Clifton Scannell Emerson Associates

Appendix 2

LAM Report

Castlebar Active Travel Mobility Plan

31/03/2022

Reference number 300857

LOCAL AREA MODEL DEVELOPMENT REPORT

SYSTRA

Castlebar Active Travel Mobility Plan

LOCAL AREA MODEL DEVELOPMENT REPORT

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1. INTRODUCTION

1.1 Overview

1.1.1 SYSTRA has been commissioned by Clifton Scannell Emerson Associates (lead-consultant) on behalf of Mayo County Council to prepare Active Travel Mobility & Transportation Plans for the towns of Castlebar and Ballina. The overall objective is to enable the authorities to introduce transport policies and a series of traffic and transportation measures up to 2040.

1.1.2 A Local Area Model (LAM) representing traffic in Castlebar has been developed for this study.

1.1.3 The purpose of this Traffic Modelling Report (TMR) is to detail the development of the Castlebar LAM and describe the traffic forecasting that has been undertaken to assess the impact of future transportation schemes.

1.2 Background information

1.2.1 Castlebar is a town in County Mayo, where the national secondary routes N60 and N85 meet the national primary route N5. The N5 is the main access route from Dublin to most of County Mayo. Castlebar was designated as a Key Town in the recently adopted Regional Spatial and Economic Strategy 2020 – 2032 (RSES). A key growth ambition for the Northern and Western Region is to build centres of scale across the region, where people and businesses seek to live, work and invest. The town has a primary role in providing regional, strategic employment development of significant scale to support the growth of the higher tier urban centres in the region, including Galway and Sligo.

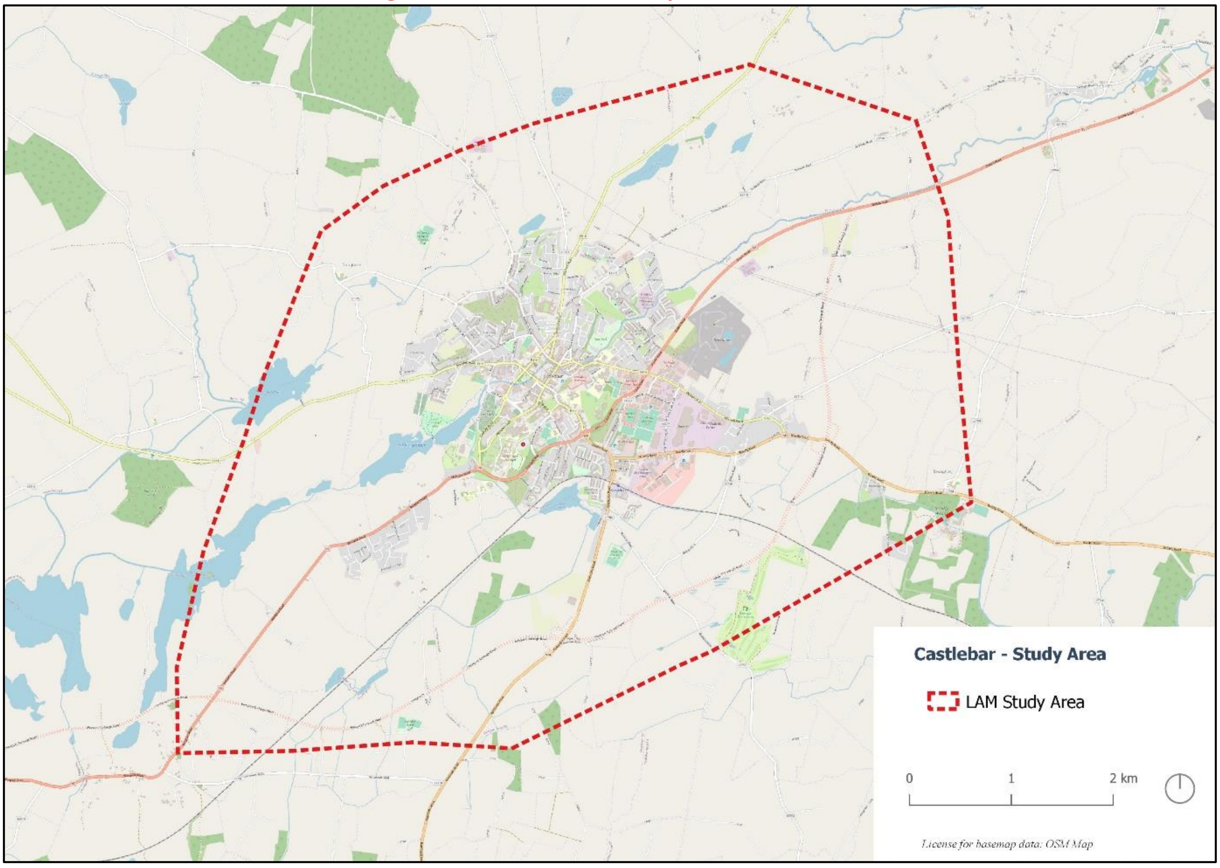
1.2.2 Traffic congestion and road safety problems are experienced within Castlebar due to the high flow of traffic along the N5, particularly in the summer months when thousands of tourists travel to the West Coast. The Castlebar Active Travel Mobility Plan will underpin evidence-based transport strategies which aim to increase accessibility, promote active travel modes, and seek to reduce car use by a variety of means and to encourage integrated land use and transport planning within and eventually between major towns. The objectives will also benefit Climate Action policies both on a county and regional level.

1.2.3 Walking and cycling strategies support sustainable activity within communities, and will serve to develop towns with networks of safe and convenient routes that will improve the quality of life for everybody in the communities. This is achieved by prioritising walking and cycling for travel to work, education, shopping and day-to-day business, whilst also providing high quality public environments and amenities.

1.3 Study Area

1.3.1 The Study Area adopted for the Castlebar Active Travel Mobility project is illustrated in Figure 1 below.

Figure 1. Castlebar Study Area



1.4 Structure of this Report

1.4.1 The remainder of this report is structured as follows:

- **Chapter 2** describes the traffic data that was collected and used in the development of the Castlebar LAM;
- **Chapter 3** presents the initial analysis of traffic data;
- **Chapters 4 to 7** set out the development of the base year traffic model, including the development of the network, zone system and model calibration and validation;
- **Chapter 8** presents how the impacts of the pandemic travel restrictions are considered;
- **Chapter 9** details the modelling of the future N5 Westport-Turlough road project; and
- **Chapter 10** summarises the LAM development process.

2. DATA COLLECTION

2.1 Summary

2.1.1 Traffic surveys were carried out in November 2021, comprising:

- Junction Turning Counts (JTC) at key junctions throughout the whole town and at key points on the road network outside Castlebar town centre, undertaken on Thursday 25th November 2021 – See Figure 2 below;
- Automatic Traffic Counts (ATC) on key roads undertaken for a period between 22nd November and 5th December 2021 – See Figure 3 below; and
- Journey time surveys on key routes through the study area, undertaken on Thursday 25th November 2021 – See Figure 4 below.

2.1.2 The surveys are described in greater detail below. The processed counts were used for calibrating the base year traffic model, and they reflect the conditions on an average weekday in November.

2.2 Traffic Counts

2.2.1 Automatic Traffic Counts (ATC) were carried out at 21 junctions, for a 24-hour period 00:00-24:00 from Monday 22nd November 2021 until Sunday 5th December 2021. Pneumatic tube detectors attached to automatic count devices were in use for the ATCs.

2.2.2 Table 1 below shows the processed observed flows from the ATCs for each location, split by vehicle classes (Car, Lights Goods Vehicle & Other Goods Vehicle) and peak periods (AM 08:00-09:00, PM 17:00-18:00).

Table 1. Processed Automatic Traffic Counts (pcu)

ATC Site	Direction	GeoDirection	AM PEAK			PM PEAK		
			CAR	LGV	OGV	CAR	LGV	OGV
28	A	NB	208	26	8	476	28	10
28	B	SB	420	35	16	289	21	9
29	A	NB	228	21	6	306	29	4
29	B	SB	184	30	8	130	15	6
30	A	NB	360	47	13	626	54	11
31	A	EB	326	19	18	147	13	7
31	B	WB	72	5	4	141	8	4
32	B	SB	397	68	17	449	71	8
33	A	EB	465	32	28	529	32	23
33	B	WB	477	43	35	637	61	28
34	A	NB	583	44	165	343	21	65
34	B	SB	695	66	72	263	44	13
35	A	NB	417	22	14	298	10	16
35	B	SB	286	21	17	418	18	26
36	A	NB	473	43	31	573	42	26
36	B	SB	308	30	20	459	23	13
37	A	NB	106	10	3	154	6	4
37	B	SB	151	15	4	181	10	3
38	A	NB	567	30	99	528	18	94
38	B	SB	530	48	70	681	37	40
39	A	NB	31	6	1	39	5	1
39	B	SB	48	7	2	30	5	2
40	A	NB	21	6	4	78	9	2
40	B	SB	68	9	2	26	4	2
41	A	NB	78	9	10	149	13	4
41	B	SB	126	21	11	82	17	6
42	A	NB	73	9	4	122	10	7
42	B	SB	135	20	6	85	13	4
43	A	NB	335	59	25	195	41	16
43	B	SB	234	23	7	347	35	8
44	A	NB	310	59	37	317	51	15
44	B	SB	200	21	25	270	36	40
45	A	NB	513	60	63	332	61	40
45	B	SB	322	39	50	457	36	26
46	A	NB	328	38	23	184	24	22
46	B	SB	123	28	20	370	35	15
47	A	NB	341	60	73	606	77	57
47	B	SB	587	73	78	361	39	38
48	A	EB	33	5	1	15	4	1
48	B	WB	23	4	1	21	2	1

Figure 2. Automatic Traffic Counts locations (November 2021 survey)

