Údarás Náisiúnta Iompair
National Transport Authority

Cork Metropolitan Area Transport Strategy

Transport Modelling Assessment Report

September 2018

National Transport Authority,
Dun Scèine,
Harcourt Lane,
Dublin 2.

Document Identification Table	
Client / Project Owner	National Transport Authority
Document Title	Transport Modelling Assessment Report
Task Order	
Task	Cork Metropolitan Area Transport Strategy
Deliverable Code	
Version	V1.0
Document Status	Draft

Document Status Tables

Version 1

	Name	Position	Date
Originated by	Paul Hussey	Principal Consultant	20/09/2018
Checked by	John Paul FitzGerald	Project Manager	20/09/2018
Approved by	John Paul FitzGerald	Project Manager	20/09/2018
NTA Review			

Version 2

	Name	Position	Date
Originated by			
Checked by			
Approved by			
NTA Review			

Version 3

	Name	Position	Date
Originated by			
Checked by			
Approved by			
NTA Review			

CONTENTS

CONTENTS i

1 Introduction 2

1.1 Background 2
1.2 Purpose of Report 2
1.3 Report Structure 3

2 Transport Network Option Development Methodology 4

2.1 Option Development and Assessment Methodology 4

3 NTA Regional Modelling System 5

3.1 Introduction 5
3.2 Regional Modelling System Dimensions 7
3.3 SWRM Structure 10
3.4 Suitability of South-West Regional Model in Developing the Strategy 19

4 CMA Transport Strategy Modelling Approach 21

4.1 Introduction 21
4.2 Land-Use Assumptions 21
4.3 Scenario Description 22
4.4 Strategy Appraisal Methodology 30

5 CMA Transport Strategy Appraisal 32

5.1 Introduction 32
5.2 Safety 32
5.3 Physical Activity (Health Appraisal) 32
5.4 Environment 34
5.5 Accessibility and Social Inclusion 34
5.6 Integration 37
5.7 Economy 39
5.8 Demand and Mode Share Analysis 42
5.9 Public Transport Network Analysis 50
5.10 Active Modes Network Operations 57
5.11 Road Network Operations 57
5.12 CMATS Supporting Measures Assessment 58

6 Conclusions 59

1 Introduction

1.1 Background

The National Transport Authority (NTA) is a public body set up under statute and established in December 2009. The role and functions of the NTA are set out in three Acts of the Oireachtas; the Dublin Transport Authority Act 2008, the Public Transport Regulation Act 2009 and the Taxi Regulation Act 2013. In August 2015, the Department of Transport, Tourism and Sport (DTTaS) published its policy document *"Investing in our Transport Future - Strategic Investment Framework for Land Transport"*. Action 4 of that framework states that: *"Regional transport strategies will be prepared by the NTA and provide an input to regional spatial and economic strategies".*

Having regard to its role in relation to transport, and the action placed upon it in the DTTaS policy document, the NTA, in collaboration with Cork County and City Councils, is developing a Transport Strategy for the Cork Metropolitan Area (CMA) covering the period 2017 to 2036. The strategy will provide a framework for the planning and delivery of transport infrastructure and services in the CMA over the next two decades. It will also provide a planning policy for which other agencies can align their future policies and infrastructure investment.

1.2 Purpose of Report

The methodology for the development of the CMA Transport Strategy 2017-2036 is undertaken on a step by step basis, from: reviewing the existing policy and transport baseline, undertaking a detailed future demand analysis, developing transport options, optimisation of land use to align with high performing transport corridors, developing the draft Strategy for public consultation and subsequently finalising the Strategy, as shown in Figure 1-1.

Figure 1-1: Cork Metropolitan Area Transport Strategy Methodology

Having developed the transport options (within the "Transport Options and Network Development Report") to serve the anticipated demand requirements for the CMA up to 2040, this report describes the process of modelling the proposed transport measures for all modes (public transport, walking, cycling, car and freight) within the National Transport Authority's (NTA) South West Regional Model (SWRM). The modelling process also considered the refinement of the transport options in tandem with the forecast land use scenarios to better support the efficient development of the transport network.

An appraisal of the Strategy options, utilising the Regional Modelling System (RMS) appraisal toolkit has been undertaken which provides a quantitative appraisal that aligns with the Department of Transport, Tourism and Sport (DTTAS) Common Appraisal Framework (CAF). Other Key Performance Indicators (KPIs) have also been assessed to understand the performance of the proposed CMATS network across all modes.

1.3 Report Structure

The following provides a description of the contents of each section of the report;

- **Section 2** summarises the Transport Network Option Development Methodology which includes the Transport Modelling Assessment.
- **Section 3** provides an overview of the NTA Regional Modelling System (RMS) which includes the South West Regional Transport Model (SWRM) used for the assessment of CMATS.
- **Section 4** details the approach to the modelling assessment which is in-line with Common Appraisal Framework (CAF) guidance.
- **Section 5** outlines the results of the appraisal of CMATS under each of the CAF criteria; and
- **Section 6** concludes the report.

2 Transport Network Option Development Methodology

2.1 Option Development and Assessment Methodology

This report describes the process of modelling the transport options developed for all transport modes. Figure 2-1 below outlines the methodology for the development and assessment of the strategy options. Having determined the Upper-limit public transport mode share demand from the "idealised" public transport network model run the Strategy transport options can now be developed, refined, optimised and assessed. This process is show below as an iterative process linking the development of the Strategy Options with the optimisation of the land use forecasts and testing within the SWRM. The resulting outcome of this process is the identification of an Emerging Preferred Strategy Network and a recommended land use optimisation that better supports the Strategy network.

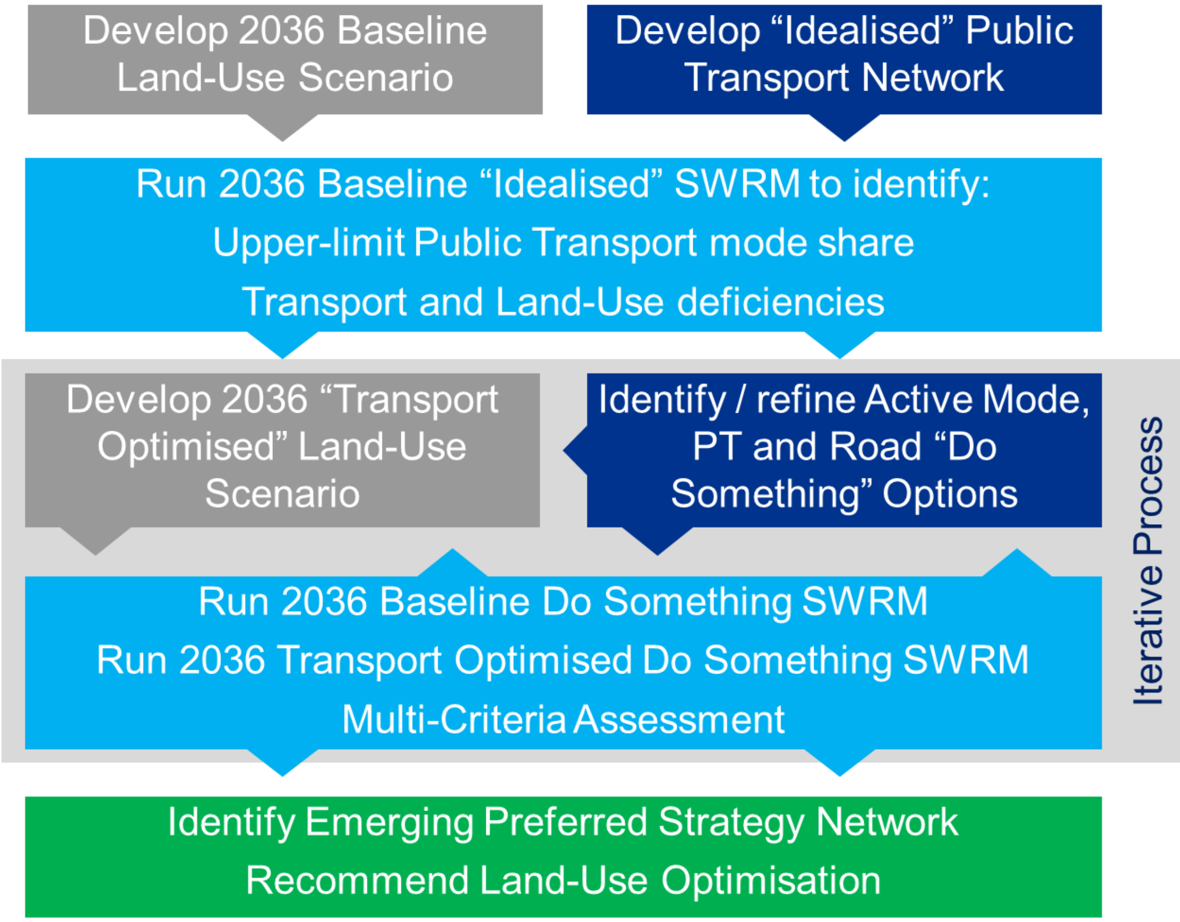

Figure 2-1: Option Development and Assessment Methodology

3 NTA Regional Modelling System

3.1 Introduction

This section describes the NTA Regional Modelling System, outlining its scope, extent, components, functionality and its suitability for use in developing the CMA Transport Strategy. The national remit of the NTA requires a system of regional models to help it deliver on its planning and appraisal needs. The NTA Regional Modelling System comprises five regional transport models covering the Republic of Ireland and centred on the five main cities of Dublin, Cork, Galway, Limerick, and Waterford and are summarised in Table 3-1 below.

Table 3-1: Regional Modelling System

Regional Modelling System	Abbreviation	Counties Covered
Eastern Regional Model	ERM	Louth, Monaghan, Cavan, Longford, Westmeath, Meath, Offaly, Laois, Kildare, Dublin, Wicklow, Carlow & Northern Wexford
South East Regional Model	SERM	Wexford, Kilkenny, Waterford & Tipperary South
South West Regional Model	SWRM	Cork & Kerry
Mid-West Regional Model	MWRM	Limerick, Clare & North Tipperary
Western Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Donegal & Leitrim

Each regional model has the following key attributes:

- Full geographic coverage of the relevant region;
- A detailed representation of the road network, particularly the impact of congestion on on-street public transport services and include modelling of residents' car trips by time period from origin to destination;
- A detailed representation of the public transport network & services, and can predict demand on the different public transport services within the regions;
- A representation of all major transport modes including active modes (walking and cycling) and includes accurate mode-choice modelling of residents;
- A detailed representation of travel demand, e.g. by journey purpose, car ownership/availability, mode of travel, person types, user classes & socio-economic classes, and representation of four time periods (AM, Inter-Peak, PM and Off-Peak); and
- A prediction of changes in trip destination in response to changing traffic conditions, transport provision and/or policy.

The South West Regional Model (SWRM), which covers Cork County & City, has been used to support the development of the CMA Transport Strategy. Figure on the following page illustrates the geographical extent of each of the Regional Models.

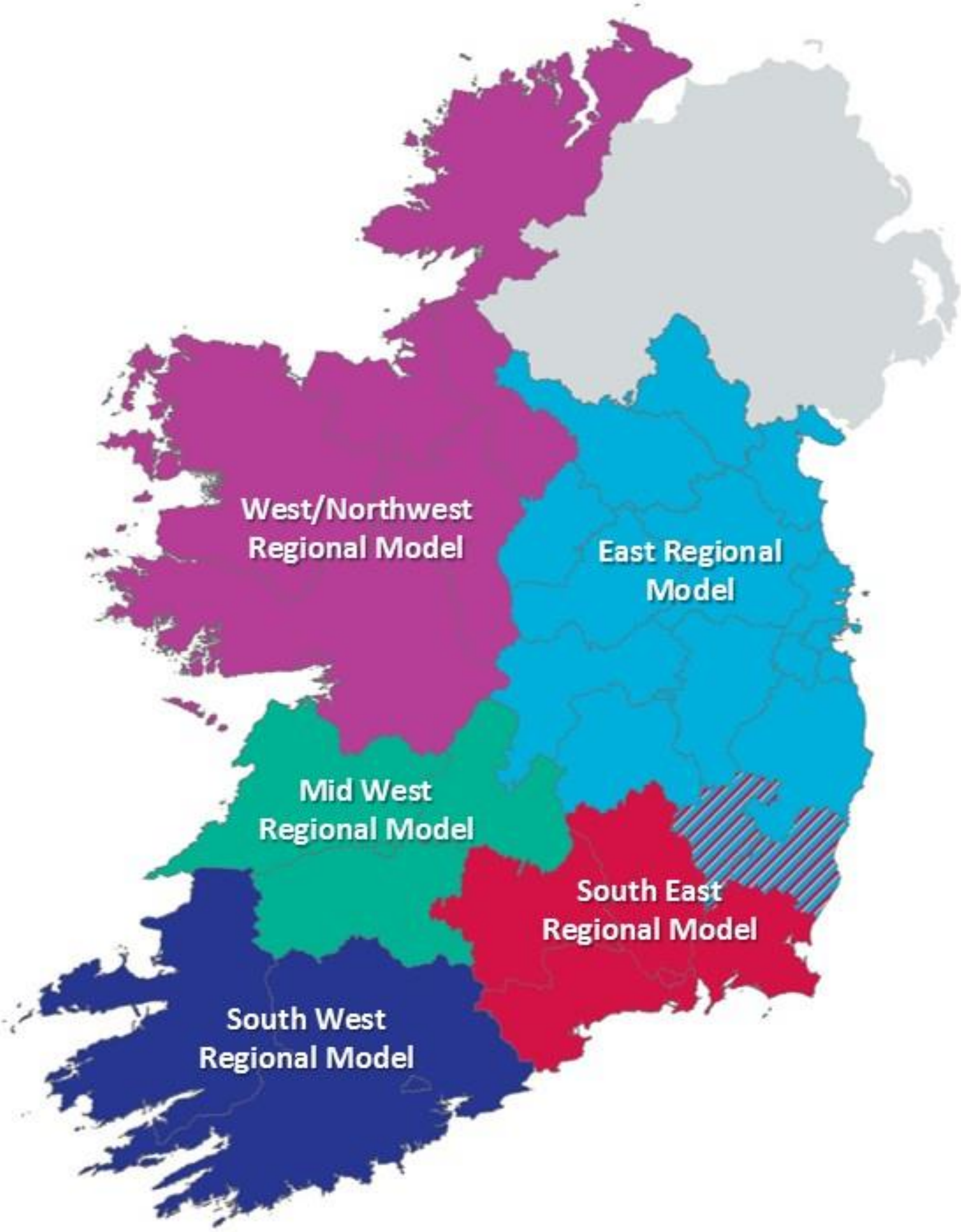

Figure 3-1: Modelling System Regional Model Areas

3.2 Regional Modelling System Dimensions

The regional modelling system features or dimensions are defined in terms of:

- Zone system.
- Modes of travel represented;
- Base year;
- Time-periods; and
- Demand segmentation;

3.2.1 Zone System

The zone system definitions for each of the regional models were based on Census Small Area (CSA) boundaries and Electoral Districts (EDs). The 2011 CSAs are the core base layer for each zoning system. CSAs are the smallest geographic unit of data available with which to define the model zone system. Each CSA is a defined geographic area associated with demographic data (e.g. population, age distribution, employment status), and the work / school travel characteristics of the population (via *Place of Work, School or College - Census of Anonymised Records* (POWSCAR)).

CSAs are subsets of EDs. ED boundaries are commonly used as the unit of geographic information in Ireland and as such it was desirable to maintain a transparent relationship between EDs and the model zone system. Regional Model zones can be smaller or larger than either of these units where required.

The criteria used for developing zone boundaries for the SWRM and other regional models included:

- Population, Employment and Education – maximum values were specified for zone population, number of jobs and persons in education;
- Activity Levels – limits were applied to zone activity levels ensuring that zones with either very low, or very high, levels of trips were not created;
- Intra-zonal Trips – threshold values were 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 were created with homogeneous land use and socio-economic characteristics where possible;
- Zone Size/Shape – thresholds were applied to zone size, and irregularity of shape, to avoid issues with inaccurate representation of route choice;
- Political Geography – as mentioned above, it is possible to aggregate all zones to ED level i.e. zone boundaries do not intersect ED boundaries;
- Special Generators/Attractors – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. were allocated to separate zones.

Figure 3-2 shows the SWRM Zone System.

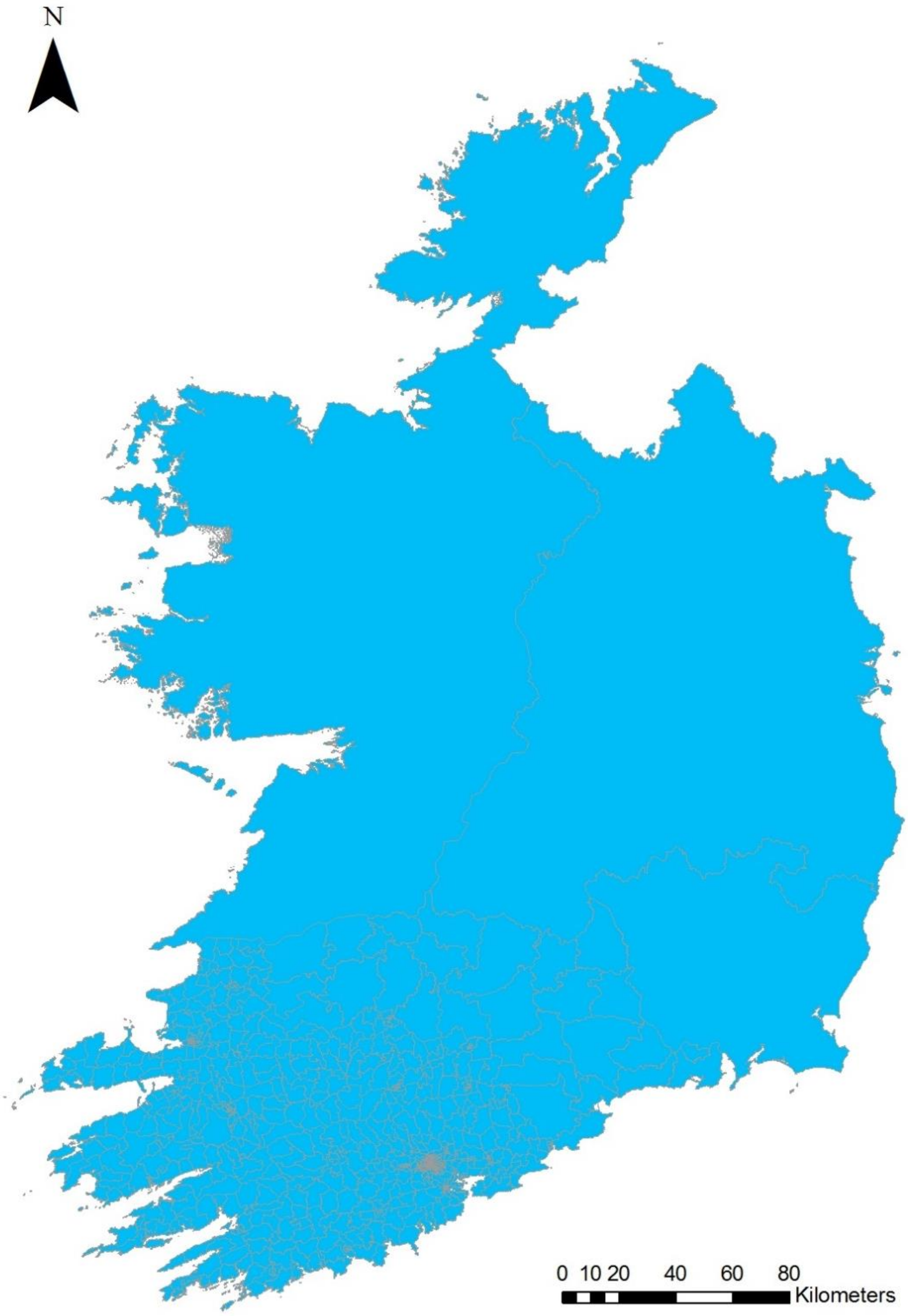

Figure 3-2: SWRM Zone System

The SWRM zone system includes:

- **Total zones: 788**;
- Cork City zones: 148;
- County Cork zones: 421;
- County Kerry zones: 188; and
- External zones: 31

3.2.2 Modes of Travel

The regional model system covers all surface access modes for personal travel and goods vehicles:

- Private vehicles – taxis and cars;
- Public transport – bus, rail, Luas, BRT, Metro;
- Active modes – walking and cycling; and
- Goods vehicles – light goods vehicles and heavy goods vehicles.

3.2.3 Base Year

The base year of each model is 2012 with a nominal month of April. This is largely driven by the date of the Census (POWSCAR) and the National Household Travel Survey (NHTS). It should be noted that the POWSCAR dates to 2011 but the travel patterns are assumed to be broadly the same in 2012.

3.2.4 Time Periods

The model represents an average weekday. The day is split into five time periods considered within each of the regional models, detailed in Table 3-2 below. The periods allow the relative difference in travel cost between time periods to be represented. Representative peak hours are used in the assignment models, which are based on period to peak hour factors derived from survey data for each time period and mode.

Table 3-2: Time Periods

Period	DEMAND MODEL FULL PERIOD	ASSIGNMENT PERIOD
AM Peak	07:00-10:00	Peak hour – based on a Peak Hour factor of 0.393 for cars, 0.393 for active modes and 0.47 for public transport
Morning Inter Peak (IP1)	10:00-13:00	Average hour from full period - based on a Peak Hour factor of 0.33 for cars, 0.33 for active modes and 0.33 for public transport
Afternoon Inter Peak (IP2)	13:00-16:00	Average hour from full period (not assigned)
PM Peak	16:00-19:00	Peak hour - based on a Peak Hour factor of 0.358 for cars, 0.358 for active modes and 0.4 for public transport
Off Peak	19:00-07:00	Free flow assignment

3.3 SWRM Structure

3.3.1 Overarching Structure

As mentioned above, the SWRM is the model used to support the development of the CMA Transport Strategy. All the regional models, including the SWRM, include 3 core modelling processes (i.e. Demand Model, Road Assignment Model and Public Transport Assignment Model) which receive inputs from the National Demand Forecast Model (NDFM) and provide outputs for transport appraisal and secondary analysis. This process is shown in Figure 3-3 below.

