Bonneagar Iompair Éireann
Transport Infrastructure Ireland

AECOM

NATIONAL TRANSPORT MODEL UPDATE DATA COLLECTION REPORT

NTpM Volume 2
December 2019

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1 Introduction

1.1 Overview

In order to provide all the relevant detail of the Transport Infrastructure Ireland (TII) National Transport Model (NTpM) in a clear and concise manner the documentation for the NTpM is split into four volumes as follows:

- NTpM Volume 1 – **Model Development Report** – Provides the background to the NTpM and outlines the development, calibration and validation of the modules of the NTpM;
- NTpM Volume 2 – **Data Collection Report** – Presents details of the data and data sources used to update and enhance the NTpM;
- NTpM Volume 3 – **Travel Demand Forecasting Report** – A detailed discussion on the background data and methodologies used to inform the estimates of future travel demand in the NTpM is presented in this report; and
- NTpM Volume 4 – **Variable Demand Model Report** – The final report provides the details on the background, development and function of the variable demand model.

This report, which is referred to as the Data Collection Report, forms Volume 2 of the NTpM suite of supporting documentation.

1.2 Model Structure

The NTpM is made up of several sub-models, each having its own unique inputs and structure:

- Demographic models are developed to estimate future year population, employment and jobs projections for each zone in the NTpM;
- Car Ownership models forecast future year car ownership and car numbers for each zone in the NTpM based on the future year demographic and economic projections;
- A Freight model is used to estimate the increase in freight demand at a national level and then to allocate this growth to zones in the NTpM with specific freight related activity;
- The Trip Attraction Generation Model (TAGM) takes the outputs of the Demographic, Car Ownership and Freight models and converts them into origin and destination zone trip ends for each mode of transport;
- A Trip Distribution Model (TDM) is used to distribute the origin and destination trip ends totals between the various zones in the model. The TDM outputs demand matrices which present the origin and destination demand (by mode) between each zone in the NTpM;
- Assignment models (Traffic, Rail & Bus) are used to assign the demand for travel represented by the demand matrices to the transport network, generating travel costs (e.g. time, distance, tolls, fares) for each mode; and
- The role of the Variable Demand Model (VDM) is to assess, if required, the impact of a change in the transport network or change in the cost of travel (e.g. fuel costs, fares) upon the demand for travel. This is calculated by comparing the zonal travel costs from the assignment models between a Do-Minimum (without change) scenario and a Do-Something scenario (with change).

This structure of the model is shown in the diagram in Figure 1.1.

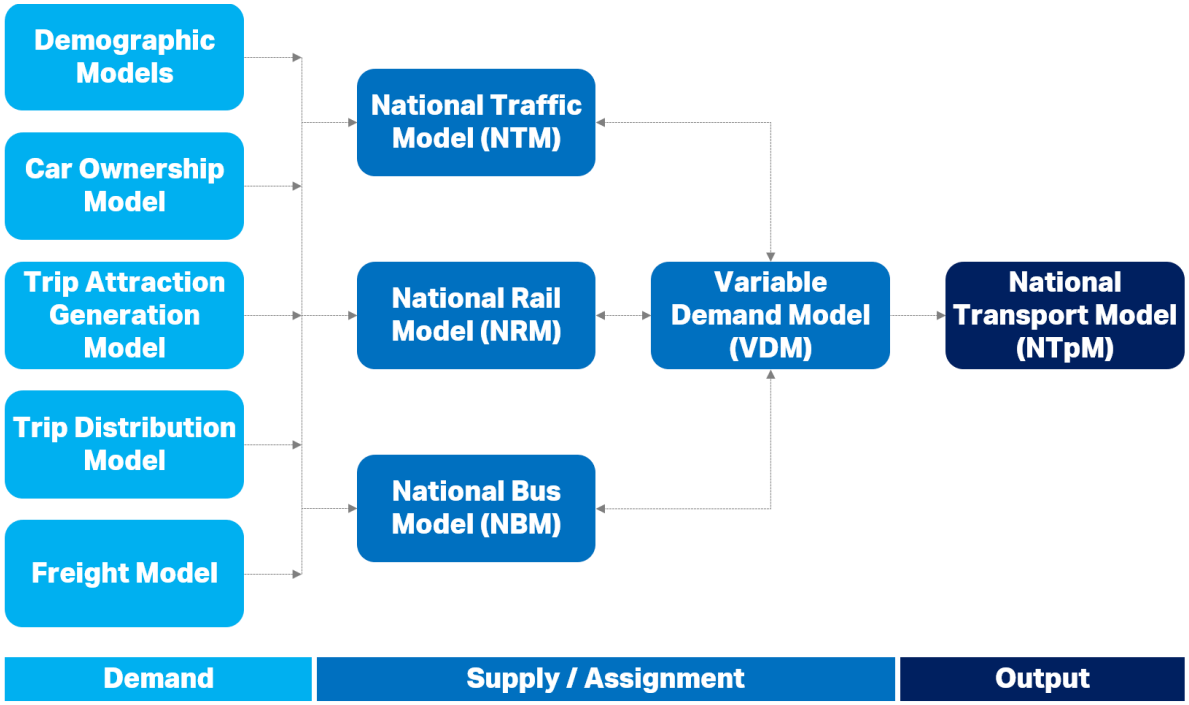

Figure 1.1. NTpM Basic Structure

1.3 Purpose of Report

This report provides details of the data that was used to inform the update of the various enhancements to the NTpM.

1.4 Structure of Report

The report is divided into a number of key chapters which discuss a core section of the model as follows:

- Network data;
- POWSCAR (Journey to work/education data);
- TII Traffic Monitoring Units;
- Heavy Goods Vehicles
- Special Zones (Ports & Airports);
- Journey time data;
- Northern Ireland Data;
- Rail data (inter urban); and
- Bus data (inter urban).

2 Network Data

2.1 Overview

As part of the NTpM update a review of the representation of the existing road, rail and bus networks was undertaken. Alongside the general need to update the networks to reflect conditions in 2016, to be in line with Census and POWSCAR data released that year, the review also identified ways to improve the representation of the networks to help better reflect the movement of trips. Details of the data used to update both the private and public transport networks are provided in this section of the report and are focused on the following areas:

- Zone Structure;
- Road Network;
- Rail Network; and
- Bus Network.

2.2 Zone Structure

2.2.1 Updating the NTpM Zone Structure

The existing NTpM was split into 1,077 transport zones (927 zones representing the Republic of Ireland and 150 zones representing Northern Ireland). To maintain compatibility with Central Statistics Office (CSO) Census data, the 3,440 Electoral Divisions[1] (ED) in the Republic were aggregated into the 927 NTpM zones. The 150 NTpM zones which represent Northern Ireland were based on an aggregation of the 582 Electoral Wards[2] in Northern Ireland.

The updated NTpM now contains a total of 1,129 transport zones (979 zones to represent the Republic of Ireland and 150 zones to represent Northern Ireland). Of the 979 zones in the Republic of Ireland, 21 are classified as Special Zones which represent the Tier 1 and Tier 2 Airports and Ports in the country, the remaining additional zones reflect the refinement of the NTpM zone structure along the M50 corridor in Dublin.

The updated NTpM offers differential treatment for special land-uses such as airports and ports (referred to as Special Zones), and as a result, they are separated from the wider, geographical zones in which they were located. Previously growth over time in demand to / from these zones was driven by the trip-end growth forecast based on the Demographic and Car Ownership forecasts and did not take account of specific forecasts for demand to / from airports and ports.

Compatibility with the NTA Regional Modelling System (RMS) was also another factor for reviewing the zone structure. The zone structure in the NTpM is based on CSO ED boundaries, while the zone structure in the NTA RMS is based on CSO Small Areas[3]. As Small Areas nest geographically within EDs, correspondence files were created between the NTpM and NTA

[1] There are 3,440 Electoral Divisions (EDs) which are the smallest legally defined administrative areas in the State. One ED, St. Mary's, straddles the Louth-Meath county border, and is presented in two parts in the SAPS tables, with one part in Louth and the other in Meath. There are 32 EDs with low population, which for reasons of confidentiality have been amalgamated into neighboring EDs giving a total of 3,409 EDs which appear in the SAPS tables.

[2] https://www.nisra.gov.uk/support/geography Electoral Wards in Northern Ireland as per 1992 Boundaries

[3] Small Areas are areas of population generally comprising between 80 and 120 dwellings created by The National Institute of Regional and Spatial Analysis (NIRSA) on behalf of the Ordnance Survey Ireland (OSi) in consultation with CSO. Small Areas were designed as the lowest level of geography for the compilation of statistics in line with data protection and generally comprise either complete or part of townlands or neighborhoods. There is a constraint on Small Areas that they must nest within Electoral Division boundaries

RMS to allow direct comparisons with respect to input (e.g. planning data) and output data (e.g. future transport demand, mode share etc.). Furthermore, the special zones in the NTpM align with similar special zones in the NTA RMS.

The zone structure of the 2016 NTpM, as updated, is provided in Figure 2.1.

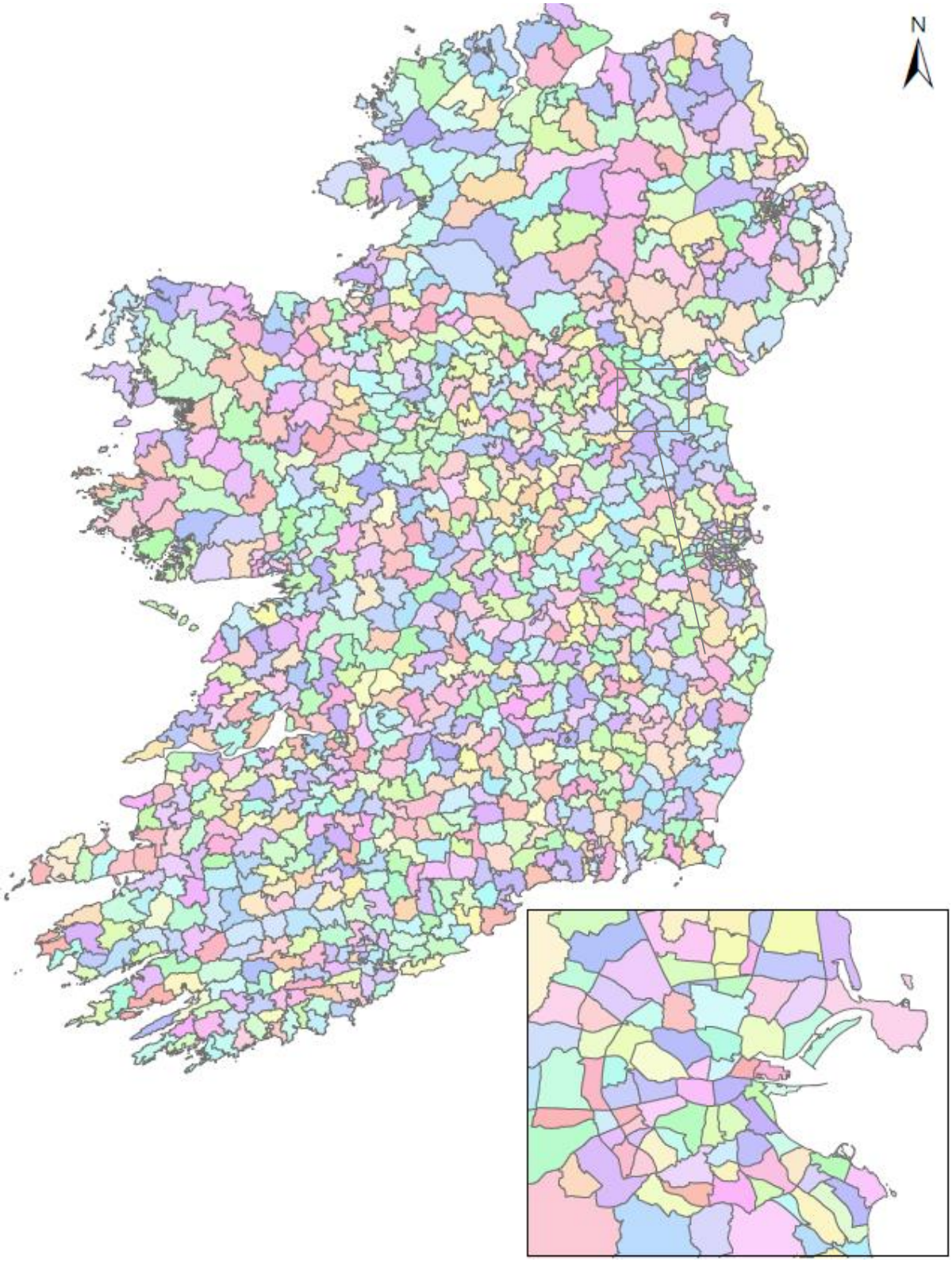

Figure 2.1: 2016 National Transport Model Zone Structure

2.2.2 Identification and Representation of Special Zones

The following Special Zones were identified and updated in the NTpM:

- Dublin Airport;
- Dublin Port;
- Dun Laoghaire Port;
- Rosslare Europort;
- Cork Ringaskiddy Port;
- Dundalk Port;
- Foynes Port;
- Galway Port.
- Cork Airport;
- Shannon Airport;
- Knock Airport;
- Waterford Belview Port; and
- Cork Tivoli Docks.

Table 2.1 provides a summary of the number of zones in each urban before and after the zone splitting process.

Table 2.1. Refinement of NTpM Zone Structure

Area	Previous Number of Zones	New Number of Zones
Dublin Airport	3	12
Dublin Port	2	4
Dun Laoghaire Port	1	2
Rosslare Europort	1	2
Ringaskiddy Port	1	4
Dundalk Port	1	2
Foynes Port	1	2
Galway Port	1	2
Cork Airport	1	2
Shannon Airport	1	2
Knock Airport	1	2
Belview Port	1	2
Cork Tivoli Docks	1	2
TOTAL	16	40

2.2.3 Example of Zone Disaggregation – Dublin Port

Dublin Port was represented within the previous NTpM as Zone 8193 (North Port) and Zone 8501 (South Port). The old NTpM Zone 8193 was split in two in order to isolate the North Port as Zone No. 81931, while the old NTpM Zone 8501 was split in two in order to isolate the South Port as Zone No. 85011 as illustrated in Figure 2.2.

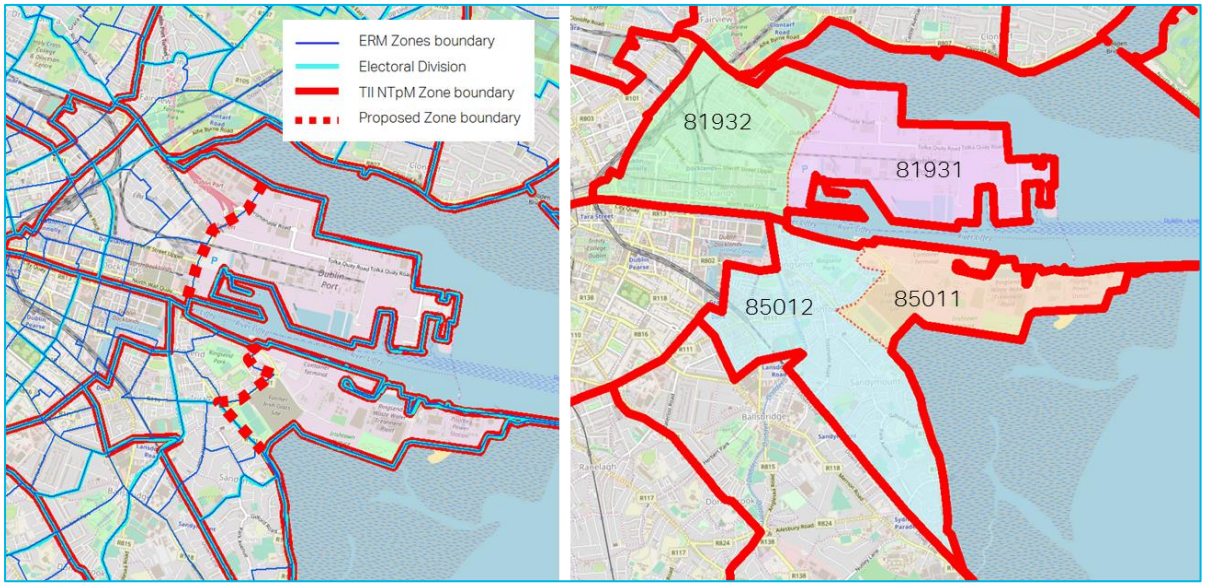

Figure 2.2: Disaggregation of prior NTpM Zones 8193 and 8501 (Dublin Port)

2.3 Road Network

2.3.1 Overview

The following sections provide an overview of the enhancements made to the representation of the road network in the NTpM, including details of the data used to inform the update and the outline methodology adopted.

2.3.2 Road Alignment & Road Classifications

The existing road network in the NTpM was checked against Open Street Map (OSM) data which was obtained for the following road classifications:

- Motorway;
- National Primary;
- National Secondary; and
- Regional.

The OSM links are shown in Figure 2.3.

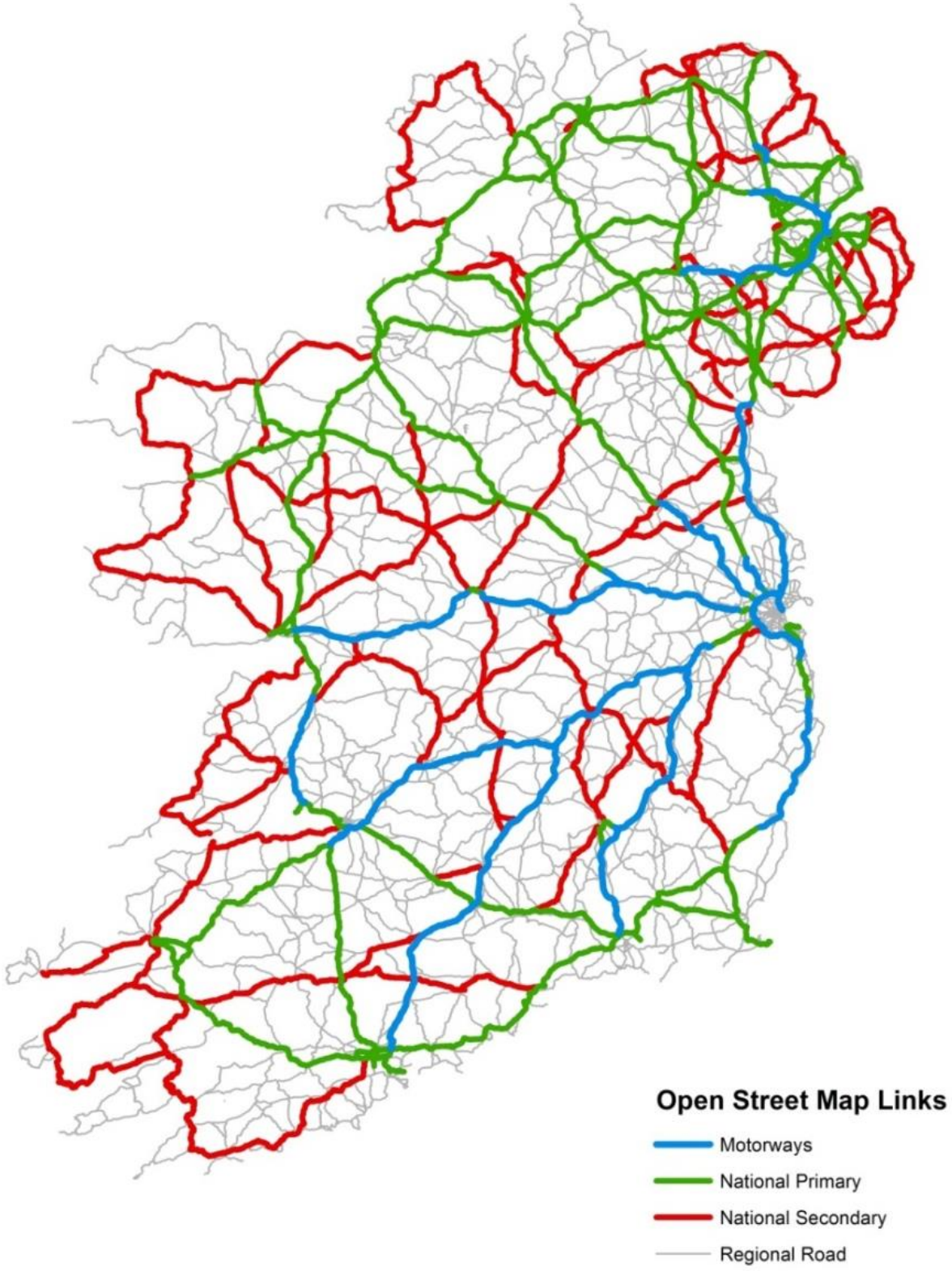

Figure 2.3: Open Street Map Links by Road Classification

2.3.3 Network Update Methodology

By exporting the VISUM road network into GIS (as a shapefile for each road classification) and overlaying the OSM data, gaps were identified between the VISUM and OSM alignments or road classification. Where required, alignments were updated to be consistent with OSM.