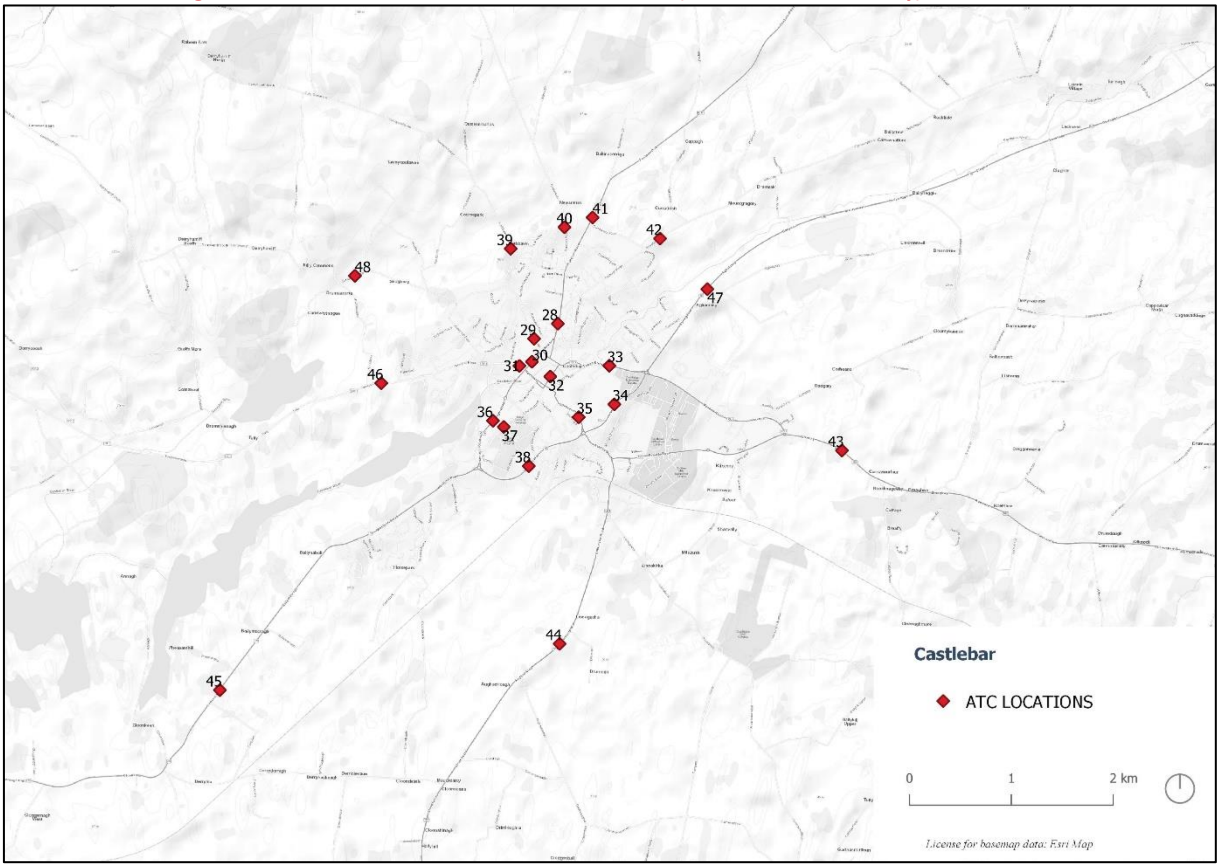
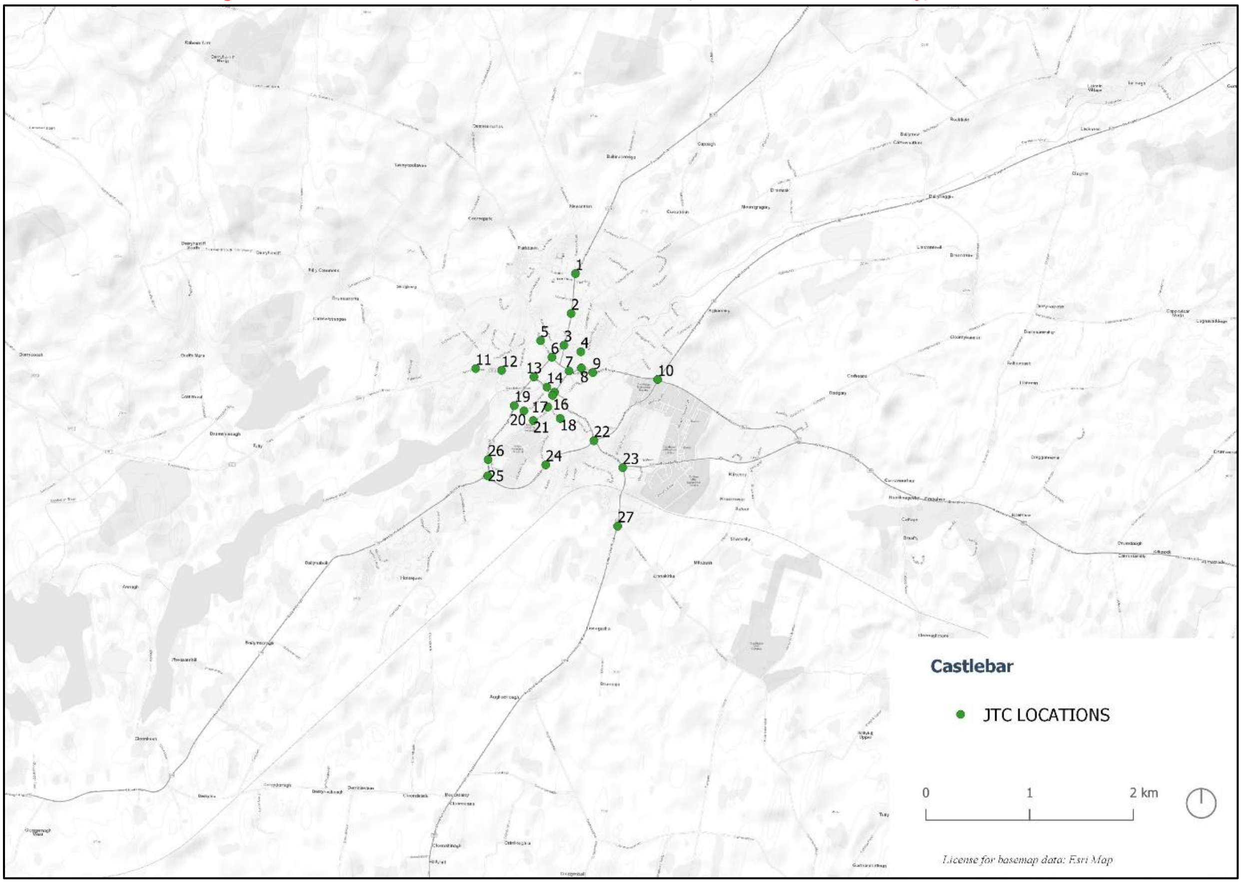


Figure 3. Junction Traffic Counts locations (November 2021 survey)



2.3 Journey Time Surveys

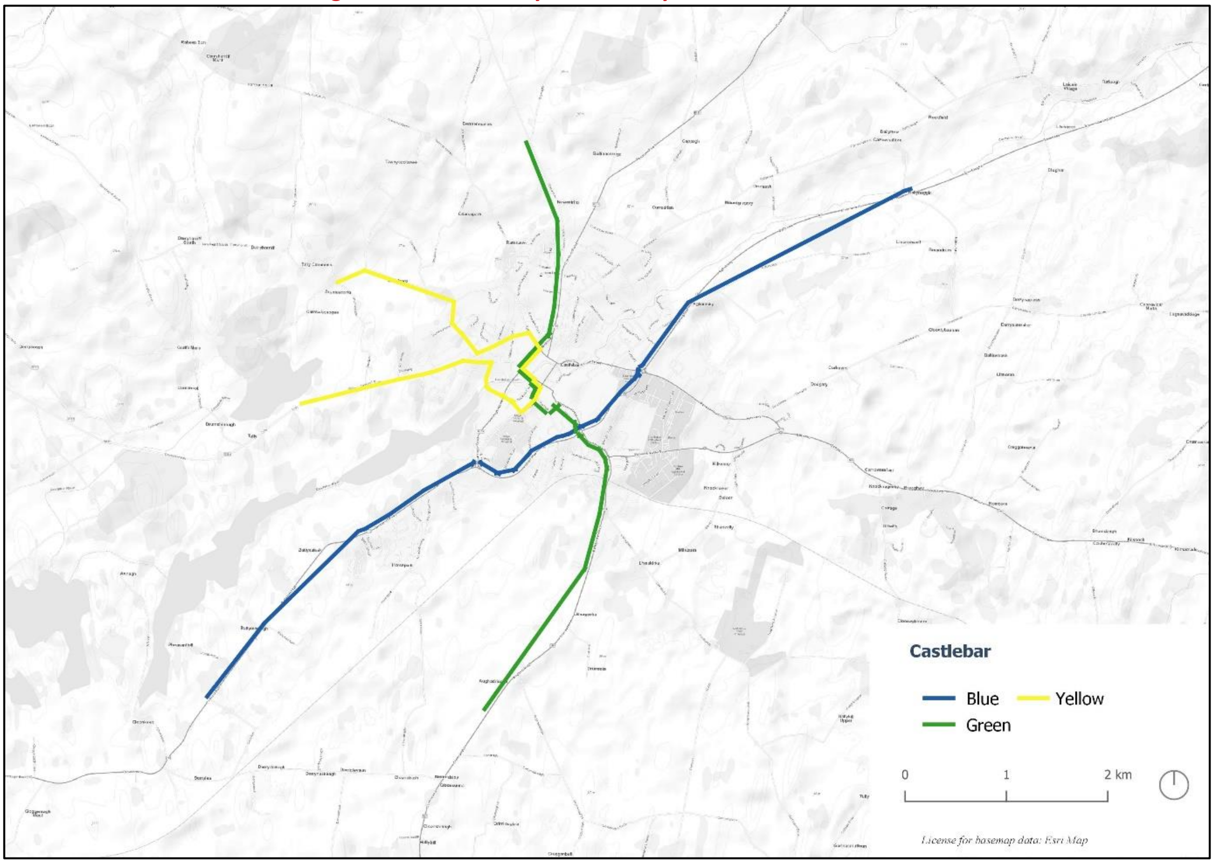
2.3.1 Journey time surveys were undertaken along the three main corridors (colour coded as blue, green and yellow in Figure 4 below) travelling through Castlebar. The routes were surveyed using a single GPS-equipped survey vehicle, driving the routes through the day and recording its position and timing. All recordings were captured on 25th November 2021.