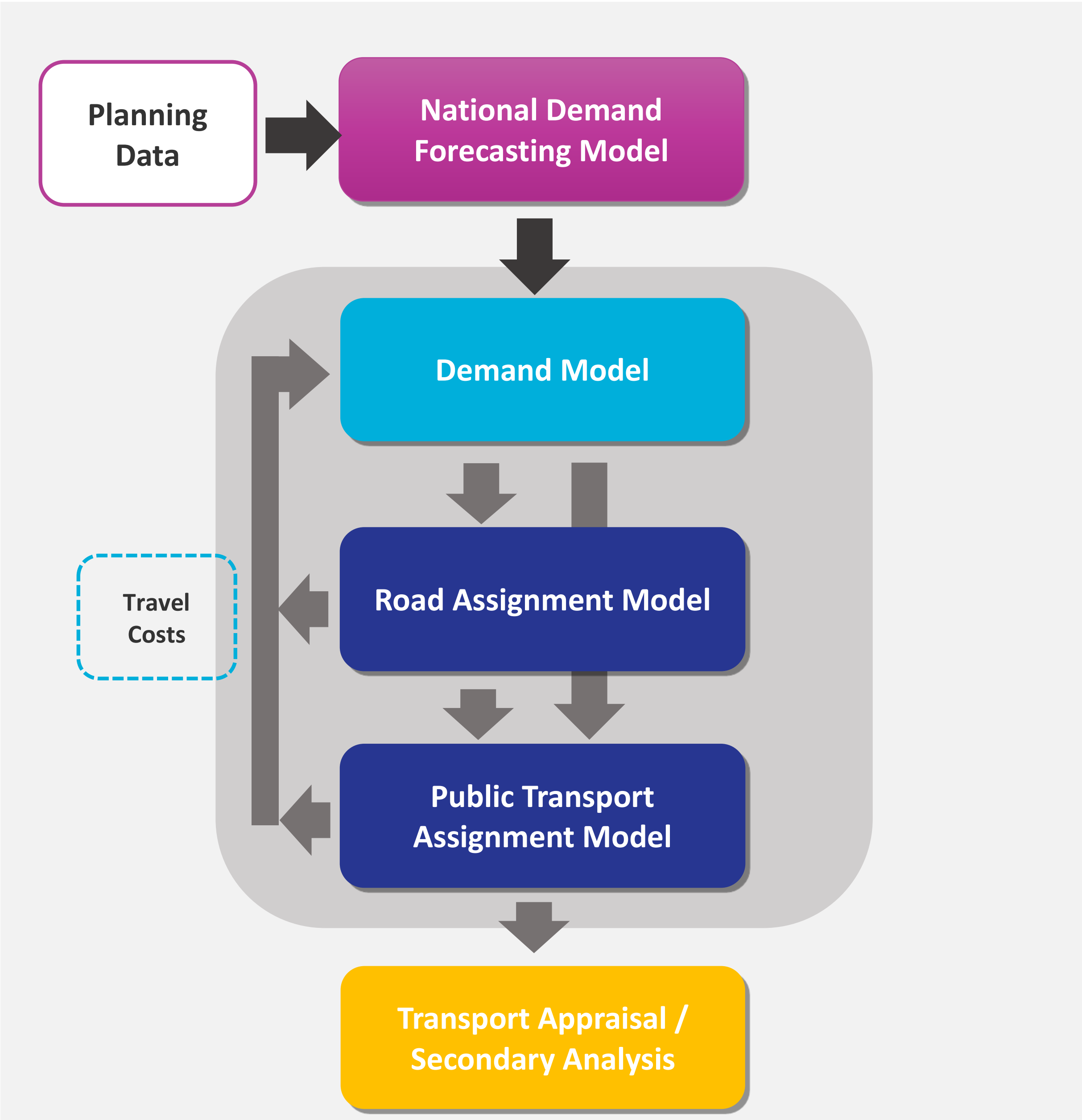

Figure 3-3: Model Structure

3.3.2 Planning Data

The Planning Data referred to above is a national database of 99 demographic and spatial variables for each of the 18,488 CSAs in the state. The main categories of planning data are:

- References and spatial definitions;
- Origin-based person types; e.g. age bands, gender, principal economic status (PES), employment type, and various combinations of categories;
- Destination-based person types; e.g. employment type or education type; and
- Households.

3.3.3 National Demand and Forecasting Model (NDFM)

The ***NDFM*** is a separate modelling system that estimates the total quantity of travel demand generated by and attracted to every Census Small Area (CSA) daily. The level of demand from, and to, each zone (referred to as trip ends) is related to characteristics such as population, number of employees and land-use data as outlined in Section 2.

The NDFM comprises the set of models and tools that are used to derive national levels of trip making, for input to each of the regional models. The NDFM outputs levels of trip making at the smallest available spatial aggregation (CSA).

The key components of the NDFM are as follows:

- The **Planning Data Adjustment Tool** (PDAT) controls the planning data inputs to the core NDFM system. It is used to amend planning data to represent the combination of general changes over time and the relevant land-use planning scenarios;
- The **Car Ownership/Car Competition Models** estimate the level of car ownership in a CSA, (sub-dividing the number of households in each CSA between 'No Car', 'Cars < Adults' and 'Cars >= Adults' households) i.e. the car competition bands;
- The **Car Availability Model** classifies the set of individual person trips as either 'Car Available' or 'Car-not-available' using calibrated relationships between the three car competition bands and the trip purpose;
- The **National Trip-End Model (NTEM)** converts the planning data into person trips, using calibrated trip rates; and
- The **Regional Modelling System Integration Tool (RMSIT)** estimates the level of trip-making by main mode (car, bus, rail and goods vehicles) between 38 of the main urban settlements in Ireland.

Figure 3-4 shows the system of NDFM models and the key regional model components that the NDFM interacts with.

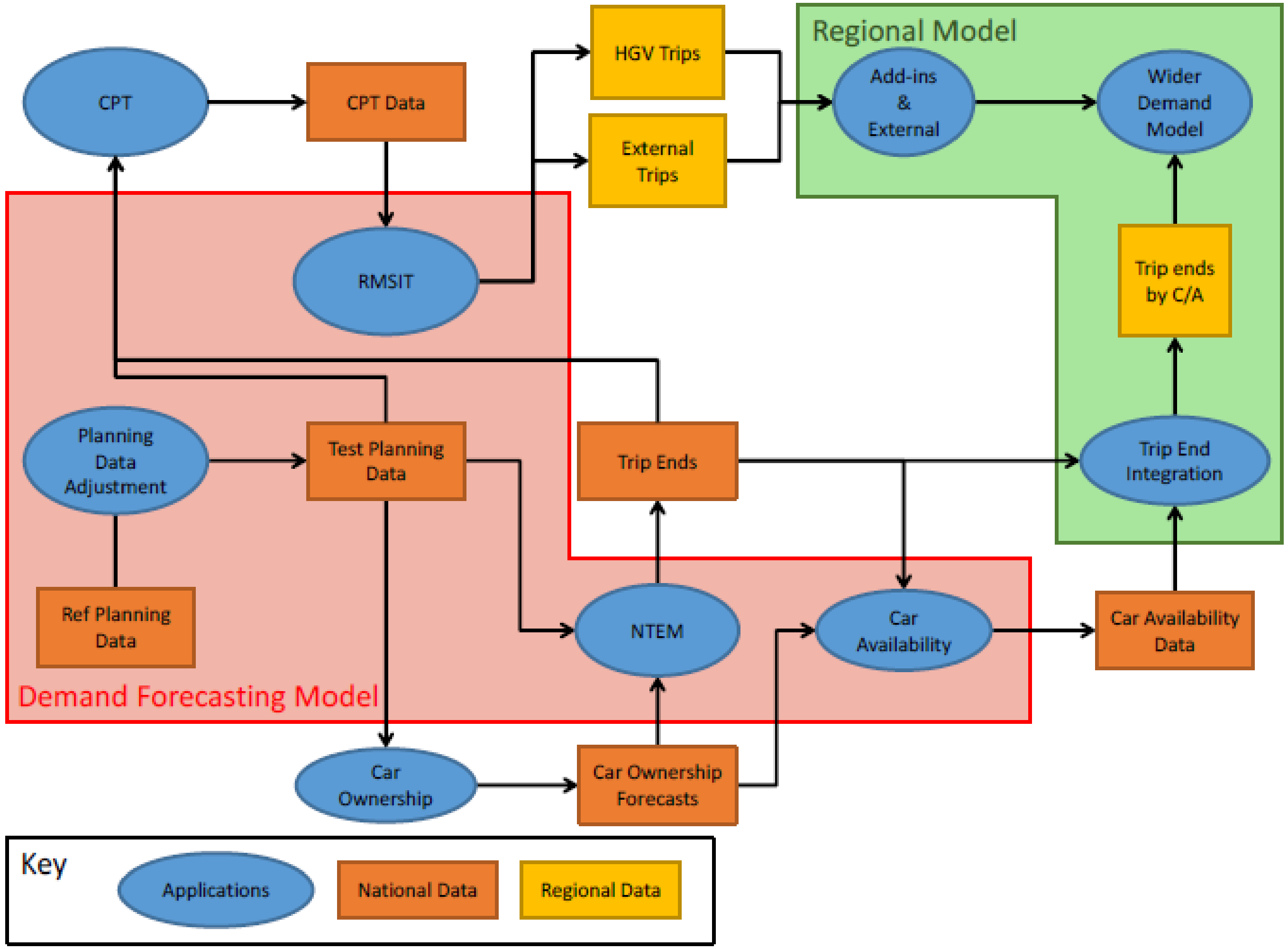

Figure 3-4: NDFM Structure

3.3.4 Demand Segments

Groups of people with similar travel behaviours (for example, commuters who own a car) are represented by distinct demand segments in the regional modelling system. This allows those groups to be treated differently in the regional demand model according to their behaviour.

The NDFM demand segments were derived from the National Household Travel Survey (NHTS) data and *Place of Work, School or College - Census of Anonymised Records* (POWSCAR) data sets. They have been segmenting into 33 distinct classifications as noted below in Table 3-3.

Table 3-3: Demand Segments

No.	Purpose	Car Availability	Third Level of Segmentation
1	Commute	Available	Blue collar
2	Commute	Available	White collar
3	Commute	Not available	Blue collar
4	Commute	Not available	White collar
5	Education	Available	Primary
6	Education	Available	Secondary
7	Education	Available	Tertiary
8	Education	Not available	Primary
9	Education	Not available	Secondary
10	Education	Not available	Tertiary
11	Escort to education	Available	Primary
12	Escort to education	Available	Secondary
13	Escort to education	Available	Tertiary
14	Escort to education	Not available	Primary
15	Escort to education	Not available	Secondary
16	Escort to education	Not available	Tertiary
17	Other	Available	Employed
18	Other	Available	Non-working
19	Other	Not available	Employed
20	Other	Not available	Non-working
21	Shopping - food	Available	Employed
22	Shopping - food	Available	Non-working
23	Shopping - food	Not available	All
24	Visit friends / relatives	Available	Employed
25	Visit friends / relatives	Available	Non-working
26	Visit friends / relatives	Not available	All
27	Employers Business	All	All

No.	Purpose	Car Availability	Third Level of Segmentation
28	All	Available	Retired
29	All	Not Available	Retired
30	One-way business	Available	All
31	One-way business	Not available	All
32	One-way other	Available	All
33	One-way other	Not available	All

3.3.5 Tours

Tours are an important aspect of how Trip Ends are modelled. The main concept is that every person is expected to make a distinct series of trips beginning from their house and ultimately returning home (signalling the end of a tour). The five distinct trip types which may comprise a tour are shown graphically below in Figure 3-5 and include:

- Simple from Home;
- Simple to Home;
- One-way from Home;
- One-way to Home; and
- Non-Home-Based (NHB) trips.

All tours are defined relative to a home or a destination. This corresponds to the concept of productions and attractions where productions are associated with homes and attractions are associated with destinations. The terms productions and attractions are not used when discussing one-way or NHB trips. These are dependent on direction, are not defined to return to a home or a particular attraction, and therefore in these cases the labels origin and destination are used referring to the start and finish location of such trips.

It is worth noting that trip chains (a tour comprising more than two trips) are modelled as multiple single trips. These consist of an outbound (one way From Home) and an inbound (one-way To Home) as well as any number of intermediate NHB trips. An example of this is shown in Figure 3-5.

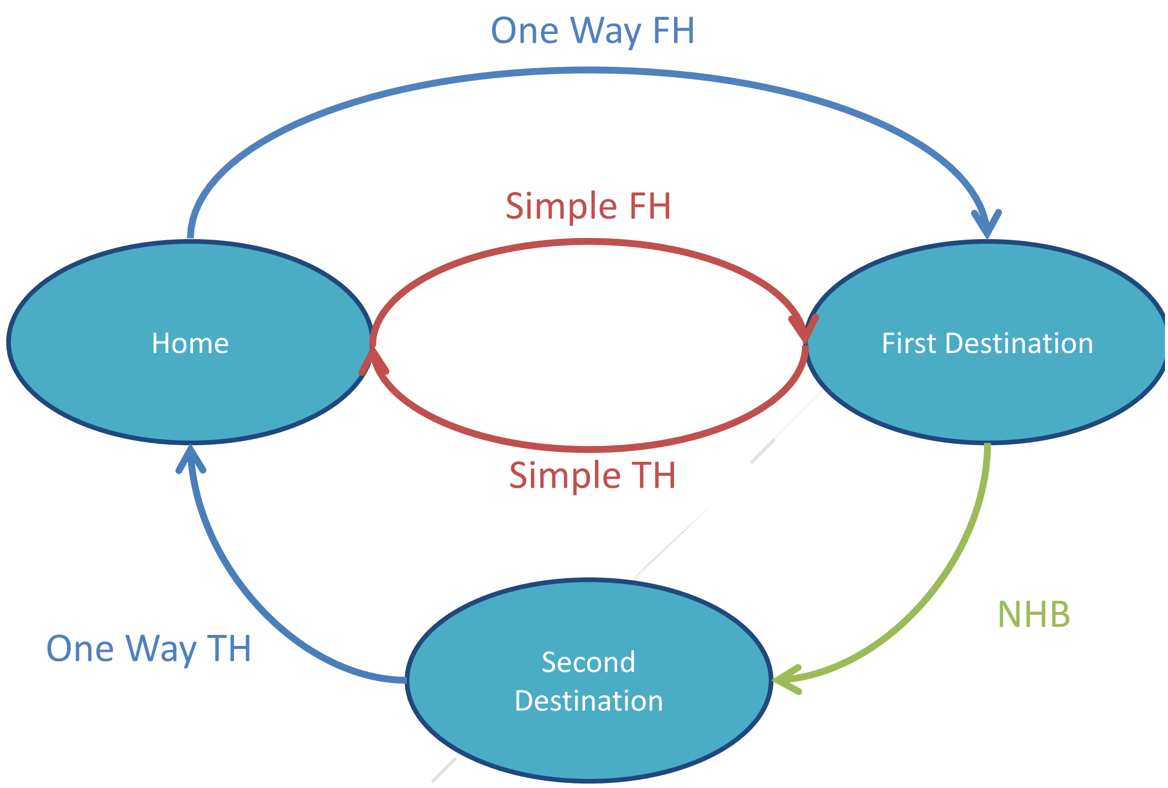

Figure 3-5 Trip Chains

Figure 3-6 shows the most basic relation of origins and destinations with respect to directional trips, comparable to simple tours.

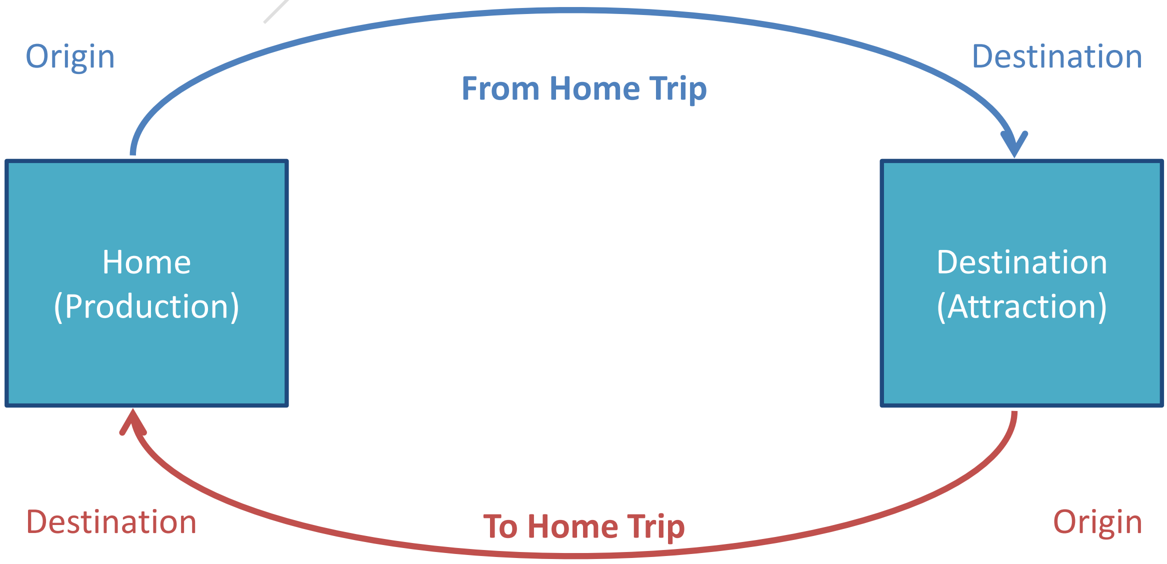

Figure 3-6 PA V OD for Simple Tours

Figure 3-7 below shows the same relationship for trip chains, where it is particularly noted that both ends of a non-home-based tour correspond to attractions.

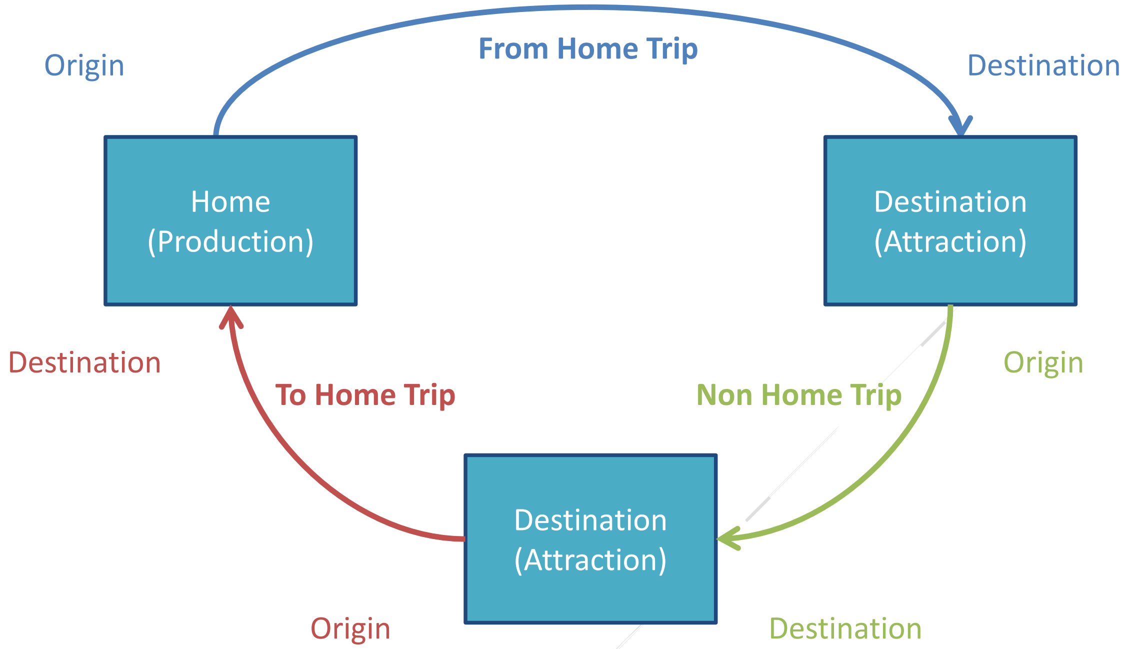

Figure 3-7 PA V OD for Extended Tours

Tours are considered as movements within or from time period to time period as shown in the Tour Grid below in Table 3-4. The tours under the diagonal for the IP1, IP2 and PM time periods (marked in green) are those which are not considered in any calculations while the off-peak tours (marked in red) are considered only in commute demand segments. Time period demand is derived either by summing the rows (From Home) or the columns (To Home).

Table 3-4: Tour Grid

TP Out\ TP In	AM	IP1	IP2	PM	OP
AM	1	2	3	4	5
IP1	6	7	8	9	10
IP2	11	12	13	14	15
PM	16	17	18	19	20
OP	21	22	23	24	25

3.3.6 SWRM Demand Model

The **Demand Model** models travel behaviour and is implemented in Cube Voyager. The demand model processes all-day travel demand from the NDFM through a series of choice models to represent combined mode, time of day, destination and parking decision making. The outputs of the demand model are a set of trip matrices which are assigned to the Road and Public Transport models to determine the route-choice and generalised costs.

The demand model consists of several components that interact in a sequential manner between the trip end model and the assignment models. It includes the following distinct components:

- Macro Time of Day;
- Mode Choice;
- Destination Choice;
- Parking; and

- Tours and One-Way.

A simple representation of the model structure is shown in Figure 3-8.

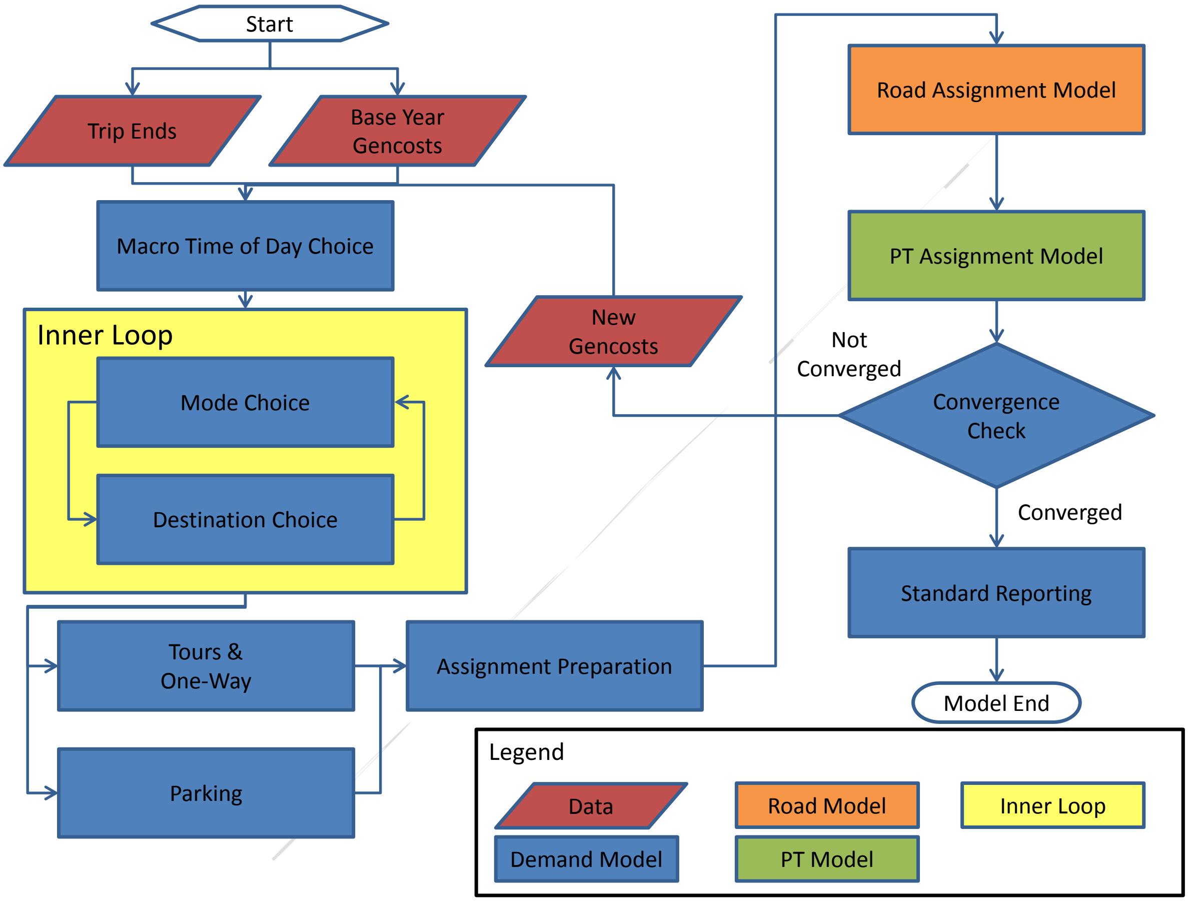

Figure 3-8: Demand Model Structure

3.3.7 SWRM Road Assignment Model

The **Road Assignment Model** (RDAM) is implemented in SATURN and includes capacity restraint whereby travel times are recalculated in response to changes in assigned flows. The main purpose of the RDAM is to assign road users to routes between their origin and destination zones. The cost of travel is then calculated by the RDAM for input to the demand model and economic appraisal.