2.3.4 Speed Flow Curves

TII operates and maintains a network of over 370 permanent traffic counters know as Traffic Monitoring Units (TMUs), which have been in operation since 2013 and provide TII with a historic and realtime dataset of traffic volumes and speeds per lane and by direction of travel across the National Road network.

The availability of observed Speed-Flow data from the network of TII TMUs allowed for the refinement of the existing Speed Flow Curves (SFCs) used in the NTpM. The Speed-Flow data from each of the TMU sites over a full year (2016) was utilised as part of the refinement of the existing SFCs used in the NTpM in order to better represent delay in the model across the National Road network.

The SFCs used in the NTpM are based on the Bureau of Public Roads (BPR) function. The function is defined as follows:

$$t_{cur} = t_0 * (1 + (a * sat^b))$$

$$sat = \frac{q}{q_{max} * c}$$

$$where\ t_{cur} = travel\ time, t_0 = free\ flow\ travel\ time,$$

$$q = flow, q_{max} = capacity\ and\ a, b\ and\ c\ are\ user - defined\ paramteres$$

Where:

t_{cur} = current speed (kph) on the link in loaded network.

t_0 = free flow speed (kph) on the link (i.e. speed limit).

q = flow and a, b, c and d are user defined parameters.

A number of Python scripts were used to extract the Speed-Flow data from every TII TMU site, process and clean the data and then estimate the BPR user defined parameters for each TMU site by direction.

The example plot shown in Figure 2.4 illustrates the relationship between flow per lane and speed for TMU Site 1113 (M11) in the northbound direction. The black line shows the BPR curve produced by the Python Script.

Figure 2.5 shows the scatter plot of all observations at Site 1113 prior to the calculation of mean speed for each site by 10 vehicle band to remove scatter from the plots, in order to fit a curve.

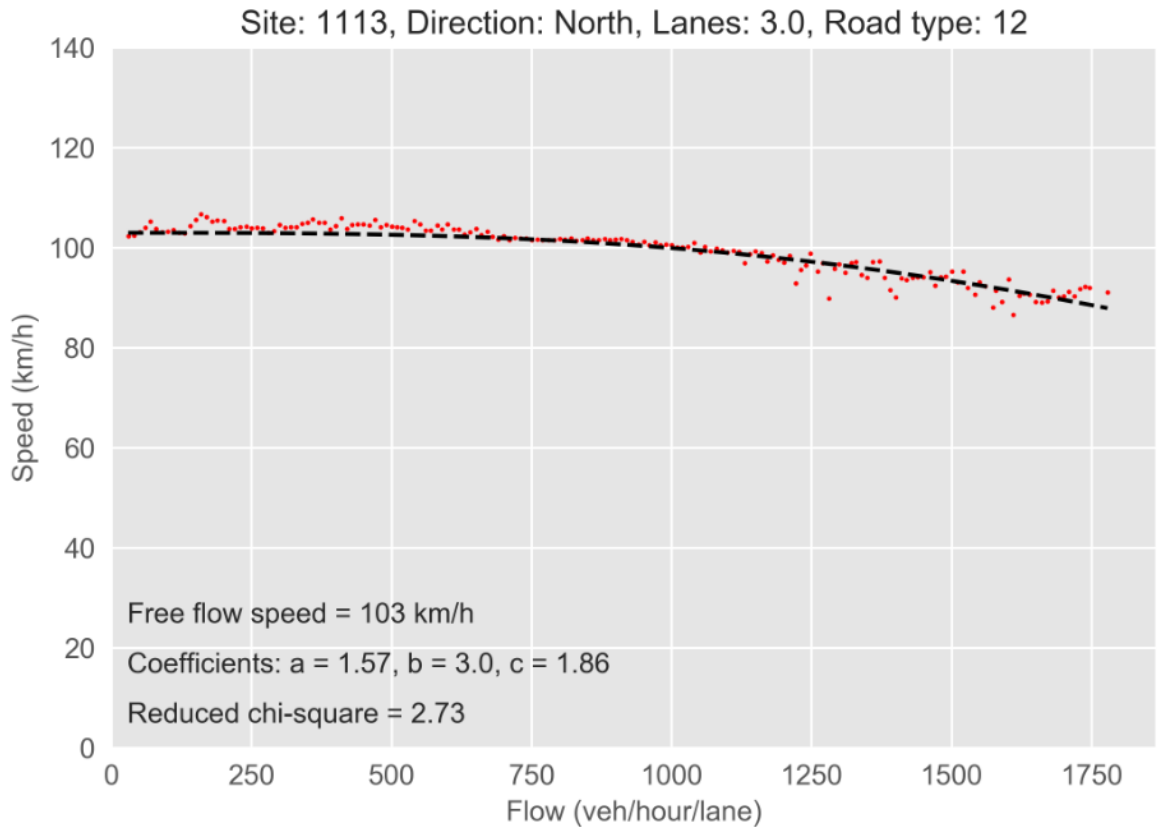

Figure 2.4: Sample Curve produced by Python Script (TMU Site 1113 – Northbound)

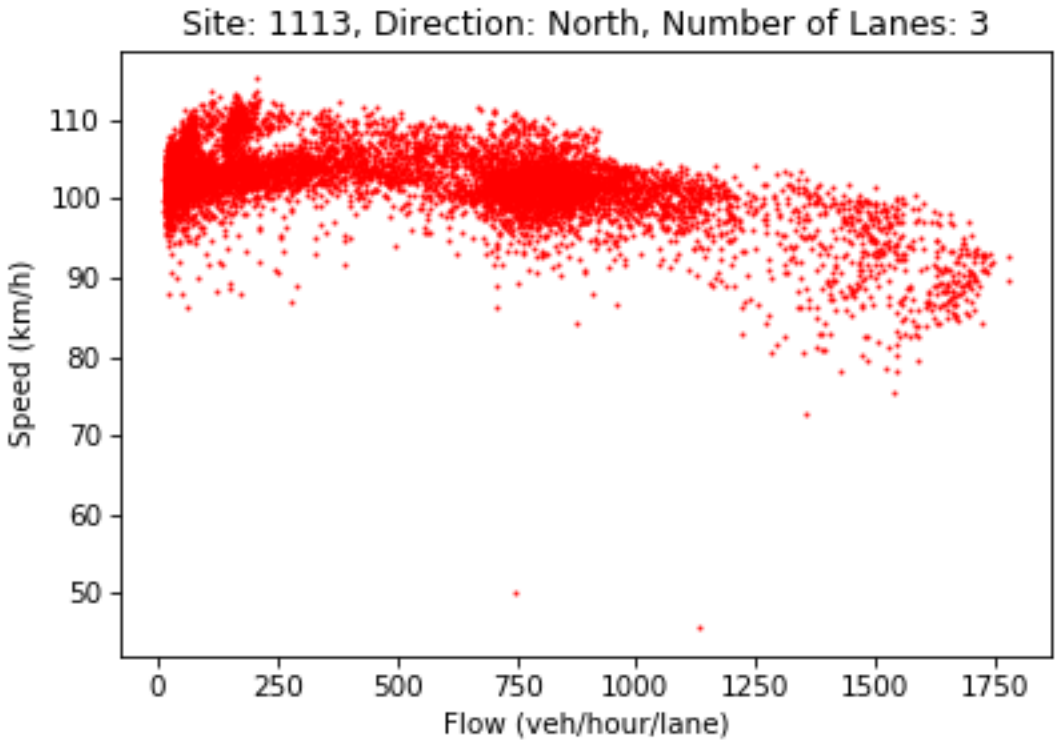

Figure 2.5: Scatter Plot produced by Python Script (TMU Site 1113 – Northbound)

As the NTpM can only apply one volume–dealy function for each link type rather than each link, average BPR curves aggregated by link type were developed for use in the NTpM. Figure 2.6 show the scatter plot genertaed for Road Type 10 (2 lane motorway – 120kph) which is based on observed data from 43 TMU sites located throughout the National Road network. Figure 2.7 shows the corresponing BRP curve generted by Python for use in the NTpM.

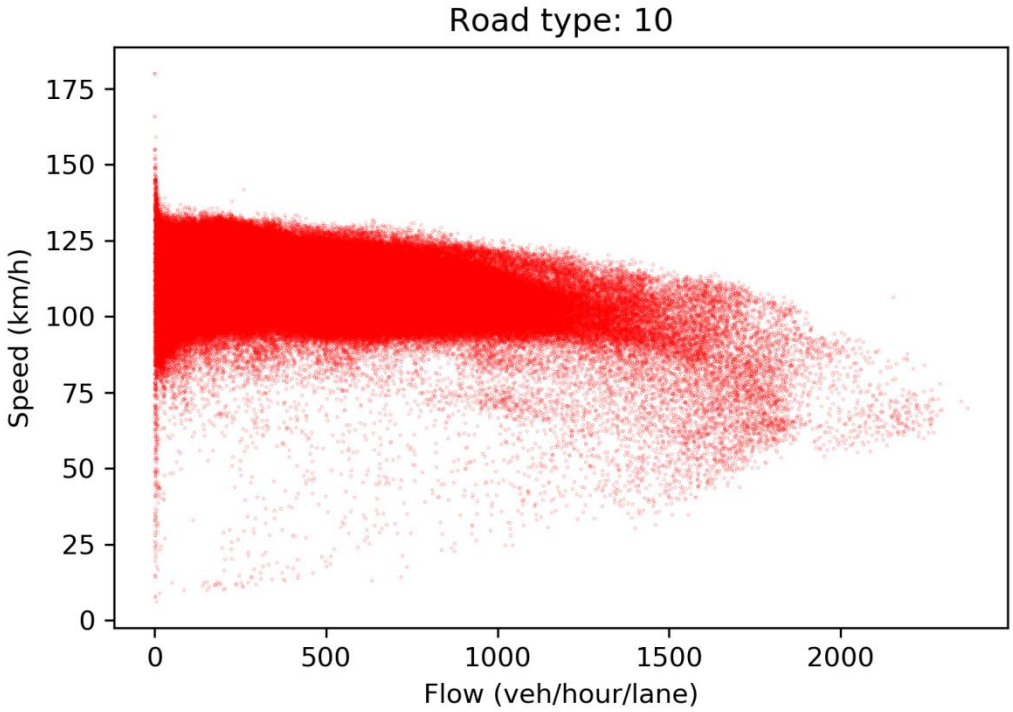

Figure 2.6: Scatter Plot produced by Python Script (All 2 lane motorways – 120kph)

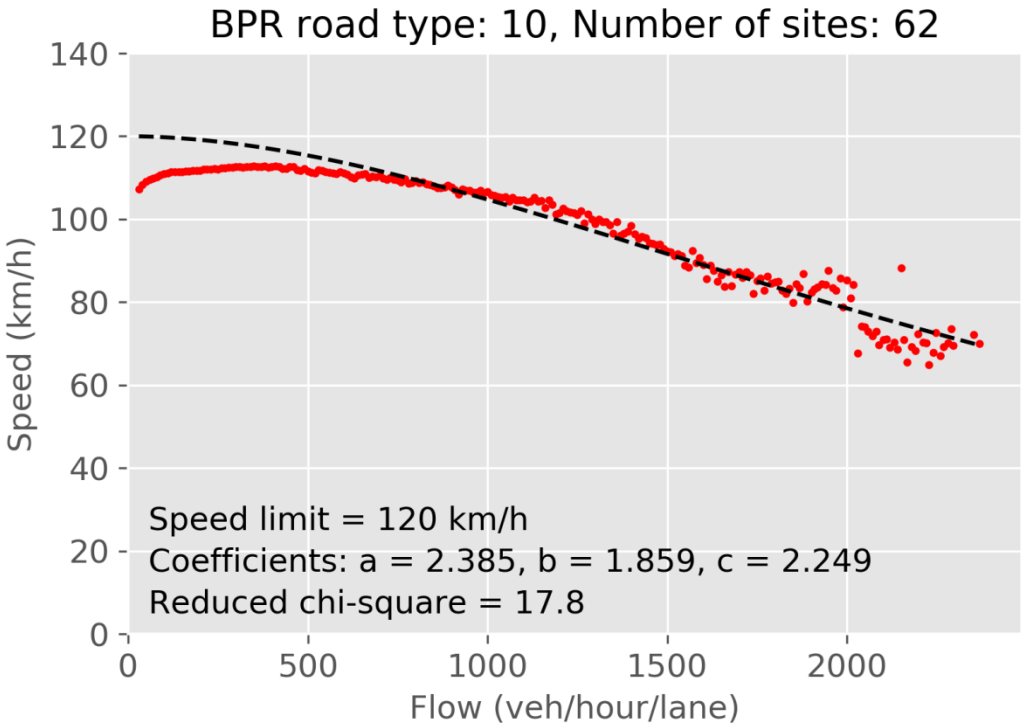

Figure 2.7: BPR Curve produced by Python Script (All 2 lane motorways – 120kph)

BPR curves were devleoped for each Road Type in the NTpM based on the aggreagted data from TMU sites. Table 2.2 provides a breakdown of the Road Types in the NTpM and the number of TMU sites used to inform the calculation of the BPR curve.

Table 2.2. NTpM Road Types and Observed TMU Sites

NTpM Road Type No.	Road Type	Speed Limit (kph)	No. of TMUs
10	Two-Lane Motorway - Rural	120	43
10	Two-Lane Motorway - Urban	120	24
12	Three-Lane Motorway	100	5
13	Three-Lane Motorway	80	1
14	Four-Lane Motorway	100	9
20	Type 1 Dual Carriageways - Rural	100	9
21	Type 2 Dual Carriageways	100	1
22	Type 3 Dual Carriageways (two-lane sections)	100	2
23	Type 3 Dual Carriageways (one-lane sections)	100	2
24	Urban Three-Lane Dual Carriageways	100	5
25	Urban Dual Carriageways	60	2
26	Urban Three-Lane Dual Carriageways	80	3
27	Type 1 Dual Carriageways – Urban	100	8
30	High Standard Single Carriageways – Rural	100	40
31	High Standard Single Carriageways – Urban	100	7
32	Regular Standard Single Carriageways	100	16
33	Low Standard Single Carriageways	100	12
34	Regional Single Carriageways	80	9
50	Urban Single Carriageways (NP)	50	5
51	Urban Dual Carriageways (NP)	60	2
53	Urban Single Carriageways (NS)	50	3
54	Urban Dual Carriageways (NS)	60	2
56	Urban Regionals	50	2
94	Route Quality Index 1-3	91	24
95	Route Quality Index 4-6	85	31
96	Route Quality Index 7-10	80	12
97	Route Quality Index 11-13	70	2
98	Route Quality Index 14-16	60	3

2.3.5 Link Capacities

Data from the TMU observations was used to identify the capacity values (qmax) to apply to each Road Type in the NTpM. The values are presented in Table 2.3 in terms of Passenger Car Unit (PCU).

Figure 2.6: Scatter Plot produced by Python Script (All 2 lane motorways – 120kph) above shows the combined scatter plot for Road Type 10 (i.e. 2 lane Motorway – 120kph) and shows that flow breakdown occurs at approximately 1900 vehicles per lane per hour (2100 PCU) assuming a 5% HGV content and HGV PCU factor of 3.

Table 2.3. NTpM Road Types and Link Capacities

NTpM Road Type No.	Road Type	Link Capacity per lane (PCU)	Total PCU Capacity
10	Two-Lane Motorway (120kph) – Rural	2100	4200
11	Two-Lane Motorway (120kph) - Urban	2100	4200
12	Three-Lane Motorway (100kph)	2100	6300
13	Three-Lane Motorway (80kph)	2100	6300
14	Four-Lane Motorway (100kph)	1950	6825[4]
20	Type 1 Dual Carriageways - Rural	1950	3900
21	Type 2 Dual Carriageways	1750	3500
22	Type 3 Dual Carriageways (two-lane sections)	1750	3500
23	Type 3 Dual Carriageways (one-lane sections)	1750	1750
24	Urban Three-Lane Dual Carriageways	2100	6300
25	Urban Dual Carriageways	2100	4200
26	Urban Three-Lane Dual Carriageways	1950	5850
27	Type 1 Dual Carriageways - Urban	1950	3900
30	High Standard Single Carriageways – Rural	1600	1600
31	High Standard Single Carriageways – Urban	1600	1600
32	Regular Standard Single Carriageways	1500	1500
33	Low Standard Single Carriageways	1300	1300
34	Regional Single Carriageways	1200	1200
50	Urban Single Carriageways (NP)	1200	1200
51	Urban Dual Carriageways (NP)	1600	1600
53	Urban Single Carriageways (NS)	1200	1200
54	Urban Dual Carriageways (NS)	1600	1600
56	Urban Regionals	1000	1000
94	Route Quality Index 1-3	1200	1200
95	Route Quality Index 4-6	1000	1000
96	Route Quality Index 7-10	800	800
97	Route Quality Index 11-13	700	700
98	Route Quality Index 14-16	600	600

[4] *Four lane Motorway was coded along the M50 in the NTpM, however only half lane capacity was applied to the fourth lane, which is an auxiliary lane between M50 junctions, therefore total PCU capacity for 4 lane motorway is 6,825.*

2.3.6 Zone Connectors

The position of all zone connectors loading directly on to the National Road network were reviewed and amended to connect to the Regional Road network to closer reflect reality. This process was undertaken to remove unexplained changes in AADTs at some locations along National Roads. Figure 2.8 shows an example of a repositioned zone connector.

