large, and therefore, it is considered that 'Matrix Estimation' has not overly distorted the overall trip length distribution inherited from the ERM.



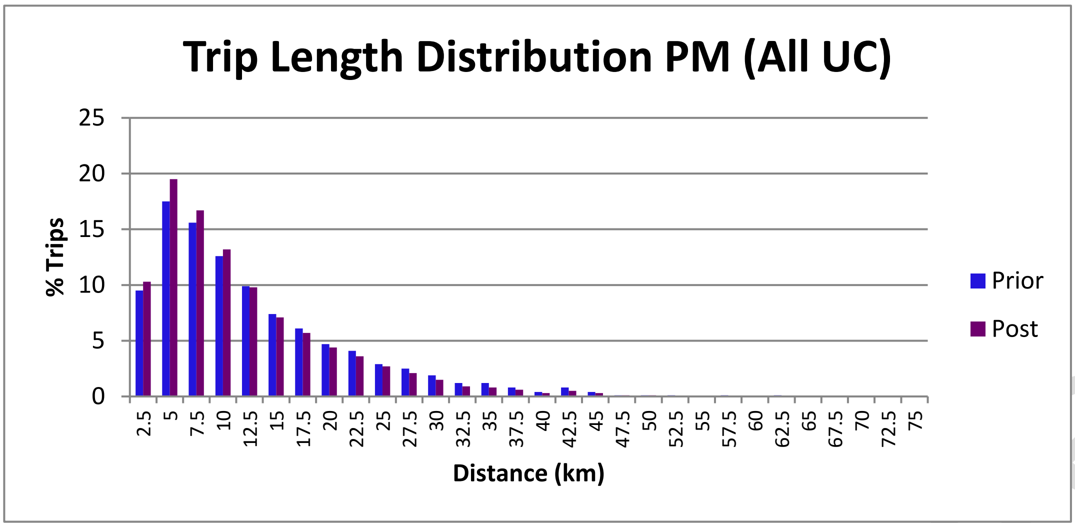
Apx Table A-21 AM Peak Trip Length Distribution