2.3.2 The routes were undertaken with the driver starting before the initial starting node to allow them to get up to speed with the other vehicles on the road before continuing beyond the final point. The driver was instructed to drive at the prevailing traffic speed insofar as it was safe and legal to do so. This is a common form of survey for recording variation in speed along a route.

2.3.3 To increase the sample size, records with a starting and a finishing time within 07:00-10:00 for AM (respectively 16:00-19:00 for PM) were included. Number of observations recorded were (both directions):

- Blue route: 15 in AM and 12 in PM
- Green route: 11 in AM and 10 in PM
- Yellow route: 15 in AM and 13 in PM

Figure 4. Journey Time Survey Routes



2.3.4 Table 2 below, shows the recorded average journey times for each of the above routes for each of the time periods surveyed.

Table 2. Observed Average Journey Times in seconds

ROUTE	DIRECTION	AM	PM
Blue	Eastbound	636	779
Blue	Westbound	641	859
Green	Northbound	948	954
Green	Southbound	817	1,222
Yellow	Eastbound	693	727
Yellow	Westbound	732	834

2.3.5 Observed travel times on the Green Route were impacted by the on-going N5 bypass construction work around the N84 junction.

3. BASE YEAR MODEL DEVELOPMENT

3.1 Introduction

3.1.1 The following chapter describes the methodology used for developing the Castlebar Local Area Model (LAM). The National Transport Authority's (NTA) Regional Modelling System (RMS) was used as a basis for the LAM development, providing initial network detail and prior demand matrices. Further refinement was undertaken in the modelled area and it was calibrated and validated to observed count data in-line with TII project appraisal guidelines.

3.2 NTA Regional Modelling System (RMS)

3.2.1 The NTA RMS comprises the following three main components:

- The National Demand Forecasting Model (NDFM);
- 5 Regional Models; and
- A suite of appraisal Modules.

3.2.2 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

3.3 West Regional Model (WRM) Overview

3.3.1 The WRM is a strategic multi-modal transport model representing travel by all the primary surface modes, including: walking and cycling (active modes); travel by car, bus, rail, tram, light goods and heavy goods vehicles; and broadly covers the Connaught province of Ireland including the counties of Galway, Leitrim, Sligo, Roscommon, Mayo and Donegal. The five regional models are shown in Figure 5 below, and highlights the location of the WRM.

Figure 5. NTA Regional Modelling System Extent

3.3.2 The WRM 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.

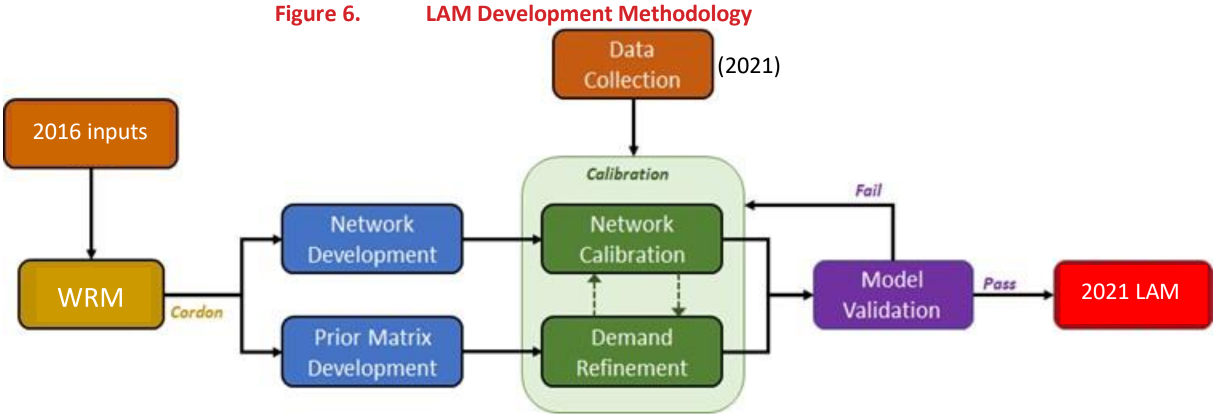
3.3.3 Destination and mode choice parameters within the WRM have been calibrated using two main sources: Census 2016 Place of Work, School or College - Census of Anonymised Records (2016 POWSCAR), and the Irish National Household Travel Survey (2017 NHTS). The NTA's RMS is the most sophisticated modelling tool available for assessing complex multi modal movements within an urban context. This provides a consistent framework for transport assessment.

3.3.4 As the study area falls within the area covered by the WRM, it therefore is an ideal tool to use as a basis for the development of the Castlebar LAM. In addition, it provides the platform to forecast future trip demand and distribution.

3.4 LAM Development Methodology

3.4.1 The methodology for developing the Castlebar LAM from the RMS is illustrated in Figure 6 below.

Figure 6. LAM Development Methodology



3.4.2 In summary, the process involves the following steps:

- **2016 WRM Run:** The calibrated base year scenario (W17R02) was used as the starting point for the Castlebar LAM;
- **WRM Cordon:** The 2016 WRM road assignment was cordoned to extract the initial network and traffic matrix covering the Castlebar LAM extent (see Figure 1). No significant change to the land use or the network were recorded between 2016 and 2021, making the 2016 calibrated WRM scenario a valid starting point to build the 2021 LAM.
- **Network and Prior Matrix Development:** The initial WRM cordoned road network was reviewed in greater detail for the study area for items including junction layouts, network speeds, missing links etc... The zone system from the WRM was disaggregated where necessary to provide a more accurate representation of traffic loading onto the road network. Several links were added to the cordoned road network.
- **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 2 for further information).
- **Calibration:** Calibration is the process of adjusting the model to better represent observed data. This was undertaken in two steps:

- Network Calibration: adjustments to the road network based on observations extracted from traffic survey data e.g. altering turning capacities at junctions, updating link speeds etc.; and
- Demand Refinement: adjustments to the prior matrix to better represent observed travel movements from count data.

- **Validation:** Validation is the assessment of the validity of the calibrated model, and its robustness in representing observed traffic conditions. Calibration and validation is an iterative process. If the results of the validation checks are unsatisfactory, then adjustments will be made as required in order to achieve a better representation of reality. The Castlebar LAM was validated in-line with TII and UK Department of Transport TAG guidance. Further information on model validation is provided in Chapter 6 of this report.

3.5 Model Area

3.5.1 The area to be analysed in detail in the Castlebar LAM is illustrated in Figure 1, and was identified through the following:

- Review of all major roads and alternative routing options in the study area; and
- Internal discussions with the project team.

3.6 Model Time Periods

3.6.1 Automatic Traffic Counts (ATC's) were undertaken at 21 locations throughout the study area (further information included in Chapter 2 of this report).

3.6.2 These ATC results were utilised to identify the typical profile of traffic demand within the study area throughout an average weekday. The ATC data suggests that the hours experiencing the highest levels of traffic are from 08:00-09:00 in the AM, and 17:00-18:00 in the PM. These peaks are also consistent with the NTA WRM.

3.6.3 Therefore, the Castlebar LAM was developed, calibrated and validated to represent the following time periods:

- AM Morning peak period: 08:00 to 09:00;
- PM Evening peak period: 17:00 to 18:00;

3.7 Demand Segmentation

3.7.1 The prior travel demand for the Castlebar LAM was derived from the NTA's WRM (See Chapter 5 for more details). The WRM assignment matrices contain the following ten user classes:

- Car Employer's Business (in work time)
- Car Commute (travel to/from work);
- Car Education (travel to/from school);
- Car Other (other non-work purposes such as shopping, visiting friends, etc);
- Retired
- Taxi;
- Light Goods Vehicles (LGV);
- Other Goods Vehicles (OGV) 1;
- OGV2 Permit Holder (5 or more axles and allowed drive in Dublin city centre); and
- OGV2 (5 or more axles and not allowed drive in Dublin city centre).

3.7.2 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 WRM, the ten user classes and their associated generalised cost parameters were retained for the Castlebar LAM.

3.8 Model Software

3.8.1 The model software used to develop the Castlebar LAM is the SATURN (Simulation Assignment of Traffic to Urban Road Networks) suite of transportation modelling programs.

3.8.2 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;
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.

3.9 Assignment Parameters

3.9.1 The Castlebar LAM was developed in SATURN and the model was calibrated and validated using release version 11.4.07 of the software. The SATURN application SATNET was used to build the various data files in to an assignable road network (UFN) file.

3.9.2 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.

3.9.3 The generalised cost and assignment parameters from the WRM road model were used in the Castlebar LAM.

4. NETWORK DEVELOPMENT

4.1 Introduction

4.1.1 This Chapter provides an overview of the network developed for the Castlebar LAM. The goal in developing the LAM was to create a model that accurately reflects current traffic conditions in the study area for the 2021 base year, and to a sufficient level of detail to allow the modelling of alternative schemes. To achieve this goal, the model must have a sufficiently defined road network and trip demand representation.

4.2 Network Development

4.2.1 The NTA's WRM was utilised as a base for generating the highway network for the Castlebar LAM. The base WRM network was developed from the HERE mapping layer which provides a detailed representation of all National Primary, Secondary, Regional and local roads in Ireland.