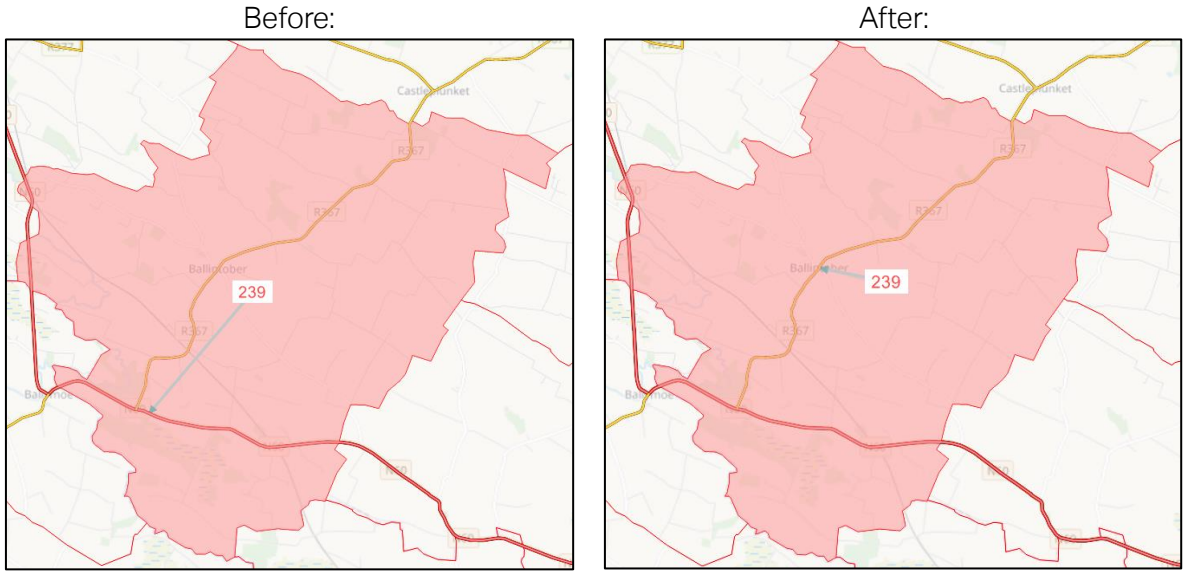

Figure 2.8: Repositioned Zone Connector

In cases where settlements are observed along a national road, zone connectors were relocated to load demand onto a local road linked to the National Road. Additional zone connectors were included where additional settlements are observed within the same zone.

2.3.7 Improved User Defined Attributes

The existing User Defined Attributes (UDA) in the NTpM were updated as required and new UDAs included as part of the update. A UDA provides road link or zone specific information such as the population of a zone or if a TMU is located on the section of road. Examples of updated/new UDAs in the NTpM is provide in the following sections.

Road Names

Road names were updated in the model using the 'Name' attribute. Motorways and National Primary Road names were updated, removing any re-classified roads. In total more than 20,000 names were added to the model.

TEN-T Road Network

A UDA, 'TENT_Network' was included for quick filtering of roads included as part of the Trans-European Transport Network (TEN-T). This allows the quality of roads to be checked against the requirements for the TEN-T road network, as well as for extracting outputs (e.g. for the TII National Road Indicators Report). The following values were applied for this attribute:

- TENT_Network = 1 (Core Network); and
- TENT_Network = 2 (Comprehensive Network).

The TEN-T Cork and Comprehensive networks are shown in Figure 2.9.

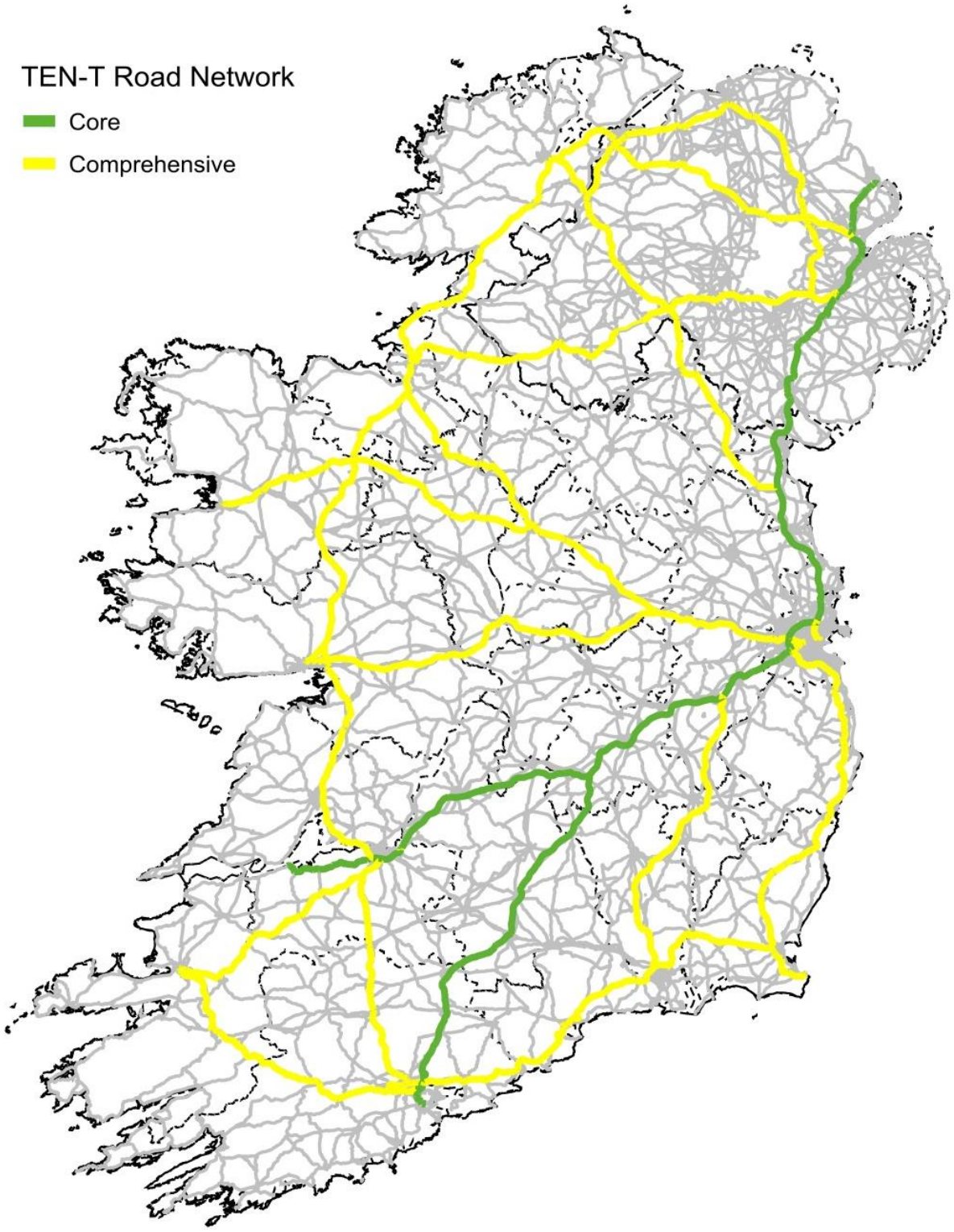

Figure 2.9: TEN-T Road Networks (Core & Comprehensive)

MMaRC Contract

The Motorway Maintenance and Renewals Contracts (MMaRC) is broken into three separate Networks as follows:

- Network A: Greater Dublin Area;
- Network B: Midlands/West of the country; and
- Network C: South and South East.

Values A, B or C were included for appropriate links under a new UDA "MMARC_C_19". The MMaRC networks are shown in Figure 2.10.

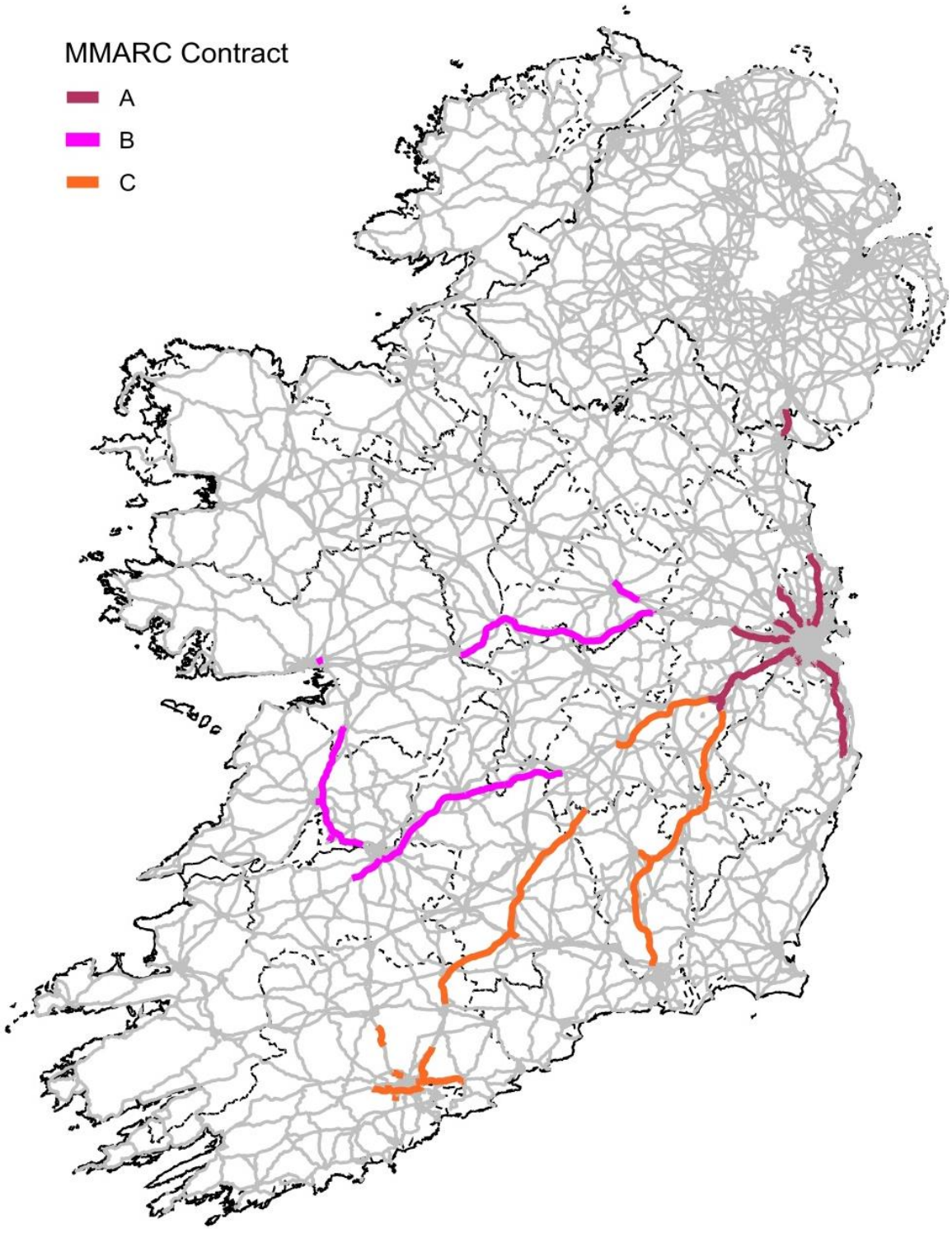

Figure 2.10: MMaRC Contract Roads

Updated Links and Connectors

A UDA, 'NetworkCheck_2016' was included to identify the Links and Connectors changed as part of the network update. This allowed for links and zone connectors to be filtered for review of the changes made since the last update of the NTM network in 2013 and to ensure that links are in the correct classification and zone connectors are connecting at the locations of settlements. Figure 2.11 shows the filtered links and zone connectors using the new 'NetworkCheck_2016' UDA.

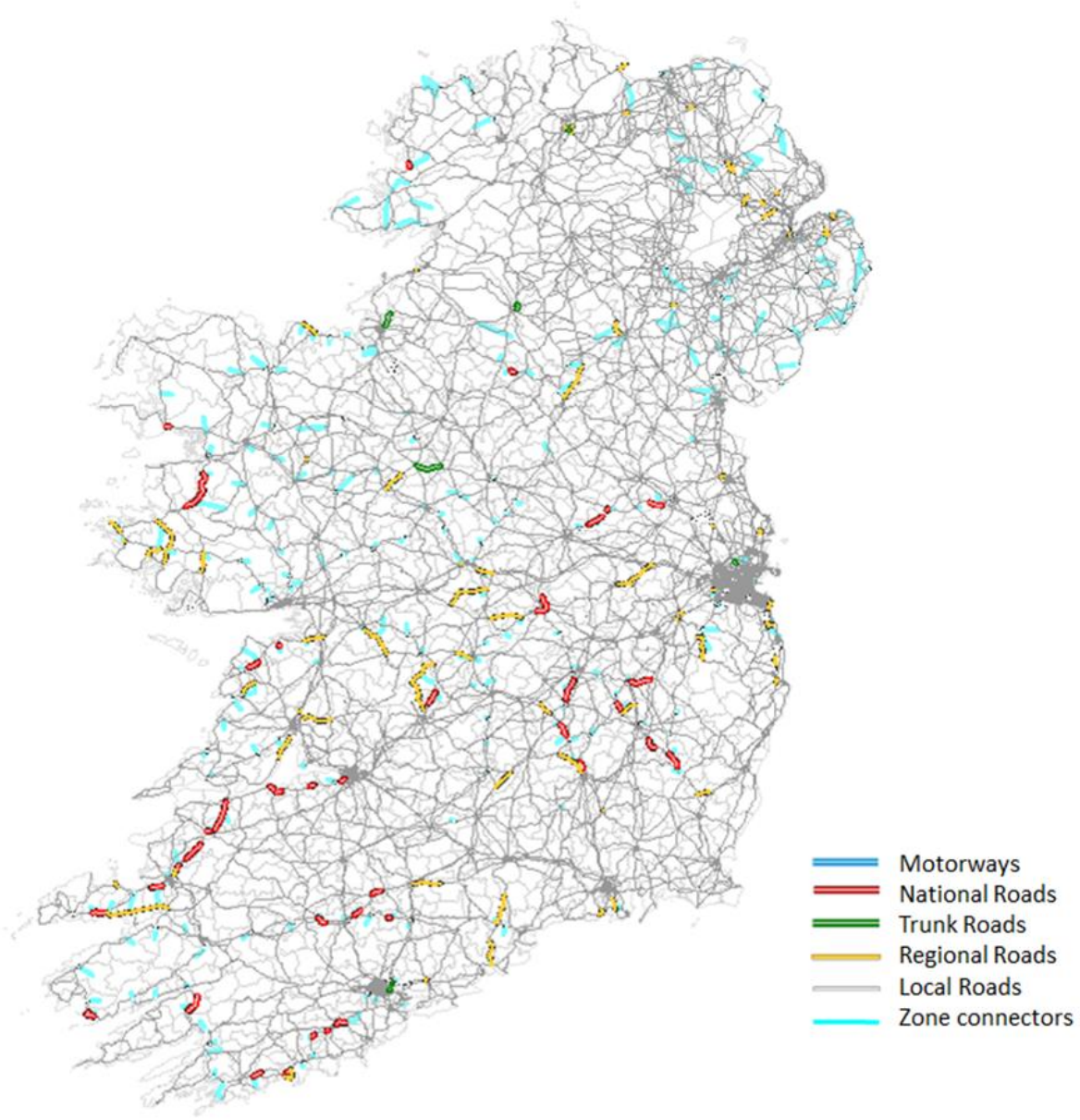

Figure 2.11: Filtered Links and Zone Connectors using 'NetworkCheck_2016' UDA

2.4 Rail Network

2.4.1 Sources of Rail Network Updates

The following sections provide an overview of the enhancements made to the representation of the Rail Network (Heavy Rail) in the NTpM. Figure 2.12 shows the extents of the rail network included in the NTpM.

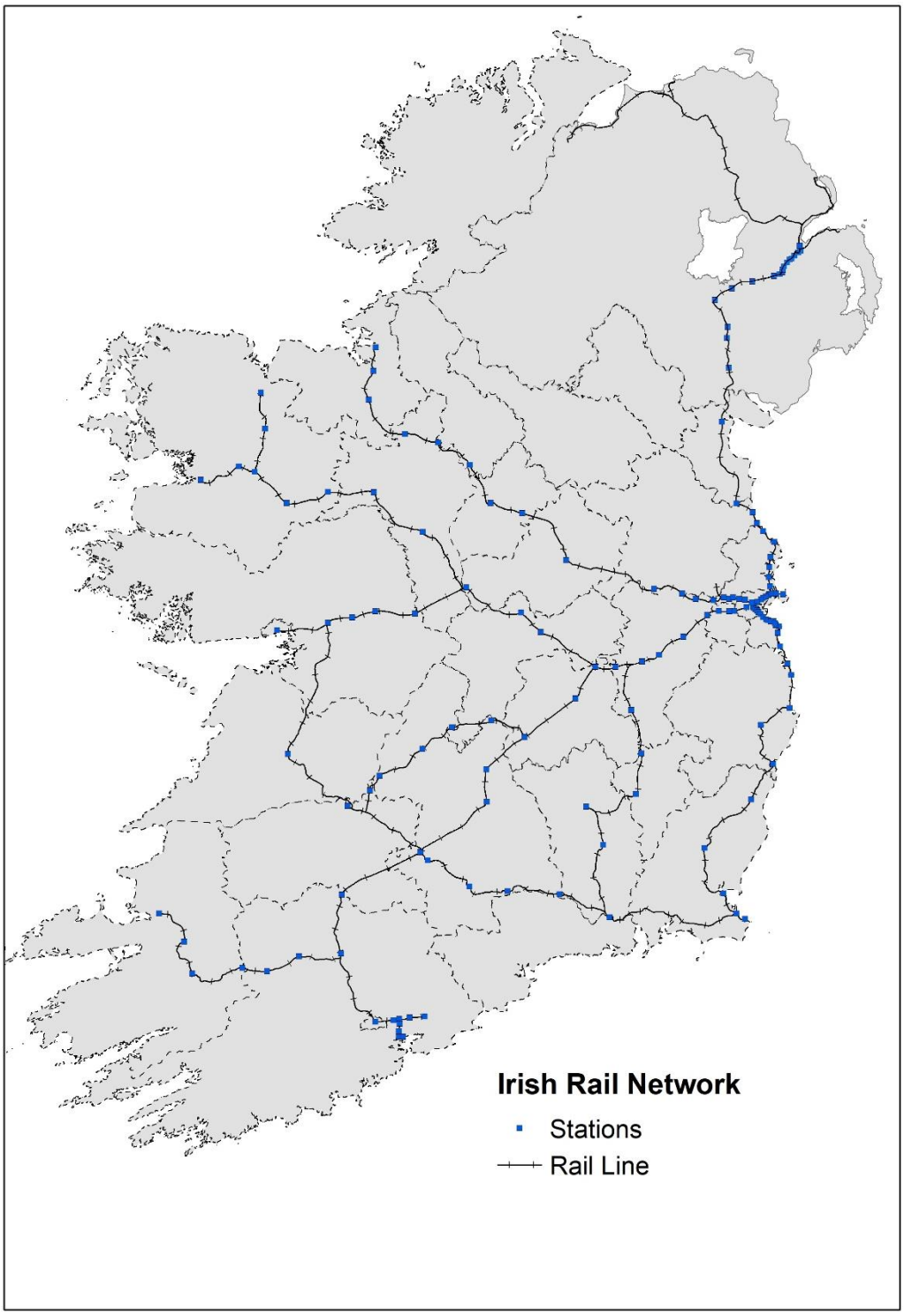

Figure 2.12: NTpM Rail Network (Heavy Rail)

2.4.2 Rail Network Update

The annual NTA Heavy Rail Census Report provided information on changes to the rail network, service plans and frequencies. The following changes have occurred to the heavy rail network since the last NTpM update:

- Hansfield Train Station (June 2013) opened on the Dublin Docklands - M3 Parkway line;
- Oranmore Train Station (July 2013) opened on the Dublin – Galway Intercity line; and
- Phoenix Park Tunnel was opened for passenger services (November 2016).