Apx Table A-22 LT Peak Trip Length Distribution



Apx Table A-23 SR Peak Trip Length Distribution



Apx Table A-24 PM Peak Trip Length Distribution

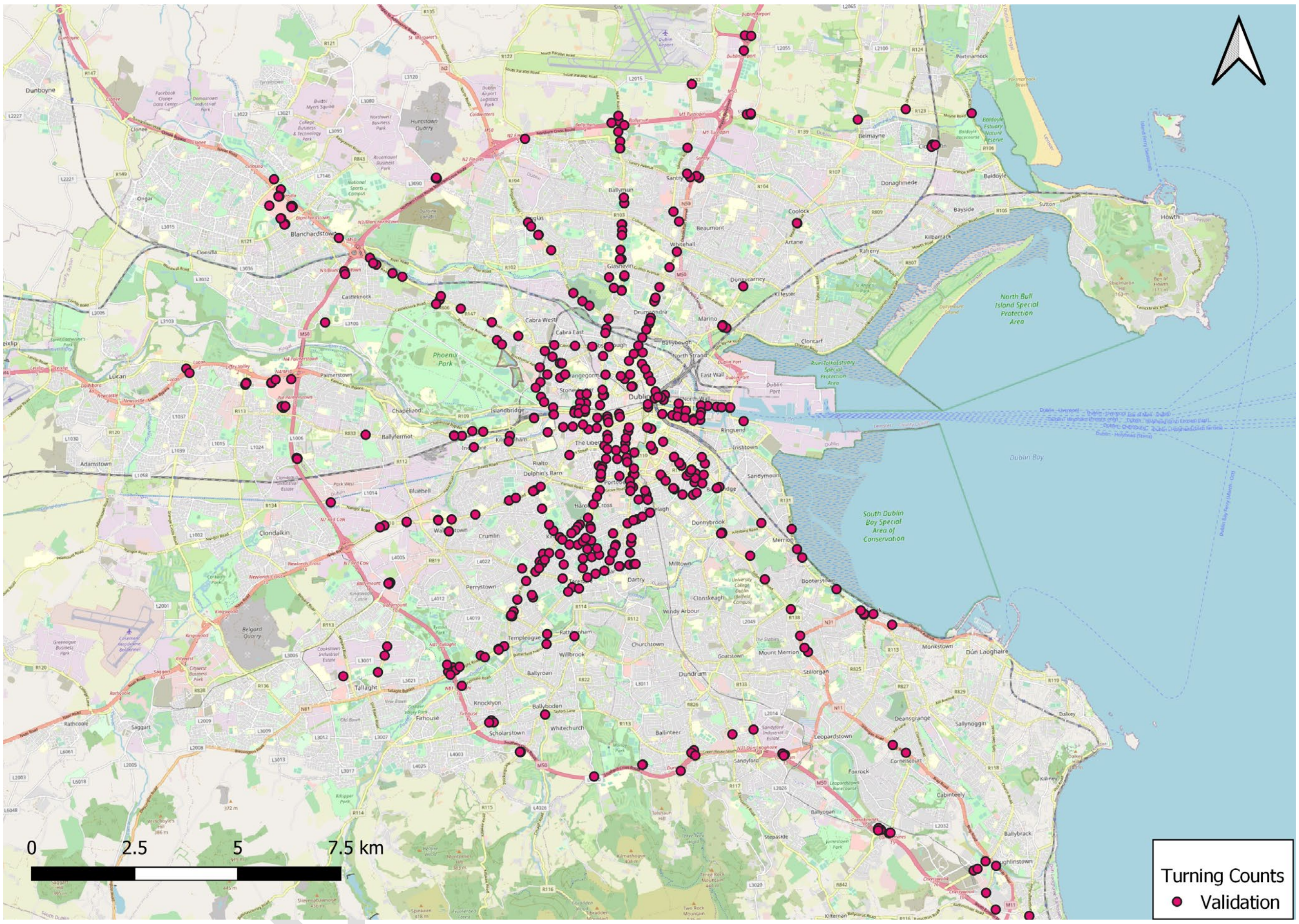
A.2.5 LAM Calibration Summary

The previous sections of this chapter have outlined the methodology used to calibrate the LAM to better reflect observed traffic survey data. In summary:

- A combination of network edits and 'Matrix Estimation' process has been used to provide a better correlation between modelled and observed traffic flows;
- The calibrated model meets all TII and DfT TAG for LGV and HGV. The LT meets the criteria for absolute/percentage difference for Cars, the other time periods fall just short of guidance although still perform well.
- The screenline results show AM, LT, SR and PM generally perform well against the TII/TAG guidance criteria. There are no large outliers across the time periods with those which do not fully meet guidance generally very close to the guideline targets in terms of % and GEH.
- For turning counts, the full TII/TAG guidance is met in all times periods with regards to the absolute/percentage difference individual link criteria for Private Cars, with LGV's and HGV's generally performing well. This highlights the turning flows in the LAM generally calibrate well against observed data.
- The R^2 and slope results provide confidence that 'Matrix Estimation' has not made significant changes to the prior matrices derived from the ERM, except where it was deemed prudent based on available traffic count data; and
- The coincidence for the trip length distribution ratio is well within TII guidelines and, as such, it is considered that 'Matrix Estimation' has not overly distorted the overall trip length distribution inherited from the ERM. The individual graphs highlight that there are no large changes in the proportion of trips lengths pre and post estimation.

A.3 Full LAM Validation

Traffic flow validation was carried out for an independent set of turning counts not initially included within calibration (Figure A-2). This provides a further independent check of the modelled turning movements within the LAM. The coverage of these turning counts is highlighted below in Apx Figure A-4 and consists of 2,025 turns across 484 junctions.



Apx Figure A-4 Turning counts used in Validation

Apx Table A-25 summarizes the turning count validation results for the LAM for each of the modelled time periods. The results demonstrate that a good level of validation has been achieved in the model across each of the peak periods when compared to observed using absolute and % TII/TAG guidance. LT meets the 15% guidance with AM, SR and PM very close at 82%, 84% and 80% respectively for private car. All criteria is met for LGVs and HGVs. All time periods perform well when comparing the observed and modelled turning proportions at the junction across Car, LGV and HGV

Apx Table A-25 Turning Count Validation Statistics

Criteria		Individual flows within 100 v/h for flows less than 700 v/h	Individual flows within 15% for flows between 700 & 2,700 v/h	Individual flows within 400 v/h for flows greater than 2,700 v/h	Individual flows – GEH < 5	Turning proportion within 10% of observed
AM	**Car**	82%			56%	90%
	LGV	100%			89%	100%
	HGV	100%			98%	100%
LT	**Car**	87%			61%	92%
	LGV	100%			88%	100%
	HGV	100%			98%	100%
SR	**Car**	84%			58%	90%
	LGV	100%			90%	100%
	HGV	100%			98%	100%
PM	**Car**	80%			56%	89%
	LGV	99%			90%	99%
	HGV	100%			99%	100%

A.3.1 Journey Time Validation

As outlined in Apx Table A-25, TII guidelines recommend that modelled journey times should be within +/- 15% of the observed time, or 1 minute if higher, in more than 85% of cases. As described earlier in the report, this has been presented as a comparison to the Mean, Median and a 50/50 Mean/Median blend of the observed journey times due to the significant differences between them and to allow full transparency when comparing the range of observed values to the modelled results.

Apx Table A-26 below, illustrates the results of the journey time comparison across both all routes and the routes that correspond with Proposed CBCs (across the full CBC Infrastructure Works) for the AM, LT, SR and PM peak hours.

Apx Table A-26 Overall Journey Time Validation Statistics

Time Period	Selected Coverage	15% Med Criteria	15% Avg Criteria	15% Blend Criteria
AM Peak	All Routes	60%	21%	54%
	CBC Routes	60%	23%	60%
LT Peak	All Routes	21%	85%	65%
	CBC Routes	20%	88%	63%
SR Peak	All Routes	19%	73%	60%
	CBC Routes	18%	78%	65%
PM Peak	All Routes	38%	29%	60%
	CBC Routes	38%	30%	63%

The above table highlights that the LAM shows a range of results when compared to the different interpretations on the raw observed TomTom data as outlined in section 5.6. All time periods in the LAM have been validated to be closer to the 50/50 blend of the observed mean and median and around 60% of routes match the observed on this basis. The LT and SR modelled periods still perform well when compared to the mean of the observed data, whereas the AM and PM modelled journey times broadly fall between the mean and median. This is broadly comparable to the journey times results from the full ERM model.