The inputs to the Road Assignment model from the demand model are the road assignment matrices from the assignment preparation stage.

The outputs from the Road Assignment model for the demand model processes consist of generalised costs skims by time period and assigned road networks in CUBE Voyager format which are passed on to the PT model.

In addition to these requirements for demand model processes, there are a series of standard SATURN outputs that are produced for use in the specific interrogation of the road networks for scheme and/or scenario assessment.

3.3.8 SWRM Public Transport Assignment Model

To generate costs to update the choice model processes, a PT assignment must be undertaken to establish new generalised costs. The **Public Transport Assignment Model** (PTAM) is implemented in Voyager and is used to allocate PT users to services between their origin and destination zones. The model includes a representation of the public transport network and services for existing and planned modes within the modelled area. The model includes:

- Rail;
- DART;
- Luas;
- Metro.
- Urban Bus;
- Inter-Urban Bus; and
- Bus Rapid Transit (BRT).

The outputs of the PT assignment model fall into two categories, those required by the demand model, and those produced for reporting and analysis purposes.

The outputs from the Public Transport Assignment model for the demand model processes consist of the assigned networks which are passed on to active mode assignment as the starting point for their network build procedure, and generalised cost skim matrices by user class for each of the assigned time periods that feed back into the main Mode and Destination choice demand model loop. An overview of the PT model process is shown below in Figure 3-9.

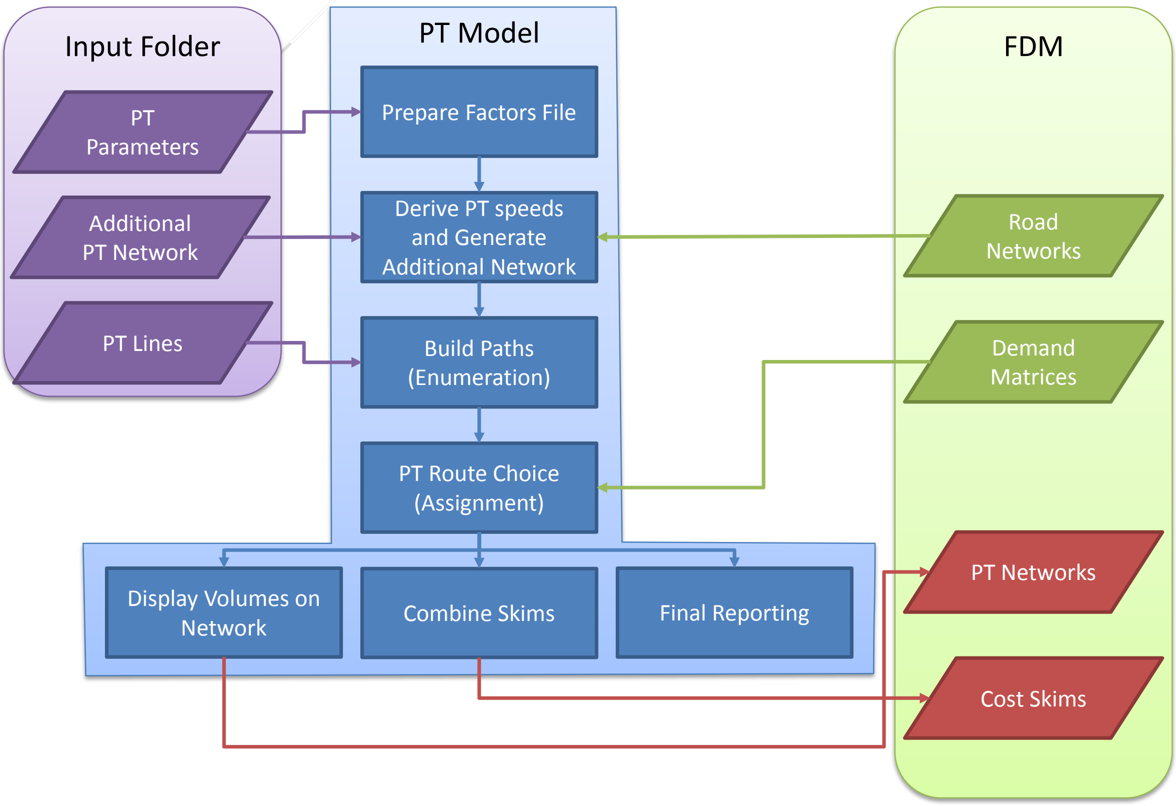

Figure 3-9: PT Model Process

3.3.9 SWRM Active Modes Model

The Regional Modelling System represents active modes (i.e. walking and cycling) within the demand model to improve the realism of travel choices. To generate costs to update the choice model processes, an **active modes assignment** must take place to establish new generalised costs. This active mode assignment assumes no crowding or delays.

The inputs for the active assignment model are the output CUBE format PT networks, the demand model produced assignment matrices and separate input pedestrian only links and cycle lanes. The outputs of this process include an assigned network with walk and cycle flows by user class, and a set of generalised cost skims. The active assignment is a CUBE-based lowest cost path assignment model with no junction modelling based purely on distance and a constant speed by mode.

Walk speeds are taken as 4.8 kph for all user classes while cycle speeds are set to 12 kph as default except in specified cases as indicated by the cycle data network input. Improvements to cycling mode provision are included through associating improvements to cycling Quality of Service to increases in service user speeds.

3.4 Suitability of South-West Regional Model in Developing the Strategy

3.4.1 Model Calibration and Validation

It is important that a strategic transport model is appropriately calibrated and validated in line with best practice guidelines. The SWRM has been subject to a comprehensive calibration and validation process whereby a substantial amount of observed data has been incorporated into both the demand model and the assignment models as presented in Table 3-5.

Table 3-5: Observed data used for model calibration and validation

Demand Model	Assignment Models
Tour proportions	Road traffic volumes
Generalised cost distributions	Road journey times
Travel distance distributions	Road trip length distribution
Modal share	Public transport in-vehicle time factors
Journey time distribution	Public transport fares and ticket types
	Public transport passenger flows
	Public transport boardings and alightings
	Public transport journey times
	Public transport interchange/transfers

The calibration and validation process ensures that the SWRM accurately reflects existing conditions and 'costs' associated with travel. This allows changes in the forecasting of transport demand and strategic transport infrastructure schemes and appropriate transport policies to be modelled and tested using the SWRM.

3.4.2 Use of SWRM for Strategic Transport Planning

The model has many strengths and features that make it the ideal tool to aid the strategic planning process. The SWRM has been developed from first principles making best use of the most recently available data (POWSCAR and NHTS) to replicate travel choices and transport network conditions as accurately as possible.

Several distinct journey purposes and characteristics including car availability, employment status, and education level are considered within the model to evaluate travel choices more accurately. This carries through to forecasting whereby specific person type demand can be forecast to derive appropriate trip distributions and future year travel conditions.

The model utilises a tour-based approach which allows for more accurate mode choice modelling and consideration of travel costs, particularly with respect to the inclusion of parking charges.

Four main modes of travel: private car, public transport, walking, and cycling are included in the model. Each mode has been calibrated individually, for each journey purpose, to replicate observed trip cost distributions.

The use of SATURN software in the road model allows for explicit junction modelling to be included in the model which improves typical network representation in congested areas over a link-based approach. Link speeds and delays are transferred to the public transport model which allows journey times of on-street modes (Bus, BRT) to reflect perceived traffic conditions rather than a strict timetable.

The model covers the CMA region plus surrounding counties, and takes full account of travel within, into and out of the CMA area.

As the model is also used as the basis for scheme evaluation, the transport networks represented contain a level of detail beyond that which would be normally required for its use as a strategic transport planning tool.

To account for the availability of parking facilities in Cork City Centre, both a free workplace parking model and a parking constraint model have been implemented to re-evaluate mode choice based on whether parking was available at the travellers' ultimate destination.

3.4.3 Summary

The South West Regional Model provides a comprehensive representation of travel patterns across the Cork Metropolitan Area and is suitable tool for the testing and appraisal of the Strategy. The limitations of strategic transport models are recognised and fully understood. The SWRM is considered the appropriate tool for fulfilling the NTA's requirements in terms of its planning and appraisal needs.

4 CMA Transport Strategy Modelling Approach

4.1 Introduction

This section details the transport modelling approach used to assess the performance of CMATS, including the modelling inputs and assumptions underpinning the assessment.

As described above, the National Transport Authority's (NTA) South West Regional Transport Model (SWRM) has been used to assess the performance of the CMA Transport Strategy.

4.2 Land-Use Assumptions

The National Planning Framework (NPF) 2040 outlines high level growth projections for the South West Region as well as the Cork Metropolitan Area.

CMA transport demand forecasts for the 2040 "Design Year" scenario were developed by the NTA based on the NPF forecasts and included extensive consultation between the NTA, Cork City and County Councils'. The following outlines the broad steps involved in the development of the CMATS land-use forecasts, with the overall population growth summarised in Table 4-1 below:

1. The NPF outlines **360,000** population growth for Southern Region;
2. The NPF outlines **115,000** population growth for Cork City and Suburbs;
3. The NPF outlines a **52,500** and **32,500** population growth for Limerick and Waterford Cities and Suburbs, respectively;
4. The remainder of the growth at a county level was apportioned across the Southern Region based on 2016 population distribution, from Census 2016;
5. This method resulted in an estimate for the population growth for the rest of Cork County, (outside of the City and Suburbs) of **43,469**, with a combined City and County population growth of **158,469**;
6. The **43,469,** population growth was then apportioned between the County Metropolitan Area (outside of the City and Suburbs area) and the County's Non-Metropolitan Area, again, based on 2016 population distribution from Census 2016;
7. On this basis, **13,380** was then apportioned to the Metropolitan Area outside of the Cork City and Suburbs area (the outer CMA); and
8. Combining the Cork City and Suburbs and Outer CMA's population growth resulted in an overall population growth of **128,380** for the entire CMA.

Following the identification of growth at the CMA level, the following steps were used to allocate growth at the settlement level within the CMA:

1. Distribute internally to CMA based on Core Strategy Distribution for City and County from their respective development plans;
2. Optimise and intensify land-use growth along the two - identified high capacity public transit corridors (identified within the "Demand Analysis Report";
3. Liaison and feedback from the Cork City and County Councils; and
4. Finalised CMATS 2040 forecasts for assessment.

Table 4-1: CMATS Land-use Forecasts

Southern Region	Population Growth 2040 NPF
Total Cork Metropolitan Area	128,380
Cork City and Suburbs	115,000
Remaining Metropolitan Area (estimate)	13,380
Remainder of Cork County (estimate)	30,089
Limerick City and Suburbs	52,500
Waterford City and Suburbs	32,500
Remainder of wider are growth outside of CMA, and Limerick and Waterford City and Suburbs	116,531
Population Growth	**360,000**

The CMATS 2040 forecasts were then converted into people trips using the NTA's National Demand Forecasting Model (NDFM), which converts planning data forecasts to trip forecasts for inclusion within the regional model.

4.3 Scenario Description

4.3.1 Do-Minimum

As per the Common Appraisal Framework (CAF) guidance, a current 'business as usual' scenario must be prepared against which the Do-Something (CMATS) option is compared against. This is referred to as the Do-Minimum scenario.

The 'Do-Minimum' network includes forecast transport demand (for the design year of 2040) and additional transport schemes (public transport, cycling and road) that are already built, under construction or are committed in terms of planning approval and allocation of funds. The list of schemes included in the Do-Minimum scenario is as follows:

- M28 Cork to Ringaskiddy: As part of the 2030 cork TEN-T network this scheme is assumed to be in place by 2040;
- Dunkettle Interchange Upgrade: As included in the Government's 'Building on Recovery: Infrastructure and Capital Investment 2016-2021'; and
- Cork City Centre Movement Strategy: The first phases of this strategy have been implemented and are included in the Do-Minimum scenario.

This scenario is set as the baseline against which all of the public transport proposals are compared against.

4.3.2 Do-Strategy

The Do-Strategy network represents the future year with all CMATS transport schemes included. The schemes are coded on top of the Do-Minimum 2040 scenario, to facilitate the assessment of the Strategy. Multiple model runs were undertaken within this scenario, with adjustments to public transport service frequencies applied to ensure no services were operating above capacity.

A summary of the schemes that have been included in the Do-Strategy scenario is provided below with further details on the schemes contained within the Main Report.

Bus Connects

CMATS proposes a comprehensive network of high frequency bus services providing radial services between corridors either side of the city core and orbital services across the network and is shown in Figure 4-1 below. The Core Radial Bus Network connect the external corridors to the City Centre and has been refined to pair Cross-City travel demand to maximise the utilisation of the bus services on these corridors. A significant improvement in the frequency of bus services on these radial routes is also proposed. The Core Radial Bus Network is set out below, including indicative frequencies in the peak travel periods:

1. Dublin-Hill – Togher - 15 minutes;
2. Ballyvolane- Donnybrook - 10 minutes;
3. Mayfield – Bishopstown - 10 minutes;
4. Glanmire – Ballincollig - 10 minutes;
5. Mahon – Apple - 10 minutes;
6. Mahon – Blarney / Tower - 10 minutes;
7. Rochestown – Apple - 10 minutes;
8. Grange – Ballincollig (via City Centre): 15 minutes; and
9. Frankfield – Fairhill - 20 minutes.

Three high frequency orbital routes are proposed to serve key destinations including Little Island and Cork Institute of Technology. The upgraded orbital network will cover proximity 50km of services and enable interchange with the proposed radial bus services. The three orbital routes, with indicative service frequency, are as follows:

1. Northern Orbital: 10-minute frequency;
2. Southern Orbital Inner: 10-minute frequency; and
3. Southern Orbital Outer: 15-minute frequency.

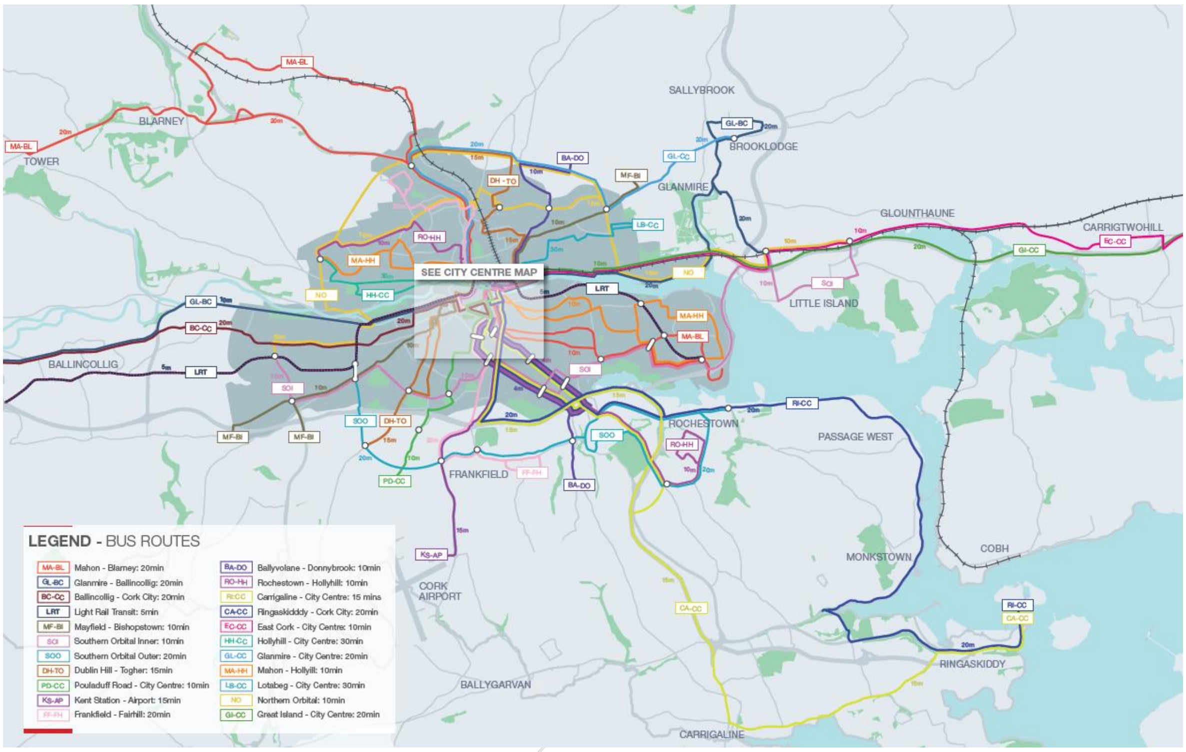

Figure 4-1: CMATS Bus Connects Network

Suburban Rail

To support sustainable growth along an enhanced railway corridor, CMATS proposed new railway stations at the following locations which have been coded into the SWRM in the Do-Strategy scenario. The proposed CMATS suburban rail network is shown in Figure 4-2 below. Improvements at Kent Station allow for through running of services between Mallow, Midleton and Cobh without impacting on Inter-City services.

Midleton / Cobh-Cork Line:

- Tivoli Docks;
- Dunkettle;
- Waterock;
- Ballynoe; and
- Carrigtwohill West.

Mallow-Cork Line:

- Blackpool / Kilbarry;
- Monard; and
- Blarney / Stoneview.

In order to meet the target demand on the strategic rail corridor it is proposed to increase the service frequency between Kent Station and Midleton, and between Kent Station and Cobh from one train every 30min to one train every 10min. It is also proposed to increase the service frequency between Kent Station and Mallow from one train every 30min to one train every 10min. It is also proposed to provide through running services between Mallow and both Midleton and Cobh to cater for the identified cross city demand. The following lists the proposed Cork Suburban Rail Service Frequencies:

- Midleton – Cork: 20 min;
- Midleton – Mallow: 20 min;
- Cobh – Cork: 20 min;
- Cobh – Mallow: 20 min,
- The combined cross city services equate to:
    - Glounthaune – Cork: 5 min;
    - Cork – Mallow: 10 min; and
    - Cross City Demand: 10 min.

Figure 4-2: CMATS Suburban Rail Network

Light Rail

CMATS proposes a strategic east-west public transport corridor from Mahon to Ballincollig via the City Centre. Approximately 25 stations have been coded in to the SWRM between Ballincollig and Mahon Point, and an estimated total journey time of 47 minutes. This is in line with similar speeds for the Red Luas line in Dublin. These stations will serve a catchment area of all existing and proposed key adjoining development areas and provide interchange with InterCity and suburban rail services at Kent station plus proposed Bus Connects services.

To serve predicted level of passenger demand to 2040, a headway of every 5 minutes has been coded, with an hourly capacity of 4,600pax/hr/dir. The following locations have been included within the catchment area of the future light-rail system in the CMA:

- Ballincollig;
- The proposed Cork Science and Innovation Park (CSIP);
- Cork Institute of Technology (CIT);

- Cork University Hospital (CUH);
- University College Cork (UCC);
- Cork City Centre;
- Kent Station / Cork North Docklands;
- Cork South Docklands; and
- Mahon.

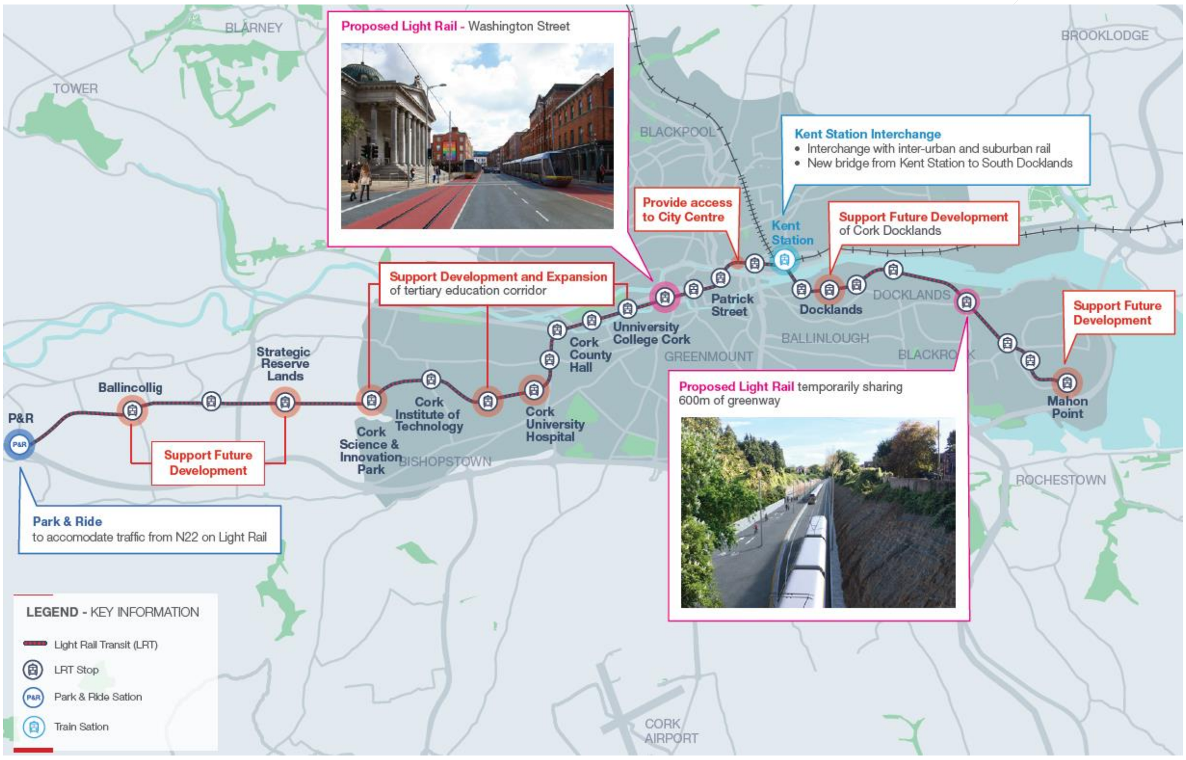

Figure 4-3: CMATS Light Rail Network

Walking

The walking network within CMATS is based on the Cork City Walking Strategy 2013 – 2018. The walking strategy was reviewed to ensure integration and alignment with the proposals for the public transport, cycling and road modes proposed in the strategy. Walking links were coded into the SWRM to coincide with new road links and internal network links within green and brownfield development areas.