In addition, the following stations were added to the network in Northern Ireland:

- Bangor West; and
- Larne Town.

As part of the update the frequency of services along each of the various rail lines was updated to reflect the 2016 daily services as outlined in Table 2.4.

Table 2.4: Weekday Rail Service Frequency by Route (2016)

Service	Route	Weekday Frequency
Intercity	Dublin to Cork /Limerick Junc./Tralee	15
	Cork /Limerick Junc./Tralee to Dublin	16
	Dublin to Belfast	8
	Belfast to Dublin	8
	Dublin to Galway	9
	Galway to Dublin	10
	Dublin to Westport/Ballina	4
	Westport/Ballina to Dublin	5
	Dublin to Sligo	7
	Sligo to Dublin	7
	Dublin to Tralee	1
	Tralee to Dublin	1
	Dublin to Limerick	4
	Limerick to Dublin	3
	Dublin to Waterford	7
	Waterford to Dublin	7
	Dublin to Rosslare	4
	Rosslare to Dublin	4
	Limerick Junction to Waterford	2
	Waterford to Limerick Junction	2
	Galway to Limerick	4
	Limerick to Galway	5
Commuter	Dublin to Portlaoise	28
	Portlaoise to Dublin	32
	Dublin to Maynooth	40
	Maynooth to Dublin	40
	Dublin to Drogheda	32
	Drogheda to Dublin	32
	Dublin to Dundalk	14
	Dundalk to Dublin	16
	Cork to Mallow	24
	Mallow to Cork	24

Service	Route	Weekday Frequency
	Cork to Midleton	22
	Midleton to Cork	22
	Cork to Cobh	24
	Cobh to Cork	24
	Newbridge to Grand Canal Dock	5
	Grand Canal Dock to Newbridge	4
	Hazelhatch to Grand Canal Dock	7
	Grand Canal Dock to Hazelhatch	7
Dart	Malahide/Howth – Bray/Greystones	71
	Greystones/Bray – Howth/Malahide	72

2.5 Inter-Urban Bus Network

2.5.1 Sources of Bus Network Updates

The following sections provide an overview of the enhancements made to representation of the Inter-Urban bus networks in the NTpM. Figure 2.13 shows the extents of the inter-urban bus network included in the NTpM.

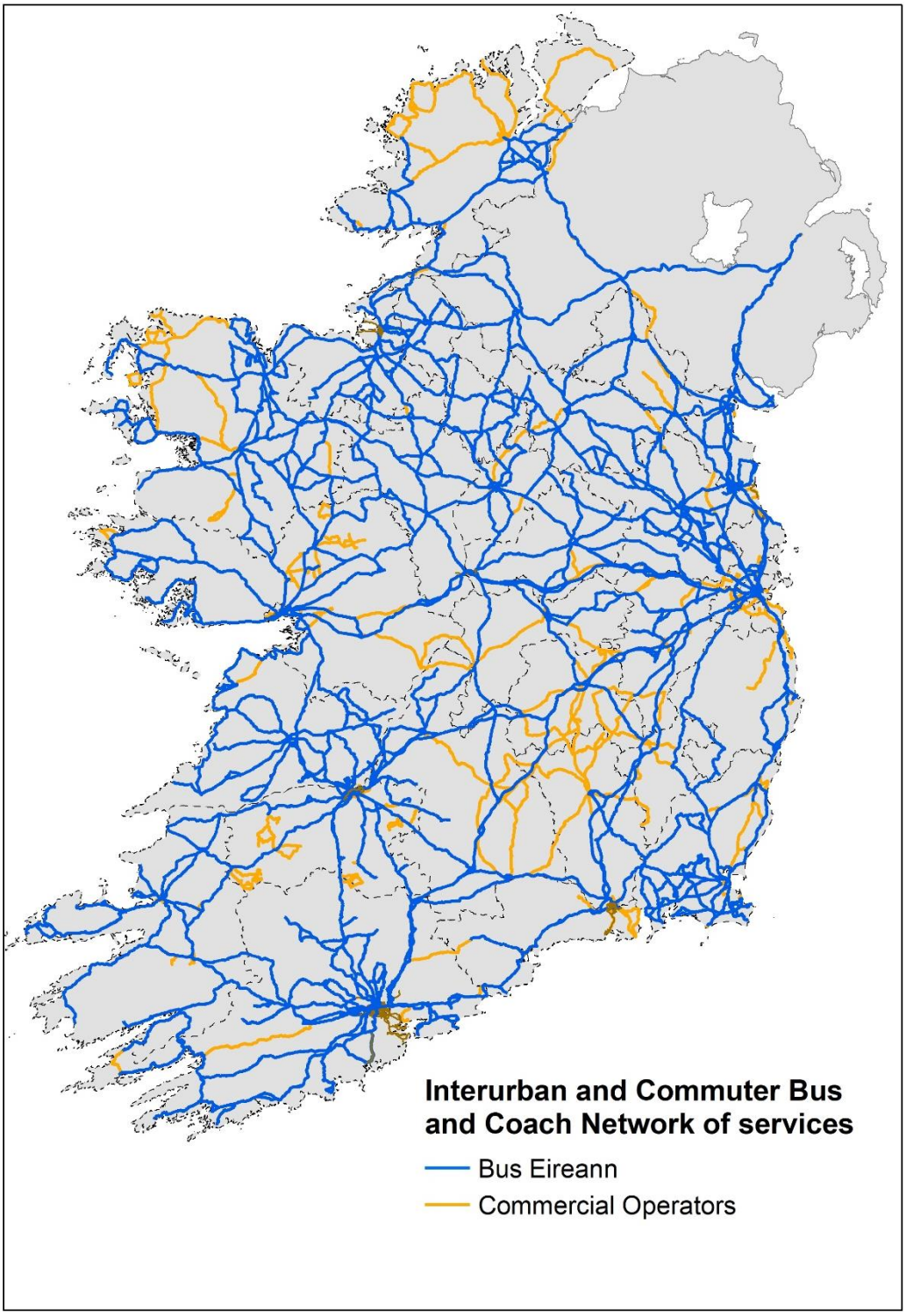

Figure 2.13: NTpM Interurban Network

2.5.2 Overview

Information on private bus service providers were referenced from the Transport for Ireland (TFI) website. TFI provides a list of private bus operates with hyperlinks to their websites that contain service and timetable information.

Section 9 presents run time and frequencies of Inter-Urban services, which were added to the NTpM.

2.5.3 Aggregate Bus Demand

Annual bus passenger demand at an aggregate level is provided by Bus Éireann and Ulster Bus based on service type. Aggregate totals (million passengers per annum) for Bus Éireann are outlined in Table 2.5 for all years between 2008 and 2016 and highlight a general decrease in passenger numbers from 2008 to 2012 with increasing passenger numbers year on year from 2012 to 2016.

Table 2.5: Aggregated bus demand 2008-2016 (million passenger per annum)

Service	2008	2009	2010	2011	2012	2013*	2014	2015	2016
Provincial City Services	21.2	18.3	16.6	16.4	16.7	17.7	18.6	19.3	20.6
Other Scheduled Services	26.9	23.9	20.6	20.1	20.1	18.1	18.6	18.5	19.1
School Transport Scheme	45.7	42.4	42.3	41.8	40.4	41.1	43.9	41.0	40.5
Total	93.8	84.6	79.5	78.3	77.2	76.9	81.1	78.8	80.2

**Discrepancy between 2013 & 2014 Annual reports for 2013 passenger figures*

There were 38.8m bus passenger trips in 2016 in Northern Ireland [5]. The annual demand for other services within the model operated by private companies were estimated based on the assumption that each timetabled service modelled operates at an average 50% of capacity with an assumed capacity of 55 seats per bus. Table 2.6 outlines the total annual (2016) demand by modelled operator.

[5] *2015-2016 Northern Ireland Transport Statistics (Department for Infrastructure)*

Table 2.6: Estimated Aggregated Bus Demand for 2016

Operator	Estimated Annual
Bus Eireann	19,108,000*
Aircoach	423,986
Ashbourne Connect	219,564
Bernard Kavanagh	30,285
Burkesbus	287,705
City Link	310,418
Dublin Coach	1,877,652
GoBus	105,996
JJ Kavanagh & Sons	363,417
John McGinley	121,139
Kenneally's	75,712
M&A Coaches	60,569
Mangan	45,427
Matthews	658,692
Shamrock Bus	90,854
Sillan	75,712
Suirway	60,569
Translink	90,854
Wexford Bus	280,134
Ulsterbus	38,800,000
Total Estimated Annual Demand	**63,086,686**

3 POWSCAR

3.1 Overview

As part of the Irish Census (2016) the Central Statistics Office (CSO) produced the Place of Work, School or College Census of Anonymised Records (POWSCAR[6]) database. The POWSCAR dataset provides detailed data on the journey to work/education at Electoral Division (ED) level. This data includes:

- Origin (residence) and destination (place of work/education);
- Time of departure; and
- Travel mode.

Outputs from the POWSCAR dataset provided the data required to construct journey to work (commuting) and journey to education origin-destination (O-D) prior demand matrices for use in the TII National Transport Model (NTpM).

3.2 POWSCAR (2016)

The POWSCAR commuting data for journey to work and education trips was released by the CSO in January 2018. Data from the POWSCAR database was extracted and processed for input to the NTpM, providing high quality origin-destination information for commuting and education trips throughout Ireland. The POWSCAR dataset also provided travel mode and time of departure, thereby allowing journeys made by various modes during various periods to be isolated.

3.3 Processing POWSCAR

A total of 3,058,607 individual records were provided in the POWSCAR database comprising a total of 1,970,728 work trips and 1,087,879 education trips. However a large proportion of the records were unusable for the following reasons:

- Place of work, school or college address was blank or not coded correctly;
- Mobile workers (no fixed place of work);
- Place of work or school overseas (outside the Island of Ireland); and
- Home school or work at home (not been recorded as an internal trip in the database).

Records with no departure time and records with no valid means of travel were also excluded from the database, the numbers of records for each excluded category are shown in Table 3.1. The sum of the total unusable records allows for double counting (i.e. record with no fixed place of work and no valid departure time is shown under these two categories) however the total number of usable records excludes double counting.

[6] https://www.cso.ie/en/census/census2016reports/powscar/

Table 3.1 Refined POWSCAR All Data (Usable Records)

Types of Records	Total Records	Usable Records	(%) of Total
Work Records	1,970,728	1,452,378[7]	-26.3%
Unusable work records[8]:			
No valid place of work	206,463		10%
No fixed place of work	174,628		9%
Place of work overseas	2,763		0.1%
Work at home	111,744		6%
No departure time	150,089		8%
No valid means of travel	93,709		5%
Total Education Records	1,087,879	965,819[9]	-11.2%
Unusable records[10]:			
No valid place of school or college	100,182		9%
Place of school overseas	768		0.1%
Home schooled	2,445		0.2%
No departure time	37,568		3.5%
No valid means of travel	37,617		3.5
Total Records	3,058,607	2,418,197	-20.9%

The POWSCAR dataset provides time of departure data in half hour intervals from 06:30 to 09:30 and records for before 6.30 and after 9.30. The data extracted for the 06:30 - 09:30 AM peak period incorporates 80% of the total usable departures to work record and 97% of usable departures to school or college as presented in the Table 3.2.

Table 3.2 Refined POWSCAR All Data (Departure Time)

Refined POWSCAR Records	Total	06:30 - 09:30	(%)
Total Work Records	1,452,378	1,171,768	80%
Total Education Records	965,819	938,856	97%
Total Records	**2,418,197**	**2,110,624**	**87%**

Source: CSO

3.4 Overview of POWSCAR Results

During the AM peak period (06:30 – 09:30) approximately 77% of all journeys to work were made by private car, van or motorcycle (including car passengers). Just over 10% of all journeys to work were made using public transport, while the remaining proportion (13%) walked or cycled to work.

In terms of journeys to education, 49% were made as car passengers, 21% by public transport and 25% by walking or cycling. The remaining 5% travelled by private car or van. Figure 3.1 and

[7] Total usable records excluding double counting.
[8] Total unusable records are shown separately for each category and include double counting.
[9] Total usable records excluding double counting.
[10] Total unusable records are shown separately for each category and include double counting.

Figure 3.2 illustrates the percentage of journeys to work and education respectively made by private modes.

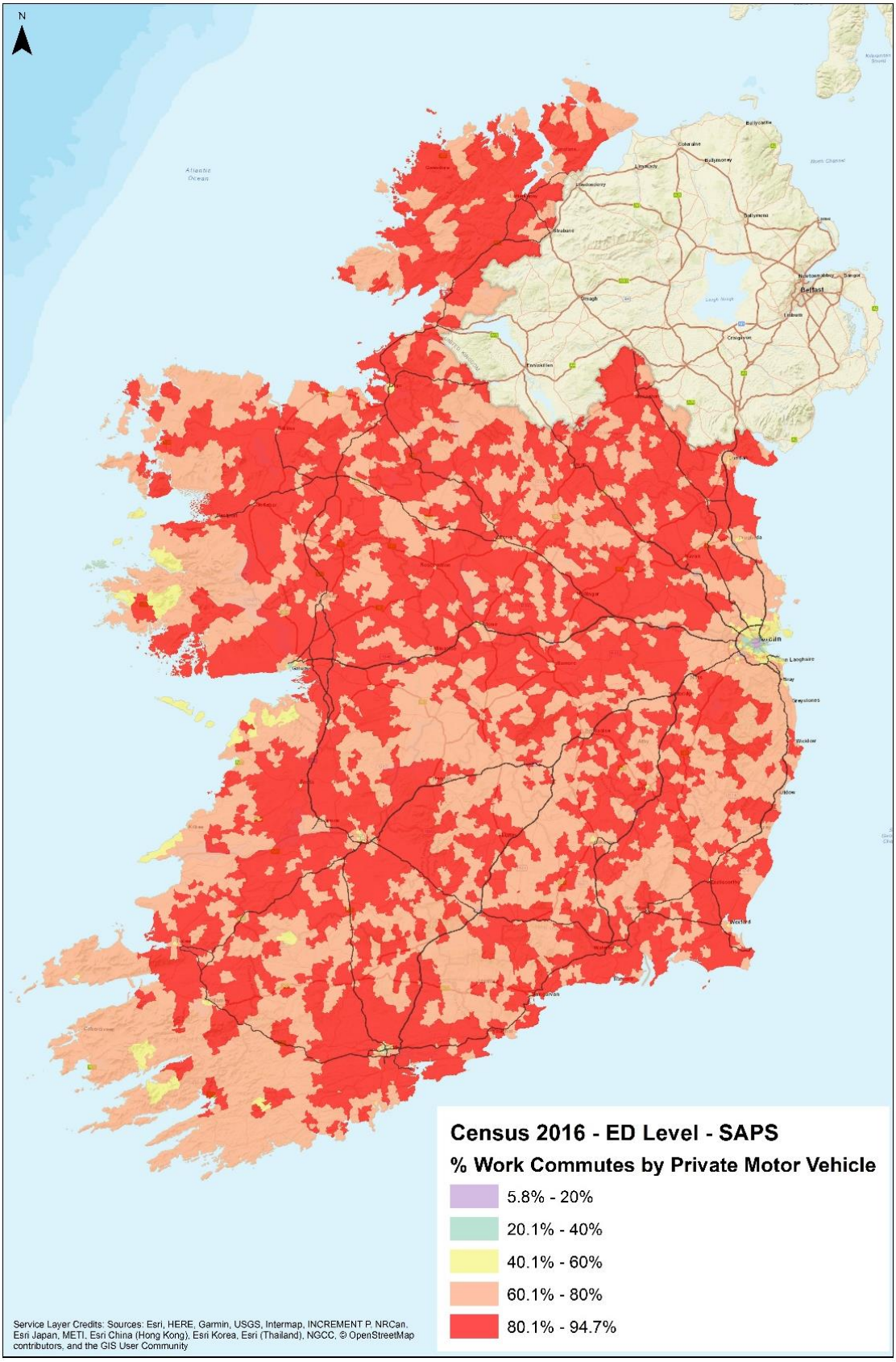

Figure 3.1 Percentage of Trips to Work by Private Modes

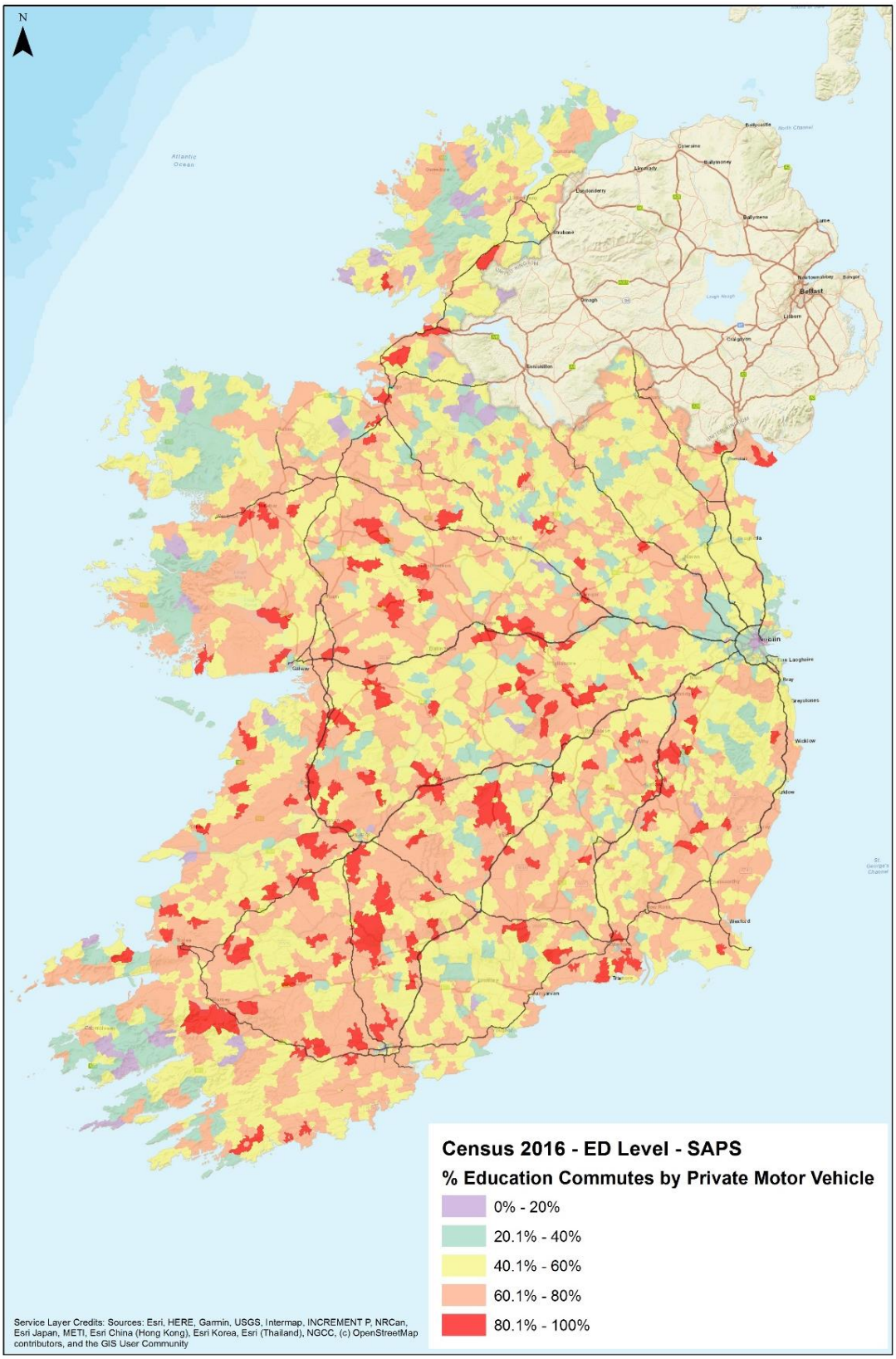

Figure 3.2 Percentage of Trips to Education by Private Modes

3.5 NTpM Prior Matrix Development

Details of how the POWSCAR data was processed and used to inform the development of the prior commuting and education trip matrices (by mode) for use in the NTpM is provided in the NTpM Model Development Report

4 Traffic Monitoring Units

4.1 Overview

Traffic volume data was made available from the network of TII Traffic Monitoring Units (TMUs). The TMUs are dispersed nationwide across the National Road network and include data for Motorway, National Primary, National Secondary and some regional routes. The TMUs provide classified count data by direction at each site. In total there are 370 TMUs; their locations are shown below in Figure 4.1. Additional TMU sites have been added to the network in 2019.