Given the variation in observed times, notably in the AM and PM peaks, it is difficult to find a balance which would validate well across all peaks. As the LT and SR represent less congested conditions, the good performance against the mean indicates that the network appears to be operating sensibly. In order to more closely match the AM and PM to the mean, large scale network changes would be required which would likely result in the LT and SR periods no longer validating as well.

It should also be noted that the journey times from the 2019 TomTom data has been calculated as an average across Monday-Thursday, which may result in slower journey times when compared to a Monday-Friday average. It was considered more prudent to use Monday-Thursday data as more representative of worst case 'average weekday' conditions for the development of the LAM.

AM Journey Time Results

Apx Table A-27 below shows a breakdown of each individual journey time route for the AM period.

Apx Table A-27 Detailed AM Journey Time Validation Statistics

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
1_Inbound	CBC1	2114	1869	-11.6%	Pass
1_Outbound	CBC1	1550	1547	-0.2%	Pass
2_Inbound	CBC16	2586	2298	-11.1%	Pass
2_Outbound	CBC16	2396	1950	-18.6%	Fail
3_Inbound	CBC1	1636	1501	-8.2%	Pass
3_Outbound	CBC1	1273	1243	-2.3%	Pass
4_Inbound	CBC2	2550	2219	-13.0%	Pass
4_Outbound	CBC2	1882	2260	20.1%	Fail
5_Inbound	CBC3	1449	1245	-14.1%	Pass
5_Outbound	CBC3	1095	1246	13.8%	Pass
6_Outbound	CBC3, CBC4	1389	1514	9.0%	Pass
6_Inbound	CBC3, CBC4	2170	1697	-21.8%	Fail
7_Inbound	CBC5	1732	1471	-15.1%	Fail
7_Outbound	CBC5	1131	1342	18.6%	Fail
8_Inbound	CBC6	1542	1418	-8.0%	Pass
8_Outbound	CBC6	848	867	2.2%	Pass
9_Outbound	CBC7	1281	1329	3.7%	Pass
9_Inbound	CBC7	1939	1691	-12.8%	Pass
10_Inbound	CBC9	2037	1951	-4.2%	Pass
10_Outbound	CBC9	1771	1765	-0.3%	Pass
11_Inbound	CBC10,CBC12	2605	2085	-20.0%	Fail
11_Outbound	CBC10,CBC12	2071	1641	-20.8%	Fail
12_Inbound	CBC11,CBC12	1981	1447	-26.9%	Fail
12_Outbound	CBC11,CBC12	1429	1252	-12.4%	Pass
13_Inbound	CBC11	1661	1280	-22.9%	Fail

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
13_Outbound	CBC11	1307	1121	-14.3%	Pass
14_Inbound	N/A	2563	1786	-30.3%	Fail
14_Outbound	N/A	1608	1665	3.6%	Pass
15_Inbound	CBC13	3143	2459	-21.8%	Fail
15_Outbound	CBC13	2018	1943	-3.7%	Pass
16_Inbound	CBC14,CBC15	2123	1718	-19.1%	Fail
16_Outbound	CBC14,CBC15	1355	1389	2.6%	Pass
18_Westbound	N/A	2863	2449	-14.5%	Pass
18_Eastbound	N/A	3275	2500	-23.7%	Fail
19_Eastbound	N/A	3105	2440	-21.4%	Fail
19_Westbound	N/A	3342	2241	-32.9%	Fail
20_Eastbound	N/A	1470	1077	-26.7%	Fail
20_Westbound	N/A	1510	1016	-32.7%	Fail
21_Eastbound	M50	3190	2387	-25.2%	Fail
21_Westbound	M50	3557	2403	-32.4%	Fail
22_Outbound	CBC13	674	499	-26.0%	Fail
22_Inbound	CBC13	662	574	-13.2%	Pass
23_Outbound	CBC2	587	643	9.5%	Pass
23_Inbound	CBC2	625	626	0.2%	Pass
24_Outbound	CBC7	700	615	-12.2%	Pass
24_Inbound	CBC7	845	602	-28.7%	Fail
25_Outbound	CBC8	548	625	14.0%	Pass
25_Inbound	CBC8	739	564	-23.7%	Fail

The table above highlights that there is a range of results in the AM peak period when comparing the modeled journey times when compared to a 50/50 blend of the mean and median observed TomTom data. Although not all meet the 15% criteria, there are a number which fall into the 15-20% range and therefore are relatively close to guidance. The largest outliers are 14-Inbound, 18-Westbound, 20-Westbound and 21-Westbound, which all just exceed a 30% difference compared to that observed. It should be noted than none of these are located on CBC routes although 21-Westbound is on the M50.

LT Journey Time Results

Apx Table A-28 below shows breakdown of each individual journey time route for the LT period.