Cycling

The cycle network development for CMATS is based on the Cork Cycle Network Plan 2017, which was reviewed to ensure integration and alignment with the transport proposals within this strategy and is shown in Figure 4-4 below. The CMATS cycle network includes for 200km of Primary, 150km of Secondary, 60km of Inter-Urban and 140km of Greenway network. The proposed cycle network was coded into the SWRM in the Do-Strategy scenario to represent the increased cycle speeds associated with the various levels of service provided by the proposed network.

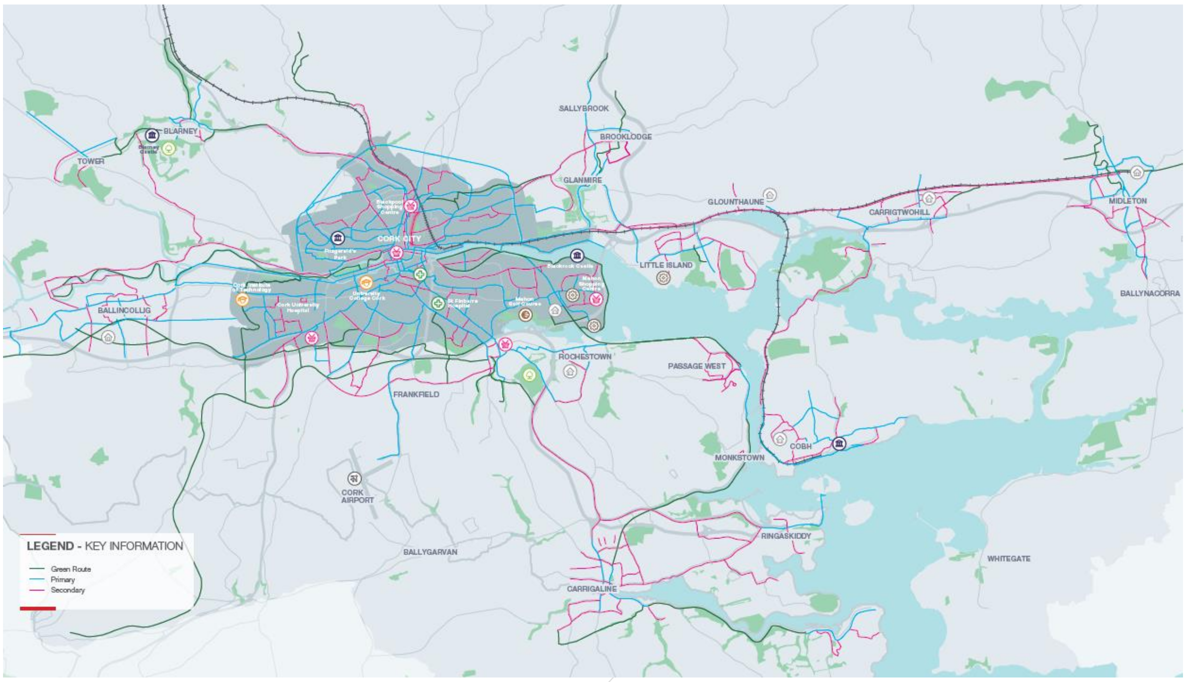

Figure 4-4: CMATS Cycle Network

Road

CMATS proposes significant investment in roads schemes up to 2040 which are shown in Figure 4-5 below and summarised below. Further details on the individual schemes is provided in the Main Report and also in the "Transport Options and Network Development Report" .

National Roads

- N40 South Ring Road;
- Dunkettle Interchange (also included in Do-Min);
- M28 Cork - Ringaskiddy (also included in Do-Min);
- N22, N25, N27 and N71 improvements;

Local Roads

- Cork Northern Distributor Road;
- Sothern Distributor Road;
- Local Road improvements to support the Cork County Urban Expansion Areas;
- City Centre Movement Strategy;
- Docklands internal roads to support development;
- South Docklands Eastern Gateway Bridge;
- Water Street Bridge;
- Mill Road Bridge; and
- Potential eastern access to Tivoli.

In addition to the new links and national road improvements described above, significant bus priority measures have been included in the SWRM SATURN road model to account for the proposed BusConnects network and are shown in Figure 4-6 below. For the purposes of model coding, it was assumed that this would be achieved through the provision of 2-way bus lanes along the majority of routes. To ensure this could be achieved, reductions in road capacity within the model had to be accounted for in areas where full bus priority could not be feasibly accommodated. The following traffic management measures were coded into the model where applicable:

- Reduction in the number of lanes;
- Right-turn bans; and
- Converting Road to 1-way inbound or outbound (e.g. Douglas);

Bus speeds in the SWRM are taken as 80% of the uncongested speed of the adjacent road network link, where a bus lane is provided. Where there are no bus lanes, the congested road speeds are applied.

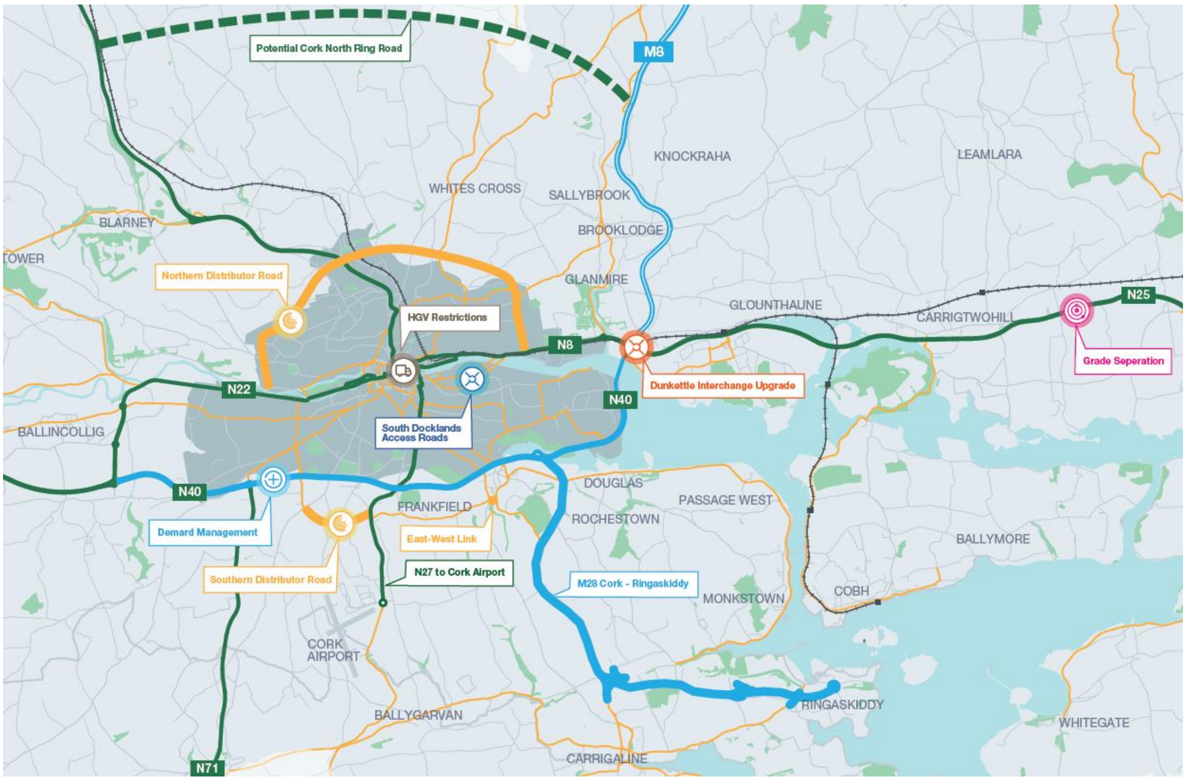

Figure 4-5: CMATS Road Network

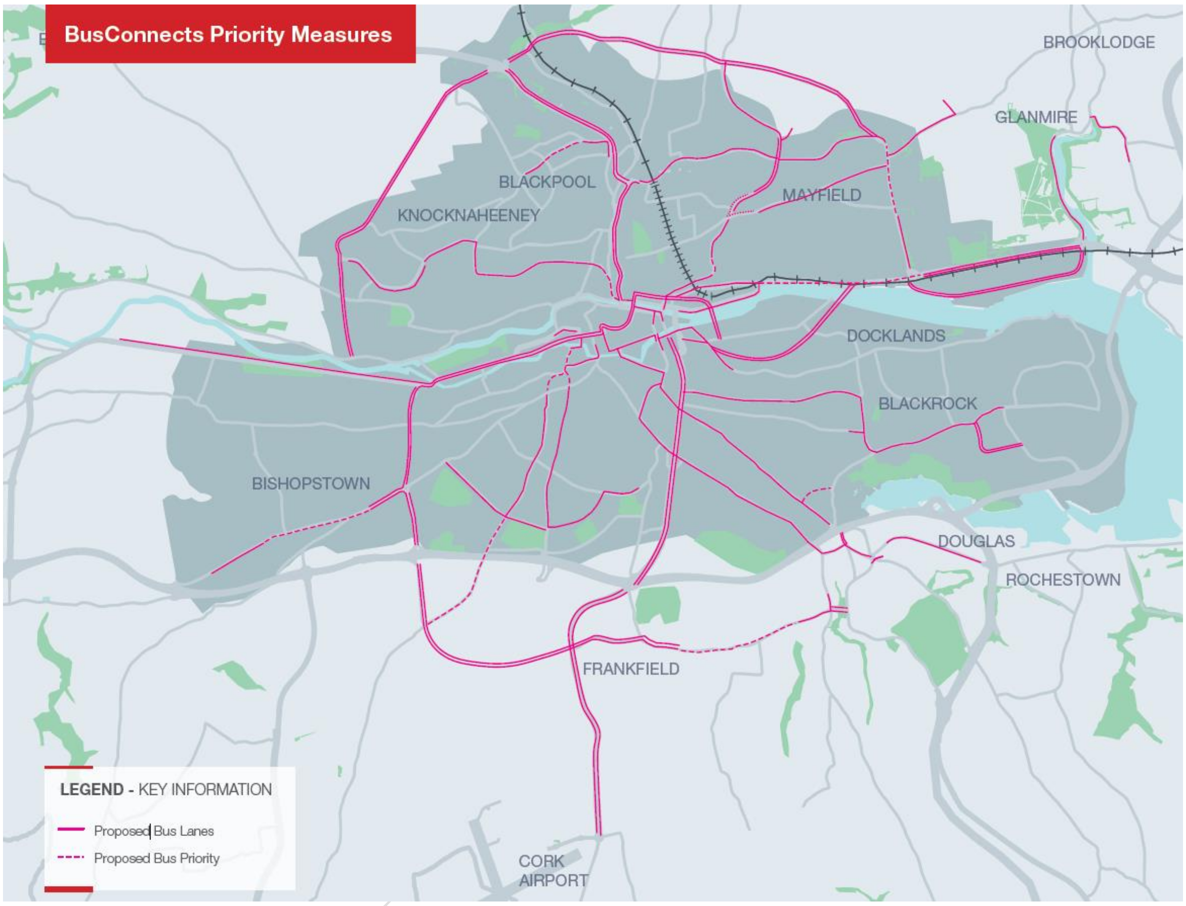

Figure 4-6: CMATS Bus Connects Priority Measures

4.3.3 Do-Strategy with Supporting Measures

To assess the impact of the proposed supporting measures contained within CMATS, an additional sensitivity test was undertaken that includes all measures included in the Do-Strategy scenario with the following additional supporting measures.

- 20% reduction in fares;
  - All public transport services will migrate to a cashless system, to facilitate driver safety and faster passenger boarding times. As a proxy to account for this in the model, a 20% reduction was applied to PT fares, predominantly due to the fact that Leap card fares are on average 20% cheaper than the cash alternative;
- Transfer penalty reduction (5mins);
  - To account for the fact that passenger transfers with Rail services in a more integrated PT system will be more seamless and therefore should not be overly penalised – a consistent 5min transfer penalty has been used in the sensitivity modelling for all PT sub-modes instead of the existing 15min penalty to/from Rail to other modes.
- Parking constraint – removal of available on-street parking to accommodate bus priority measures, cycle schemes etc;
  - 50% reduction in on-street spaces assumed within the model.
- N40 Toll demand management;

- The distance based multi-point tolling measures contained within the N40 Demand Management Study were coded into the SWRM Road model which includes for tolls at the following locations.
  - Dunkettle to Mahon;
  - Douglas West to Kinsale Road;
  - Togher to Sarsfield Road.

This model run provides an indication of the likely improvement in sustainable mode share resulting from the 'softer' (non-infrastructure) CMATS measures.

4.4 Strategy Appraisal Methodology

This section sets out the methodology and the evaluation process employed to assess the performance of the CMATS transport measures.

4.4.1 Methodology

The procedure for the assessment of CMATS is guided by the 'Common Appraisal Framework (CAF) for Transport Projects and Programmes, March 2016' published by the Department of Transport, Tourism and Sport (DTTAS), which requires schemes to be appraised under the objective headings below.

- Safety;
- Physical Activity;
- Environment;
- Integration;
- Accessibility and Social Inclusion; and
- Economy.

It should be noted that a more detailed appraisal of the individual public transport schemes identified within CMATS will be required at a later stage in the planning process for each scheme.

The CMA Transport Strategy has been assessed under the 6 CAF criteria with the Key Performance Indicators (KPIs) and method of measurement for each KPI displayed in Figure 4-2 below.

Table 4-2: CMATS CAF Criteria and KPIs

CAF Criteria	KPI	Measure
Safety	Safety improvements as a result of the Strategy implementation	Monetised benefits as output from COBALT software within the NTA Safety Appraisal Tool
Physical Activity (Health)	Health Benefits	Monetised Health and Absenteeism benefits calculated using the NTA Health Appraisal Tool
	Absenteeism Benefits	
Environment	Change in Transport Emissions related to the Strategy implementation	Transport emission from the ENEVAL Appraisal Tool
Integration	Public Transport Integration	Number of public transport interchange trips
	Transport Policy Integration	Average Mode Shift to Public Transport
Accessibility and Social Inclusion	Accessibility to Key Attractors	Trips to Key Attractors (schools, hospitals etc.) by Public Transport
	Accessibility by PT from Socially Deprived Areas	Trips by Public Transport from Socially Deprived Areas
Economy	Transport User Benefits	TUBA Output
	Cost	Scheme Cost Estimates

In addition to the CAF assessment the transport modelling results have been analysed further to examine the difference in performance compared to the Do-Minimum scenario. This additional analysis is undertaken on selective model outputs and used to better understand the impact of the CMATS measures. The following additional indicators were assessed using SWRM outputs:

- Demand and Mode Share Analysis;
- Public Transport Network Operations;
- Active Mode Network Operations; and
- Road Network Operations.

5 CMA Transport Strategy Appraisal

5.1 Introduction

As described in section 4, the Do-Minimum and Do-Strategy scenarios have been quantitatively assessed under each of the CAF appraisal categories. This section outlines the results for each scenario using the Key Performance Indicators (KPIs) and measurements outlined in Table 4-2.

5.2 Safety

5.2.1 Road Safety

The Safety Appraisal Module within the RMS Appraisal toolkit was used to assess the Safety benefits associated with the CMATS measures.

The Safety Appraisal Module process is based on a bespoke version of the COBALT spreadsheet. The bespoke version of the COBALT Ireland spreadsheet has been developed by Transport Infrastructure Ireland (TII) for use with the regional transport models. COBALT (COst and Benefit to Accidents – Light Touch) is a computer program developed by the UK Department of Transport (DfT) to undertake the analysis of the impact on accidents as part of economic appraisal for a road scheme.

Table 5-1 below displays the Safety Appraisal results comparing the Do-Minimum and the Do-Strategy scenario.

Table 5-1: CMATS Safety Appraisal Results

Item	Do-Minimum (DM)	Do-Strategy (DS)	Difference (DS vs DM)
Economic Summary (€000)	1,010,149	987,322	-22,827
Accident Summary	37,606	36,360	-1,246
Casualty Summary			
Fatal	1,030	1,015	-15
Serious	2,637	2,569	-68
Slight	54,033	52,335	-1,698

As shown in the table above, the CMATS measures result in significant savings (approx. €23m) in collision costs. There are also significant reductions in the levels of casualties on the road network, with the reductions of 15, 68 and 1,700 in fatal, serious and slight casualties respectively.

5.3 Physical Activity (Health Appraisal)

Active travel modes, i.e. walking and cycling, can bring about significant benefits for our health and environment. The consideration of health benefits arising from transport is an integral part of the appraisal process adopted to inform transport policy and investment decisions.

Transport related changes to the following factors can have health impacts and have been assessed for CMATS:

- Physical activity – increased levels of activity can positively impact on reducing the risk of death and occurrence diseases such as heart, diabetes and cancer related illnesses; and
- Absenteeism – this is expected to decrease when more people walk or cycle. Moderate physical activity can lead to a reduction in the number of sick days and a healthier workforce can, in turn, provide benefit to employers and overall economy;

5.3.1 Physical Activity Benefits

The health benefits associated with physical activity are derived from a reduction in the relative risk of premature death - the 'Relative Risk of Mortality' is directly linked to the time spent walking and cycling based on the average length, speed and frequency of new trips encouraged by active travel modes. This indicator provides a calculation of the lives saved due to the health benefits of cycling and walking.

Table 5-2 below shows the monetised benefits of the change in walking and cycling based on the relative difference between the Do-Minimum and Do-Strategy scenario. The results of the assessment show positive benefits for Cycling due to the increase in cycling mode share between the scenarios. There is a dis-benefit for walkers when comparing the Do-Minimum and Do-Strategy scenarios. This is due to the large mode shift from walking to public transport and cycling modes due to the improved infrastructure for these modes provided by CMATS.

Table 5-2: CMATS Monetised Physical Activity Health Benefits

Net Impact per annum (€)	
Cyclists	**€365,639.85**
Walkers	**-€4,202,792.36**

5.3.2 Absenteeism Benefits

Benefits associated with a reduction in absenteeism primarily arise through increases in physical activity levels leading to increased productivity resulting from a reduction in short-term sick leave.

As shown in Table 5-3 below the implementation of CMATS results in approximately 45 days saved in absenteeism which results in €9,000 in economic savings.

Table 5-3: CMATS Absenteeism Health Benefits

	Monetised Benefits	Absent Days Saved
Increased output from reduction in absenteeism per year	**€ 8,621**	**45**

Similarly, to the physical activity health benefits the reduced number of walking trips compared to the Do-Minimum scenario results in lower levels of absenteeism benefits arising from active modes usage.

5.4 Environment

5.4.1 Emissions

The percentage change in transport emissions has been estimated from modelling outputs using the Environmental module of the RMS appraisal toolkit. It estimates emission levels for the following emission categories:

- Nitrogen Oxide & dioxide;
- Particulate Emissions;
- Hydrocarbon;
- Carbon Monoxide & Dioxide;
- Benzene;
- Methane; and
- Butadiene.

Table 5-4 below provides a summary of the emissions levels for the Do-Minimum and Do-Strategy scenarios in metric tonnes. The implementation of the CMATS measures is shown to reduce environmental emissions in the range of 2 to 5%. The 2.4% reduction in particulate emissions is particularly beneficial as this is considered to be particularly harmful to the health of people in close proximity to the emitted particulate.

Table 5-4: CMATS Environmental Emissions Summary

Scenario / Emission Type	Nitrogen Oxide & dioxide	Particulate Emissions	Hydrocarbon	Carbon Monoxide & Dioxide	Benzene	Methane	Butadiene
Do-Minimum	3,153.1	29.2	144.8	2,201,787	1.2	33.9	1.9
Do-Strategy	3,056.2	28.5	140.5	2,156,093	1.2	32.2	1.8
% Difference	-3.1%	-2.4%	-3.0%	-2.1%	-3.6%	-5.0%	-3.4%

5.5 Accessibility and Social Inclusion

The SWRM model has been used to assess the Accessibility and Social Inclusion benefits associated with the implementation of CMATS.

Transport investment, by its nature, has a particularly strong role to play in respect of improving accessibility for people living in rural areas with poor access, people who suffer from mobility and sensory deprivation, connecting young people, particularly those who live in disadvantaged areas, to services, education and work opportunities.

To quantify this, public transport accessibility changes have been extracted from the SWRM for the Do-Minimum and Do-Strategy scenarios and are discussed further below.

5.5.1 Public Transport Isochrone Assessment

Isochrone maps are useful for displaying changes in public transport accessibility and journey time improvements between scenarios. Figure 5-1 and Figure 5-2 below show the PT Journey Time to City Centre changes for the Do-Minimum and Do-Strategy scenarios respectively.