Figure 4.1 TMU Locations by Road Type

TMUs are permanent traffic counters which collect data constantly through sensors called loops. Inductive loops consist of wire "coiled" to form a loop that usually is a square or rectangle that is installed into or under the surface of the roadway.

Inductive loops are used in signal detection, once a vehicle drives over a loop sensor the loop field changes which allow the detection device to detect the presence of an object (vehicle).

Inductive loops are also used to classify types of vehicles as each vehicle passing the loop leaves a unique signature which can be matched with specific vehicle body type.

Loops are installed on each lane in each direction, therefore extensive information per lane per direction can be collected and analysed.

4.2 National Traffic Profile from TMUs

The profile of traffic, nationally, over an average weekday was obtained from a number of TMUs for 2016 and compared to 2013 data. Figure 4.2 and Figure 4.3 show the traffic profile broken down by light and heavy vehicles for 2013 and 2016 respectively.

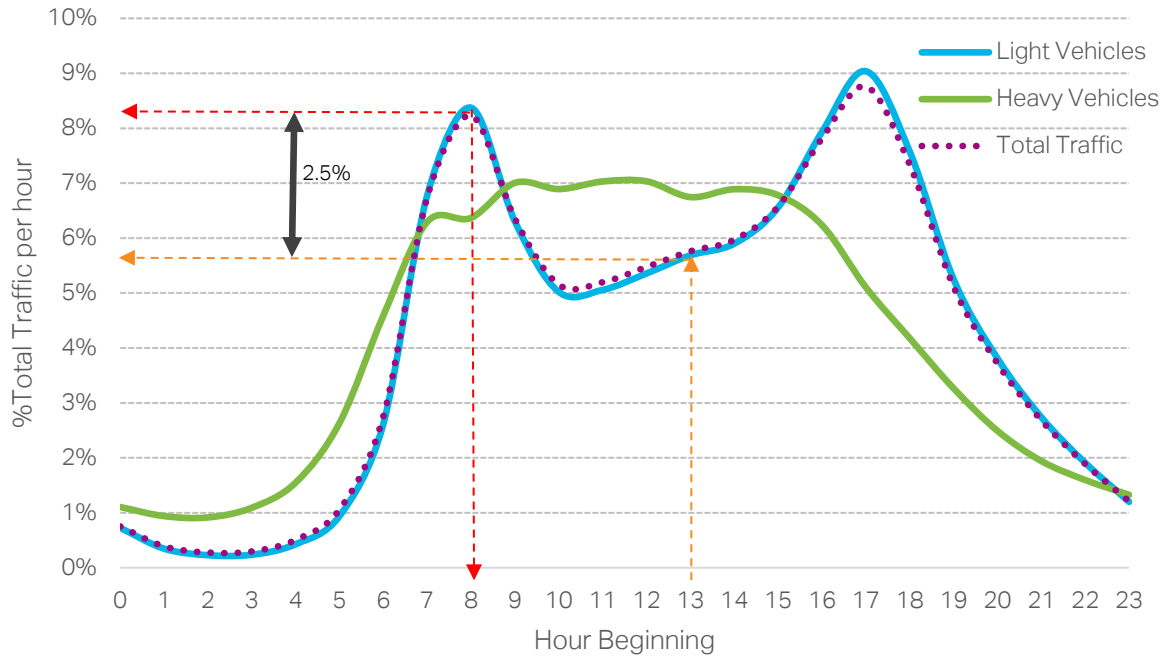

Figure 4.2 Traffic Flow profile for 2013

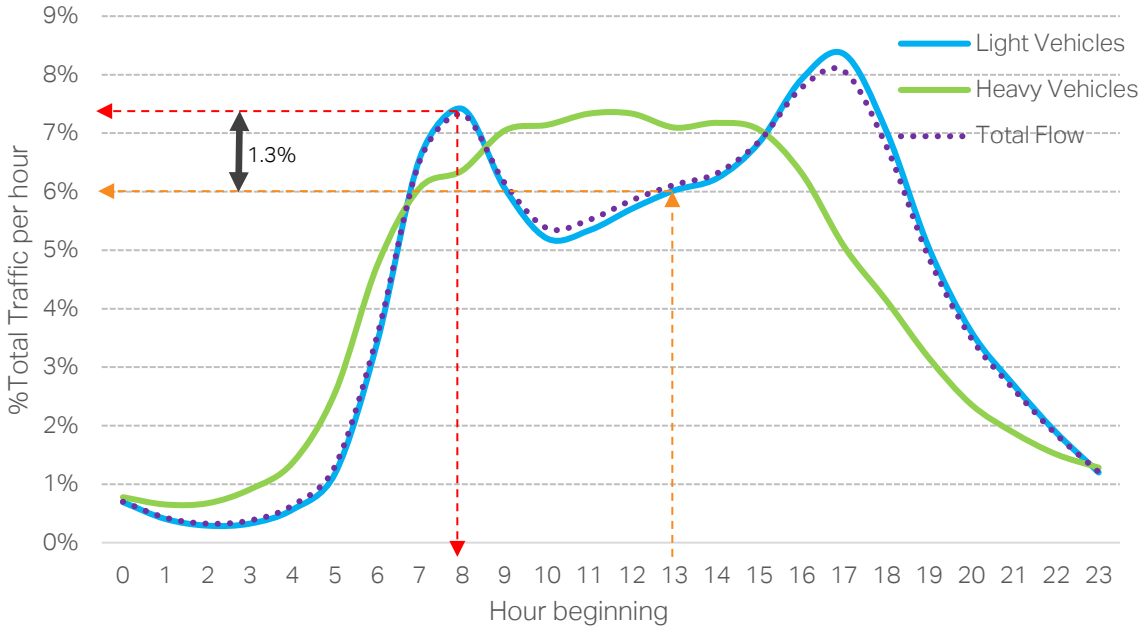

Figure 4.3 Traffic Flow profile for 2016

Morning and interpeak are highlighted by red and orange arrows in both profiles in Figure 4.2 and Figure 4.3. In both profiles the morning peak hour is around 8 am, however the proportion of total traffic during the AM peak has dropped from 8.2% to 7.3%. The traffic flow profile of the interpeak (shown by an orange arrow for 1pm) increased from 5.8% to 6.1%, therefore the gap between morning and inter peak has reduced significantly. This suggests the morning peak time traffic is spreading and that demand outside peak periods is increasing.

Figure 4.1 and Table 4.1 show the traffic growth rates on each road category on the National Roads network, as per the TII Indices website[11].

Table 4.1 Annual Growth Rates on National Roads Network

Road Category	2014/2015	2015/2016	2016/2017
All National Roads	3.9%	4.2%	3.1%
Motorway	4.8%	5.1%	3.9%
National Primary	3.7%	4.1%	2.7%
National Secondary	2.7%	2.6%	2.1%

Source: <TII>

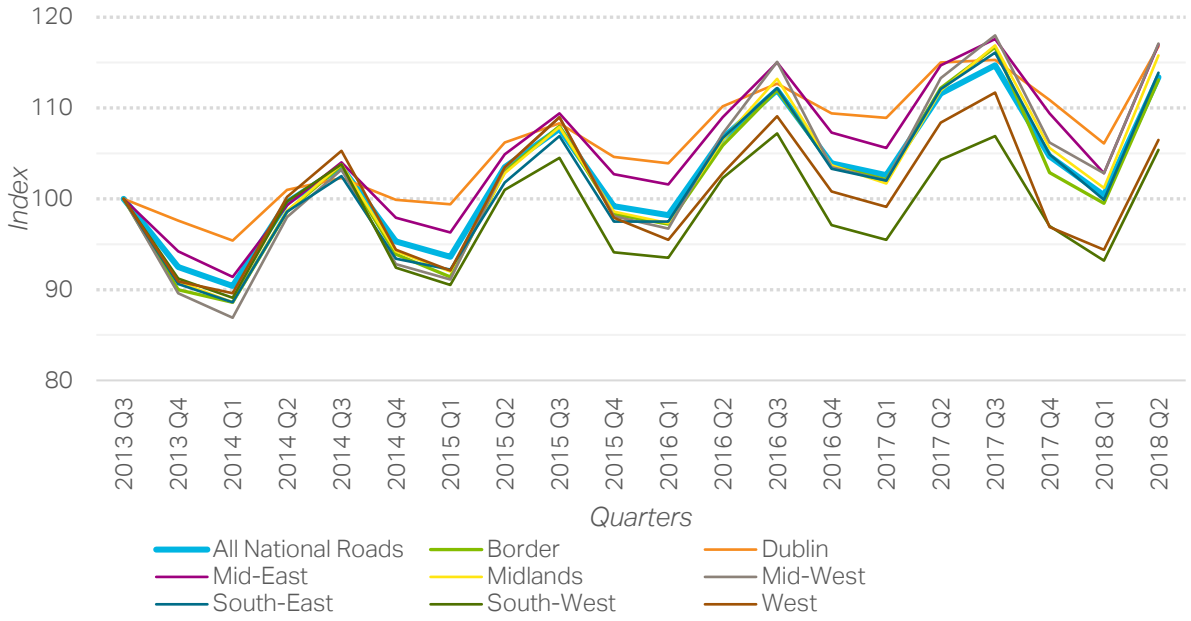

Figure 4.4 Traffic Indices between Q3 2013 and Q2 2018

Figure 4.1 shows that there was a rapid growth of traffic between 2013 and 2016, however, the last two years of data show traffic growth slowing down or even dropping below 2017 or 2016 levels. The average growth for all National Roads shows 2018 Q1 and Q2 below 2017 levels.

4.3 Additional Traffic Count Data

Additional traffic count data (temporary Automatic Traffic Counts) was made available by TII and the NTA from various studies and projects throughout Ireland. These traffic counts were used to inform the model validation process as they provided an independent dataset not used in the model calibration process.

[11] *TII Traffic Indices, https://data.tii.ie/indices/index.html*

5 Heavy Goods Vehicles

5.1 Overview

As part of the 2013 NTpM update, the Central Statistics Office (CSO) provided the National Roads Authority (NRA) with data on the movement of freight throughout Ireland at inter-county level (based on the 2012 CSO National Survey of Transport of Goods by Road). Data was provided by the CSO on total freight movements by axle type and port usage which was used to inform the development of the prior demand freight matrices for the 2013 update of the NTpM.

As part of the update of the NTpM the CSO provided TII with data from their 2016 'National Survey of Transport of Goods by Road' which is published under the cover of 'Road Freight Transport Survey'. Further information is provided in the following section.

5.2 Key Statistics

A summary of the key statistics from the 2016 Road Freight Transport Survey is provided in Table 5.1 and shows that there has been a significant increase in HGV movements since the NTpM was last updated using data from the 2012 survey.

Table 5.1 Road Freight Summary Statistics (2013 – 2016) CSO

Category	2012	2013	2014	2015	2016	% Change (2012 – 2016)
Tonne-km (million)	9,895	9,138	9,772	9.844	11,564	17%
Tonnes Carried (thousands)	108,07	108,83	112,49	118,05	141,66	31%
Vehicle Kilometres (million)	1,361	1,261	1,307	1,302	1,558	14%
Average No. of Vehicles	76,971	76,967	83,650	87,094	98,656	28%
Laden Journeys	10,057	9,925	10,094	10,279	12,090	20%

Source: <CSO>

5.3 Data Provided by CSO

For the update of the NTpM the CSO provided TII with the following data at county level:

- Number of HGV journeys classified by:
    - Rigid/articulated truck by county of origin and county of destination;
    - Main type of work by county of origin; and
    - Type of goods by county of origin.
- HGV tonnes and tonne kilometres classified by:
    - County of origin and county of destination;
    - Main type of work by county of origin; and
    - Type of goods by county of origin.

In addition, the CSO provided TII with data on the number of daily HGV journeys using Dublin Port or Rosslare Port classified by county of origin and county of destination[12].

[12] No data was provided for Cork or Foynes Ports

Data from the CSO survey relates to Irish registered goods vehicles and the CSO do not have similar data on foreign registered vehicles operating in the Republic of Ireland.

5.4 Number of HGV Journeys

The total number of daily HGV trips by county is provided in Table 5.2 and illustrates that there were on average 21,898 HGV trips per day in 2016. This value includes the following classification of vehicle types:

- Rigid Trucks;
- Rigid Trucks with Trailers; and
- Articulated Trucks.

Table 5.2: Number of Daily Journeys ('000) by HGV by County of Origin and County of Destination

County	No. of Origin Trips	No. of Destination Trips
Carlow	33	33
Cavan	420	423
Clare	908	918
Cork	2752	2751
Donegal	447	443
Dublin	5494	5505
Galway	1156	1148
Kerry	695	696
Kildare	983	968
Laois	412	418
Leitrim	95	97
Limerick	458	458
Longford	185	192
Louth	566	566
Mayo	697	692
Meath	1034	1041
Monaghan	408	405
Northern Ireland East	53	54
Northern Ireland North	124	126
Northern Ireland West & South	97	99
OTHER	179	183
Offaly	390	392
Roscommon	292	290
Sligo	187	185
Tipperary	1594	1600
Waterford	737	729
Westmeath	369	357
Wexford	506	499
Wicklow	627	630
Total	**21,898**	**21,898**

Source: CSO Road Freight Transport Survey (2016)

5.5 Disaggregation to NTpM Zone Level

Since the data provided by the CSO is at county level, there was a need to disaggregate the data to NTpM zonal level. This was achieved by determining the relationship between the total number of goods vehicle trip ends for each county and key county-level economic measures that were likely to influence the number of heavy vehicle movements (i.e. employment in certain sectors such as retail and construction). This relationship was then applied back to the equivalent economic data at zonal level to determine the proportion of HGV traffic that should be attributed to each NTpM zone within a county.

Multivariate regression analysis was performed to determine the relationship between various economic variables and the total HGV trip ends. The combination of variables that provided the most statistically significant relationship with HV trip ends was as follows:

- POWSCAR Industry Group 3: Construction (POWSCAR_3);
- POWSCAR Industry Group 4: Wholesale, Retail Trade, Transportation and Storage, Accommodation and Food Service Activities (POWSCAR_4); and
- POWSCAR Industry Group 8: Other Service Activities (POWSCAR_8).

The equation that resulted from the regression analysis was as follows:

*HV Trip Ends (000s) = 112.75 + (0.0436 * POWSCAR_3) + (0.0085 * POWSCAR_4) + (0.009 * POWSCAR_8)*

Application of this equation to zonal level POWSCAR employment data provided a measure of relative HGV trip ends for each NTpM zone, which was then used to disaggregate the actual county level HGV trip ends to NTpM zones. The spatial distribution of NTpM zones with jobs in POWSCAR Industry Groups 3, 4 and 8 in excess of 500 are shown in Figure 5.1 and demonstrates that these zones in general represent key population settlements within each county.

This process ensured that total trip ends for each county were controlled to the original CSO data, but they were distributed throughout the county in a consistent and robust way. The same process and regression equation were applied to each of the three goods vehicle categories for which information was provided by the CSO.

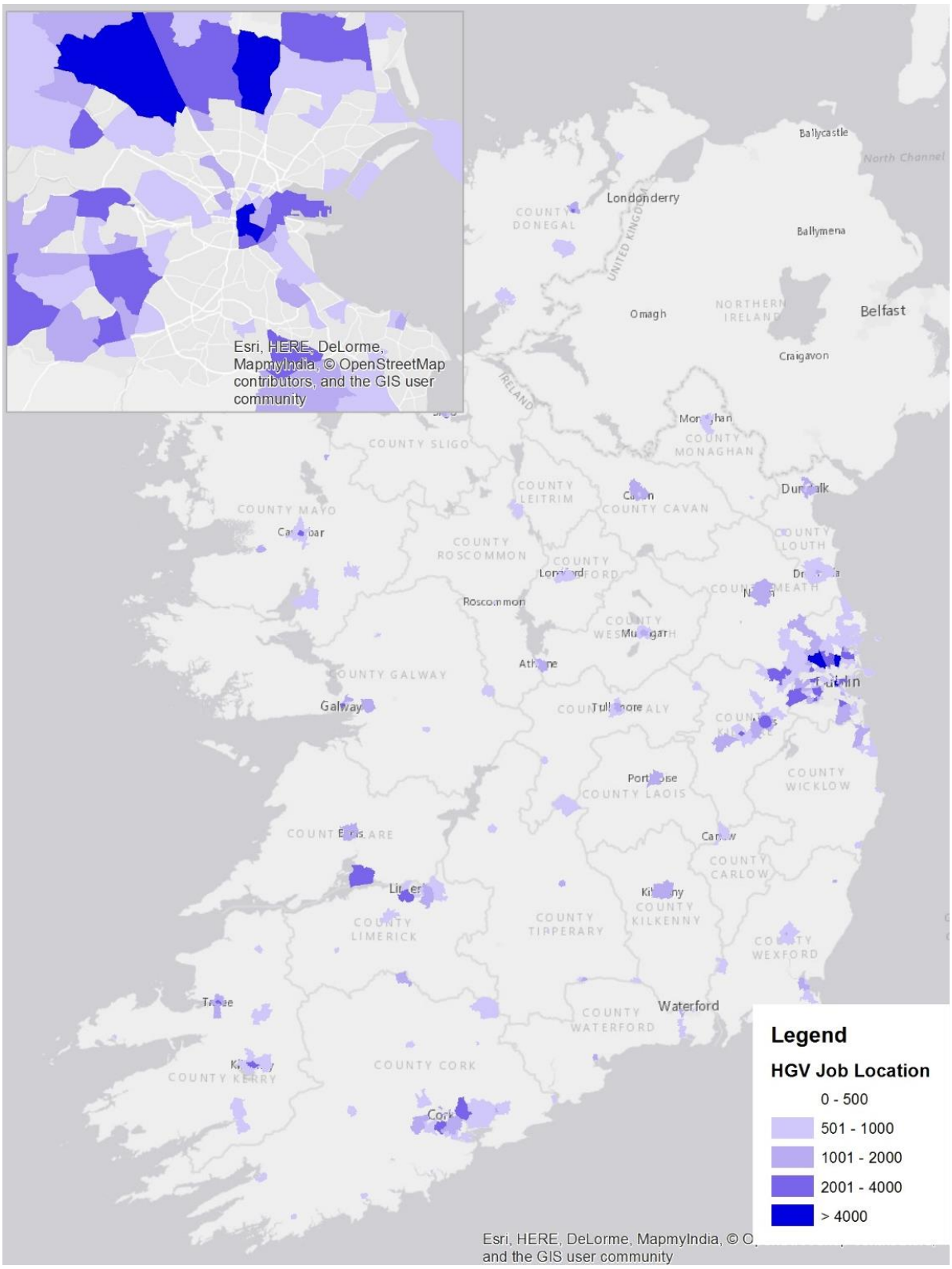

Figure 5.1 Employment Locations for Industry Groups 3, 4 & 8

6 Special Zones (Ports & Airports)

6.1 Overview

All ports and airports outlined in the National Ports Policy[13] and National Aviation Policy[14] documents have been included as 'Special Zones' in the NTpM. The National Ports Policy categorises ports into three groups as follows:

- Port of National Significance (Tier 1) – Dublin Port, Port of Cork and Shannon Foynes Port;
- Port of National Significance (Tier 2) – Port of Waterford and Rosslare Europort; and
- Ports of Regional Significance – Drogheda Port, Dún Laoghaire Harbour, Galway Harbour, New Ross Port and Wicklow Port (and all other ports that handle freight).