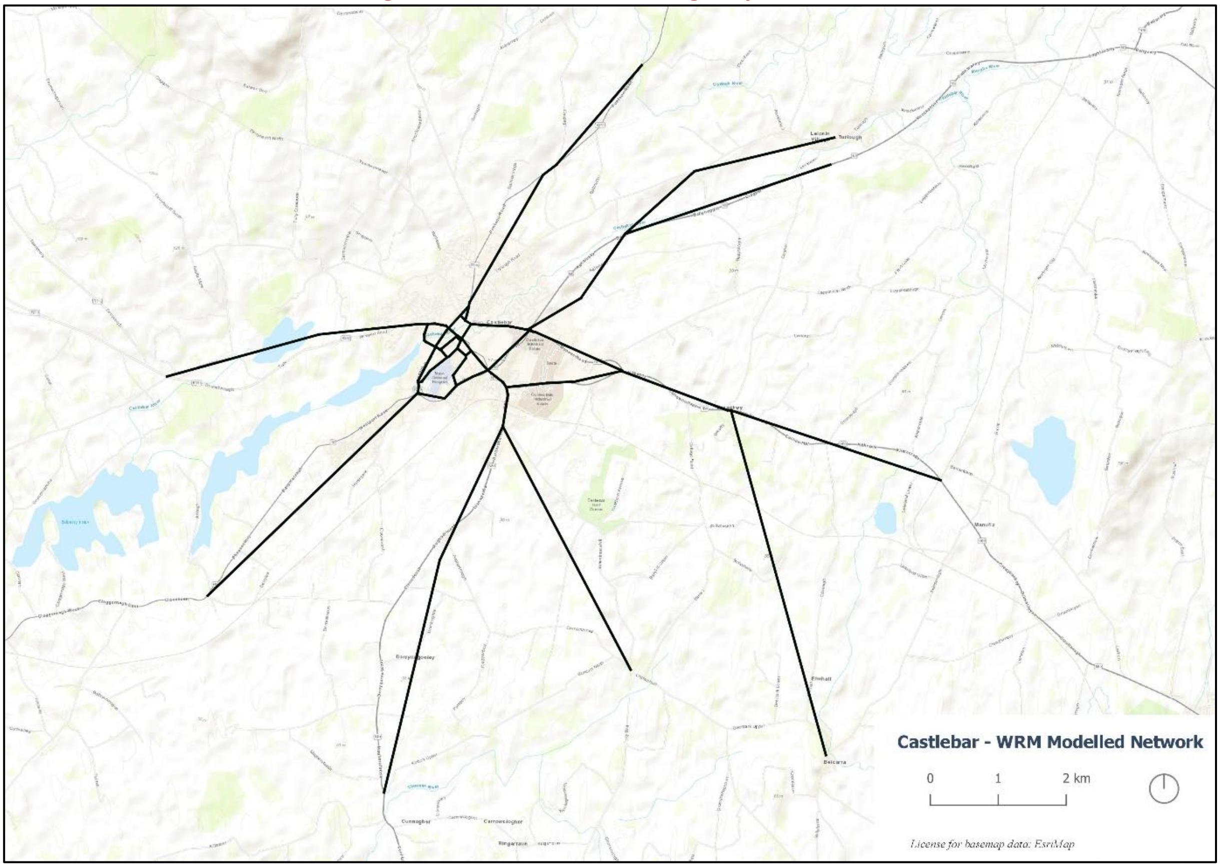
4.2.2 The Castlebar LAM road network, extracted from a cordon of the WRM, is illustrated in Figure 7. A detailed review was undertaken of all model coding in the study area using digital mapping systems such as Google Earth to ensure it represented, as accurately as possible, the existing road network. This included aspects such as network speed limits, availability of bus lanes, junction layouts, pedestrian crossing points etc.

4.2.3 Junction capacities and saturation flows were adopted from the Network Coding Guidelines 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.

4.2.4 Traffic signals' phasing and timing were provided by Mayo County Council and included in the LAM coding.

4.2.5 As illustrated in Figure 7, the WRM 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 the national primary routes to minor residential streets. The short dead-end links in Figure 7 are "spigots" used to load traffic from the zones accurately onto the network, and reflect the further developed zone system that is outlined in Section 5 below.

Figure 7. Castlebar LAM Highway Network



5. ZONE SYSTEM AND PRIOR MATRIX DEVELOPMENT

5.1 Introduction

5.1.1 This chapter describes the development of the base LAM trips matrix with reference to the following aspects:

- Zone system development; and
- Matrix development.

5.1.2 These matrices were later subjected to matrix estimation as part of the process of calibrating the model. The matrices described in this section are referred to as 'prior' matrices.

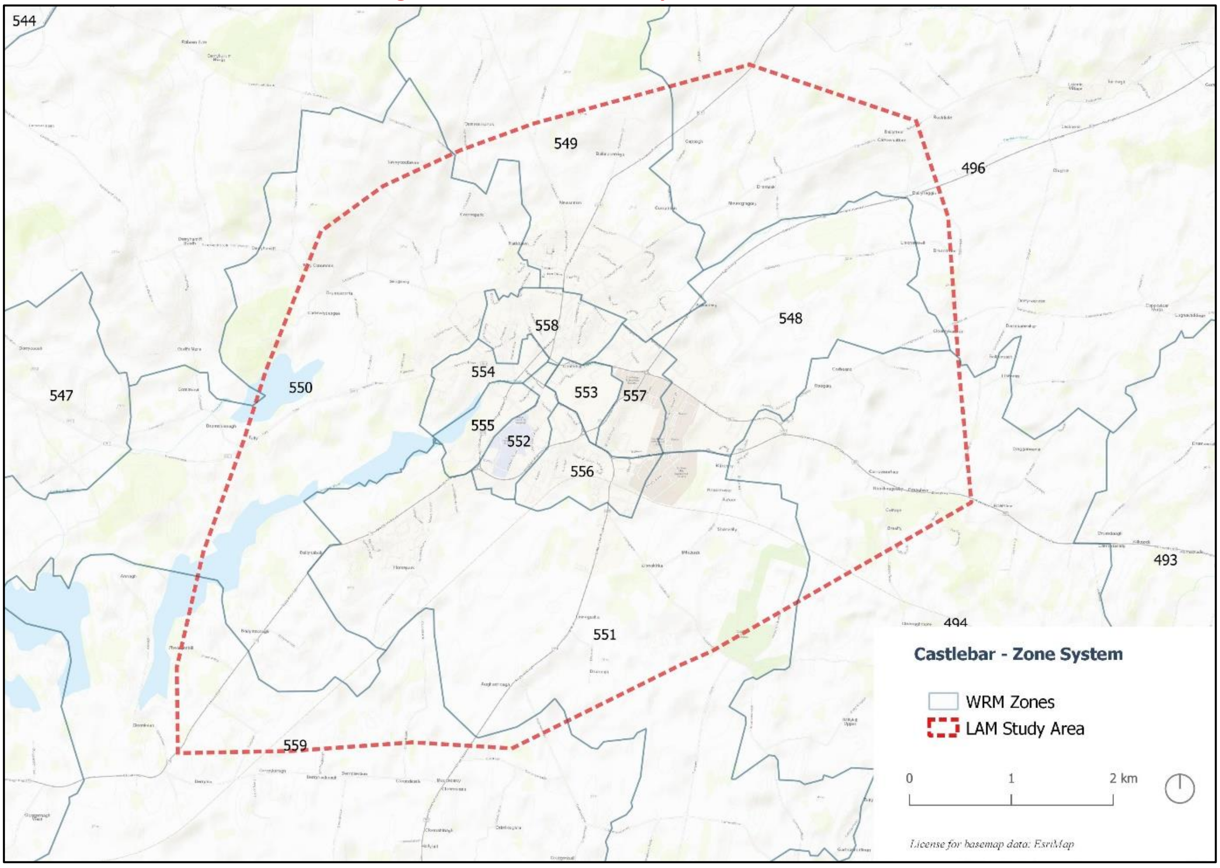
5.2 Zone System Development

5.2.1 Similar to the road network described previously, the base Castlebar LAM zone system was adopted from the WRM. The WRM 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 centres across the model area. Other data sources such as MyPlan and Geo Directory were also used to obtain information on specified land-use zoning and location of commercial development. The following rules were then applied to generate 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 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;
- 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.

5.2.2 Figure 8 below illustrates the WRM zone system within the study area.

Figure 8. WRM Zone System

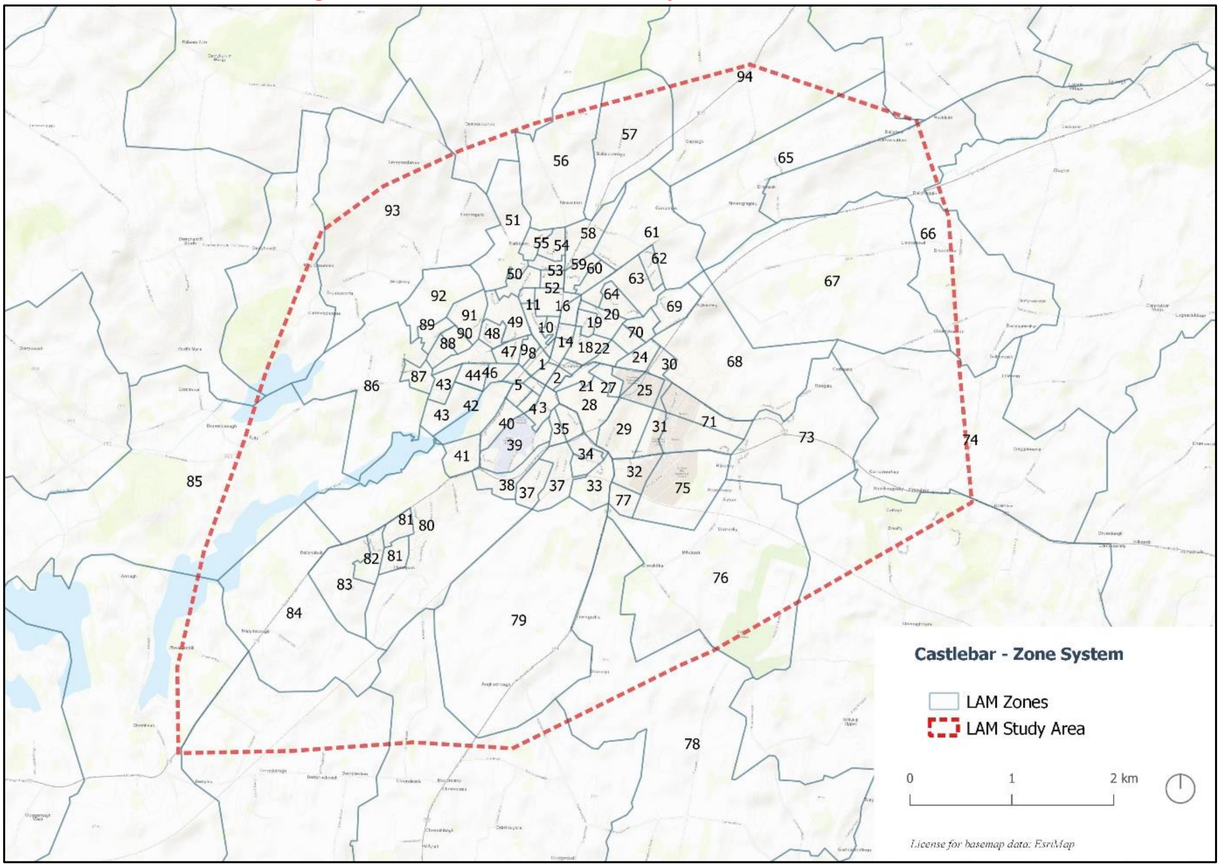


5.2.3 In the parts of the WRM, close to City areas, the WRM zones are represented in quite a high level of detail. As such, individual housing estates and key employers have been given their own zones. However, in areas further away from the town centre, the WRM zones become larger and more aggregate in nature primarily due to the lower levels of activity (population and employment) in these areas.