The public transport journey times include access time to a public transport service, wait time for the service and transit time to the City Centre

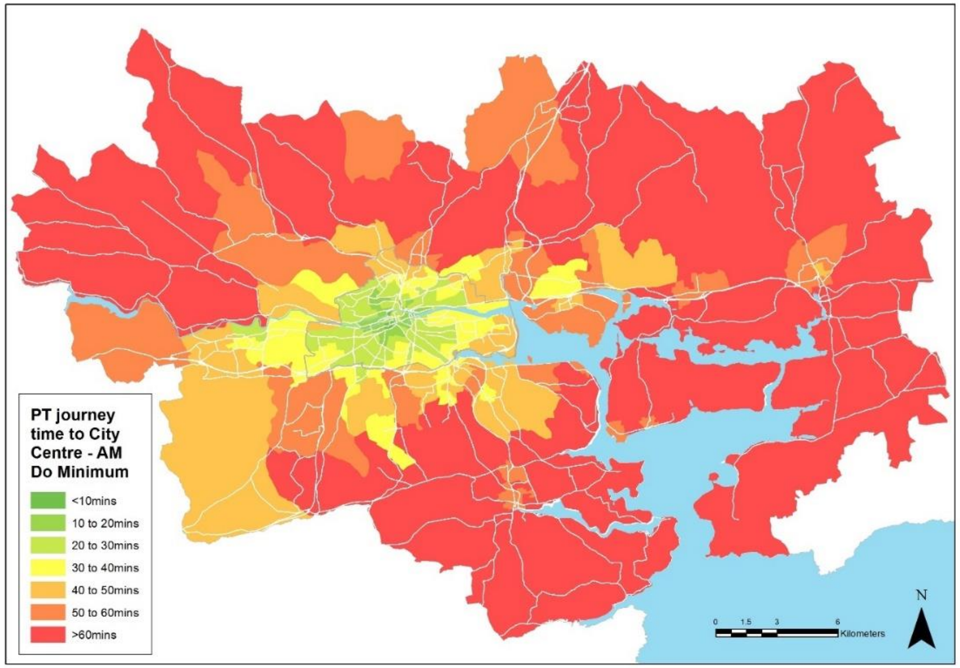

Figure 5-1: Do-Minimum – PT Journey Time to City Centre

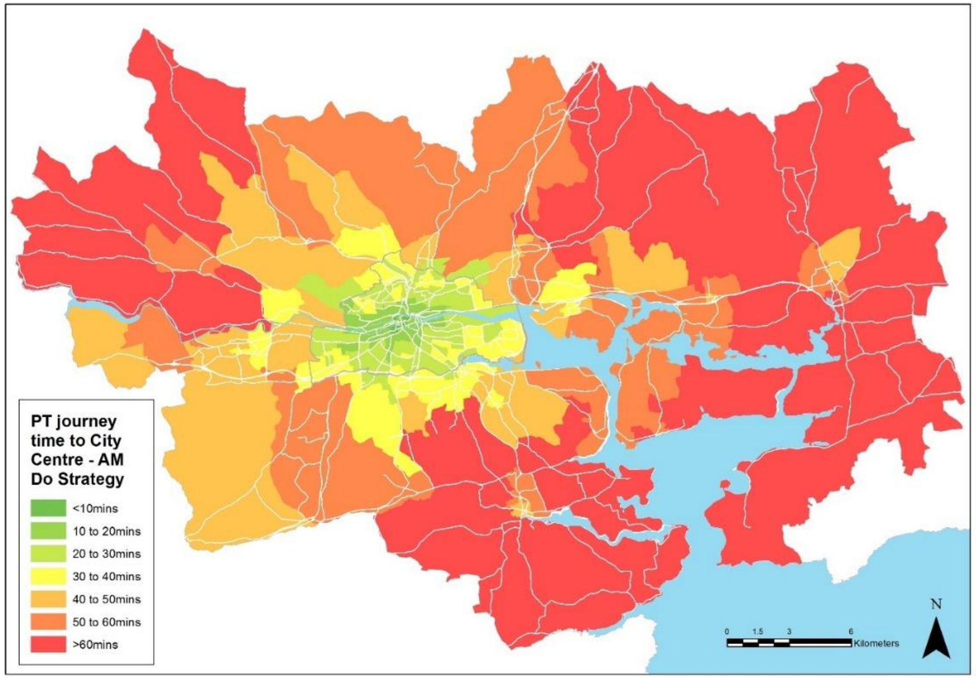

Figure 5-2: Do-Strategy – PT Journey Time to City Centre

As shown in the figures above, the analysis indicates increased public transport accessibility levels across the Metropolitan area in the Do-Strategy scenario. There are improvements forecast to journey times to the City Centre from wider catchments due to the improvements to bus network coverage, new rail stations and the proposed LRT line.

5.5.2 Accessibility by Public Transport to Key Attractors

The change in public transport mode share to key trip attractors across the CMA, has been used to assess accessibility. A summary of the AM Trips to Key Attractors for the Do-Minimum and Do-Strategy is presented in the Table 5-5 below.

Table 5-5 PT Demand to Key Attractors

Key Attractors	Do-Minimum - AM Demand					Do-Strategy - AM Demand					AM PT Mode Share	
Key Attractors	Road	PT	Walk	Cycle	Tot	Road	PT	Walk	Cycle	Tot	Do-Minimum	Do-Strategy
Patrick's St	358	542	1,057	273	2,231	359	878	875	286	2,398	24%	37%
UCC	1,073	1,840	1,581	257	4,750	1,739	2,529	1,194	346	5,807	39%	44%
Hollyhill Ind. Est.	474	235	512	112	1,333	607	394	397	167	1,565	18%	25%
St Finbarr's Hosp.	709	83	233	46	1,071	625	150	236	47	1,057	8%	14%
Airport Bus. Park	3,101	79	116	56	3,352	3,012	180	105	59	3,356	2%	5%
Mahon Point	2,537	223	559	183	3,502	2,204	736	410	154	3,504	6%	21%
Little Island Bus. Park	1,067	115	69	16	1,267	991	196	53	34	1,274	9%	15%
Cork University Hospital	3,049	512	1,052	204	4,817	2,758	1,099	861	240	4,958	11%	22%
Cork Institute of Technology	3,465	963	730	144	5,302	3,106	1,576	461	157	5,301	18%	30%
Douglas Village Centre	758	54	164	32	1,008	738	85	153	36	1,012	5%	8%
Ringaskiddy / Port of Cork	1,253	98	63	16	1,431	1,305	102	29	14	1,450	7%	7%
Cork South Docklands	2,310	895	1,717	246	5,168	2,992	3,215	2,273	422	8,901	17%	36%
TOTAL for key Attractors	**20,154**	**5,639**	**7,853**	**1,585**	**35,232**	**20,436**	**11,140**	**7,047**	**1,962**	**40,583**	**16%**	**27%**

The results of the assessment show substantial improvements in public transport mode share for trips to the key attractors outlined above. Overall the public transport mode share increases from 16% to 27% in the Do-Strategy scenario.

5.5.3 Public Transport Accessibility to Socially Deprived Areas

The social inclusiveness of the transport networks provided in each scenario has been measured by assessing the change in public transport mode share for trips from socially deprived areas across the Cork Metropolitan Area. Areas across the CMA have been classified based on the POBAL Deprivation Index. The index provides a method of measuring the relative affluence or disadvantage of a particular geographical area using data compiled from various censuses.

The Table 5-6 below represents the Average AM PT mode shift between the Do-Minimum and Do-Strategy scenarios disaggregated by social category of areas across the CMA.

Table 5-6 Average AM PT mode shift between the Do-Minimum and Do-Strategy by area type

Description	Average AM PT mode shift
very disadvantaged	6.4%
disadvantaged	5.3%
marginally below average	3.1%
marginally above average	3.6%
affluent	5.8%
very affluent	8.3%
Total	**4.1%**

The results of the assessment show that the overall PT mode share changes on average by 6.4% and 5.3% in 'very disadvantaged' and 'disadvantaged' areas.

5.6 Integration

CMATS aims to support integration between Sustainable Transport and Land Use. In order to assess the integration performance of CMATS, the percentage change in the modelled sustainable mode share was calculated for each scenario to assess the compatibility with Smarter Travel policy.

In addition, the level of interchange between public transport modes was measured for the Do-Minimum and Do-Strategy scenarios to assess how well the CMATS proposals integrate with one another.

5.6.1 Policy Integration

The percentage change in the modelled sustainable mode share was calculated for each scenario to assess the compatibility with Smarter Travel policy, which aims to prioritise sustainable modes.

Table 5-7 below shows the public transport mode share for the Do-Minimum and Do-Strategy scenarios for both the AM peak hour and over a full day. The results show substantial improvement in PT mode share between the two scenarios.

Table 5-7 Average AM PT mode shift between the Do-Minimum and Do-Strategy

	Do-Minimum	Do-Strategy
AM PT Mode Share	13.0%	20.5%
24hr PT Mode Share	9.3%	14.6%

5.6.2 Interchange between Public Transport Services

Table 5-8 and Table 5-9 below show the overall level of interchange between public transport modes for the Do-Minimum and Do-Strategy scenarios respectively.

Table 5-8 AM Peak Hr Do-Minimum Interchange

	To		
From	**Bus**	**Rail**	**Luas**
Bus	670	150	0
Rail	112	0	0
Luas	0	0	0

Table 5-9 AM Peak Hr Do-Strategy Interchange

	To		
From	**Bus**	**Rail**	**Luas**
Bus	1,433	202	1,072
Rail	203	0	711
Luas	433	161	0

The results show a substantial increase in the level of passengers interchanging between public transport services in the AM peak following the introduction of the CMATS measures. There are 800 additional passengers transferring between bus services and over 1,000 passengers transferring from bus services to the Luas line. Overall interchange levels increase from 932 in the Do-Minimum scenario to 4,215 in the Do-Strategy scenario – an increase of 352%. This clearly demonstrates the integration benefits of the CMATS measures.

In addition to the overall interchange levels, the interchange numbers at Kent station for the Do-Minimum and Strat are shown in Table 5-10 and the Table 5-11 below.

Table 5-10 Do-Minimum AM Peak Hr Kent station Interchange

To From	Kent Rail	Kent Luas	Other (Bus)
Kent Rail		0	137
Kent Luas	0		11
Other (Bus)	65	49	

Table 5-11 Do-Strategy AM Peak Hr Kent station Interchange

To From	Kent Rail	Kent Luas	Other (Bus)
Kent Rail		711	139
Kent Luas	161		11
Other (Bus)	58	45	

The results show that in the Do-Strategy scenario, almost 900 passengers are transferring between Rail and Luas services in the AM peak hour. Overall interchange levels at Kent station increase from 262 in the Do-Minimum scenario to 1,125 in the Do-Strategy scenario – an increase of 329%.

5.7 Economy

This chapter sets out an assessment of estimated transport user benefits for the CMA Transport Strategy scenario. This provides a high level indication of whether the proposed investment required for the Strategy is worthwhile.

This assessment has taken account of relevant guidance of the Department of Public Expenditure and Reform and the Department for Transport, Tourism and Sport (DTTAS).

The purpose of this assessment is to provide an initial high level indication of the performance of the package of strategy infrastructure schemes, i.e. do the benefits of implementing the Strategy exceed the costs. It is undertaken at a level of detail that is appropriate for this stage of transport strategy development, i.e.

- Cost estimates for the proposals are developed based on cost outturns for similar projects rather than detailed design; and
- Benefits are forecast based on outputs from the transport modelling assessment of the proposals which use broad assumptions regarding scheme operation and design.

5.7.1 Cost Estimate

An outline cost estimate of the Strategy has been prepared based on estimates of per/km costs used for the NTA Greater Dublin Area Transport Strategy and other studies. The profile of expenditure is based on an estimated programme of works to deliver the Strategy by 2040 and are in line with outline implementation plan provided in the Main Report.

The outline cost estimates are high level estimates based on values from individual scheme development, broad per km rates, and other general assumptions for each strategy option. The estimates are provided for the purposes of this high-level estimate of transport user benefits only and should not be used or relied upon for any other purposes.

More detailed cost estimates will be undertaken at each scheme development stage for each individual scheme included in the Strategy, as appropriate. The estimates of scheme capital costs are presented in Table 5-12, in 2016 prices and exclusive of VAT.

Table 5-12 CMATS Outline Scheme Cost Estimates

Scheme	Capital Expenditure (€m)
Cork Luas (LRT)	1084.8
Rail Upgrade (New Stations, Electrification and Kent Upgrade)	273.3
Cork BusConnects	545.8
Cycle Network	230.9
Walk Network	3.0
National Roads *(Note: M28 and Dunkettle Interchange are included in DoMin so costs not included for appraisal)*	144.3
Regional and Local Roads (N27, Docklands etc.)	487.8

Park and Ride	15.2
Demand Management	20
Integration & ITS	70
Total	**2,875**

In addition to the capital costs of the schemes, an allowance was made for appropriate annual operation and maintenance (O&M) costs and an allowance for fleet and infrastructure renewal requirements over the assessment period.

Estimates were developed based on comparative costs of similar schemes and previous experience. The total annual operating cost estimate and fleet renewal cost estimate over the assessment period for the entire CMA Transport Strategy is detailed in Table 5-13 below.

Table 5-13 CMATS Operational and Maintenance Costs

Estimate	Cost (€m)
Average Annual O&M Cost	17.8
Average Annual Fleet and Infrastructure Renewal Cost	7.8

5.7.2 Transport User Benefits Appraisal

The Transport User Benefits Appraisal (TUBA) (v1.9.4) program has been used to estimate transport user benefits arising from the Strategy. The assessment compares the “Do-Minimum” scenario (i.e. not to progress with the proposals) with a “Do-Something” scenario (i.e. the scheme) and estimates the benefits resulting from the scheme in terms of:

- Transport user time impacts;
- Vehicle operating cost impacts;
- Transport provider revenue impacts; and
- Impacts related to emissions (greenhouse gases).

2.5.2 TUBA is the ‘best practice’ software used in transport scheme appraisal across the UK and Ireland and was developed specifically for the purpose of cost benefit analysis and economic appraisal.

Inputs from the Transport Models

In order to calculate the changes in travel costs as a result of the implementation of the Strategy, travel demand and cost skims are extracted from the Do-Minimum and Do-Strategy transport model runs. The demand is split by purpose with common value of time and the travel costs are split into the appropriate sub-components as required in the guidance.

For the purposes of this assessment, it is assumed that all the schemes proposed as part of the Strategy start operating on a phased basis up to 2040. Full details of the phasing of transport schemes is contained in the Main Report.

Standard economic parameters

Standard transport appraisal parameters in Ireland are available from the following documents:

- Department of Public Expenditure and Reform 'Public Spending Code', 2013;
- Department of Transport 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes', 2016 - Appendix 1: Application Rules for Cost-Benefit Parameter Values; and
- NRA 2011 'Project Appraisal Guidelines', 2011 - Unit 6.11 National Parameters Values Sheet.

All general transport appraisal parameters are taken from the above documents. Updated vehicle purpose splits and vehicle occupancy rates were derived from the NTA's National Household Travel Survey (2012).

The other main input assumptions to the assessment are as follows:

- A price base year and present value year of 2016;
- A strategy opening year of 2040;
- A standard appraisal period of 30 years;
- Residual value period of a further 30 years;
    - ***No growth in transport demand beyond 2040 has been assumed in the TUBA assessment.***
- A discount rate of 5% as per the DPER 'Public Spending Code';
- Shadow pricing has been included in line with the DPER 'Public Spending Code', i.e. a shadow price of public funds of 130% and a shadow price of labour of 80%;
- All outputs are presented in market prices; and
- Annualisation factors have been developed from a detailed analysis of observed data and transport model outputs.

5.7.3 Cost Benefit Analysis

A simple assessment was undertaken to compare the estimated transport user benefits to the set of outline cost estimates.

Generally, if the forecast benefits for the Strategy exceed the estimated costs, then the investment can be considered worthwhile. The results of the assessment of the Strategy are presented below in Table 5-14.

Table 5-14 Transport Economic Efficiency (TEE) Table

	€ m
Present Value of Transport User Benefits	4,843
Present Value of Strategy Costs	1,652
Net Present Value	3,190
Transport User Benefit to Cost Ratio	**2.93:1**

5.8 Demand and Mode Share Analysis

5.8.1 Demand Analysis

Figure 5-3 and Figure 5-4 below show the Cork Metropolitan Area (CMA) 24Hr and AM Demand Distribution by mode for the Base Year (2011) and the forecast (2040) Do-Minimum and Do-Strategy scenarios.

The analysis shows in an increase in overall trips within the CMA from approximately 830,000 in the base year 2011 to 1.2million trips in 2040 – representing a 45% increase in demand.

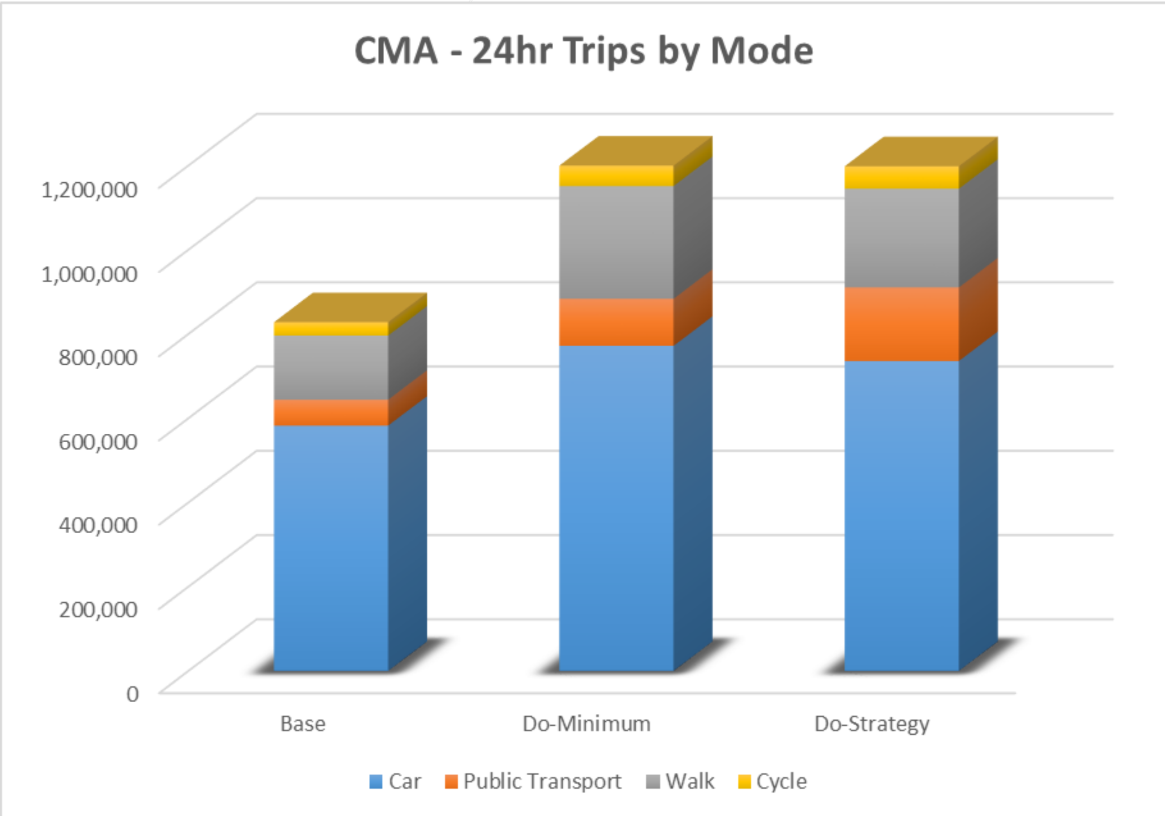

Figure 5-3: CMA 24Hr Demand Distribution

Trips within the AM time period across the CMA increase from approximately 200,000 in the base year 2011 to 300,000 trips in 2040 – representing a 48% increase in demand.

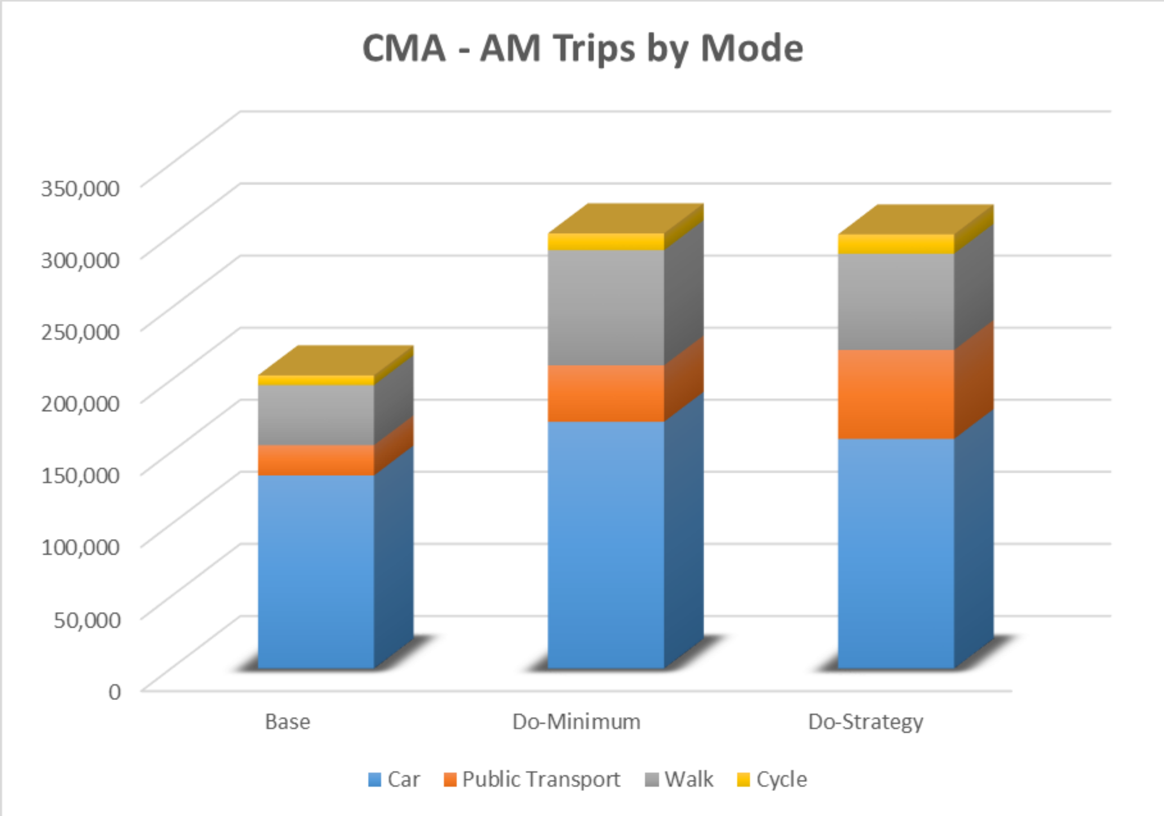

Figure 5-4: CMA - AM Demand Distribution

5.8.2 Mode Share Analysis

This section provides an analysis of mode share for trips within the CMA in 2040. The mode shares for 24-hour, each individual time period and by area for the Do-Minimum and Do-Strategy scenarios are shown in Figure 5-5 to Figure 5-10 below. Maps showing the Car mode share by SWRM zone for the Do-Minimum and Do-Strategy scenarios is also provided in Figure 5-11 and Figure 5-12

The results of the assessment show a substantial increase in sustainable mode share in the Do-Strategy scenario compared to the Do-Minimum. 24-hour PT mode share increases from 9.3% to 14.6%, with corresponding reductions in Car mode share reducing from 64.3% to 61.4%.

Within the AM, the PT mode share is 20% which represents a substantial improvement on the 13% in the Do-Minimum scenario.