The National Aviation Policy categoriese airports into two groups as follows:

- State Airports – Dublin, Shannon and Cork; and
- Regional Airports – Donegal, Ireland West Airport Knock, Kerry and Waterford.

6.2 Data Sources – Ports

6.2.1 Annual Tonnage

The Statistics of Port Traffic published by the CSO provides details of freight through all of the Tier 1, 2 and 3 ports in tonnage terms. Table 6.1 provides the annual tonnages in 2016 for all Tier 1, 2 and 3 ports.

Table 6.1 2016 Annual Tonnage per Port

Tier	Port	Tonnages (000s)
1	Dublin	23,849
	Cork	8,977
	Shannon Foynes	10,949 (1,725)[15]
2	Rosslare	2,179
	Waterford	1,325
3	Drogheda	1,223
	Galway	588
	New Ross	270
	Wicklow	152
	Dundalk	43

[13] *National Ports Policy (2013) – Department of Transport, Tourism and Sport*
[14] *A National Aviation Policy for Ireland (August 2015) – Department of Transport, Tourism and Sport*
[15] **Based on figures from the Shannon Foynes Masterplan[15] approximately 84% of tonnage into the port leaves by boat. The figure outlined is estimate of tonnage carried by HGVs.*

6.2.2 HGV Annual Average Daily Traffic

Annual Average Daily Traffic (AADT) HGV movements for the Tier 1 Ports was available from a number of existing data sources. Data for Dublin Port North and South docks were obtained from the Dublin Port Masterplan 2040[16]. In additional traffic count data for the South Docks was obtained from Dublin City Council.

As part of the Ringaskiddy Port Redevelopment Environmental Impact Statement (EIS) (Appendix 8.7 Trip Generation & Distribution)[17], 2012 daily HGV movements were available for both Ringaskiddy and Tivoli Ports. This was converted to 2016 using TII Traffic Monitoring Unit (TMU) data for the intervening years.

Traffic data was available for Foynes Port for March 2017 from an existing traffic study. This was converted to annual 2016 HGV AADT using annual growth and seasonality factors which were obtained from the nearest TII TMU. Table 6.2 provide a summary of the daily HGV movements at each Tier 1 Port. No existing data was available for the Tier 2 and Tier 3 Ports.

Table 6.2 Tier 1 Port HGV AADT

Tier 1 Port	Tonnage (000s)	HGV AADT
Dublin (Combined North & South)	23,849	9,217
Cork (Combined Tivoli & Ringaskiddy)	8,977	1,805
Shannon Foynes	1,725*	436

The collated HGV AADT values for the Tier 1 Ports represent the 'loaded' and 'unloaded' trips. For the purposes of the base year NTpM it was assumed that each load requires two movements (i.e. HGV arrives to the port empty and leaves loaded and vice versa). The HGV AADT estimated from the data sources outlined and average load per HGV trip for each Tier 1 port are provided in Table 6.3.

Table 6.3 Tier 1 Port HGV AADT & Average Loads

Tier 1 Port	Tonnage (000s)	HGV AADT	Average Load (Tonnes)
Dublin (Combined North & South)	23,849	9,217	14.2
Cork (Combined Tivoli & Ringaskiddy)	8,977	1,805	27.3
Shannon Foynes	1,725*	436	21.7
	National Average Load per HGV		21.0

The 'National Average' load per HGV shown in the Table 6.3 (21.0 tonnes) was used to convert tonnage from all other ports to HGV AADT with an assumed two movements per load. The estimated AADT for each of the other ports is outlined in Table 6.4.

[16] https://www.dublinport.ie/wp-content/uploads/2018/07/DP-Mplan-Review-Strategic-Transport-Study-FINAL-2018-6-22.pdf
[17] https://www.ringaskiddyportredevelopment.ie/index.cfm/page/vol_iiib_traffic_and_transport?twfld=260&download=true

Table 6.4 2016 Estimated HGV AADT Tier 2 & 3 Ports

Tier	Port	Tonnages (000s)
2	Rosslare	567
	Waterford	345
3	Drogheda	318
	Galway	153
	New Ross	153
	Wicklow	40
	Dundalk	11

6.2.3 NTpM Peak Hour Conversion Factors

To convert HGV AADT to NTpM modelled peak hours, existing data from the Tier 1 data sources outlined previously was used to estimate the proportion of HGV AADT in each NTpM modelled hour (AM Peak & Inter Peak). These proportions are outlined in Table 6.5 for the ports where hourly count data was available. The average was used to convert 2016 HGV AADT to peak hour across all ports for the purpose of the NTpM.

Table 6.5 Proportion of HGV AADT during NTpM Modelled Peak Hours

Port	AM Peak	Inter Peak
Ringaskiddy	9.7%	8.7%
Tivoli	5.4%	8.4%
Dublin South	5.6%	4.9%
Foynes	10.3%	10.1%
Average	**7.8%**	**8.0%**

6.3 Data Sources – Airports

6.3.1 Dublin Airport

As part of updated zone structure for the NTpM, Dublin Airport was modelled as two separate Special Zones, 8451 & 8452, for staff and passenger respectively. Traffic survey data collected as part of the Dublin Airport Masterplan Study which provided the total number of vehicles in and out of the airport and the number of vehicles in and out of the staff access was used to inform the development of the base year (2016) Dublin airport vehicular demand for the NTpM update.

Additional data from an NTA survey at Dublin Airport 2011[18], the most recent survey available at the time of the NTpM update, was used to breakdown the passenger trips by trip purpose. Based on the survey results it was assumed that 14.8% of all passenger trips were employer's business with the remainder modelled as other trip purpose. Table 6.6 provides the breakdown by zone (staff and passenger) and trip purpose for light vehicle traffic to/from Dublin Airport for each NTpM modelled peak hour.

[18] *https://www.nationaltransport.ie/wp-content/uploads/2012/04/NTA-Survey-at-Dublin-Airport-2011.pdf*

Table 6.6 Dublin Airport Staff & Passenger Car Traffic by Modelled Peak Hour

	Zone		Total		Commute		Employers Business		Other	
			O	D	O	D	O	D	O	D
AM	8451	Staff	53	413	53	413	0	0	0	0
	8452	Passengers	997	1507	0	0	141	214	856	1293
IP	8451	Staff	327	185	327	185	0	0	0	0
	8452	Passengers	1208	1471	0	0	171	209	1037	1262

Based on mode share data from the NTA survey the numbers of bus passengers were estimated. However, as the NTpM only models interurban bus routes the bus passenger demand was reduced to the estimated demand for interurban bus routes. This was estimated based on the distribution of trips outlined in the survey, from which it was estimated that a total of 34.5% of passengers used interurban bus services.

The mode share for staff was taken from the POWSCAR dataset used as part of the prior matrix development. This was converted to interurban bus journeys based on the reported journey times of the trip in POWSCAR, all journey above 1 hour were assumed to use interurban services. Interurban bus demand represented at 11% of all staff bus journey to the airport.

The total bus demand to/from the Airport is shown in Table 6.8 As before 14.8% of passenger demand was assumed to be represent the Employer's Business trip purpose.

Table 6.7 Dublin Airport Staff & Passenger 15 Hour Bus Demand

	Zone		Total		Commute		Employers Business		Other	
			O	D	O	D	O	D	O	D
15 HR	8451	Staff	70	49	70	49	0	0	0	0
	8452	Passengers	4165	3794	0	0	591	538	3574	3256

6.3.2 All Other Airports

In the absence of more detailed data demand to/from all other airports (Shannon, Cork, Knock, Donegal and Kerry) was based on the average daily number of arrivals and departures. This was estimated as a five day average based on the weekly arrival and departures at each airport. Though Waterford airport is included as a Special Zone in the NTpM all commercial flights ceased in 2016.

It was assumed that for departure times between 09:00 – 11:00 and 14:00 -16:00 at each airport, demand (car) on the network would be between the modelled average peak hours of 07:00 - 9:00 and 12:00 -14:00 respectively. All departures between 09:00 – 24:00 would travel between 07:00 -22:00 for bus based trips.

For demand from the airport it was assumed passenger arriving between 06:30 – 08:30, 11:30-13:30 and 06:30 – 21:30 would travel between the modelled AM, Inter Peak and 15 hour periods. There was also allowance made at Shannon & Cork airports for two way taxi and drop off car journeys based on the NTA surveys undertaken at each airport.

It was assumed that each plane arriving and departing was 90% full and a capacity of 330 was used for transatlantic flights and 215 for all other flights. The bus mode share at Shannon and

Cork was available from the NTA airport surveys and was approximately 13% for each. This mode share was also assumed for all other regional airport.

The percentage of Employer's Business trips to/from Shannon and Cork was 32% and 27% respectively as reported in the NTA airport survey. An average of these values was used to estimate Employer's Business trips from all other airports. Commuting demand was taken from the POWSCAR prior matrices. Table 6.8 presents the AM & IP car demand and 15 hour bus demand for all airports excluding Dublin.

Table 6.8 All Airports (excl. Dublin) AM, IP and 15 Hour Demand

Zone	Airport	AM Car Demand		IP Car Demand		15 Hour Bus Demand	
		O	D	O	D	O	D
3581	Shannon	307	734	432	469	201	107
77711	Cork	220	409	489	592	112	124
5801	Knock	57	203	220	147	24	24
1801	Donegal	6	5	6	41	7	6
4451	Kerry	4	25	14	2	2	2
7021	Waterford	6	2	4	4	2	1

6.3.3 Airport Passenger Trip Distribution

The NTA Dublin Airport Study gives a breakdown of the origin of surveyed trips to/from Dublin Airport as shown below in Table 6.9. The destination distribution was assumed to be the as the origin. All destinations within Dublin were excluded from the Bus demand distribution as this demand is not considered interurban and would likely use a Dublin Bus services not modelled within the NTpM bus model.

Table 6.9 Passenger Origin – Dublin Airport

Trip Origin	Irish Passengers	%	Non-Irish Passengers	%	All Passengers	%
Dublin City Centre	901	8%	4,551	39%	5,452	24%
Dublin City North	1,385	12%	1,159	10%	2,544	11%
Dublin City South	907	8%	847	7%	1,754	8%
Fingal	1,515	13%	1,562	13%	3,077	13%
South Dublin	972	9%	449	4%	1,421	6%
Dun Laoghaire/ Rathdown	1,047	9%	491	4%	1,538	7%
Meath	506	4%	267	2%	773	3%
Kildare	603	5%	230	2%	833	4%
Wicklow	429	4%	242	2%	671	3%
Outside of GDA	3,110	27%	1,971	17%	5,081	22%
Total	11,375		11,769		23,144	100%

The trips originating outside the GDA are further disaggregated by road corridor within the survey as shown below in Figure 6.1. Zones outside the GDA were assigned to the corridors outlined below based on the closest distance. Demand was proportioned to each zone within the areas outlined above and corridors below based on the existing total demand.

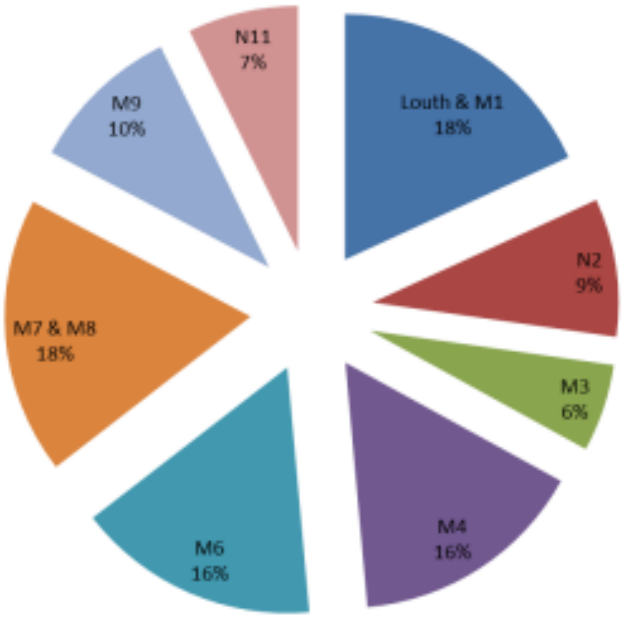

Figure 6.1 Breakdown of Passenger Trips from Outside the GDA

The distribution of commuting staff for Dublin Airport was taken from the prior matrices based on the 2016 POWSCAR dataset. Figure 6.2 shows the distribution of car passenger demand travelling to Dublin Airport.

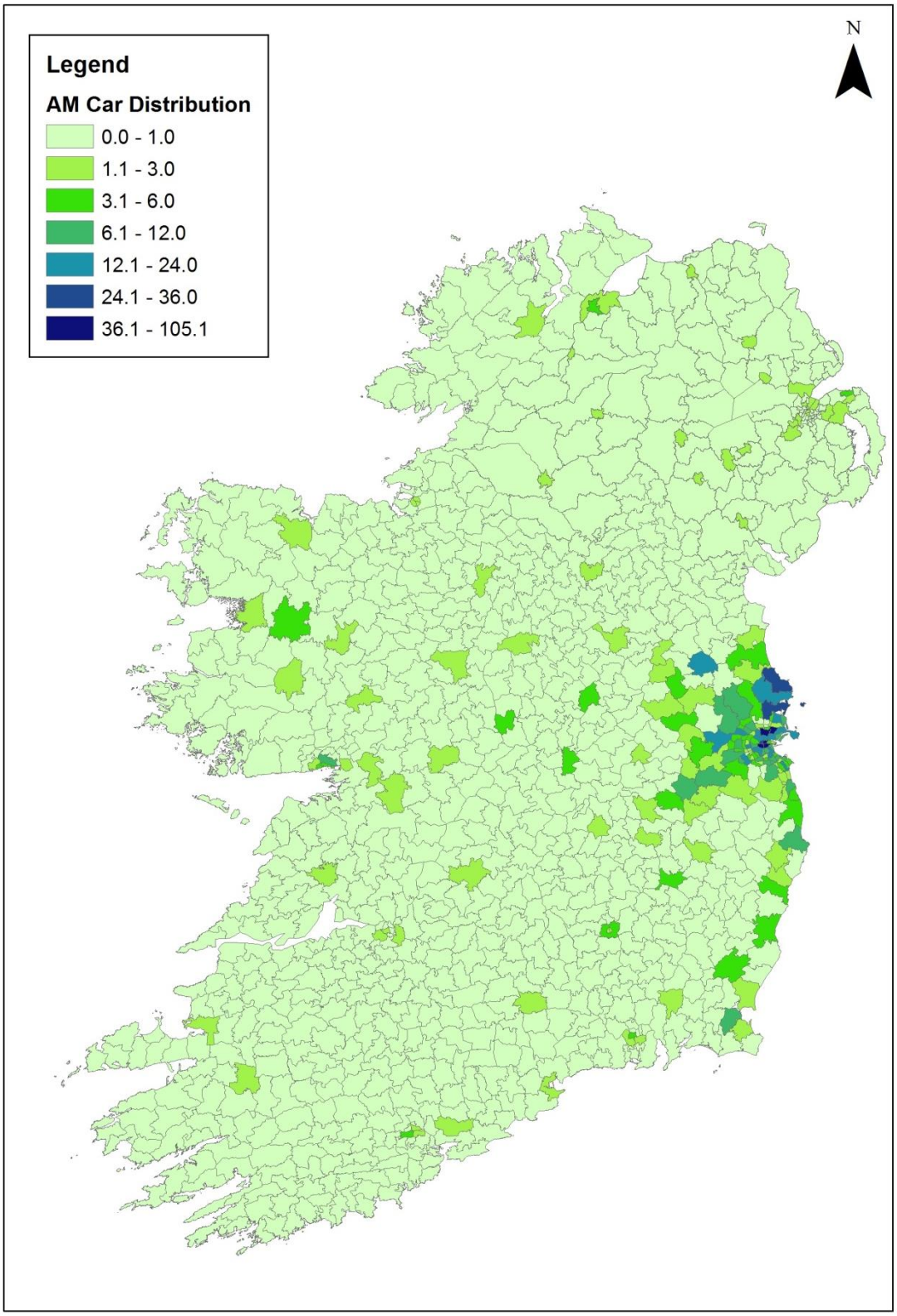

Figure 6.2 AM Peak Hour Modelled LV Demand to Dublin Airport

6.3.4 Airport Passenger Trip Distribution – Shannon Airport

Passenger origin information was also available for Shannon Airport as shown below in Table 6.10. Within each county the demand was further disaggregated based on total demand within the zone to all other zones.

Table 6.10 Shannon Airport Passenger Trip Distribution

County	Passengers	%	County	Passenger	%
Tyrone	0	0.0%	Sligo	0	0.0%
Fermanagh	0	0.0%	Roscommon	0	0.0%
Down	0	0.0%	Offaly	2	0.7%
Derry	0	0.0%	Monaghan	0	0.0%
Armagh	0	0.0%	Meath	1	0.4%
Antrim	1	0.4%	Mayo	6	2.2%
Dublin City	1	0.4%	Louth	0	0.0%
Dun Laoghaire	1	0.4%	Longford	0	0.0%
Fingal	2	0.7%	Leitrim	0	0.0%
South Dublin	0	0.0%	Laois	0	0.0%
Limerick City & County	79	28.7%	Kilkenny	0	0.0%
Galway City	39	14.2%	Kildare	0	0.0%
Cork City	10	3.6%	Kerry	29	10.5%
Waterford City & County	2	0.7%	Galway County	10	3.6%
Wicklow	1	0.4%	Donegal	0	0.0%
Wexford	1	0.4%	Cork County	9	3.3%
Westmeath	2	0.7%	Clare	69	25.1%
Tipperary South	5	1.8%	Cavan	1	0.4%
Tipperary North	3	1.1%	Carlow	1	0.4%

6.3.5 Airport Passenger Trip Distribution – Other Airport

To distribute the demand to and from all other airports, each zone in the NTpM was assigned to its geographically closest airport and the demand to/from each airport distributed to the zones closest to it. The demand was proportioned based on the total demand to/from each zone to/from all other zones in the model.