Apx Table A-28 Detailed LT Journey Time Validation Statistics

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
1_Inbound	CBC1	1361	1497	10.0%	Pass
1_Outbound	CBC1	1340	1651	23.2%	Fail
2_Inbound	CBC16	1634	1859	13.8%	Pass
2_Outbound	CBC16	1709	1964	14.9%	Pass

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
3_Inbound	CBC1	1115	1224	9.8%	Pass
3_Outbound	CBC1	1062	1282	20.7%	Fail
4_Inbound	CBC2	1359	1735	27.7%	Fail
4_Outbound	CBC2	1695	2148	26.7%	Fail
5_Inbound	CBC3	827	1039	25.6%	Fail
5_Outbound	CBC3	938	1229	31.1%	Fail
6_Outbound	CBC3, CBC4	1375	1514	10.1%	Pass
6_Inbound	CBC3, CBC4	1592	1679	5.5%	Pass
7_Inbound	CBC5	1065	1181	10.9%	Pass
7_Outbound	CBC5	1036	1241	19.8%	Fail
8_Inbound	CBC6	804	976	21.4%	Fail
8_Outbound	CBC6	771	873	13.2%	Pass
9_Outbound	CBC7	1199	1296	8.1%	Pass
9_Inbound	CBC7	1216	1382	13.6%	Pass
10_Inbound	CBC9	1470	1701	15.8%	Fail
10_Outbound	CBC9	1458	1719	17.9%	Fail
11_Inbound	CBC10,CBC12	1590	1832	15.2%	Fail
11_Outbound	CBC10,CBC12	1479	1537	3.9%	Pass
12_Inbound	CBC11,CBC12	1141	1268	11.1%	Pass
12_Outbound	CBC11,CBC12	1076	1296	20.5%	Fail
13_Inbound	CBC11	1010	1158	14.7%	Pass
13_Outbound	CBC11	999	1082	8.3%	Pass
14_Inbound	N/A	1310	1546	18.0%	Fail
14_Outbound	N/A	1266	1618	27.8%	Fail
15_Inbound	CBC13	2042	2109	3.3%	Pass
15_Outbound	CBC13	1700	1844	8.5%	Pass
16_Inbound	CBC14,CBC15	1232	1447	17.5%	Fail
16_Outbound	CBC14,CBC15	1156	1301	12.6%	Pass
18_Westbound	N/A	2058	2247	9.2%	Pass
18_Eastbound	N/A	2103	2367	12.5%	Pass
19_Eastbound	N/A	2226	2185	-1.8%	Pass
19_Westbound	N/A	2054	2204	7.3%	Pass
20_Eastbound	N/A	997	1105	10.8%	Pass
20_Westbound	N/A	1016	972	-4.4%	Pass
21_Eastbound	M50	2173	2208	1.6%	Pass
21_Westbound	M50	2161	2194	1.5%	Pass
22_Outbound	CBC13	518	488	-5.9%	Pass
22_Inbound	CBC13	491	513	4.5%	Pass
23_Outbound	CBC2	636	667	4.9%	Pass
23_Inbound	CBC2	585	564	-3.5%	Pass
24_Outbound	CBC7	708	603	-14.8%	Pass

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
24_Inbound	CBC7	670	561	-16.3%	Fail
25_Outbound	CBC8	513	610	18.8%	Fail
25_Inbound	CBC8	579	522	-9.9%	Pass

The table above highlights that there is a range of results in the LT period when comparing the modeled journey times when compared to a 50/50 blend of the mean and median observed TomTom data. The largest outliers are 5-Outbound at 31% and 4 and 14 Outbound differing by 27.7% and 27.8% respectively when compared to the observed journey times.

SR Journey Time Results

Apx Table A-29 below shows breakdown of each individual journey time route for the SR period.

Apx Table A-29 Detailed SR Journey Time Validation Statistics

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
1_Inbound	CBC1	1426	1511	6.0%	Pass
1_Outbound	CBC1	1444	1816	25.8%	Fail
2_Inbound	CBC16	1809	1866	3.2%	Pass
2_Outbound	CBC16	2074	2124	2.4%	Pass
3_Inbound	CBC1	1176	1277	8.6%	Pass
3_Outbound	CBC1	1217	1450	19.2%	Fail
4_Inbound	CBC2	1364	1803	32.2%	Fail
4_Outbound	CBC2	1962	2387	21.7%	Fail
5_Inbound	CBC3	821	1046	27.3%	Fail
5_Outbound	CBC3	1100	1399	27.2%	Fail
6_Outbound	CBC3, CBC4	1493	1736	16.3%	Fail
6_Inbound	CBC3, CBC4	1532	1646	7.5%	Pass
7_Inbound	CBC5	1052	1186	12.8%	Pass
7_Outbound	CBC5	1233	1412	14.5%	Pass
8_Inbound	CBC6	842	932	10.7%	Pass
8_Outbound	CBC6	922	1111	20.5%	Fail
9_Outbound	CBC7	1478	1425	-3.5%	Pass
9_Inbound	CBC7	1228	1343	9.4%	Pass
10_Inbound	CBC9	1561	1762	12.8%	Pass
10_Outbound	CBC9	1611	1807	12.2%	Pass
11_Inbound	CBC10,CBC12	1607	1800	12.0%	Pass
11_Outbound	CBC10,CBC12	1845	1641	-11.1%	Pass
12_Inbound	CBC11,CBC12	1216	1295	6.5%	Pass
12_Outbound	CBC11,CBC12	1219	1470	20.6%	Fail
13_Inbound	CBC11	1044	1150	10.2%	Pass
13_Outbound	CBC11	1188	1147	-3.4%	Pass