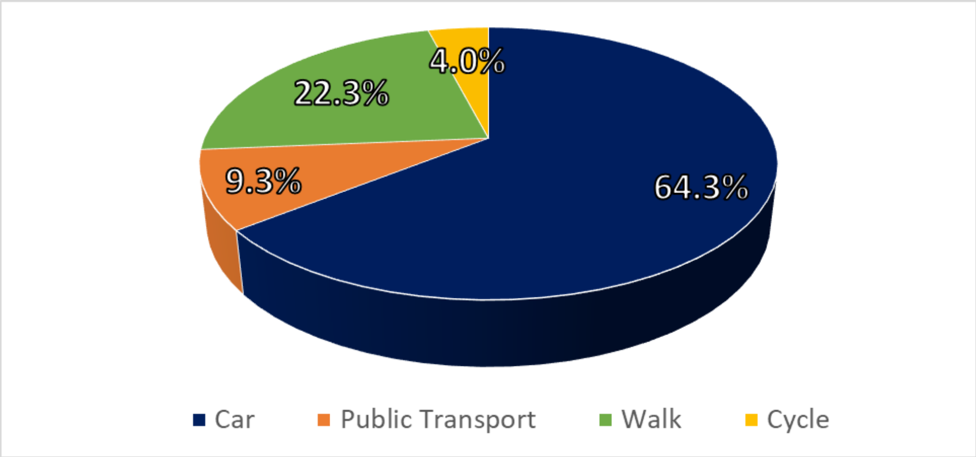

Figure 5-5: Do-Minimum - 24 Hr Metropolitan Area Mode Share

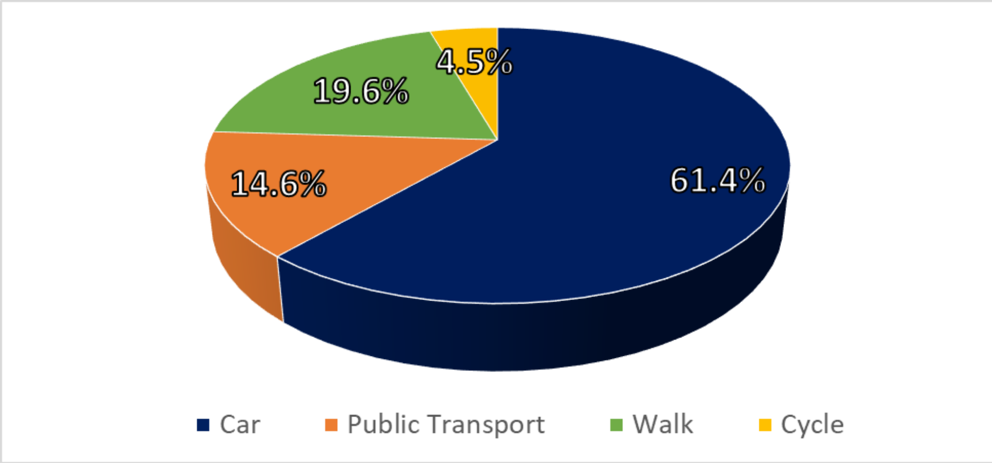

Figure 5-8: Do-Strategy - 24 Hr Metropolitan Area Mode Share

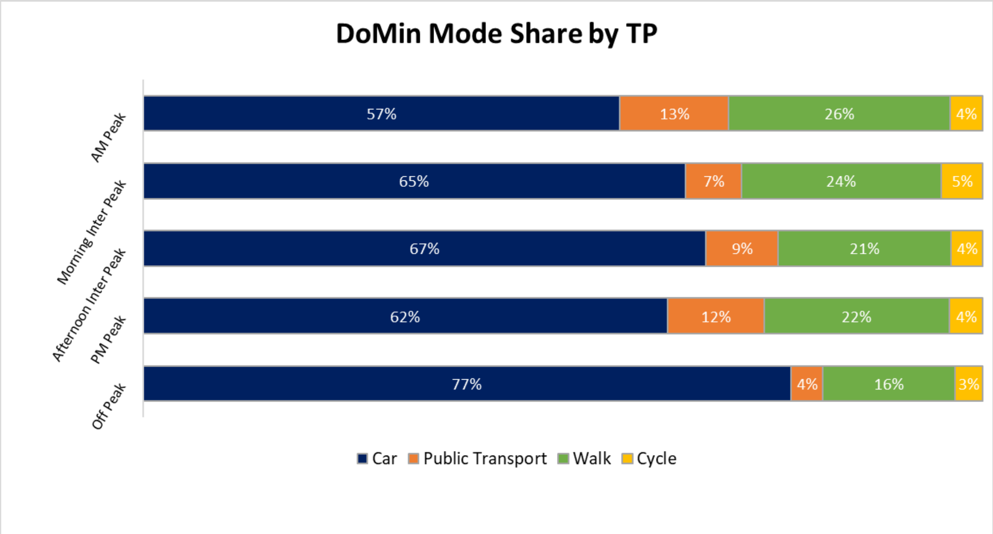

Figure 5-6: Do-Minimum Mode Share by Time Period

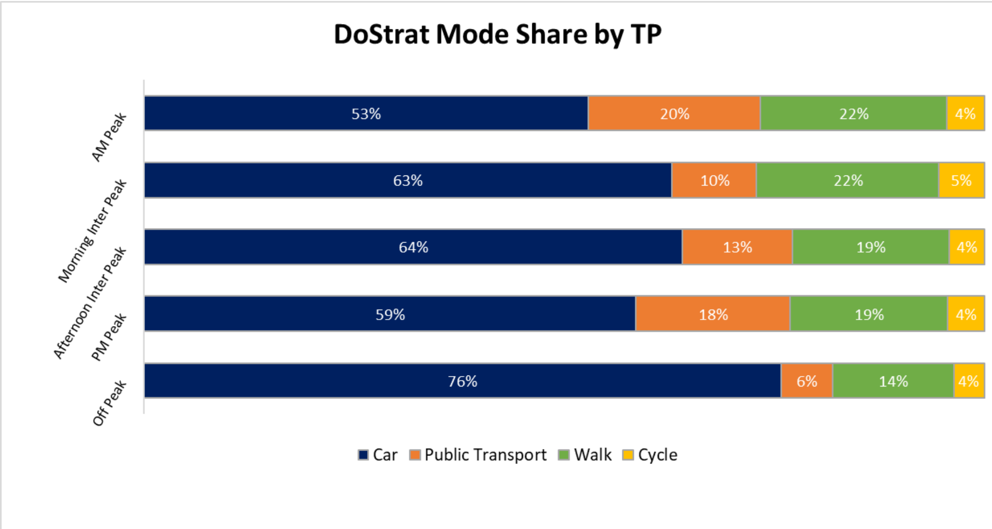

Figure 5-9: Do-Strategy Mode Share by Time Period

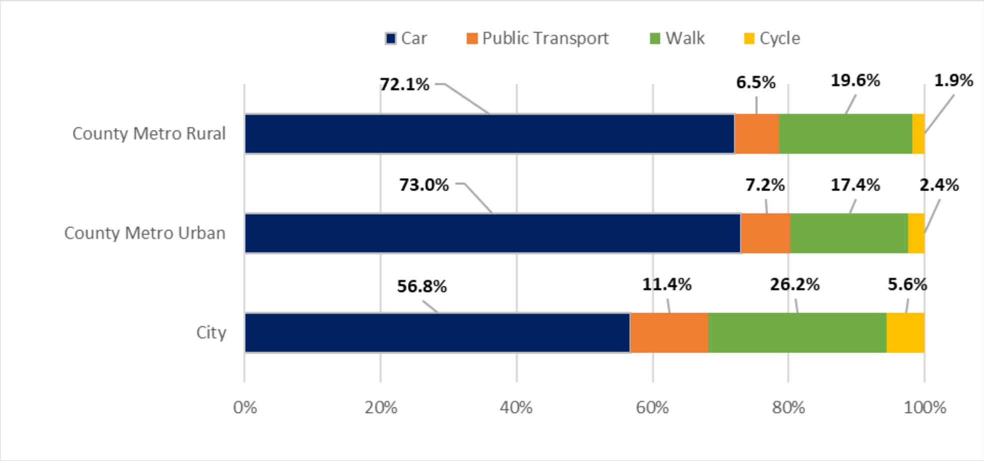

Figure 5-7: 24hr Do-Minimum Mode Share by Settlement

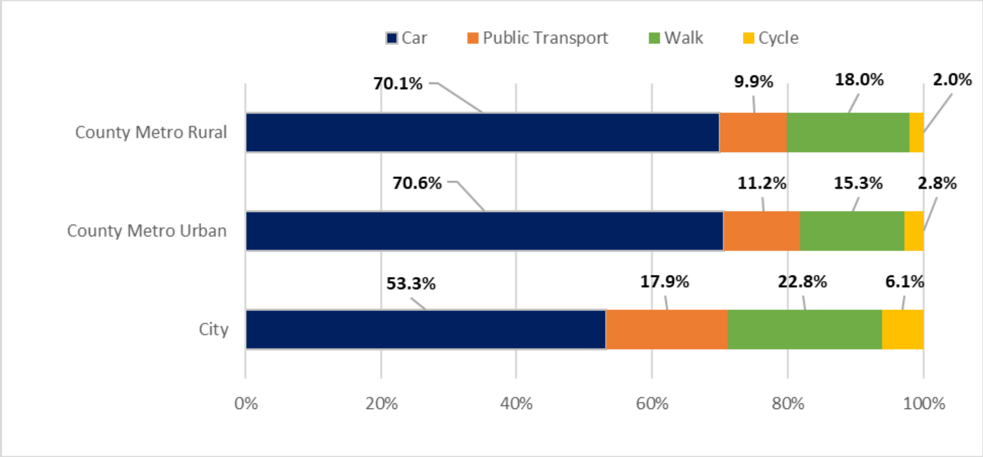

Figure 5-10: 24hr Do-Strategy Mode Share by Settlement

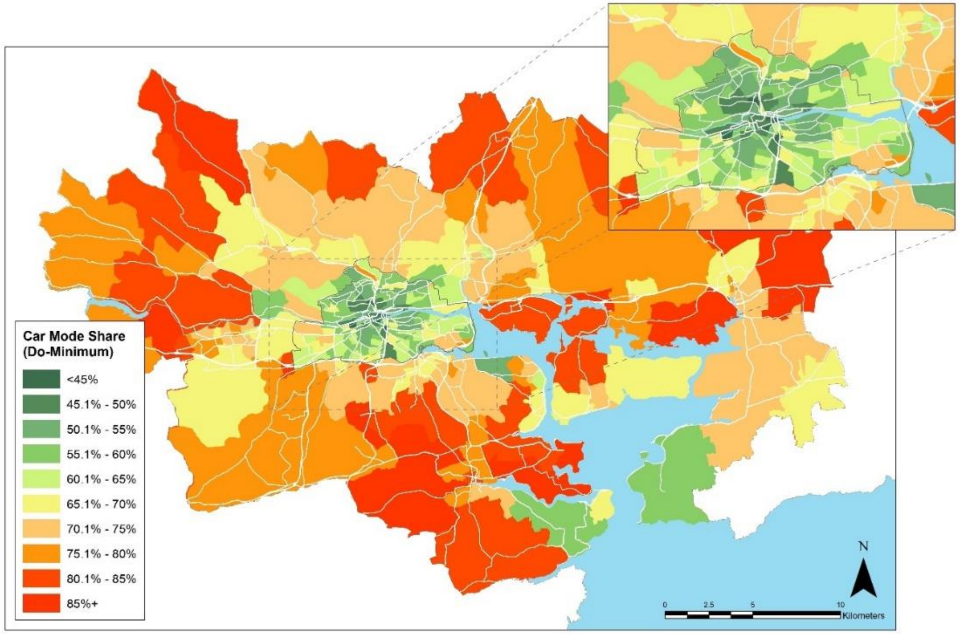

Figure 5-11: Do-Minimum Mode Share

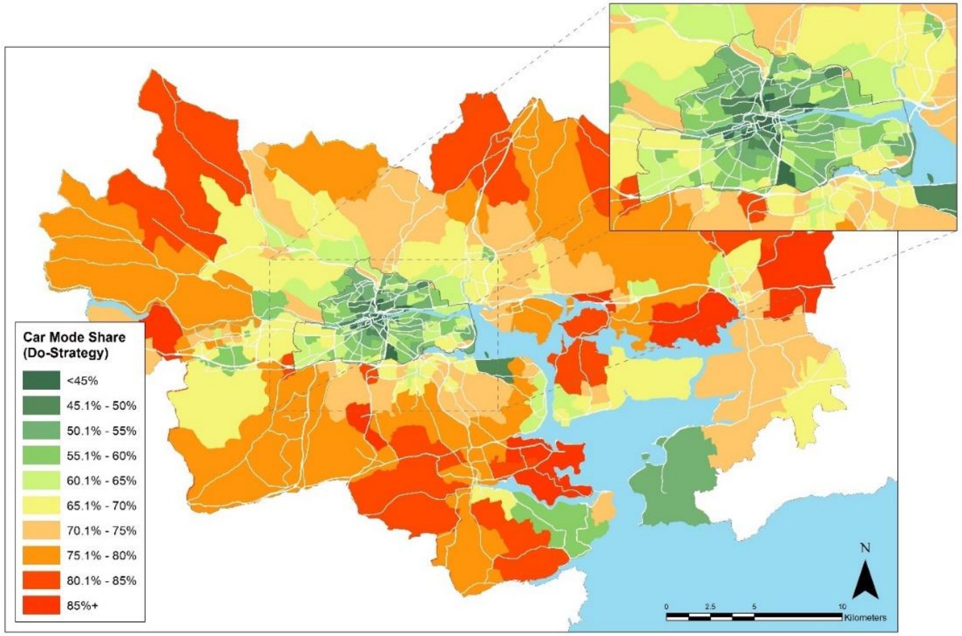

Figure 5-12: Do-Strategy Mode Share

5.8.3 Trip Length Distribution

Another Key Performance Indicator (KPI) used in the assessment is Trip Length Distribution (TLD). TLDs provide detail on the number of trips by journey length for each mode. They can be used to compare scenarios and indicate how trip patterns are changing. The Trip Length Distribution for the Do-Minimum and Do-Strategy for all trips is displayed in the Figure 5-13 below.

This shows reduced levels of short trips, with people able to travel longer distances due to the improved transport network and accessibility provided by the CMATS meaures.

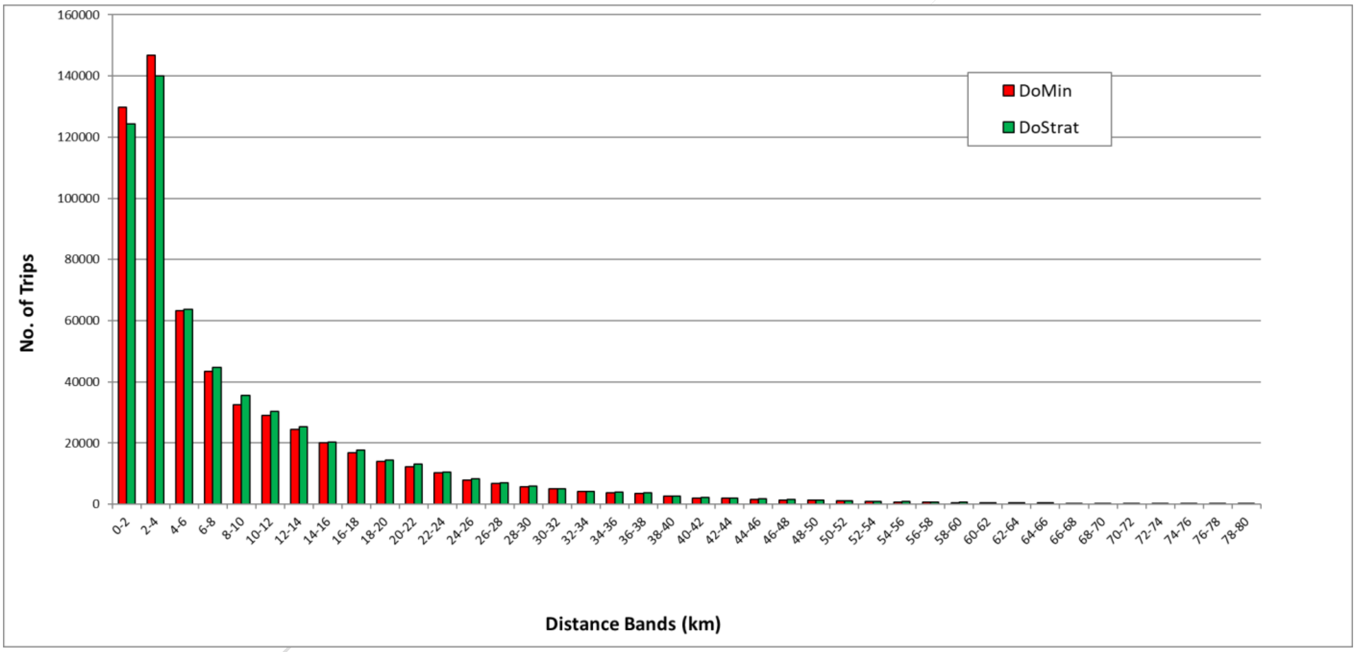

Figure 5-13: Do-Minimum and Do-Strategy Trip Length Distribution

The Trip Length Distribution for each Mode - Car, PT, Walk and Cycle are presented in Figure 5-14, Figure 5-15, Figure 5-16 and Figure 5-17 respectively below.

The results show reduced levels of Car trips across all distance bands, particularly over short distance (<10km). Public Transport trips are shown to increase substantially across all distance bands in the Do-Strategy scenario, as the new CMATS public transport measures provide a viable alternative to travel by car.

Walking trips are shown to reduce compared to the Do-Minimum scenario. This is because within the Do-Minimum scenario the increased level of trips could not be accommodated on the existing public transport and cycle network. The road network is also heavily congested resulting in many people forced to walk to complete their trip.

The introduction of the CMATS cycle network results in large increases in cycling trips compared to the Do-Minimum scenario, particularly over the 4-12km range, due to the provision of high quality cycle routes across the CMA to access the city centre core.