7 Journey Time Data

7.1 Overview

In order to ensure the model accurately reflects the base year network conditions in terms of speed, distance and delay, a comparison between modelled and observed journey times is used and is essential to the model validation process.

There are a number of standard approaches to collecting journey time data, such as the moving observer, Automatic Number Plate Recognition (ANPR) or Bluetooth surveys and GPS data (via Sat Nav devices). These survey methods are useful for obtaining journey time information but are short term in nature and can therefore only provide a brief snapshot of an area considered for analysis. Given the scale of journey time data required across the full National Road network for the NTpM, the use of these standard methods would be time consuming and expensive, as it would require a vast amount of ANPR cameras/Bluetooth devices to be available and staff to install and monitor them.

Due to the nature and scale of the journey time data required for the NTpM update, an alternative approach was adopted which obtained journey time data using the Google Maps Distance Matrix Application Programming Interface (API)[19].

7.2 Google Map Distance Matrix API

The Google Maps Distance Matrix API is a service that is provided by Google that uses crowd-sourced traffic information to generate journey times and distances for a matrix of origins and destinations. In order to use this service, an API key must be obtained that allows the user to make up to a maximum of 2,500 requests per day for free, or up to 100,000 requests per day if billing is enabled.

Information is returned based on the recommended route between user defined start and end points, and the API calculates journey duration and distance values for each request. The three mandatory parameters that are needed for the API are Origin, Destination and API key with other optional inputs depending on the user's requirements such as mode (driving, public transport, cycling or walking), arrival time and departure time.

The use of Google Maps Distance Matrix API allows for the collection of a large scale dataset and reduces the processing and analysis time associated with other methods. Due to the scale of the NTpM, the use Google Maps Distance Matrix API is the most feasible and appropriate solution for the collection of journey time data to inform the development, calibration and validation of the NTpM.

There are noted limitations of the journey time data provided by Google such as the inability to isolate journey times by vehicle classifications (i.e. Car versus HGV) and "black box" source of the data.

[19] https://developers.google.com/maps/documentation/distance-matrix/

7.3 Journey Time Data Collection Process

Scripts were developed that use the Google Maps Distance Matrix API to make multiple journey time requests at once, and to allow for the outputs of the API to be analysed rapidly. The Google Maps Distance Matrix API provides two methods of obtaining journey times:

- Live journey times; and
- Predicted journey times.

It should be noted that journey times are unavailable for dates in the past, journey times can only be obtained for the present (live) and the future (predicted). In order to record live journey times, a defined number of iterations and a frequency is required along with the input coordinates for all of the origins and destinations.

Once the script is initiated journey times start to record immediately and repeat for the specified number of iterations and frequency. This process can be difficult to manage as the API request limits mean that only a handful of O-D pairs can be analysed outside of office hours when the tool is running throughout the evening until the early morning.

Therefore using predicted journey times is a more practcal approach when collecting and analysing a large number of O-D pairs as dates and times can be specified, and the results are produced almost immediately. Although not as accuarte as recording live journey times, the predicted journey time method is appropriate for large scale high-level analysis, and this process was selected for collecting journey time data for the National Transport Model update.

7.4 Data Collection

Journey times were generated for a 24-hour period for a Wednesday in early February which represents a neutral weekday for the routes and data points illustrated in Figure 7.1. The following data extraction frequencies were used to generate the journey times:

- Peaks (07:00 – 09:00 & 17:00 – 19:00) – 5 minutes intervals;
- Inter-peak (09:00 – 17:00) – 12 minutes intervals; and
- Off-peak (19:00 – 07:00) – 20 minutes intervals.

This data was then collected and analysed to allow for a validation of the data source against TII's own ANPR data (for a smaller overall length of the National Roads network). In total there were 978 Origin-Destinations pairs included as part of the journey time data collection process which covered all Motorways, National Primary Roads and National Secondary Roads in the Republic of Ireland and selected routes within Northern Ireland.

Figure 7.1 Journey Time Data Routes for the NTpM

7.5 Validation of Google Journey Time Data

7.5.1 Overview

In order to assess the accuracy of the predicted journey time data a comparison was undertaken with TII ANPR data on the M50 and other Dublin radial routes. The assessment compared the average hourly ANPR and Google Maps Distance Matrix API predicted times across a 24hr period. Figure 7.2 shows the ANPR camera locations in the Greater Dublin Area.

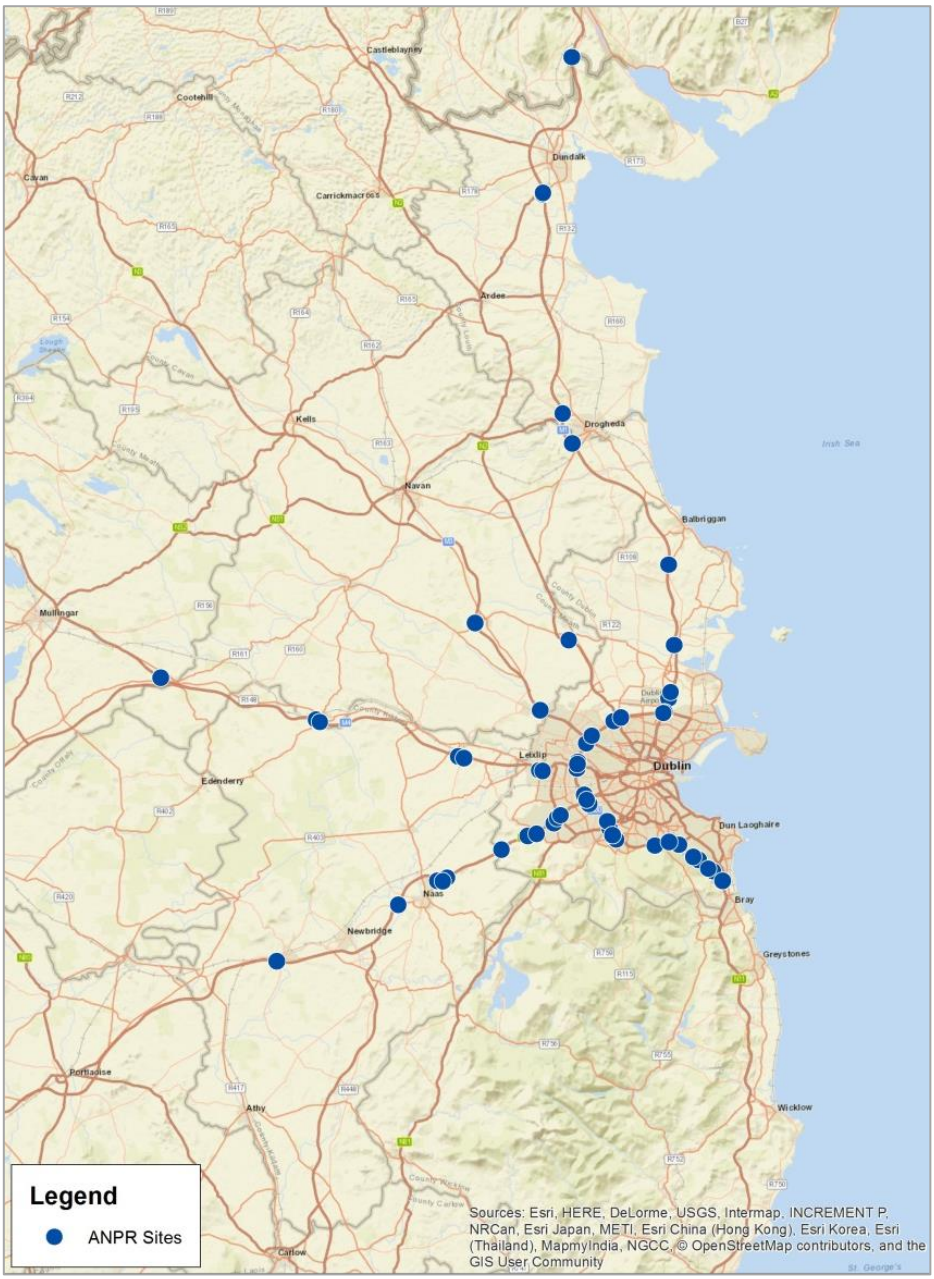

Figure 7.2 TII ANPR Camera Locations

7.5.2 Methodology

The purpose of this exercise was to establish the accuracy of the predicted journey times method and to determine if this accuracy was acceptable to use this method to undertake the full journey time analysis for the entire National Road network. Hourly ANPR data was obtained from TII between 1st September 2016 until 24th May 2017 which was used as a validation dataset.

The coordinates of each of the locations of the ANPR cameras were used as the input coordinates for the Google Maps Distance Matrix API, and journey times were generated hourly for a 24 period for a neutral weekday (Wednesday 10th January).

7.5.3 Findings

Overall the predicted journey times from the Google Maps Distance Matrix API were found to be accurate. Most of the sites validated were found to be near perfect during the off-peak periods. Some minor discrepancies were found during the peak periods. This is to be expected as the daily variation in journey times can be significant on certain routes.

Table 7.1 shows a summary of each of the ANPR sites that were analysed with their average ANPR and Google Maps Distance Matrix API journey time, and whether they were validated. The validation criterion for this exercise was for the Google data to be within 15% and within one standard deviation of the ANPR data for more than 85% of the cases.

The results show there were no sites with an average difference of +/-15% or above or outside of one standard deviation which resulted in all of the 25 sites validating. All of the data was also compared for goodness of fit by generating a trend line and an R^2 for the data. Figure 7.3 shows the trend line fitted to the data which gives an R^2 goodness of fit value of 0.9827.

Table 7.1 Comparison of 24-hour Average Google & ANPR Journey Times

Site	Average Google Predicted Journey Time (seconds)	Average ANPR Journey Time (seconds)	ANPR Standard Deviation (seconds)	Average % Difference	Validated
M1S NI Border to J17	510	498	42	2.5%	Yes
M50N J5 to J3	236	222	42	6.1%	Yes
M50N J6 to J5	167	172	41	2.8%	Yes
M50N J7 to J6	136	138	40	1.2%	Yes
M50N J9 to J7	199	212	39	6.2%	Yes
M50N J11 to J9	201	204	39	1.6%	Yes
M50N J12 to J11	70	77	38	10.3%	Yes
M50N J13 to J12	331	335	38	1.3%	Yes
M50N J15 to J13	111	117	38	4.9%	Yes
M50N J16 to J15	81	83	35	2.3%	Yes
M50N J17 to J3	1833	1646	27	11.4%	Yes
M50S J3 to J5	240	231	21	4.2%	Yes
M50S J3 to J6	418	424	18	1.4%	Yes
M50S J3 to J7	576	591	17	2.5%	Yes
M50S J3 to J9	761	779	17	2.3%	Yes
M50S J5 to J6	181	193	16	6.3%	Yes
M50S J7 to J9	184	189	16	2.5%	Yes
M50S J9 to J11	186	189	16	2.0%	Yes
M50S J11 to J12	76	73	17	4.3%	Yes
M50S J12 to J13	228	232	19	1.7%	Yes
M50S J13 to J14	68	74	20	9.0%	Yes
M50S J14 to J15	127	130	19	2.2%	Yes
M50S J15 to J16	87	97	19	9.7%	Yes
N4E J9 to J7	646	652	18	0.8%	Yes
N4E J7 to J4	387	399	18	3.0%	Yes

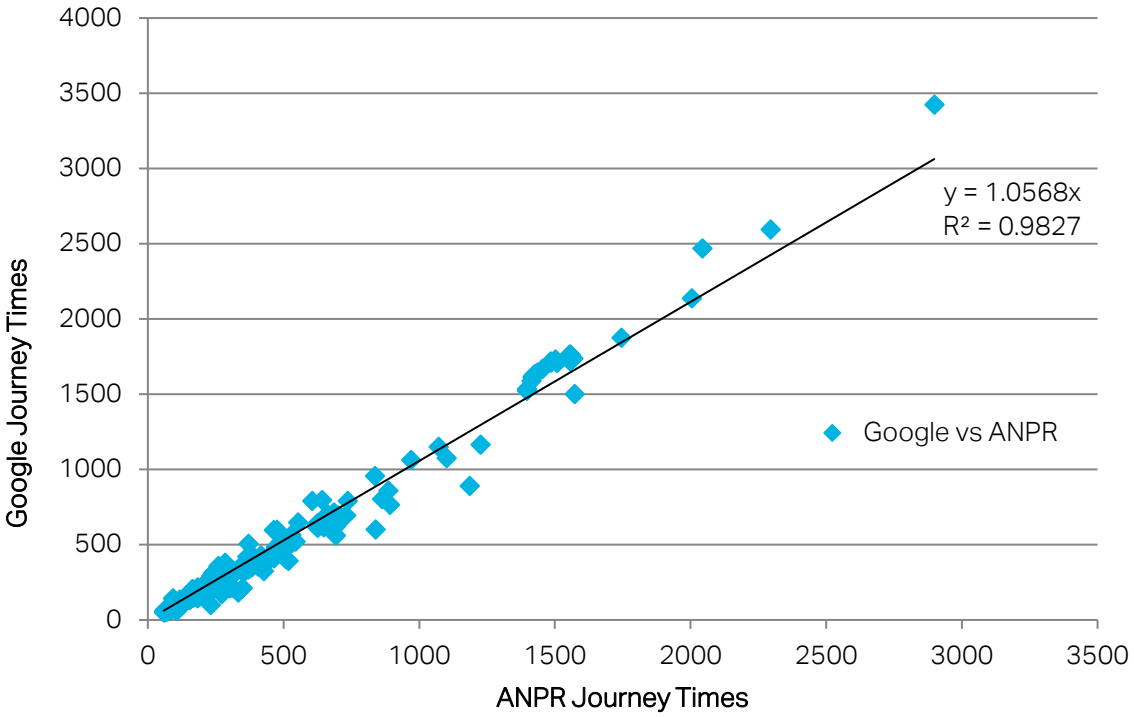

Figure 7.3 Google vs ANPR Goodness of Fit

Figure 7.4 demonstrates an example of the comparison of a validated site between the predicted Google and the observed ANPR data on the M50, where journey times are similar for the two methods over 24 hours.

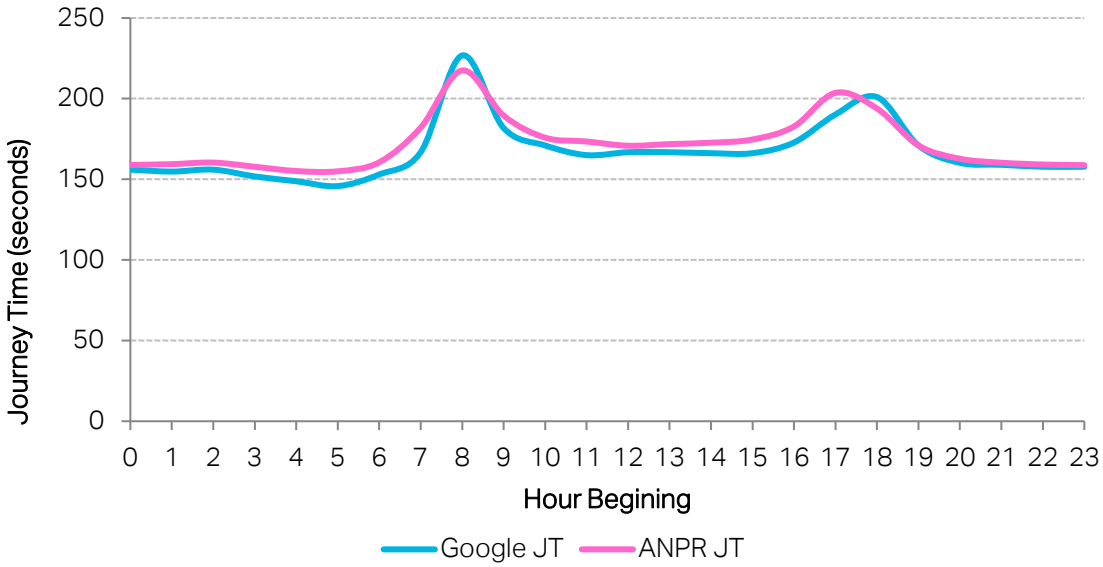

Figure 7.4 ANPR & Google Comparison (M50 J6 to J5 NB)

7.5.4 Conclusion

Following the analysis, it was decided to proceed with using the Google Maps Distance Matrix API data for validation of the NTpM as the data was shown to be an accurate reflection of observed journey times.

8 Northern Ireland Data

8.1 Overview

The existing NTpM was split into 1,077 transport zones (927 zones representing the Republic of Ireland and 150 zones representing Northern Ireland). To maintain compatibility with Central Statistics Office (CSO) Census data, the 3,440 Electoral Divisions[20] (ED) in the Republic were aggregated into the 927 NTpM zones. The 150 NTpM zones which represent Northern Ireland were based on an aggregation of the 582 Electoral Wards[21] in Northern Ireland.

The updated NTpM now contains a total of 1,129 transport zones (979 zones to represent the Republic of Ireland and 150 zones to represent Northern Ireland). No changes were made to the zone structure in Northern Ireland as part of the latest NTpM update.

The ROI commuting demand matrices for the NTpM were derived entirely from the 2016 POWSCAR dataset which includes details of travel to work in terms of mode of travel, time of day, origin (home) and destination (workplace) locations.

In the latest version of the NTpM the NI matrices were synthesised using the NI trip end model (TEMPRO NI) and a gravity model to distribute the trips.

8.2 TEMPRO Data

The first step in developing a trip matrix is to determine the number of trips originating from and destined for each model zone, commonly referred to as "trip ends". The UK has an established trip end model which uses demographic and socio-economic data to determine the number of trips originating from and destined for every area of Great Britain. This information is broken down by time of day, trip purpose and mode of travel. Users may access this information via an application called "TEMPRO", with data available at various levels of detail from TEMPRO zones consisting of very few electoral wards, to county or national level.

A version of TEMPRO for Northern Ireland was developed using the same underlying methodology as the Great Britain model. The TEMPRO Northern Ireland model was developed on behalf of Roads Service for the A5 Western Transport Corridor study. AECOM obtained trip end data for the year 2011 from the Northern Ireland Department of Regional Development (NIDRD) Roads Service data section. Data was provided for an average 2011 weekday, and for the following categories:

Time of Day:

- AM peak period (07:00 – 10:00);
- Inter-peak period (10:00 – 16:00);

Trip Purpose:

- Home-Based Work;

[20] *There are 3,440 Electoral Divisions (EDs) which are the smallest legally defined administrative areas in the State. One ED, St. Mary's, straddles the Louth-Meath county border, and is presented in two parts in the SAPS tables, with one part in Louth and the other in Meath. There are 32 EDs with low population, which for reasons of confidentiality have been amalgamated into neighboring EDs giving a total of 3,409 EDs which appear in the SAPS tables.*

[21] https://www.nisra.gov.uk/support/geography *Electoral Wards in Northern Ireland as per 1992 Boundaries*

- Non Home-Based Work;
- Home-Based Employers' Business;
- Non Home-Based Employers' Business;
- Home-Based Education;
- Non Home-Based Education;
- Home-Based Shopping;
- Non Home-Based Shopping;
- Home-Based Personal Business;
- Non Home-Based Personal Business;
- Home-Based Recreation/Social;
- Non Home-Based Recreation/Social;
- Home-Based Visiting Friends & Relatives;
- Home-Based Holiday/Day Trip;
- Non Home-Based Holiday/Day Trip.