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
14_Inbound	N/A	1347	1559	15.8%	Fail
14_Outbound	N/A	1448	1729	19.4%	Fail
15_Inbound	CBC13	2068	2145	3.7%	Pass
15_Outbound	CBC13	1883	1990	5.7%	Pass
16_Inbound	CBC14,CBC15	1256	1444	15.0%	Fail
16_Outbound	CBC14,CBC15	1236	1453	17.6%	Fail
18_Westbound	N/A	2356	2328	-1.2%	Pass
18_Eastbound	N/A	2307	2419	4.9%	Pass
19_Eastbound	N/A	2647	2227	-15.9%	Fail
19_Westbound	N/A	2145	2256	5.2%	Pass
20_Eastbound	N/A	1354	1033	-23.7%	Fail
20_Westbound	N/A	1364	987	-27.7%	Fail
21_Eastbound	M50	2403	2319	-3.5%	Pass
21_Westbound	M50	2410	2509	4.1%	Pass
22_Outbound	CBC13	632	486	-23.1%	Fail
22_Inbound	CBC13	529	520	-1.8%	Pass
23_Outbound	CBC2	657	680	3.5%	Pass
23_Inbound	CBC2	587	577	-1.7%	Pass
24_Outbound	CBC7	808	608	-24.8%	Fail
24_Inbound	CBC7	691	567	-17.9%	Fail
25_Outbound	CBC8	615	613	-0.4%	Pass
25_Inbound	CBC8	493	525	6.5%	Pass

The table above highlights that there is a range of results in the SR period when comparing the modeled journey times when compared to a 50/50 blend of the mean and median observed TomTom data. The largest outliers are route 4 inbound at 32.2% and 5 Inbound and Outbound at 27.3% and 27.2% difference between the modelled and observed journey times respectively.

PM Journey Time Results

Apx Table A-30 below shows breakdown of each individual journey time route for the PM period.

Apx Table A-30 Detailed PM Journey Time Validation Statistics

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
1_Inbound	CBC1	1469	1435	-2.3%	Pass
1_Outbound	CBC1	1803	2438	35.2%	Fail
2_Inbound	CBC16	2550	1891	-25.9%	Fail
2_Outbound	CBC16	2777	2586	-6.9%	Pass
3_Inbound	CBC1	1225	1286	4.9%	Pass
3_Outbound	CBC1	1558	1901	22.0%	Fail
4_Inbound	CBC2	1579	1923	21.8%	Fail

Route	CBC Correspondence	Observed Median/Mean Blend	Modelled	% Diff	Pass/Fail
4_Outbound	CBC2	2572	2618	1.8%	Pass
5_Inbound	CBC3	869	1069	23.1%	Fail
5_Outbound	CBC3	1439	1493	3.7%	Pass
6_Outbound	CBC3, CBC4	2120	1856	-12.4%	Pass
6_Inbound	CBC3, CBC4	1811	1639	-9.5%	Pass
7_Inbound	CBC5	1201	1194	-0.6%	Pass
7_Outbound	CBC5	1779	1741	-2.1%	Pass
8_Inbound	CBC6	1045	928	-11.2%	Pass
8_Outbound	CBC6	1326	1226	-7.5%	Pass
9_Outbound	CBC7	1851	1514	-18.2%	Fail
9_Inbound	CBC7	1651	1392	-15.7%	Fail
10_Inbound	CBC9	1897	1755	-7.5%	Pass
10_Outbound	CBC9	2103	2079	-1.2%	Pass
11_Inbound	CBC10,CBC12	1902	2118	11.4%	Pass
11_Outbound	CBC10,CBC12	2539	1713	-32.5%	Fail
12_Inbound	CBC11,CBC12	1331	1341	0.7%	Pass
12_Outbound	CBC11,CBC12	1728	1502	-13.1%	Pass
13_Inbound	CBC11	1100	1159	5.4%	Pass
13_Outbound	CBC11	1397	1261	-9.8%	Pass
14_Inbound	N/A	1580	1612	2.0%	Pass
14_Outbound	N/A	2120	1848	-12.8%	Pass
15_Inbound	CBC13	2722	2163	-20.5%	Fail
15_Outbound	CBC13	2552	2316	-9.2%	Pass
16_Inbound	CBC14,CBC15	1523	1503	-1.3%	Pass
16_Outbound	CBC14,CBC15	1801	1613	-10.4%	Pass
18_Westbound	N/A	2995	2417	-19.3%	Fail
18_Eastbound	N/A	2557	2680	4.8%	Pass
19_Eastbound	N/A	3611	2284	-36.8%	Fail
19_Westbound	N/A	2677	2435	-9.0%	Pass
20_Eastbound	N/A	1409	1109	-21.3%	Fail
20_Westbound	N/A	1471	1019	-30.8%	Fail
21_Eastbound	M50	3670	2432	-33.7%	Fail
21_Westbound	M50	3285	2362	-28.1%	Fail
22_Outbound	CBC13	744	515	-30.7%	Fail
22_Inbound	CBC13	520	516	-0.8%	Pass
23_Outbound	CBC2	803	732	-8.8%	Pass
23_Inbound	CBC2	697	652	-6.4%	Pass
24_Outbound	CBC7	1149	611	-46.8%	Fail
24_Inbound	CBC7	667	575	-13.9%	Pass
25_Outbound	CBC8	982	618	-37.1%	Fail
25_Inbound	CBC8	786	537	-31.7%	Fail

The table above highlights that there is a range of results in the PM peak period when comparing the modeled journey times when compared to a 50/50 blend of the mean and median observed TomTom data. The PM contains larger outliers compared to the 15% guidance compared to the other periods with 24 Outbound at -46.8%, 25 Outbound at -37.1% and 19 Eastbound at -36.8%. 25 Outbound and 19 Eastbound represent notable increases in journey time compared to the AM peak period which are difficult to model in an average model such as the LAM without and are likely due to outliers in the observed data.