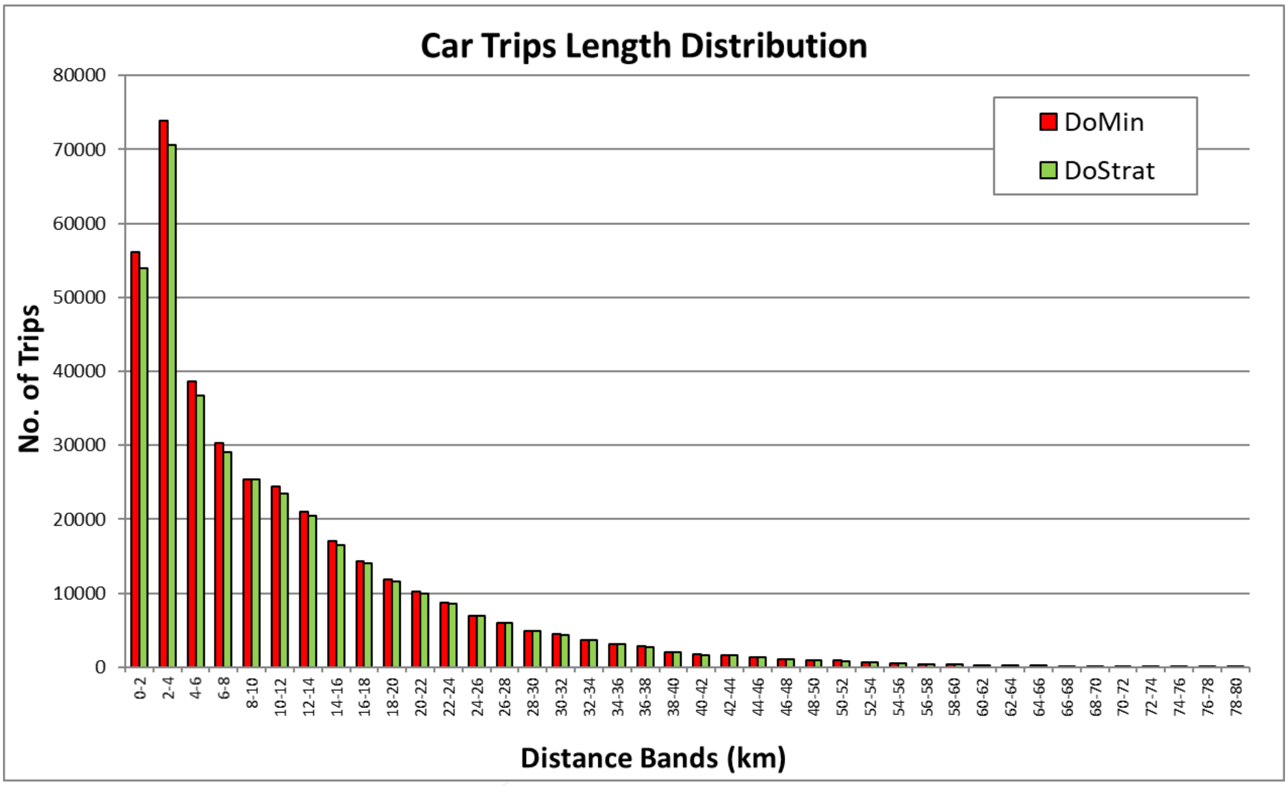

Figure 5-14: Road Trip Length Distribution

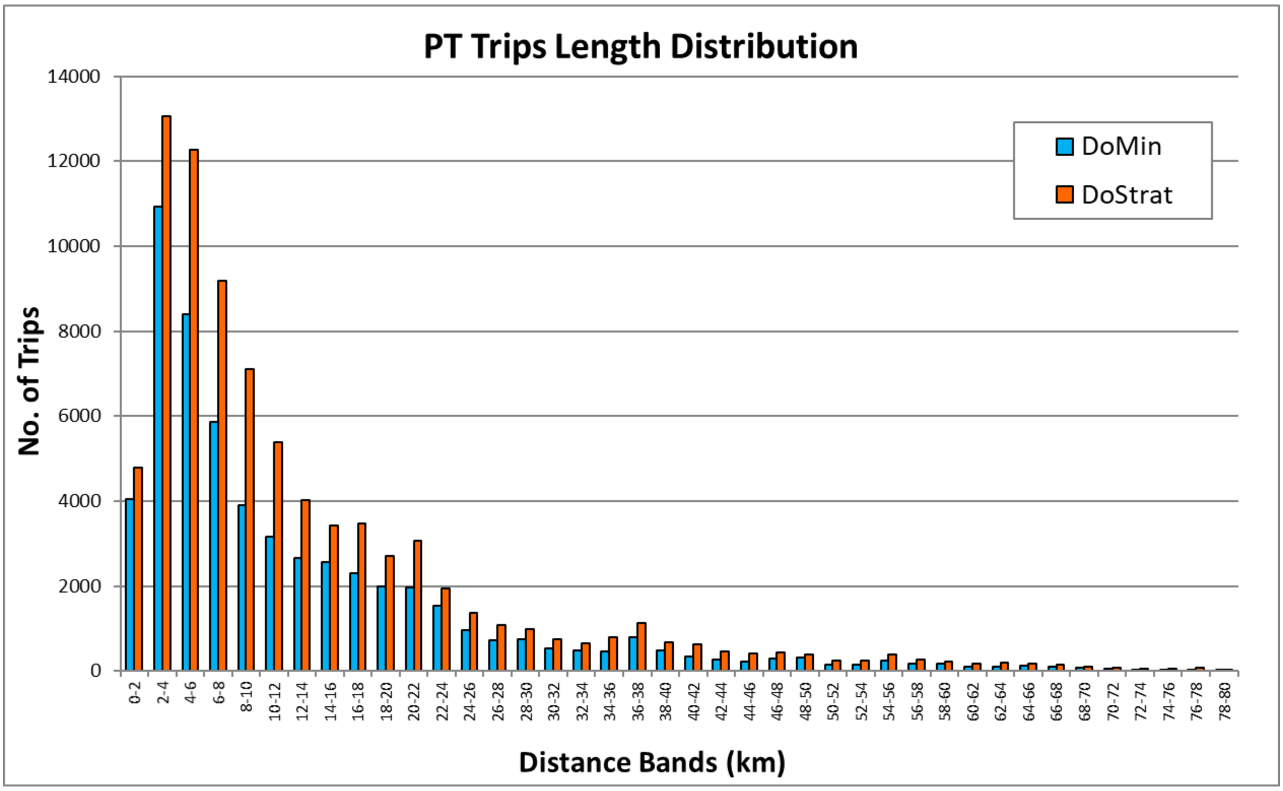

Figure 5-15: PT Trip Length Distribution

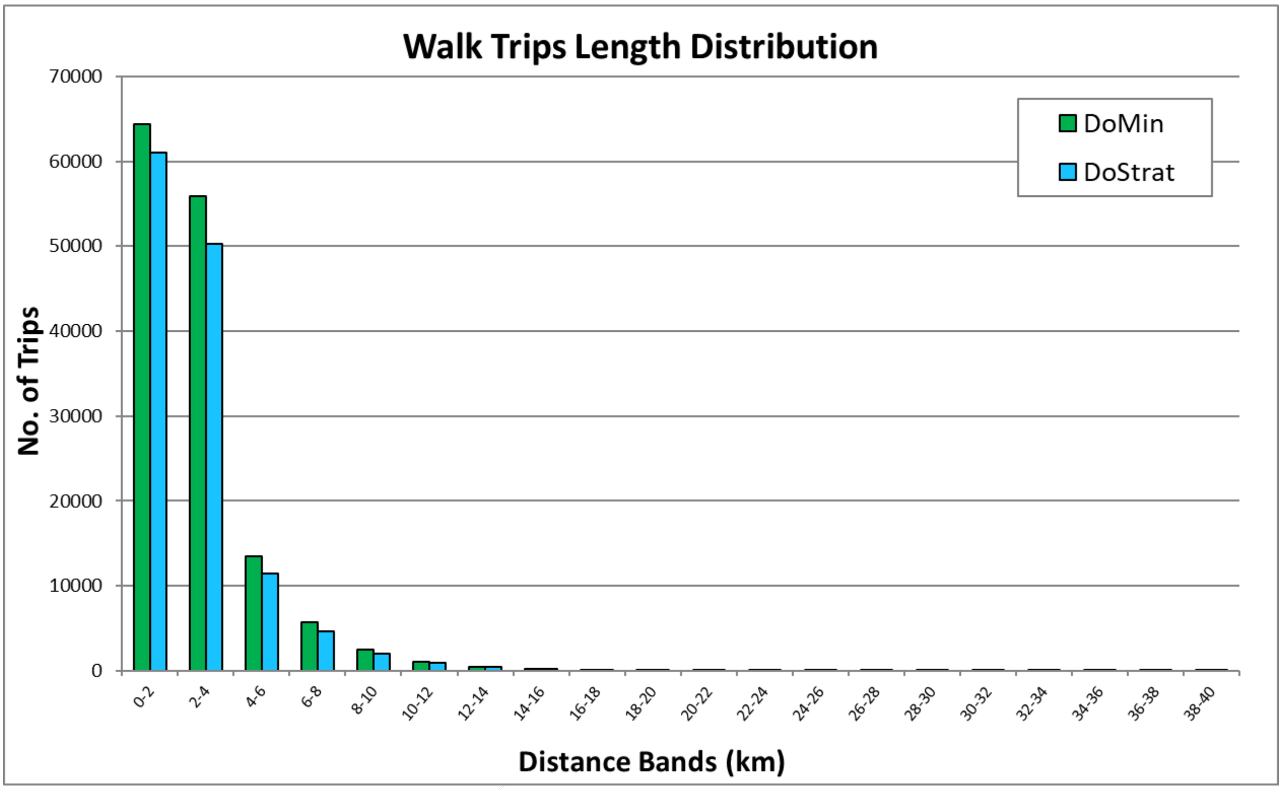

Figure 5-16: Walk Trip Length Distribution

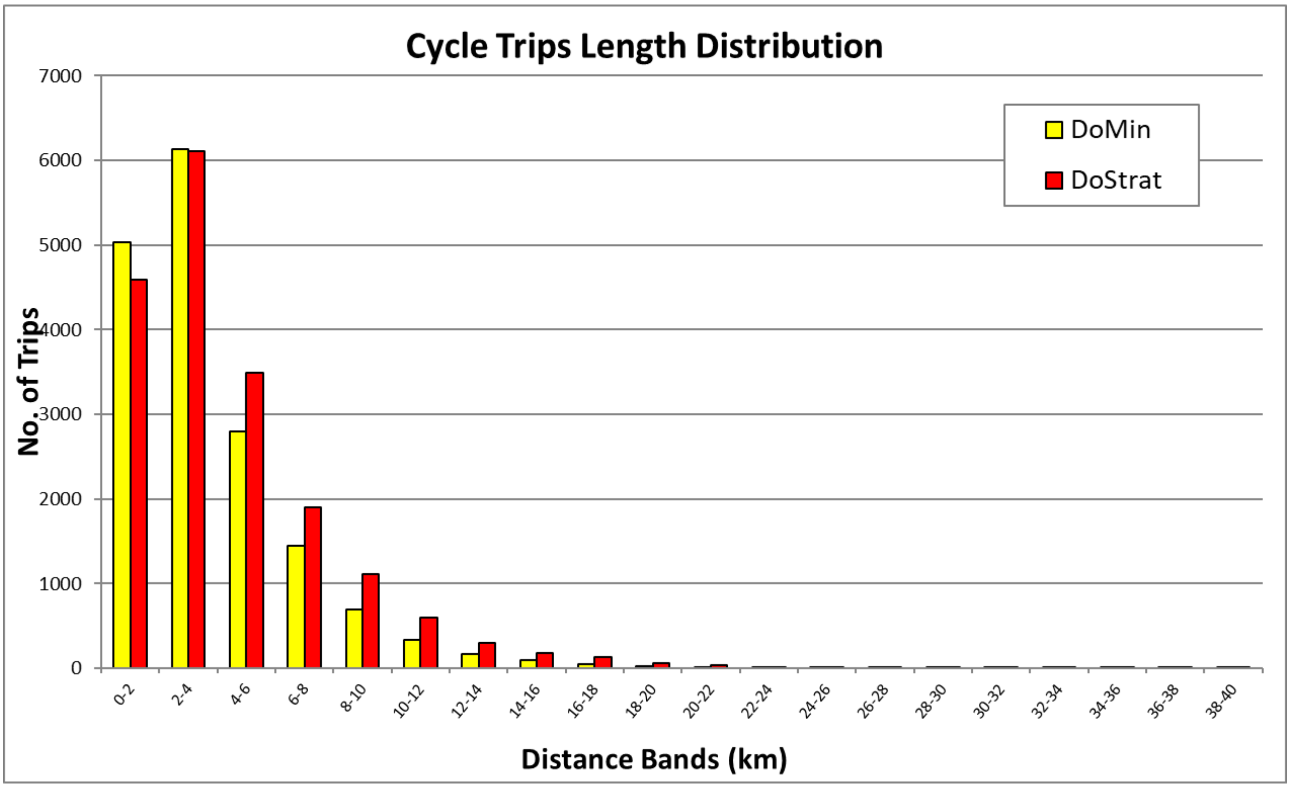

Figure 5-17: Cycle Trip Length Distribution

5.9 Public Transport Network Analysis

This section provides further detail on the performance of the CMATS Do-Strategy public transport network compared to the Do-Minimum scenario.

Table 5-15 below shows the breakdown of AM Trips by PT Sub-Mode for the Do-Minimum and Do-Strategy scenarios.

Table 5-15 AM Peak Hr PT trips by Sub-mode

Sub-mode	Do-Minimum	Do-Strategy
Rail	6,665	10,587
Luas	0	11,756
Bus	27,707	31,083
Total	**34,362**	**53,426**

The results show a 55% increase in public transport trips compared to the Do-Minimum scenario with substantial increases across all of the public transport sub-modes. Almost 12,000 trips will be made on the new Luas service in the AM peak hour.

5.9.1 Strategic Rail Assessment

The AM Peak hour Line-Flow profile, on the Mallow–Midleton and Mallow-Cobh sections of the CMA rail network are displayed in the Figure 5-18 for the Southbound direction and Figure 5-19 below for the Northbound direction.

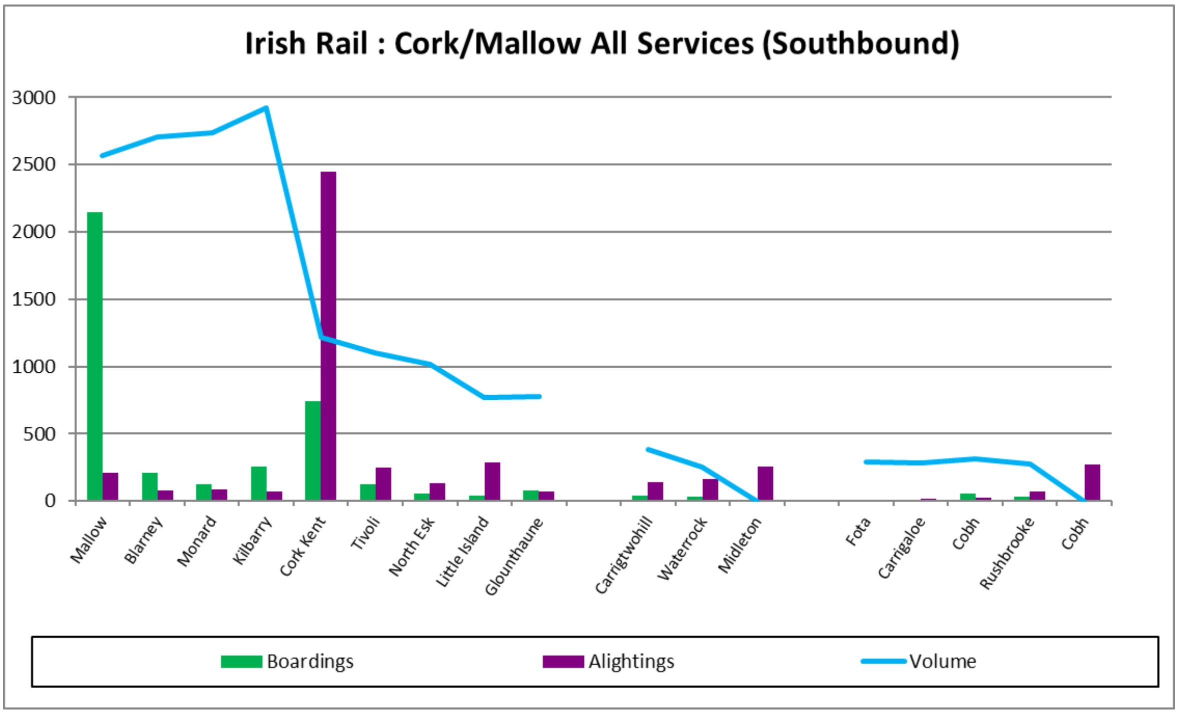

Figure 5-18: AM Peak Hr Southbound Rail Line Flow

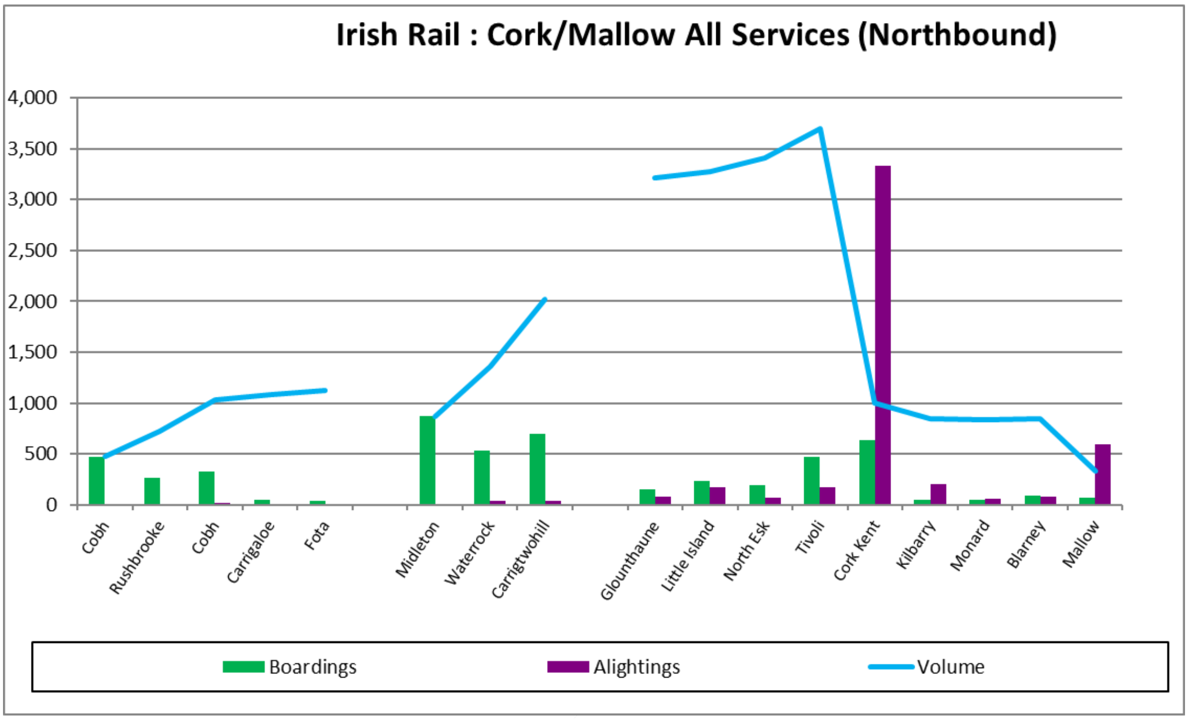

Figure 5-19: AM Peak Hr Northbound Rail Line Flow

The PM Peak hour Line-Flow profile, on the Mallow–Midleton and Mallow-Cobh sections of the CMA rail network are displayed in Figure 5-20 for the Southbound direction and **Error! Reference source not found.** below for the Northbound direction.

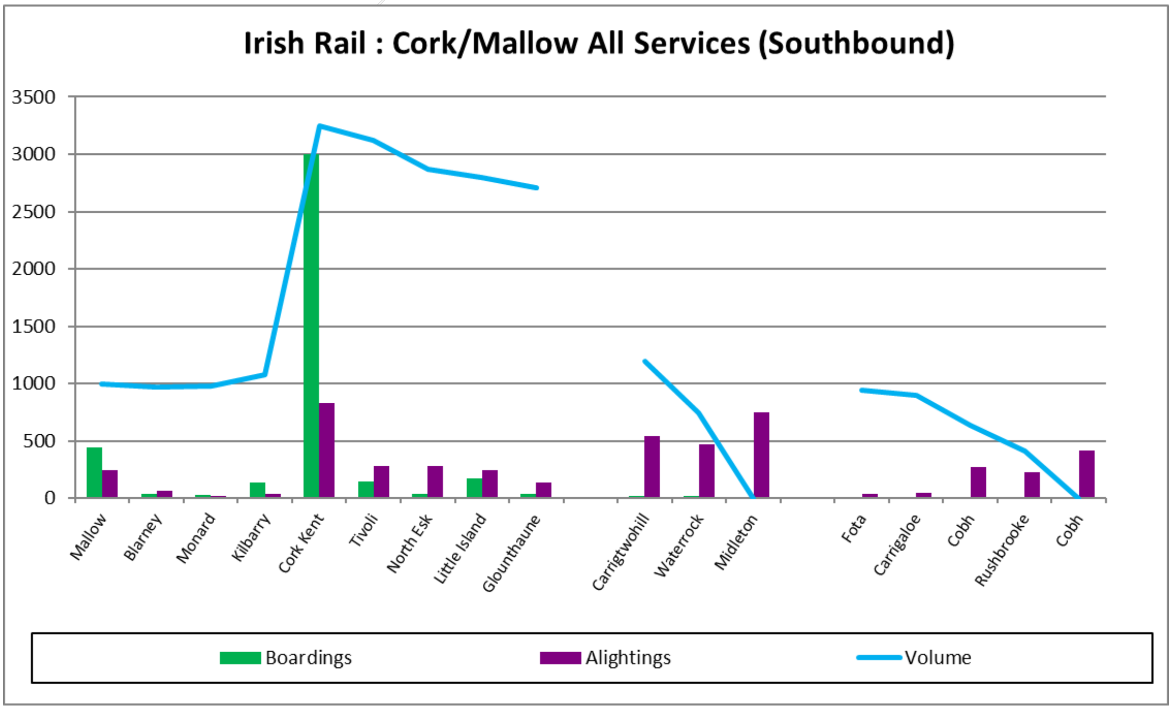

Figure 5-20: PM Peak Hr Southbound Rail Line Flow

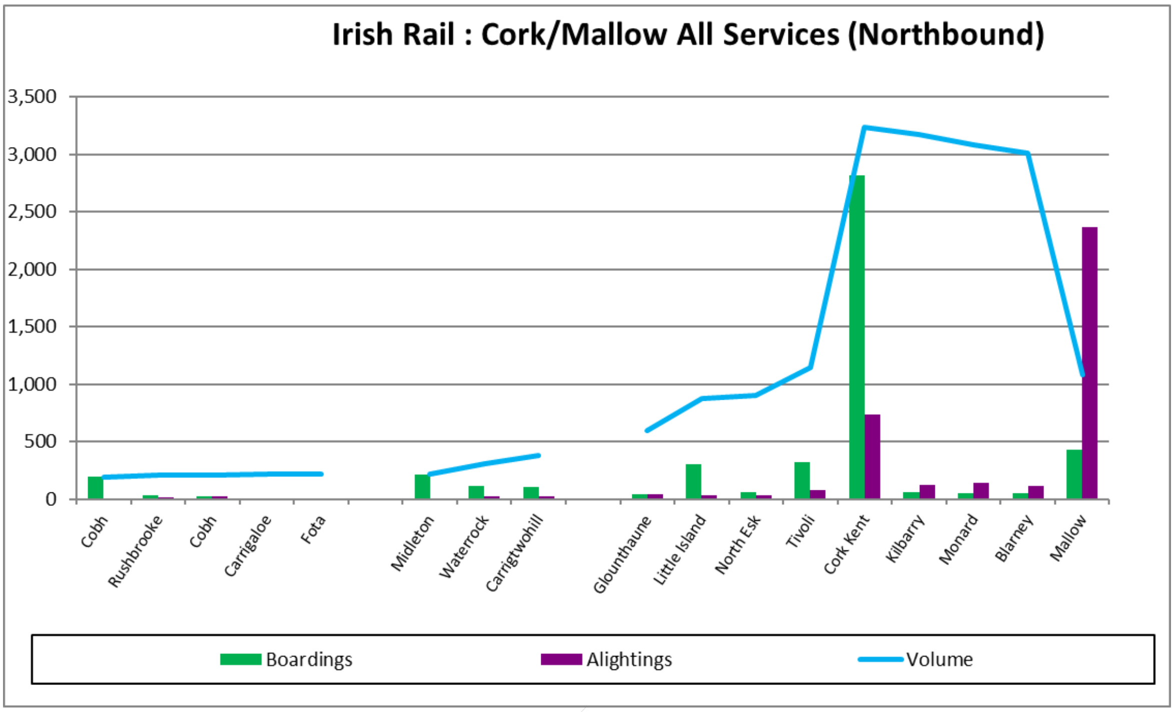

Figure 5-21: PM Peak Hr Northbound Rail Line Flow

The model results show that the improvements to the CMA rail network proposed within CMATS result in substantial usage of the lines in peak periods. The peak line profile occurs in the AM peak westbound / northbound at Tivoli station with approximately 3,600 passengers. There are significant boardings and alightings at Mallow across the peak periods due to the new cross city commuter services from this station.

5.9.2 East-West Corridor Operational Assessment

This section provides a summary of the performance of the proposed East-West LRT line within CMATS. The AM Peak hour Luas Line-Flow profiles are displayed in the Figure 5-22 for the Eastbound direction and Figure 5-23 below for the Westbound direction.