5.2.4 A detailed review was undertaken of all WRM zoning and centroid connectors in the study area. On review of this, a number of edits were applied to the WRM zone system in order to provide a more accurate representation of traffic loading onto the road network for the Castlebar LAM.

5.2.5 Figure 9 below illustrates the zonal system developed for the study area. In total, 106 zones have been created, with 94 internal zones within the study area and 12 external zones representing the roads that enter the area of interest. This level of detail ensures that traffic loads accurately within the Castlebar LAM study area.

Figure 9. Castlebar LAM Zone System



5.3 Prior Matrix Development

5.3.1 As noted previously in Chapter 1, the Full Demand Model carries out mode and trip destination choice for all zones within the WRM. The FDM has been calibrated using Census data, hence providing a robust and accurate representation of trip distribution across the model network. In order to generate prior matrices for the study area, a cordon was extracted from the calibrated 2016 WRM base year scenario. The cordon function within SATURN, facilitates the extraction of trip matrices for a subset area of the WRM whilst maintaining route and destination choice from the full model.

5.3.2 A bespoke Excel spreadsheet tool was created to disaggregate the cordoned WRM matrices to each of the 94 internal LAM zones. This tool used available data on population, employment, and education places at Census small area level, to split trips to/from each WRM 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 WRM matrix.

6. CASTLEBAR LAM EARLY CHECKS

6.1 Introduction

6.1.1 During the development of the Castlebar LAM model 2021 reference case network, initial assignments of the AM and PM periods were undertaken, and flow comparisons undertaken between the WRM 2016 network and the developed LAMs in order to identify model discrepancies.

6.2 Flow comparison overview

6.2.1 The comparison showed an impact on flows in the wider area as a result of the addition of more detailed infrastructure in the LAM model. This analysis shows the distribution and choice of all trips associated with the new zone system and so the absolute number of vehicles being forced to re-route is relatively small, particularly given that these are spread around the LAM boundaries, rather than focussed on one point.

Figure 10. AM Traffic Flow Distribution WRM model

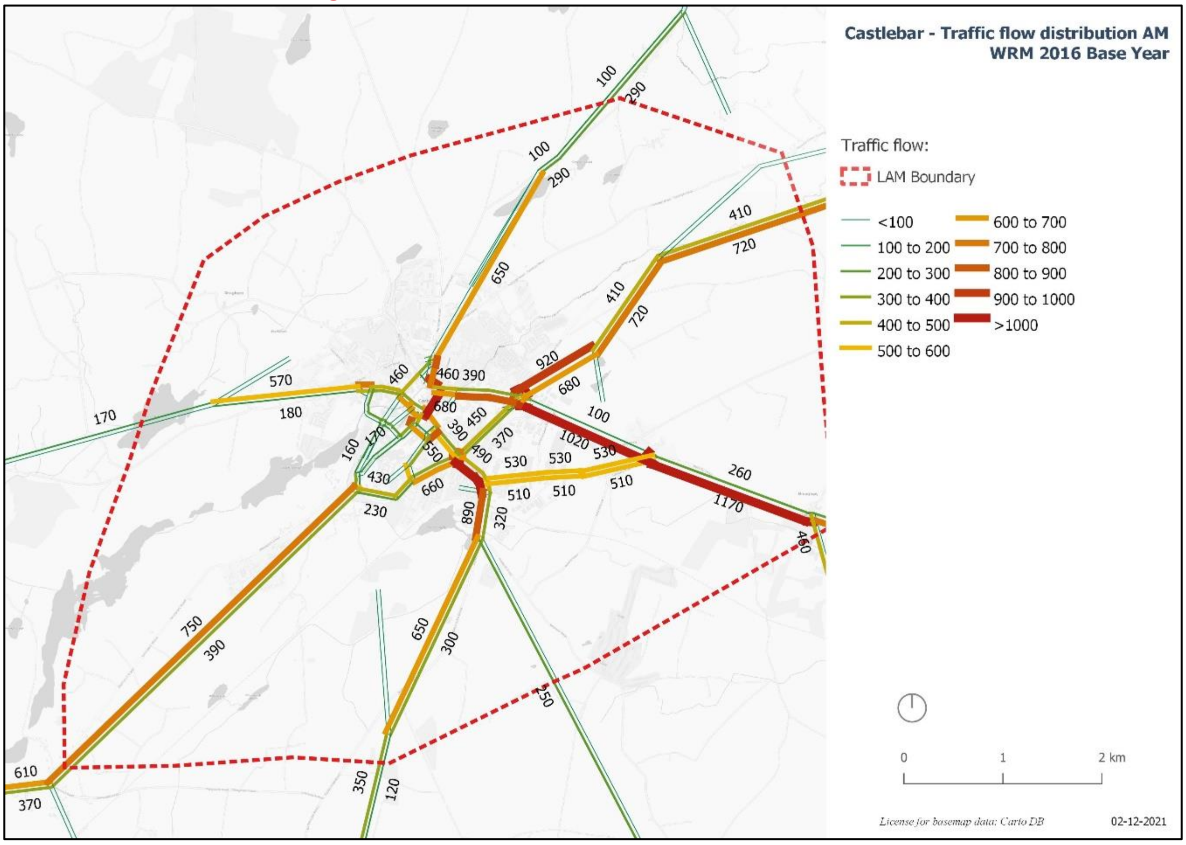
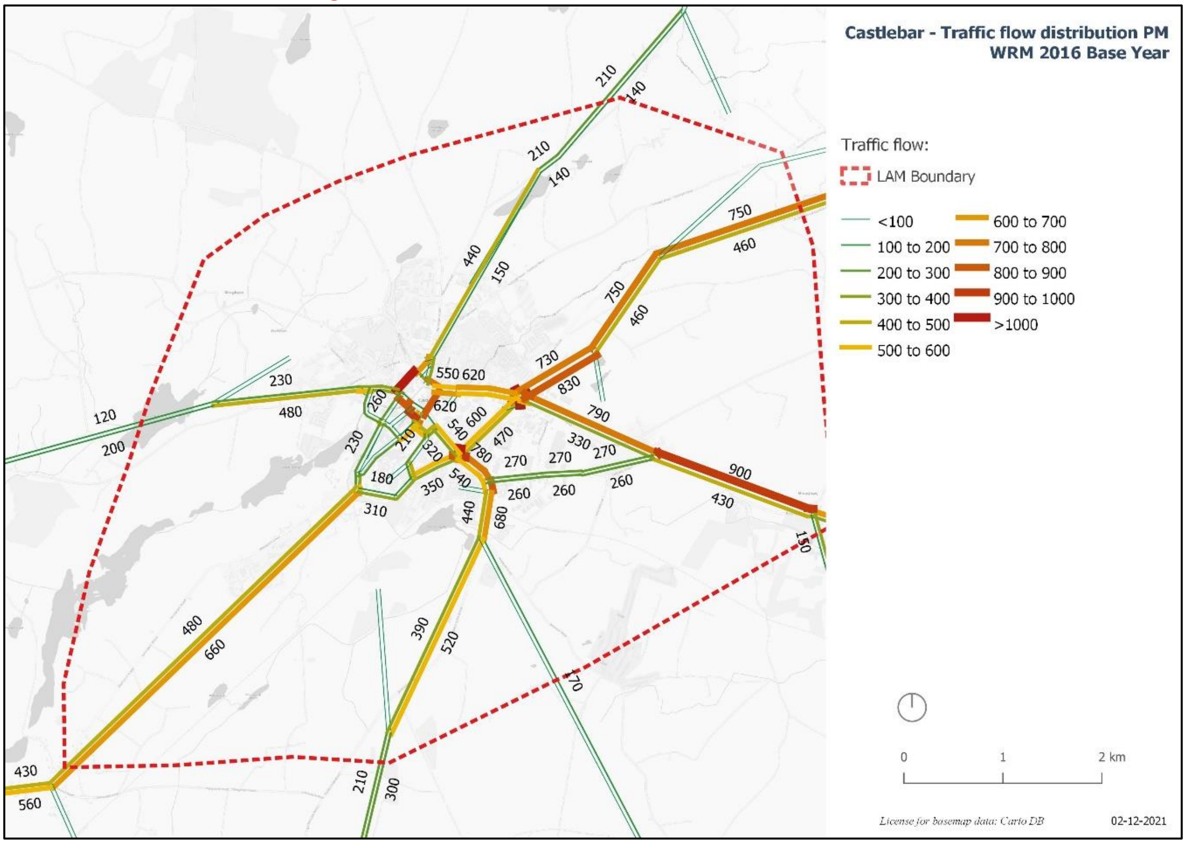