A.4 Summary

The previous sections of this chapter have outlined the validation checks undertaken to assess the robustness of the calibrated LAM. In summary:

- The LAM meets all TII and TAG validation criteria for the turning counts with regards to absolute/percentage difference. The results against GEH criteria meet guidance for LGV/HGV but are slightly below guidance for Private Cars. All vehicle types and time periods perform well when comparing observed and modelled turning proportions.
- The journey times have been compared against a 50/50 blend of the mean and median TomTom data due to the significant difference in the journey time results given by the individual mean and median results. In each period the overall modelled times are close to guidance, matching in approximately 60% of routes. The LT and SR perform significantly better when compared directly against the mean of the observed. The above is comparable if not slightly improved in comparison to the ERM validation results.

Appendix B. Draft Initial Modelling Outputs

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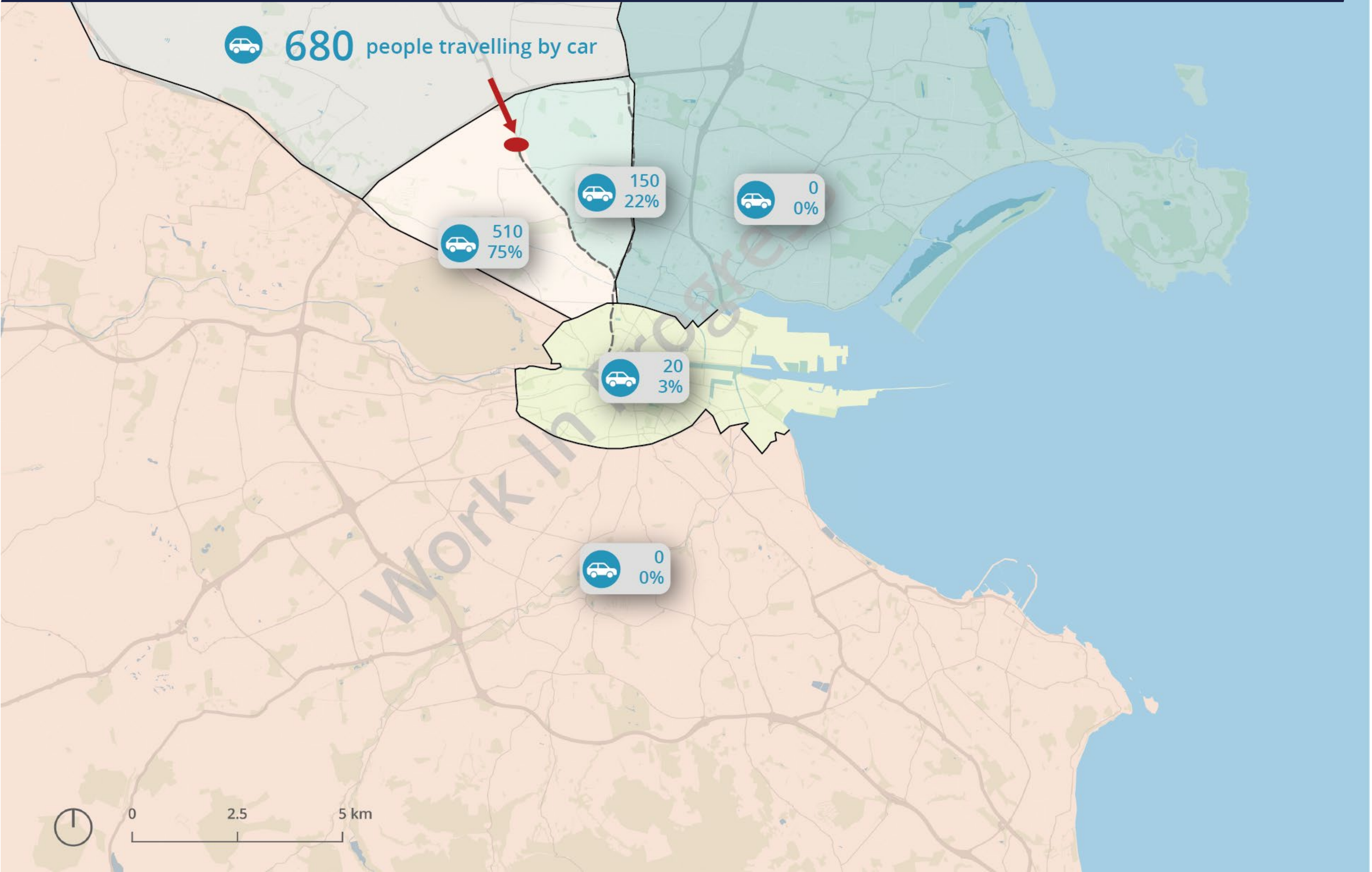
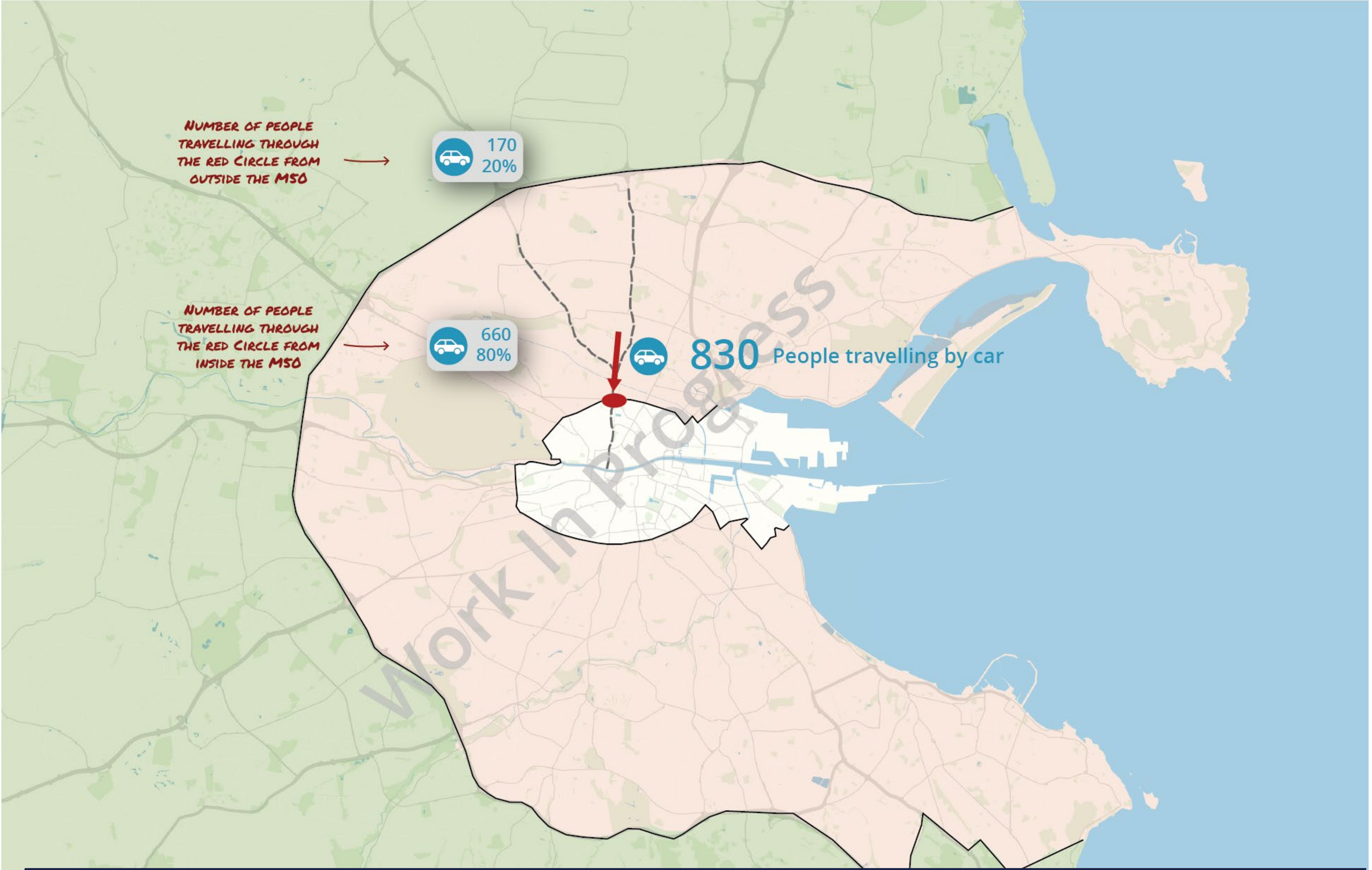
Finglas to Phibsborough CBC Transport Modelling Report
Appendix B
Work in Progress / Draft Strategic Model Outputs