The NTpM trip matrices represent the following time periods:

- AM peak hour (highway assignment) – average of 07:00 – 09:00;
- Inter-peak hour (highway assignment) – average of 12:00 – 14:00;
- 15 Hour/all-day (PT assignment).

In order to convert the TEMPRO highway trip ends into model AM and IP period trip ends, conversion factors based on Automatic Traffic Count (ATC) data from 45 sites within NI were applied. The factors are shown in Table 8.1

Table 8.1 Time Period Conversion Factors

Time Period	Factor
AM TEMPRO Period (07:00 – 10:00) – AM Model Period (07:00 – 09:00)	0.682
IP TEMPRO Period (10:00 – 16:00) – IP Model Period (12:00 – 14:00)	0.333

The highway trip ends were then halved to represent the average AM peak hour and the average IP hour. The original NTpM matrices were developed for fewer trip purposes than provided in the TEMPRO data, so in some cases TEMPRO trip purposes were aggregated to match the existing model. Trip purposes were aggregated as shown in Table 8.2.

Table 8.2 NTpM and TEMPRO Trip Purposes

Model Trip Purpose	TEMPRO Trip Purposes Included
Home-Based Work (HBW)	Home-Based Work
Home-Based Employers' Business (HBEB)	Home-Based Employers' Business
Home-Based Education (HBED)	Home-Based Education
Home-Based Other (HBO)	Home-Based Shopping Home-Based Personal Business Home-Based Recreation/Social Home-Based Visiting Friends & Relatives Home-Based Holiday/Day Trip
Non Home-Based Employers' Business (NHBEB)	Non Home-Based Employers' Business
Non Home-Based Other (NHBO)	Non Home-Based Work

Model Trip Purpose	TEMPRO Trip Purposes Included
	Non Home-Based Education Non Home-Based Shopping Non Home-Based Personal Business Non Home-Based Recreation/Social Non Home-Based Holiday/Day Trip

These trip purposes were further aggregated into the three purposes included in the latest NTpM which are: commute; employers' business and "other".

9 National Rail Model Data

9.1 Rail Demand

The development of the rail demand matrices used a number of data sources as outlined below:

- 2016 POWSCAR database;
- Irish Rail Census 2016;
- Origin Destination 1st class tickets sales information;
- Line route loading data; and
- Aggregate rail demand.

9.2 2016 POWSCAR Database

The 2016 CSO POWSCAR database provides journey to work and education data across all modes of transport. Of the 2,110,624 trips recorded in April 2016 and departing between 06.30 and 09.30, 3.1% were made by rail. This origin and destination data was used to develop the prior rail commuting matrix and supplement the 'other' trip purpose matrix.

The CSO data was also used to estimate the approximate car availability for each of the rail commute trips based on the number of cars available in the household, the number of workers and non-workers in the household and the composition of the household.

9.3 Irish Rail Census 2016

Irish Rail conducted a comprehensive series of passenger counts at railway stations throughout Ireland in November 2016. The information collected as part of the census was as follows:

- Journey times and number of services along key Intercity, Commuter and Dart lines;
- Daily patronage of each line;
- Daily boarding and alighting totals at each station; and
- Hourly profiles of demand for each line.

The journey time and number of services information was used to validate the modelled network whilst the daily patronage and total station demand provided control totals as part of the development of the rail demand matrices.

The total number of daily inter city services decreased from 154 in 2012 to 120 in 2016. The only heavy rail intercity line where the number of services increased was Dublin to Cork, which operated an additional three trains per day by 2016. In terms of DART, in 2016 there were 17 more commuter services per day and 17 more Dart services per day than there were in 2012.

Table 9.1 shows daily rail journeys in the GDA between 2003 and 2016. The number of rail journeys in the GDA increased year on year up to its peak of approximately 144,000 in 2007. This was followed by a period of decline in patronage from 2008 to 2010.

Between 2011 and 2013 the number of daily journeys within the GDA remained relatively static. There has been a 3.6% increase in patronage in the GDA in the period 2015-2016. However,

between the 2 year period 2014 to 2016 there has been a 19% increase in patronage within the GDA. Overall GDA patronage is now at 86% of its peak level in 2007.

Table 9.1 Trends in Daily Rail Patronage 2003-2016 - GDA

Year	DART	Dundalk - Gorey	Longford – Dublin - Bray	Dublin – Carlow/ Athlone/ Portlaoise	Total
2003	68,152	19,446	11,642	8,246	**107,486**
2004	64,435	20,419	13,614	9,219	**107,687**
2006	81,560	23,305	21,966	11,349	**138,180**
2007	83,618	24,624	23,836	11,722	**143,800**
2008	75,753	22,191	22,678	11,145	**131,767**
2009	63,559	18,037	19,992	9,760	**111,348**
2010	55,929	17,446	18,770	9,042	**101,187**
2011	55,629	17,611	18,531	9,455	**101,226**
2012	56,835	17,895	17,915	8,490	**101,135**
2013	55,921	17,801	17,100	9,283	**102,101**
2014	55,003	18,780	19,097	11,371	**104,251**
2015	64,905	20,430	22,000	12,003	**119,338**
2016	67,123	21,782	22,432	12,278	**123,615**

Source: NTA

9.4 Origin Destination 1st Class Ticket Sales Information

Information on tickets sold in 2017 have been made available for the National Model update by Irish Rail. Table 9.2 shows the total number of 1st Class tickets sold in 2017. As first class travel is only available on certain services[22] such as Cork-Dublin, Tralee-Dublin and Belfast-Dublin; there are stations where this data is not applicable. Therefore, the 1st class ticket data is a partial sample of origin-destination trips on the rail network, which is used to inform the development of business trips by rail and in combination with POWSCAR data on commuting by rail to generate 'other' purpose trip matrices.

[22] http://www.irishrail.ie/rail-fares-and-tickets/first-class-travel

Table 9.2 Number of 1st Class Tickets per Origin Station

Station (Origin)	Total Boarding's
Galway Ceannt	0
Athlone	0
Gorey	0
Dundalk Clarke	146
Drogheda MacBride	234
Skerries	1
Dublin Connolly	10,469
Sallins and Naas	0
Adamstown	1
Tullamore	0
Cobh	0
Limerick Colbert	0
Cork Kent	12,368
Tralee Casement	115
Farranfore	28
Killarney	321
Rathmore	9
Millstreet	21
Banteer	3
Mallow	1,611
Charleville	173
Limerick Junction	860
Thurles	425
Templemore	8
Ballybrophy	1
Portlaoise	111
Kildare	1
Newbridge	0
Dublin Heuston	17,622
TOTAL	44,528

Source: Irish Rail

9.5 Aggregate Rail Demand

Rail demand[23] is recorded at an aggregate level by Irish Rail on an annual basis. Aggregate totals (million passengers per annum) are outlined below in Table 9.3 from 2008 to 2017 and highlight a general decrease in passenger numbers from 2008 to 2012 with slight annual increases from 2013 through 2017.

Table 9.3 Irish Rail Aggregate Demand (million passengers/year)

Service	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Inter City/ Commuter	24.78	21.27	21.36	21.45	20.92	20.64	21.26	22.42	-	-
DART	19.86	17.52	16.79	15.92	15.99	16.06	16.54	17.28	-	-
Total	44.6	38.8	38.2	37.4	36.9	36.7	37.8	39.7	42.8	45.5

Source: Irish Rail Annual Reports

The 2016 of 42.8m was used as a control total for the rail demand matrices during the model development process. Though the NTpM is intended as a model of the Republic of Ireland the yearly demand for Northern Ireland Railways was also used as a control total for the rail demand in Northern Ireland. According to the Translink annual report, the aggregate passenger total demand was 13.5 million in 2016.

[23] *Data provided in Iarnród Éireann (Irish Rail) Annual Reports 2008 to 2016*

10 National Inter-Urban Bus Model Data

10.1 Overview

The development of the bus demand matrices used a number of data sources as outlined below;

- 2016 POWSCAR database;
- Bus Eireann Timetables & Headways;
- Private Operator Services & headways; and
- Aggregate bus demand.

10.2 2016 POWSCAR Database

The 2016 CSO POWSCAR database provides journey to work and education data across all modes of transport. Of the 2,110,624 trips recorded in April 2016 and departing between 6.30 and 9.30, 12.1% were made by bus. However, of this demand 70% is home to education trips which are assumed to be predominantly catered by school buses and is not classed as inter urban demand. Therefore, only home to work commuting POWSCAR bus trips were used to develop the bus commuting matrix.

10.3 Bus Eireann Services

A full review was undertaken of the Bus Éireann modelled services including validation of the services included, run times and headways. A number of Bus Éireann services have stopped running since the last NTpM update in 2013. These include a number of former expressway routes and regional services. In addition, a number of routes have been shortened or combined with other routes. There are also a number of new routes and variation to existing routes. These changes were collated and included in the update of the NTpM.

Table 10.1 provides a summary of the Bus Éireann Expressway Service, their run time and frequency. In addition to the Expressway Services all Bus Éireann Regional Services are also included in the NTpM.

Table 10.1 Bus Éireann Expressway Service Run Time & Frequency

Service no.	Route	Run Time	Frequency
X1	Dublin- Dublin Airport – Newry- Belfast	2hr 20min	9 services per day
2	Dublin Airport – Dublin – Arklow – Gorey- Enniscorthy – Wexford	2hr 25min	14 services per day
4	Dublin Airport – Dublin – Carlow – Waterford – New Ross	3h 30min	12 services per day
X5	Dublin- Dublin Airport – Newry	1h 30mins	12 services per day
X8	Dublin Airport – Dublin – Cashel – Fermoy - Cork	4h 15min	6 services per day
X12/12	Dublin Airport – Dublin – Portlaoise – Roscrea – Nenagh -Limerick	3hr 25mins	6 services per day
13	Limerick - Adare – Listowel – Tralee	2hr 5mins	9 services per day
14	Limerick -Kerry Airport – Killarney	2hr 5mins	9 services per day
X20/20	Dublin – Dublin Airport – Athlone – Ballinasloe - Galway	3hr 45min	17 services per day
22	Dublin – Dublin Airport – Mullingar – Longford - Ballina	3hr 15min	6 services per day
23	Dublin – Dublin Airport – Mullingar – Longford - Sligo	3hr 10min	6 services per day
X30/30	Dublin – Dublin Airport – Cavan – Enniskillen – Donegal Town – West Donegal	4hr	13 services per day
32	Dublin – Dublin Airport – Monaghan – Letterkenny	4hr	9 services per day
40	Rosslare Harbour – Waterford – Cork – Killarney – Kerry Airport - Tralee	4hr 45min	9 services per day
X51	Limerick – Galway Express	1rh 20min	13 services per day
51	Cork – Limerick – Shannon Airport – Ennis – Galway	4hr 20min	16 services per day
52	Ballina – Castlebar – Galway	2hr 25min	6 services per day
55	Limerick – Clonmel – Waterford	2hr 25min	8 services per day
64	Galway – Ireland West Airport Knock – Sligo - Derry	5hr 10min	8 services per day

10.4 Private Operator Services

Information on private bus service providers were extracted from the Transport for Ireland (TFI) website. TFI provides a list of private bus operators with links that contain service and timetable information. Table 10.2 presents run time and frequencies of private operator services outlined on the TFI website.

It should be noted that only services which operate daily on weekdays have been included in the model. Service that run infrequently (i.e. less than 5 days per week) or through predominantly urban areas have not been included in the model.

Table 10.2 Inter-Urban Service Run Time & Frequency

Service Provider	Service no.	Route	Run Time	Frequency
Airport Hopper	767	Maynooth - Leixlip - Lucan - Liffey Valley - Airport	50min	Hourly
	777	Tallaght - Belgard - Newlands - Clondalkin - Fonthill - Liffey Valley - Dublin Airport	45min	Hourly
Ardcavan	722	Wellington Bridge - Wexford - Enniscorthy - Gorey - Dublin City Centre - Dublin Airport	3h 30min	Daily
	-	Enniscorthy - Wexford - Ballinaboola - New Ross - Limerick	4h	Weekly
	-	Maynooth - Tullow - Bunclody - Enniscorthy - Wexford	2h 15min	Weekly
JJ Kavanagh	717	Clonmel - Kilkenny - Athy - Dublin City - Dublin Airport	3h 10min	9 services per day
	736	Dublin Airport - Dublin City - Carlow - Waterford	3h 25min	12 services per day
	735	Limerick - Nenagh - Roscrea - Portlaoise - Dublin Airport	4h 15min	10 services per day
Dublin Coach	M1 Express	Dublin – Belfast Direct	1h 50min	16 services per day
	M7 Express Service	Dublin to Ennis / Killarney / Tralee via Limerick	4h 30min	35 service per day
	N7 Service	Portlaoise to Dublin Airport	1h 55min	24 services per day
	N7 Supplementary Service	Kildare - Newbridge - Naas	49min	10 services per day
	M9 Express Service	Cork - Waterford - Kilkenny - Dublin	4h 20 min	10 services per day
	-	Dublin Airport - Dundrum	45min	42 services per day
	Portarlington Connector	Portarlington - Monasterevin - Kildare	25min	16 services per day
	307	William Street - Cappavilla - via Brookfield	21min	13 services per day
	308	William Street to University of Limerick - Annacotty - William Street	37min	13 services per day
Collins Coaches	980	Ballybay - Carrickmacross - Ardee - Slane - Dublin	2h 10min	12 services per day

Service Provider	Service no.	Route	Run Time	Frequency
Swords Express	500	Swords - Dublin	49min	34 services per day
Finnegan Bray	143	Southern Cross - Bray Dart - Shankill - Cabinteely - Sandyford	45min	6 services per day
	144	Southern Cross - Bray Dart	15min	12 services per day
Silver Dawn Travel	UCD01	Portarlington - Monastrevin - Kildare - Newbridge - Rathcoole - Dublin	2h	Daily
Globus	707	Cork - Dublin City Centre - Dublin Airport	3h 15min	8 services per day (plus 4 additional services on Friday)
	720	Galway - Dublin City	3h	13 services per day
Express Bus	870	Dublin City Centre - Blanchardstown - Damastown Industrial Park	30min	8 services per day
Wexford Bus	740	Wexford - Enniscorthy - Arklow - Dublin City - Dublin Airport	2h 45min	18 services per day
	340	Wexford - Waterford	1h 15min	8 services per day
	376	Wexford - Enniscorthy - Ballon - Carlow	1h 30min	2 services per day
Citylink	660/761	Galway – Dublin Airport	2h 45min	23 services per day
	763	Galway - Ballinasloe - Athlone - Dublin City - Dublin Airport	4h	7 services per day
	712x	Limerick - Dublin Airport	2h 30min	8 services per day
	251	Galway - Limerick - Cork - Cork Airport	3h 10min	5 services per day
John Kearns	847	Portumna - Tullamore - Maynooth - Dublin	3h 8min	2 services per day
	845	Birr - Tullamore - Maynooth - Dublin	2h 28min	8 services per day
	NUM02	Maynooth - Enfield - Tullamore - Birr	2h 25min	Daily
	844	Birr - Portumna - Galway	1h 50min	2 services per day
John McGinley	933	Moville - Derry - Dublin Airport - Dublin City	5h 30 min	2 services per day
	932	Annagry - Letterkenny - Dublin Airport - Dublin City	5h	3 services per day
Aircoach	703	Killiney - Dalkey - Dun Laoghaire - Blackrock - Ballsbridge - Grand	1h 9min	Hourly

Service Provider	Service no.	Route	Run Time	Frequency
		Canal Dock - Port Tunnel - Dublin Airport		
	702	Greystones - Bray - Shankill - Blackrock – Ballsbridge – Grand Canal Dock - via Port Tunnel - Dublin Airport	1h 41min	Hourly
	700	Dublin Airport - City Centre - Stillorgan - Sandyford - Leopardstown	60min	15 min
	704X	Dublin Airport - Dublin City - Cork	3h 25min	Hourly
	705X	Belfast - Dublin Airport - Dublin City	2h 10min	Hourly
Matthews	910	Bettystown - Laytown - UCD	60min	Daily
	902/903	Dundalk - Drogheda - IFSC	1h 40miin	Daily
	912	Bettystown - Laytown - IFSC	1h 15min	Daily
	900/901	Dundalk - Drogheda - Dublin	1h 30min	23 services per day
McConnon Travel Limited	180	Clones - Ardee - Slane - Finglas - Dublin	2h 12min	2 services per day
St Kevin's Bus Glendalough	181	Glendalough - Bray - Shankill - Stillorgan - UCD - St. Stephen's Green	1h 20min	3 services per day
Sillan Tours Ltd	179	Cootehill - Killberry - Navan - Dublin	2h 25min	9 services per day
Ashbourne Connect	193	Ashbourne - IFSC - Dublin City Centre	1h 1min	7 services per day
	194/194A/194X	Ashbourne - IFSC - Dublin City Centre - UCD	1h 15min / 1h 29min / 59min	13 services per day
M&A Coaches	828	Cashel - Littleton - Johnstown - Durrow - Portlaoise	50min	4 services per day
Translink	X1/X2	Dublin Airport - Belfast	2h 25min / 2h 10min	22 services per day
	X3/X4	Dublin Airport - Derry Londonderry	3h 50min / 4h 5min	8 services per day
Geraghty Travel	NUG09	Ballymote - Castlerea - Dunmore - Galway	3h 30min	Daily (Friday only)
	NUG08	Ballinamore - Carrick - Castlerea - Dunmore - Galway	3h 55min	Daily (Friday and Thursday only)
	-	Strokestown - Longford - Athlone - Gort - Limerick	3h 52min	Daily (Friday only)

Service Provider	Service no.	Route	Run Time	Frequency
	-	Tubbercurry - Castlerea - Roscommon - Limerick	4h 13min	Daily (Friday only)
	-	Carrigallen - Longford - Galway	3h 6 min	Daily (Friday only)
Burkebus	427	Tuam - Galway City	-	14 services per day
	428	Milltown - Galway	-	Daily (Friday only)
	435	Headford - Galway City	-	5 services per day
Bus Feda	-	Galway - Donegal	3h 5min	2 services per day
Fingal Express	Lusk Route	Lusk - Dublin	45min	4 services per day
	Skerries / UCD Route	Skerries - Rush - Lusk - Dublin	1h 30min	Daily
Foyle Coaches	Inishowen - Letterkenny	Moville -Malin - Ballyliffin - Fahan - Bridgend - Letterkenny	1h 50min	4 services per day
	Carndonagh - Derry	Carndonagh - Derry	40min	4 services per day
	Shrove - Moville - Derry	Shrove - Moville - Derry	1h 5min	4 services per day

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