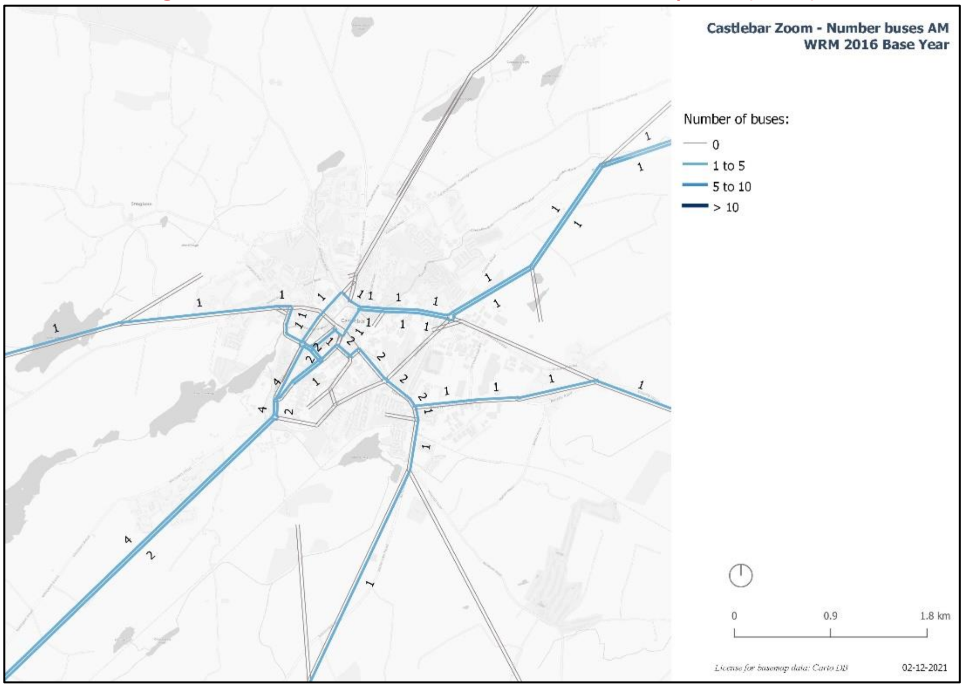
Figure 11. PM Traffic Flow Distribution WRM model



6.3 Bus Flow Assumptions

6.3.1 There are only a few modelled buses in Castlebar in the WRM (see Figure 12). Their contribution to traffic is not significant and can be ignored in the LAM.

Figure 12. Number of modelled buses in the AM period (WRM)



7. MODEL CALIBRATION AND VALIDATION

7.1 Overview of the Calibration and Validation Process

7.1.1 Once base prior matrices have been generated, the calibration process aims to reduce differences between observed and modelled traffic characteristics. Generally, the components of the model that may be adjusted on the demand side are trip distribution and trip production/attraction. This adjustment usually involves trip matrix estimation.

7.1.2 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.

7.1.3 The Castlebar 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.

7.1.4 The following sections of this chapter detail the calibration process undertaken to ensure that the LAM accurately reflects baseline conditions, including information on:

- Traffic Count Data;
- Calibration Steps;
- Matrix Estimation; and
- Calibration Statistics (i.e. GEH and Linear Regression Analysis).

Traffic Count Data

7.1.5 To ensure the robustness of the developed strategic model, a series of traffic counts for the study area have been used to assist in the calibration and validation of base model flows. The following surveys were used in the process:

- Junction Turning Counts (JTC) at 27 points (178 individual movements);
- Automatic Traffic Counts (ATC) at 38 points; and
- Moving Car Observer (MCO) Journey Time Surveys along 3 existing paths.

7.1.6 The ATC and JTC survey locations are illustrated in Figure 2 and Figure 3 respectively. The Journey Time Surveys are discussed in further detail in section 8.3 describing the model validation process.

7.1.7 Turning counts were undertaken at key locations to provide detailed movements within the specified junctions. The locations of ATC surveys provide a record of traffic in the study area over an extended period of time (14 days). Incorporating this information enables an accurate representation of traffic flows within the model.

Calibration Steps

7.1.8 As an initial calibration step, all modelled movements with corresponding junction turning counts were examined to determine if the count exceeded modelled capacity. Remedial steps were then taken to permit realistic flows in the model.

7.1.9 Similarly, the capacity and speeds of modelled links were also checked to ensure they were broadly in line with survey information.

7.1.10 As the LAM was coded based on best practice guidelines developed during the NTA Regional Model Scoping Process, the network coded was an accurate and up-to date representation of the existing road network. If required however, the following network model parameters were adjusted if there was clear reason for doing so:

- Junction type (Priority, Signalised, Roundabout);
- Road lengths;
- Signal timings;
- Link free flow travel speed;
- The number of approach lanes at each junction arm;
- Traffic lane width per junction approach, and the lane discipline adopted (including prohibited turns);
- Saturation flow through junctions;
- Assumed road capacities;
- Link based flow-delay relationships;
- Any other traffic management measures that may impact on capacity, such as bus lanes, traffic calming, parking controls and cycle-lanes.
- Zone co-ordinates; and
- Zone loading points (connections to the network).

Trip Demand Adjustment (Matrix Estimation)

7.1.11 Following calibration of the network, trip demand is adjusted in line with count data, so that there is an improved agreement between counts and modelled flows. The base prior matrix is fed into a SATURN programme called ME2. ME2 then adjusts origin-destination patterns to produce a trip demand matrix that better replicates traffic counts when assigned to the network. When this replication is satisfactory, the matrix is said to be calibrated.

7.1.12 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.

7.1.13 The algorithm driving the ME2 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 through trips contained within the original car trip matrix. By restricting such long through trips, the matrix adjustment algorithm is forced to create or re-distribute short trips.

Calibration Statistics - GEH

7.1.14 The GEH statistic is a measure that considers both absolute and proportional differences in flows. Thus, for high levels of flow, 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:

$$GEH = \sqrt{\frac{(\text{observed} - \text{modelled})^2}{0.5 \times (\text{observed} + \text{modelled})}}$$

7.1.15 The reason for introducing such a statistic is due to 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 PCUs/hr may be considered a big difference if the flows are of the order of 100 PCUs/hr, but would be unimportant for flows in the order of several thousand PCUs/hr. Equally, a 10% error in 100 PCUs/hr would not be important, whereas a 10% error in, say, 3,000 PCUs/hr might mean the difference between adding capacity to a road or not.

7.1.16 In general, the GEH parameter is less sensitive to the above statistical biases since a modeller would probably feel 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.

7.1.17 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.

7.1.18 The UK Design Manual for Road & Bridges (DMRB) Volume 12a guidelines (Traffic Appraisal in Urban Areas) are a widely accepted standard in Ireland (with TII basing their guidelines on this document) that provides extremely robust validation criteria to which certain types of highway models should adhere. This document sets a guideline that 85% of links should have a GEH less than 5 (when measured in vehicles per hour) as shown in Table 3 below. In addition, it is commonplace to establish that 90% of assessment links have a GEH of less than 10 and that 100% of validation links have a GEH less than 20.

Table 3. Calibration Criteria

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	
Modelled journey times compared with observed times	
Times within 15% or 1 minute if higher	>85% of cases

7.2 Model Calibration Results

Traffic Flow and GEH Calibration Results

7.2.1 Table 4 below summarises the GEH calibration results for the model after the matrix estimation process, for each of the three modelled time periods. The full list of GEH results for each traffic count location are presented in the accompanying calibration dashboards in Appendix A.

Table 4. Count Calibration Statistics (Post-Calibration)

GEH	AM	PM
GEH < 5	94%	85%
GEH 5 to 10	5%	12%
GEH > 10	1%	3%

7.2.2 The figures demonstrate that an excellent calibration has been achieved in the model for the morning and evening peak periods, with overall GEH<5 of 94% and 85% respectively, which falls well within TII standards.