October 2020

Destination of private car trips, starting outside the M50 cordon, in the AM peak (1hr) using the Proposed CBC Route in 2020 (pre COVID-19)





Origin of private car trips in the AM peak (1-hour) using the Proposed CBC Route and crossing the Royal Canal in 2020 (pre COVID-19)

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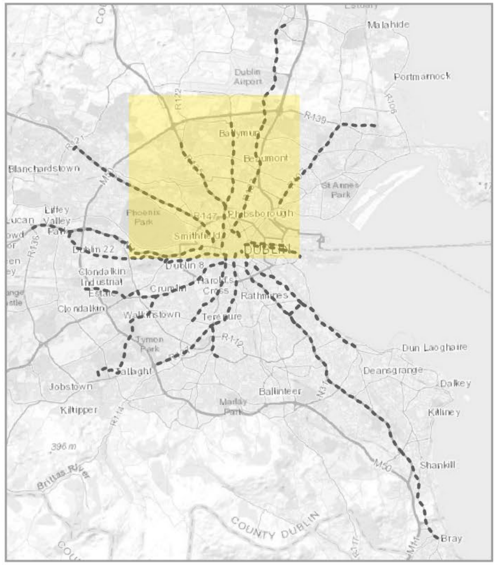
Change in Bus Passengers as a result of the Proposed CBC

Proposed CBC – Estimated additional Bus Patronage with CBC in place (AM Peak 2028)

Flow Difference

- < 50
- 50 to 100
- 100 to 200
- 200 to 300
- 300 to 400
- 400 to 600
- 600 to 800
- 800 to 1000
- > 1000