7.2.3 Figure 13 to Figure 14 show the Modelled vs Observed flow totals for the AM & PM peak hours.

Figure 13. Castlebar AM Calibration – Modelled vs Actual Flows

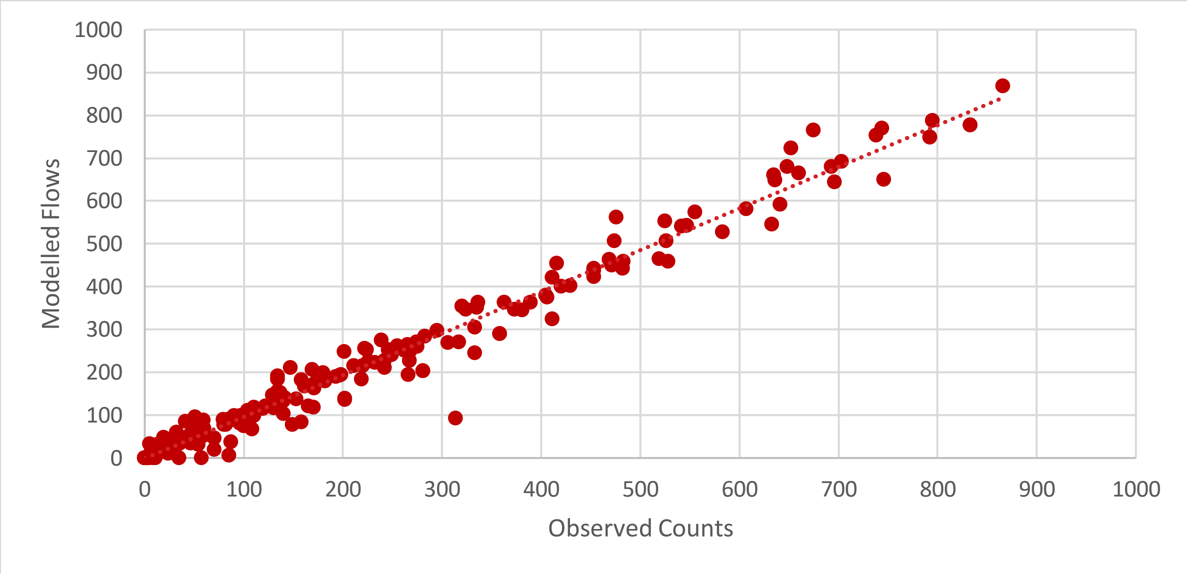
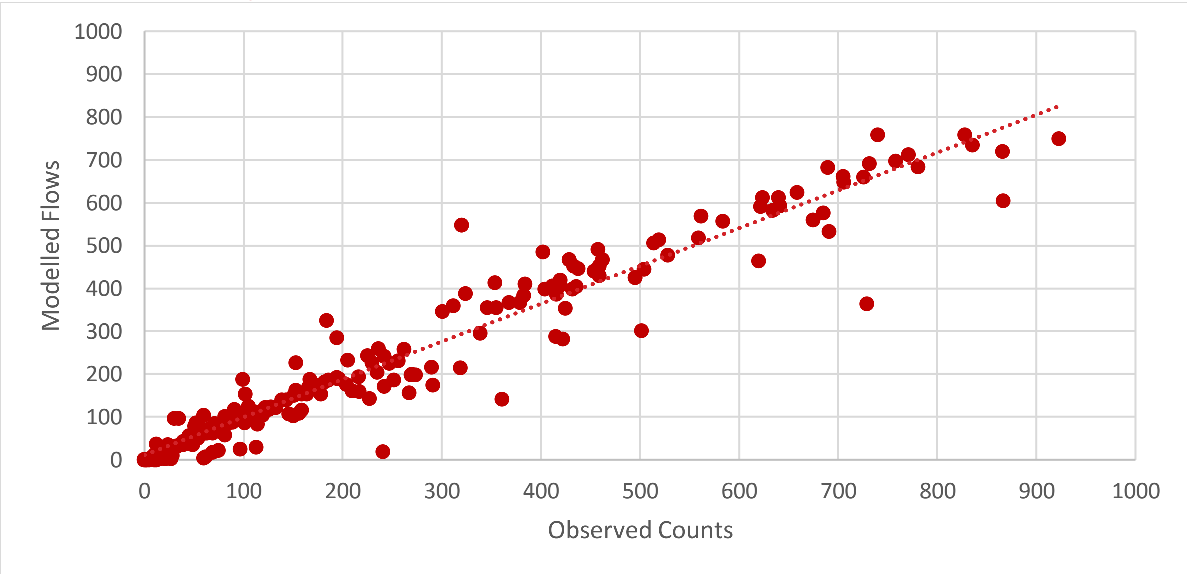


Figure 14. Castlebar PM Calibration – Modelled vs Actual Flows



Comparison with Automated Number Plate Recognition (ANPR) data

7.2.4 ANPR data was collected by TRACSIS on 25th of November 2021 between 7am and 7pm at 10 points, as shown in Figure 15. This was used to generate an observed "through traffic" matrix between these 10 zones for the AM (7-10am) and PM (4-7pm) periods.

7.2.5 An equivalent matrix of vehicular trips between these 10 LAM external zones was skimmed. The observed matrices were factored to convert the 3-hour period to a single hour, as in the LAM. Figure 16 & Figure 17 compare the top ten OD-pairs observed and modelled demand in the AM and PM periods. It can be seen from the figure that the major external-to-external movements in the LAM matches the ANPR data quite well.

Figure 15. ANPR Survey Sites

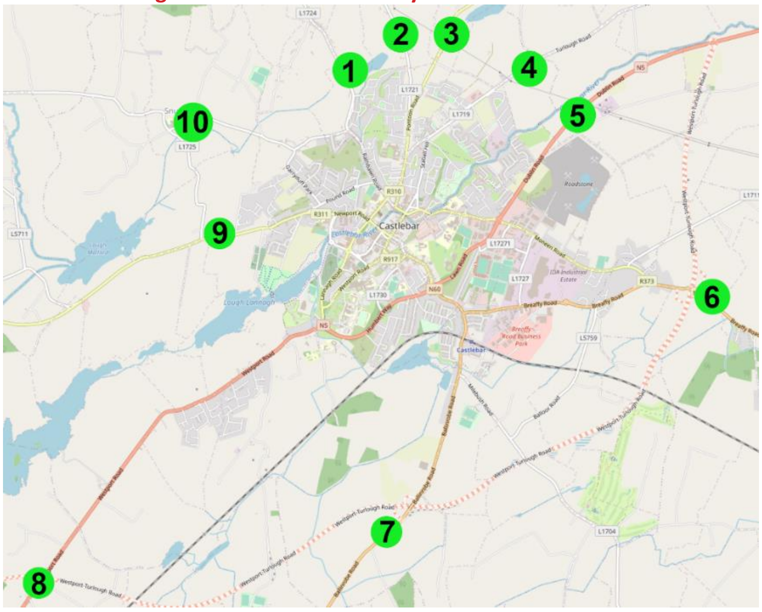


Figure 16. ANPR / LAM Comparison: AM

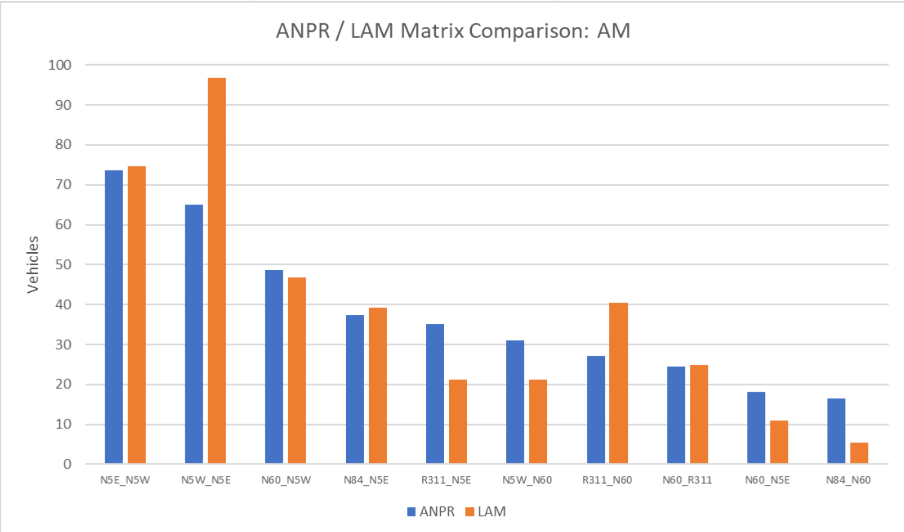
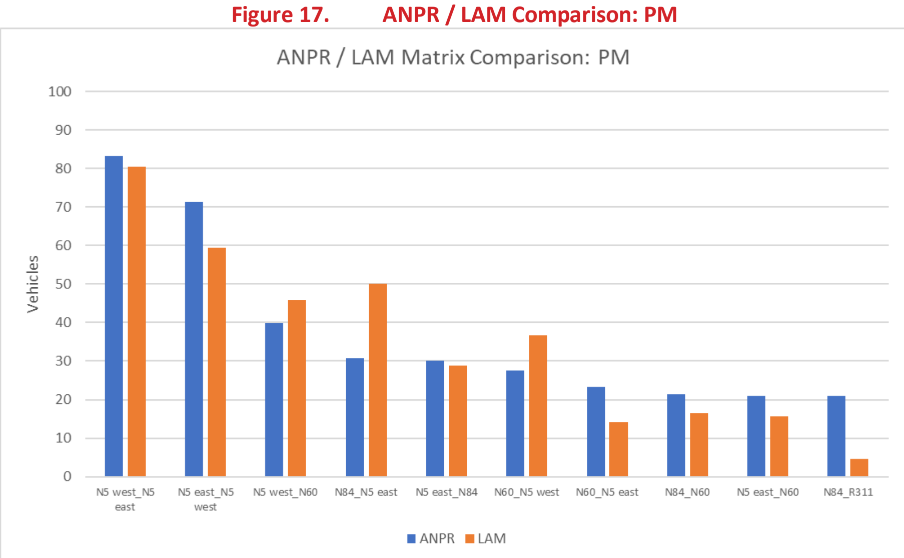


Figure 17. ANPR / LAM Comparison: PM



7.3 Journey Time Validation

7.3.1 As outlined in Section 7.1, Table 3, 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. Table 5 below details the overall results for the cumulative route totals and the individual timing sections for the coloured journey time routes shown in Figure 4. The results show a good match to TII guidelines, with 8 routes of 10 meeting the +/-15% observed criterion.

7.3.2 The Green Southbound route is not included in the validation table as modelled and observed distances differ significantly (28%). Clarifications are currently pending with the project survey team in relation to these differences.

Table 5. Journey Time Validation

PERIOD	ROUTE	DISTANCE (m)			TIME (s)			TII Criteria
		Obs	Mod	%Diff	Obs	Mod	%Diff	
AM	Blue Eastbound	8,948	9,096	2%	636	651	2%	ok
AM	Blue Westbound	8,900	9,070	2%	641	650	1%	ok
AM	Green Northbound	6,915	6,842	-1%	948	879	-7%	ok
AM	Green Southbound	9,086	6,552	-28%	817	736	-10%	-
AM	Yellow Eastbound	6,090	6,141	1%	693	784	13%	ok
AM	Yellow Westbound	6,064	6,089	0%	732	786	7%	ok
PM	Blue Eastbound	8,948	9,096	2%	779	696	-11%	ok
PM	Blue Westbound	8,900	9,070	2%	859	665	-23%	No
PM	Green Northbound	6,915	6,842	-1%	954	959	1%	ok
PM	Green Southbound	9,086	6,552	-28%	1,222	861	-30%	-
PM	Yellow Eastbound	6,090	6,141	1%	727	870	20%	No
PM	Yellow Westbound	6,064	6,089	0%	834	921	10%	ok

7.4 Calibration and Validation Summary

7.4.1 This chapter provides an overview of the calibration and validation of the Castlebar local area traffic model. In summary:

- The NTA WRM was used as a basis for development of Castlebar local area traffic model with additional network and zonal detail added to more accurately represent localised traffic movements;
- The model has been calibrated and validated in-line with TII Project Appraisal Guidelines and meets all specified criteria for both the AM and PM;
- The LAM is fit for purpose, and represents AM and PM peak period base year traffic conditions well, as demonstrated statistically through calibration and validation.
- It provides a robust basis for assessing transport scheme options as:
  - The model realistically represents journey times; and
  - The modelled traffic flows match observed count data.

8. PANDEMIC TRAVEL RESTRICTIONS CONSIDERATION

8.1 Introduction

8.1.1 Recommendations to limit movements and encouragements to work from home if possible were in place at the time the traffic survey was made (November 2021).

8.1.2 Traffic volumes and patterns were obviously impacted by these travel restrictions. We analysed historical data from TII automated counters in the area to quantify the impacts the restrictions has on traffic at the time of the survey.

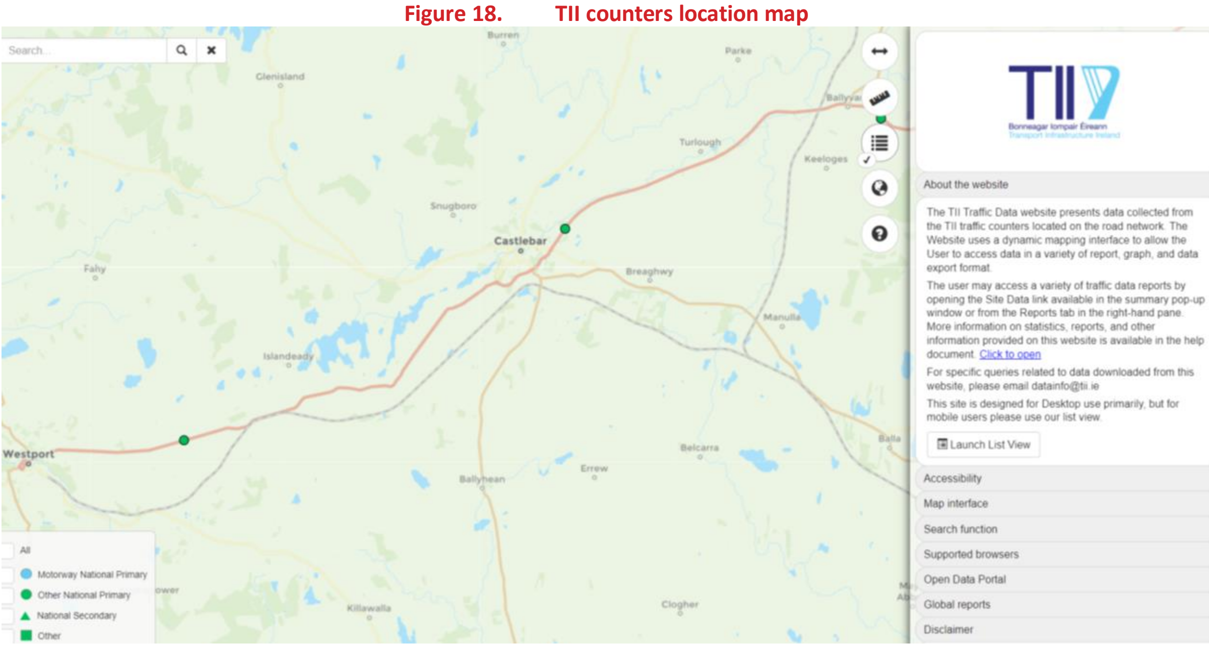
8.2 TII counters analysis

8.2.1 The following two TII traffic counters were included in the analysis:

- TMU N05 130.0 E - N05 Between Turlough and Castlebar
- TMU N05 110.0 W - N05 Between Westport and Castlebar

8.2.2 Map below shows their location on a map. Both are recording N5 traffic on either side of Castlebar.

Figure 18. TII counters location map



8.2.3 We extracted traffic data for the same period of the year (last 2 weeks in November) in 2018, 2019 and 2021. Comparing 2021 traffic to the average 2018-2019 traffic allows us to estimate what the traffic would have been in "normal" conditions at the time of the survey.

Table 6. TII counters observed flows

	Average weekday 08:00-9:00				Average weekday 17:00-18:00			
Description	2021	2019	2018	**2021 Vs. Av (2018-2019)**	2021	2019	2018	**2021 Vs. Av (2018-2019)**
N05 Between Turlough and Castlebar	1,114	1,196	1,170	**-6%**	1,133	1,226	1,226	**-8%**
N05 Between Westport and Castlebar	813	896	876	**-8%**	809	910	889	**-10%**

8.3 Outcome

8.3.1 The TII counters analysis shows that traffic in 2021 at the time of the survey was lower than it was in 2018 and 2019 over the same period.

8.3.2 For consistency, the 2021 LAM has been calibrated using non-modified observed data from the survey. To test scenarios in the LAM it is however recommended to factor the demand to represent normal traffic conditions, without the travel recommendations that where in place at the time of the survey.

8.3.3 For the Castlebar LAM, 2021 calibrated demand matrices should be factored by:

- 1.07 (i.e. +7%) in the AM
- 1.09 (i.e. +9%) in the PM

9. N5 WESTPORT TO TURLOUGH ROAD PROJECT

9.1 Introduction

9.1.1 The proposed N5 Westport to Turlough project (refers as the N5 road project onwards) stretches from northwest of Westport in the townland of Deerpark East to a point East of Castlebar in the townland of Ballyneggin. The design of the proposed N5 mainline is a Type 2 Dual Carriageway with major junctions proposed at the intersection of the N59, existing N5, N84 and N60.

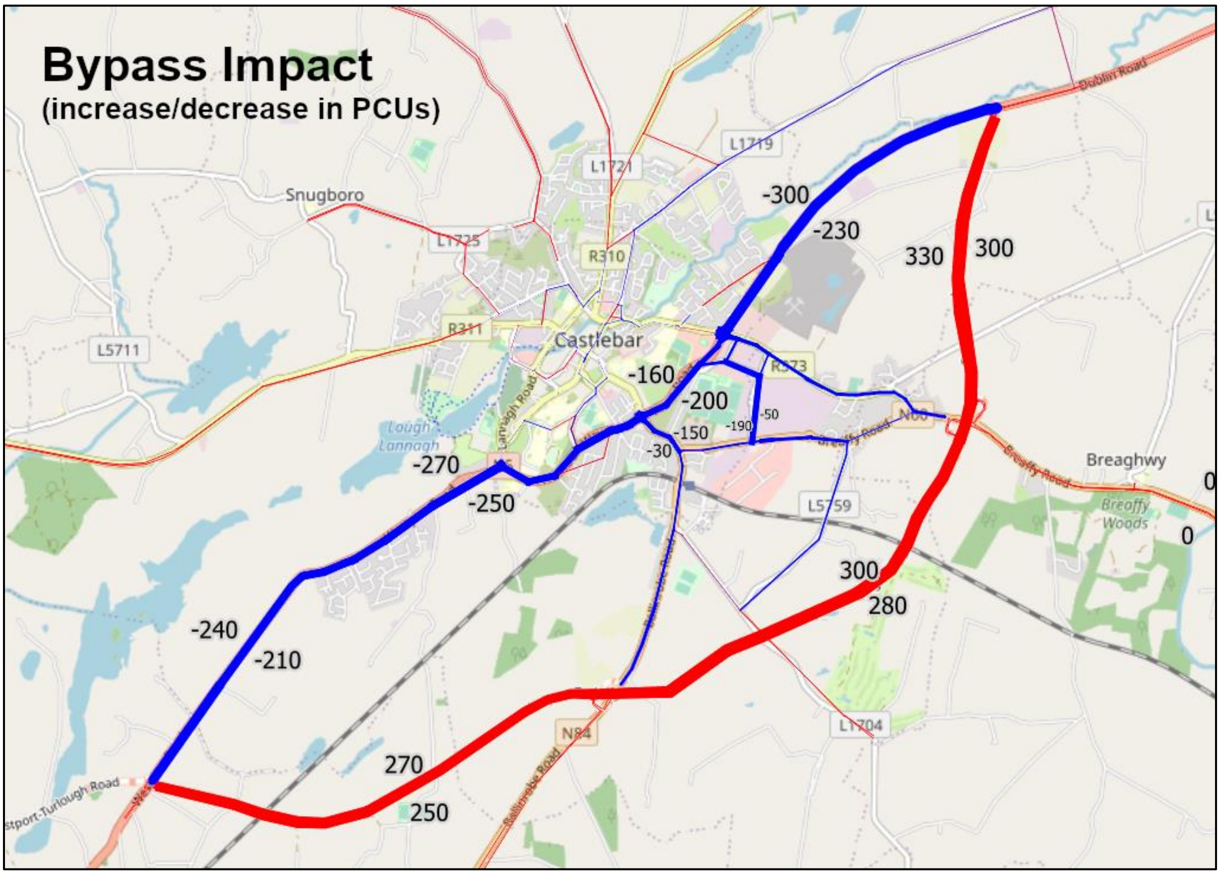
9.2 Modelling the N5 road project in Castlebar LAM

9.2.1 The N5 road project has been coded in the LAM as per available design maps. The calibrated 2021 LAM AM road demand has been assigned to a scenario “with the N5 road project” to estimate traffic redistribution in the Castlebar area.

9.2.2 The map below shows a flow difference plot between a scenario with the N5 road project and without. The model predicts circa 300 pcu/h per direction on the new road. It is worth noting the following observations:

- 2021 calibrated demand is slightly lower than a “normal” period – See section 8
- Assigned demand doesn’t include any long distance rerouting as limited to LAM perimeter

Figure 19. AM Flow difference with/without N5 road project



10. CONCLUSION

10.1.1 The Castlebar LAM is a robust tool representing traffic in the study area in greater details. Two time periods are considered and both validate well against observed data.

10.1.2 The impacts of the pandemic-related travel restrictions have been assessed and quantified. The 2021 calibrated demand can be adjusted to represent more "normal" traffic conditions.

10.1.3 The N5 Westport to Turlough road project, due to open in 2022/2023, has been coded and tested in the LAM. Due to the near-completion of this scheme, it should be included in any scenario testing.

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