0 1 2 km

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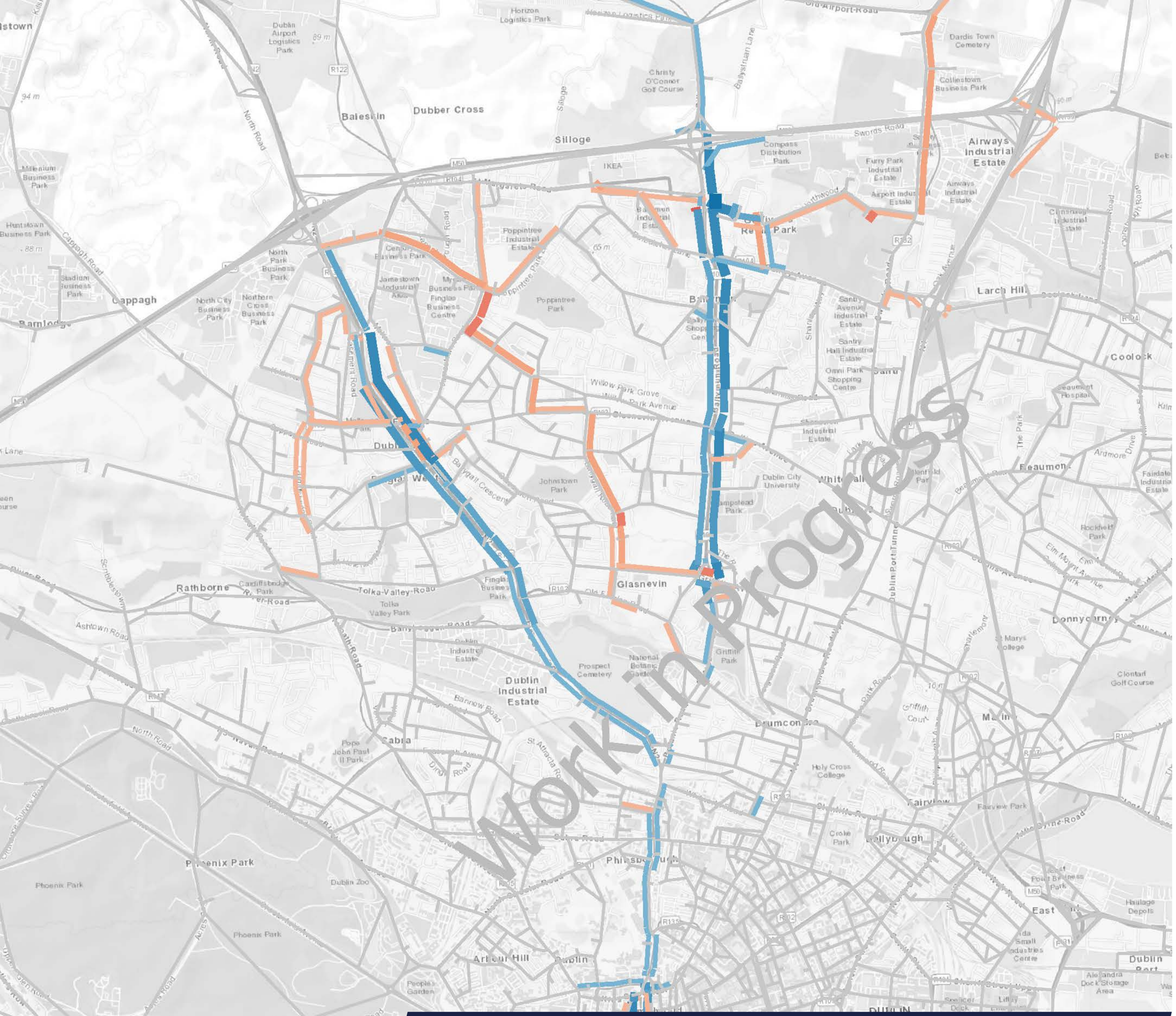
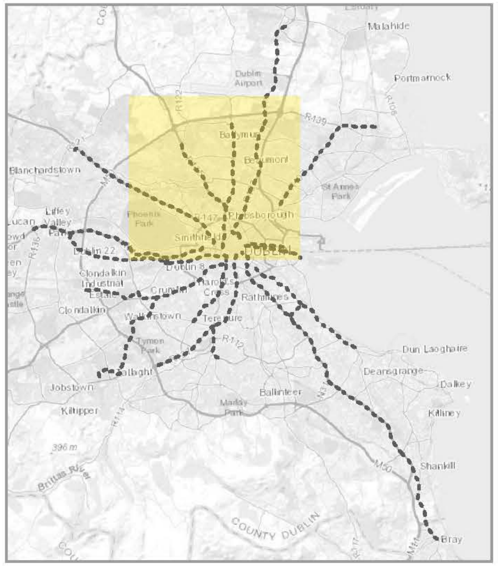
Proposed CBC – Estimated change in road traffic with CBC in place (AM Peak 2028)



Flow Difference

< -1000	100 to 200
-1000 to -800	200 to 300
-800 to -600	300 to 400
-600 to -400	400 to 600
-400 to -300	600 to 800
-300 to -200	800 to 1000
-200 to -100	> 1000
Other network links	



0 1 2 km

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Change in Road traffic flows as a result of the Proposed CBC

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