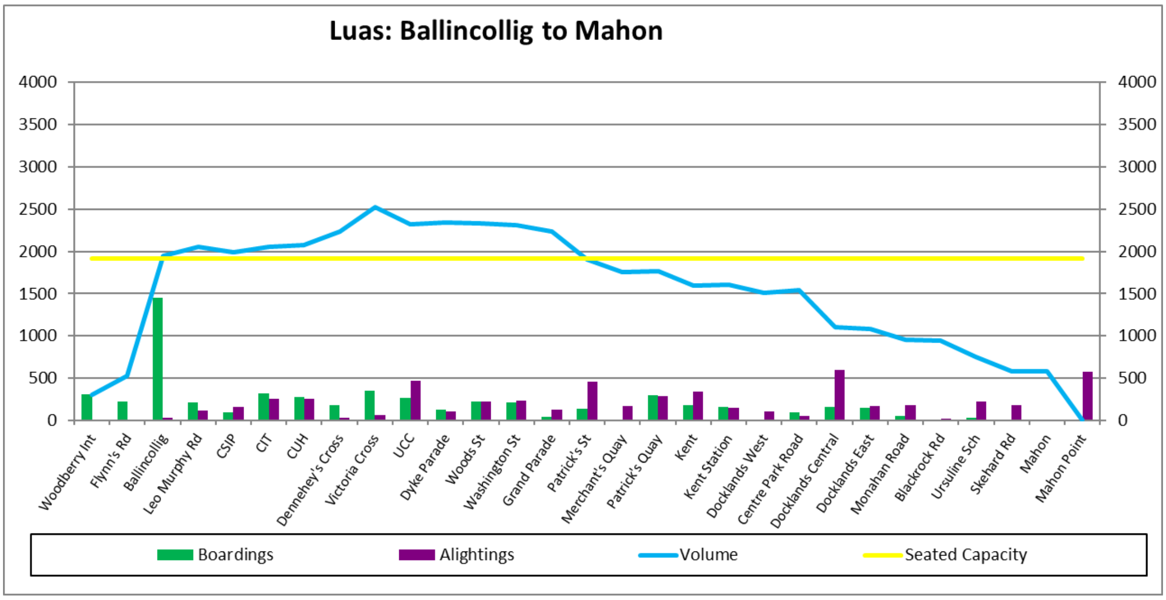

Figure 5-22: AM Peak Hr Luas EB Line Flow

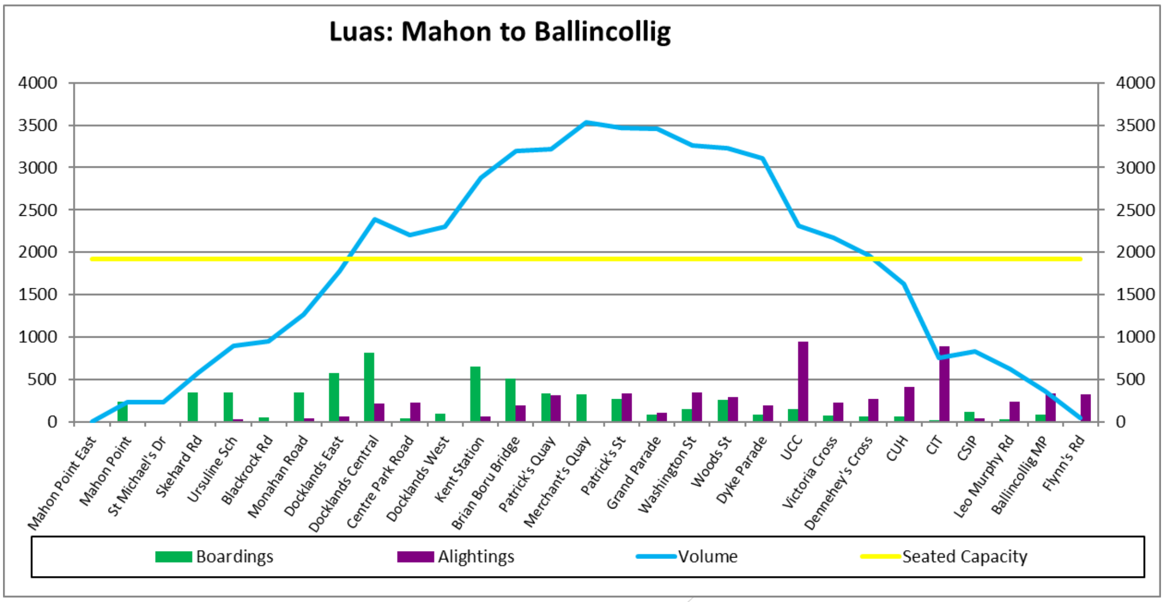

Figure 5-23: AM Peak Hr Luas WB Line Flow

The PM Peak hour Luas Line Flow profiles are displayed in Figure 5-24 for the Eastbound direction and Figure 5-25 below for the Westbound direction.

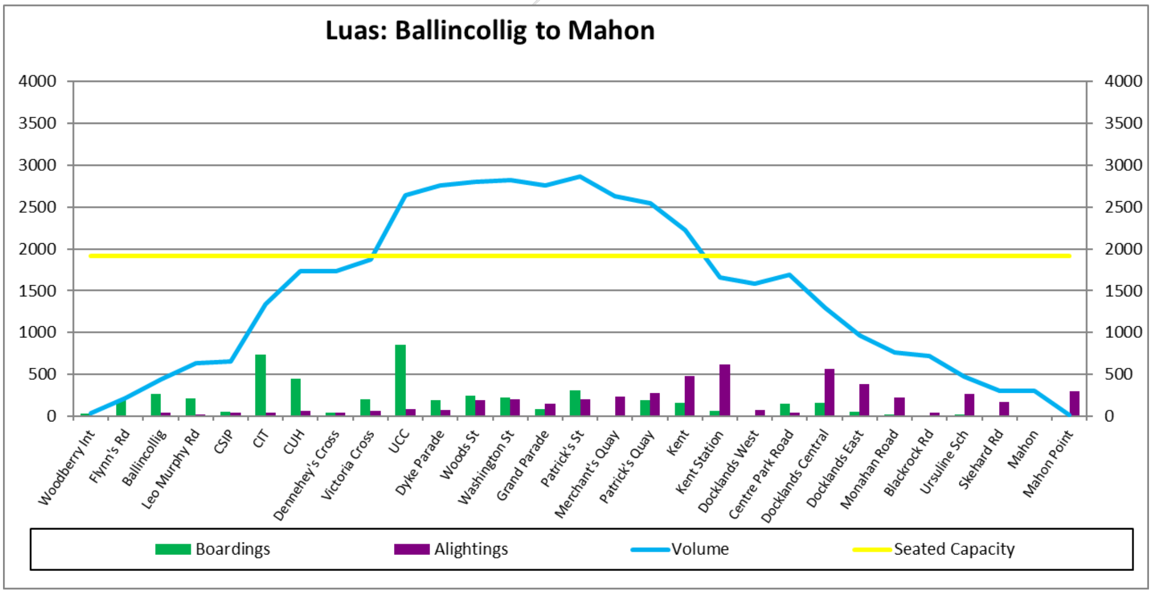

Figure 5-24: PM Peak Hr Luas EB Line Flow

The model results show that the proposed LRT line will be well utilised with the peak line profile occurring westbound in the morning peak at approximately 3,500 passengers.

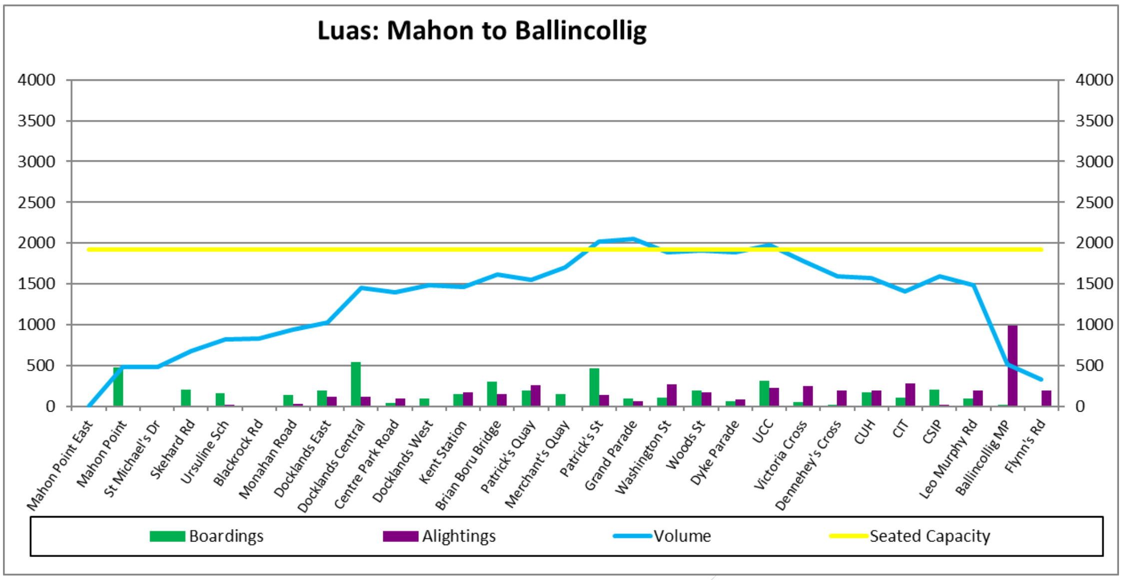

Figure 5-25: PM Peak Hr Luas WB Line Flow

Figure 5-26 below shows the AM peak hour flows on the LRT and Rail lines in the Do-Strategy scenario. This shows substantial usage of the upgrades rail line with flows greater than 3,000 passengers per hour westbound from Glounthane. The LRT line also shows strong patronage levels with flows greater than 3,000 passengers per hour in the city centre section.

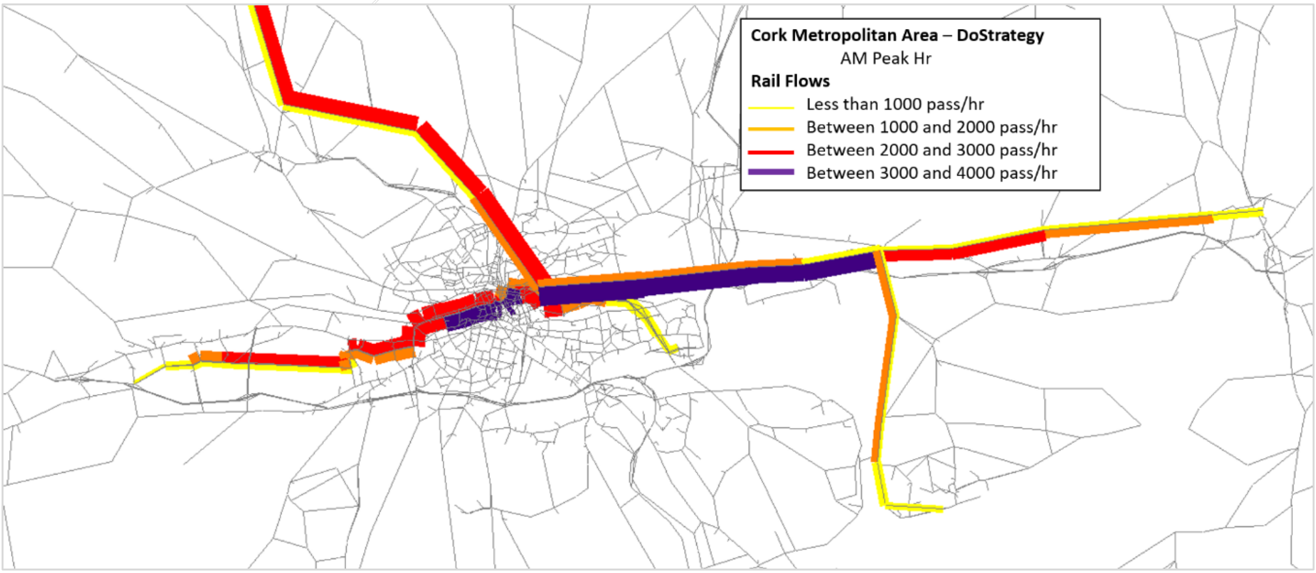

Figure 5-26: AM Peak Hour - Rail and LRT Flow Bandwidths

5.9.3 Bus Network Service Operational Assessment

This section provides a summary of the performance of the proposed BusConnects network within CMATS.

Figure 5-27 below shows the AM peak hour flows on the Bus network in the Do-Strategy scenario. This shows substantial usage of the bus network across the CMA. In particular, the South Douglas

Road corridor towards the city centre in the morning peak with flows up to 2,000 passengers per hour. Other corridors with very high passenger flows are the N20 (southbound), Mahon, Lower Glanmire Road, Wilton and from Mayfield. There are also very high bus flows through the city centre, showing the benefit of the new cross city services.

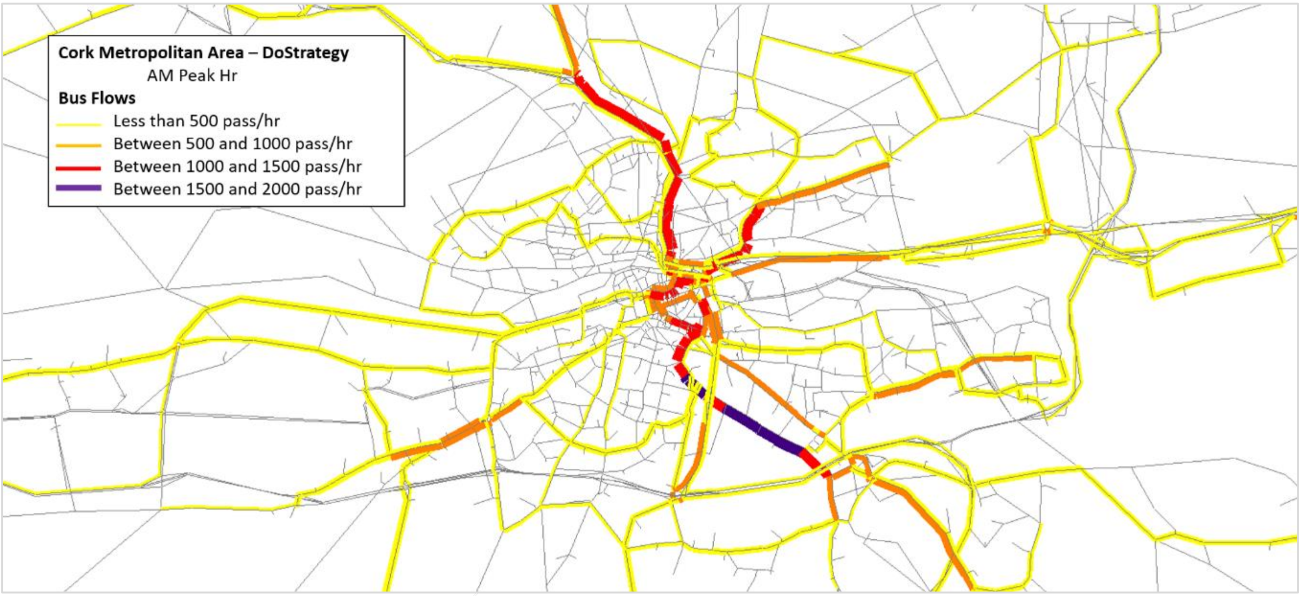

Figure 5-27: AM Peak Hour - Bus Flow Bandwidths

A summary of bus patronage by line in the AM peak hour is provided in Table 5-16 below. For each route, the table details the Headway (HW), Maximum Volume at any point on the route and also the Total boardings for each line.

The results show that the highest performing individual routes are:

- Route 3 – Mayfield to Bishopstown WB;
- Route 6 – Mahon to Tower – EB; and
- Route 6A – Mahon to Blarney – EB.

Table 5-16 Summary of Bus Patronage for the AM Peak

Name	HW	Max Volume	Total Boardings
CC Route 1: Dublin Hill - Togher SB	15	184	392
CC Route 1: Dublin Hill - Togher NB	15	186	422
CC Route 2: Ballyvolane - Donnybrook SB	10	363	606
CC Route 2: Ballyvolane - Donnybrook NB	10	333	707
CC Route 3: Mayfield - Bishopstown WB	5	833	1,906
CC Route 3: Mayfield - Bishopstown EB	10	221	736
CC Route 4: Glanmire - Ballincollig WB	20	227	626
CC Route 4: Glanmire - Ballincollig EB	20	135	455
CC Route 4a: Ballinglanna - Ballincollig WB	20	151	502
CC Route 4a: Ballinglanna - Ballincollig EB	20	135	420
CC Route 5: Mahon - Apple WB	10	224	651
CC Route 5: Mahon - Apple EB	10	194	403
CC Route 6: Mahon - Tower WB	20	192	528
CC Route 6: Mahon - Tower EB	10	521	1,031
CC Route 6A: Mahon - Blarney WB	20	193	529
CC Route 6A: Mahon - Blarney EB	7.5	679	1,314
CC Route 7: Rochestown - Apple WB	10	363	690
CC Route 7: Rochestown - Apple EB	10	241	695
CC Route 8: Ballincollig - Grange WB	15	240	629
CC Route 8: Ballincollig - Grange EB	20	110	277
CC Route 9: Frankfield- Fairhill SB	20	66	183
CC Route 9: Frankfield- Fairhill NB	20	116	192
Orbital Route 1: Northern Orbital EB	10	96	341
Orbital Route 1: Northern Orbital WB	10	193	532
Orbital Route 2: Southern Inner Orbital EB	10	317	1,022
Orbital Route 2: Southern Inner Orbital WB	10	381	990
Orbital Route 3: Southern Outer Orbital EB	20	63	169
Orbital Route 3: Southern Outer Orbital WB	15	301	488
Radial Route 1: Glanmire - City Centre SB	20	122	199
Radial Route 1: Glanmire - City Centre NB	20	90	165
Radial Route 2: Tivioli Estate -City Centre SB	30	3	6
Radial Route 2: Tivioli Estate -City Centre NB	30	27	45
Radial Route 3: Ringaskiddy-Passage-City Centre SB	20	115	300
Radial Route 3: Ringaskiddy-Passage-City Centre NB	20	166	364
Radial Route 4: Ringaskiddy-Passage-City Centre SB Express	20	83	196
Radial Route 4: Ringaskiddy-Passage-City Centre NB Express	20	111	212
Radial Route 5: Ringaskiddy-Carrigaline-City Centre SB	15	181	440
Radial Route 5: Ringaskiddy-Carrigaline-City Centre NB	10	367	742
Radial Route 6: Ringaskiddy-Carrigaline-City Centre SB Express	15	114	236
Radial Route 6: Ringaskiddy-Carrigaline-City Centre NB Express	15	245	328
Radial Route 7: Cork Airport - Kent Station SB	20	143	150
Radial Route 7: Cork Airport - Kent Station NB	20	74	77
Radial Route 8: Pouladuff - City Centre SB	30	18	25
Radial Route 8: Pouladuff - City Centre NB	30	29	38
Radial Route 9: Apple - City Centre EB	30	9	15
Radial Route 9: Apple- City Centre WB	30	8	20
Radial Route 10: N25 - City Centre EB	30	114	355
Radial Route 10: N25 - City Centre WB	20	382	592

5.10 Active Modes Network Operations

5.10.1 Active Modes Assignment

This section provides a summary of the performance of the Active Modes (Walking and Cycling) network within CMATS. Figure 5-28 presents the combined active flows (Walk + Cycle) in the AM Peak hour across the CMA.

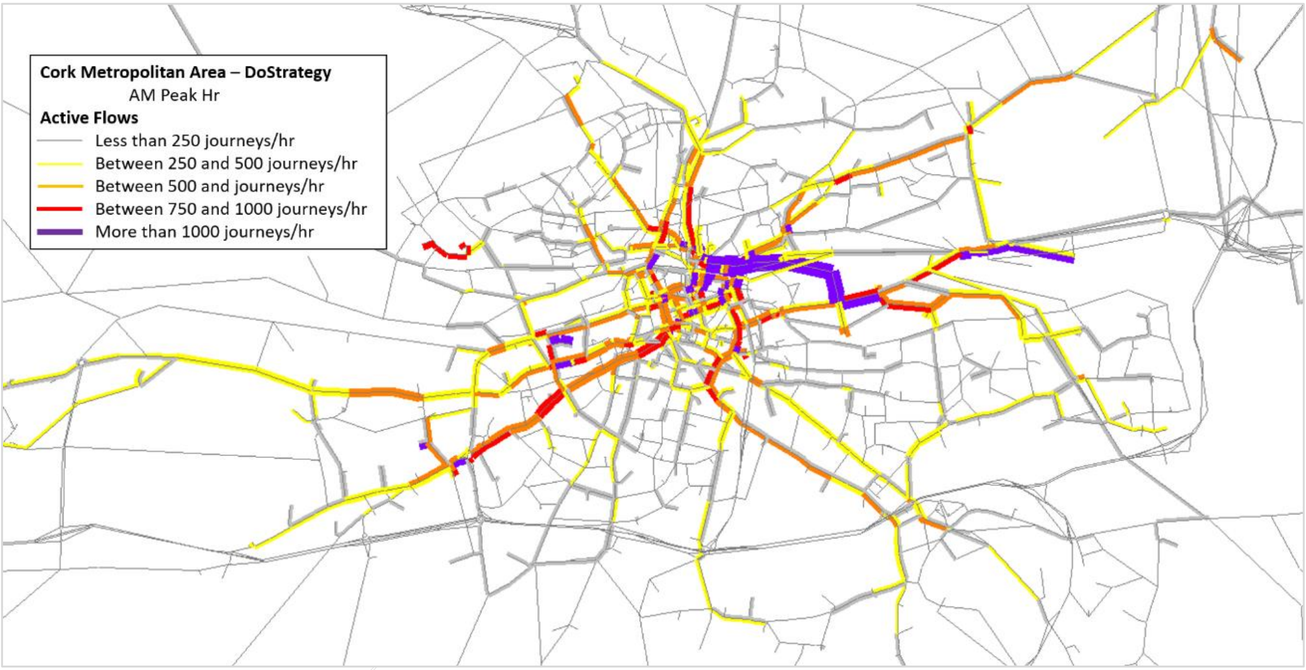

Figure 5-28: AM Peak Hr Active Mode Flows

The shows very high demand from the new development areas – Cork Docks and Tivoli. High levels of active modes usage is shown inbound to the city centre from Wilton, Douglas, Glanmire. Walking and Cycling trips greater than 1,000 in the peak hour are also evident in the vicinity of UCC and CSIP.

5.11 Road Network Operations

This section provides detail on the performance of the road network. Table 5-17 below presents High-Level Road Network statistics for the Do-Minimum and Do-Strategy extracted from the SWRM SATURN road model in the AM peak hour.

Table 5-17 AM Road Network Assignment Statistics

Assignment Stats	Do-Minimum	Do-Strategy
Transient Queues (PCU.HRS)	8,283	6,892
Over-Capacity Queues (PCU.HRS)	4,874	2,507
Link Cruise Time (PCU.HRS)	43,585	40,231
Total Travel Time (PCU.HRS)	56,742	49,629
Travel Distance (PCU.KMS)	3,393,625	3,157,303
Average Speed (KPH)	60	64

The results show substantial improvements in road network performance between the Do-Minimum and Do-Strategy scenarios. Over-capacity queueing – a measure of congestion on the wider road network shows a reduction of 49% between the two scenarios.

5.12 CMATS Supporting Measures Assessment

5.12.1 Do-Strategy with Supporting Measures

As discussed previously in Section 4.3, an additional sensitivity test has been undertaken to test the impact of the proposed supporting measures contained within CMATS. This scenario includes all measures included in the Do-Strategy scenario with the following additional supporting measures.

- 20% reduction in fares;
    - All public transport services will migrate to a cashless system, to facilitate driver safety and faster passenger boarding times. As a proxy to account for this in the model, a 20% reduction was applied to PT fares, predominantly due to the fact that Leap card fares are on average 20% cheaper than the cash alternative;
- Transfer penalty reduction (5mins);
    - To account for the fact that passenger transfers with Rail services in a more integrated PT system will be more seamless and therefore should not be overly penalised – a consistent 5min transfer penalty has been used in the sensitivity modelling for all PT sub-modes instead of the existing 15min penalty to/from Rail to other modes.
- Parking constraint – removal of available on-street parking to accommodate bus priority measures, cycle schemes etc;
    - 50% reduction in on-street spaces assumed within the model.
- N40 Toll demand management;
    - The distance based multi-point tolling measures contained within the N40 Demand Management Study were coded into the SWRM Road model which includes for tolls at the following locations.
        - Dunkettle to Mahon;
        - Douglas West to Kinsale Road;
        - Togher to Sarsfield Road.

This model run provides an indication of the likely improvement in sustainable mode share resulting from the 'softer' (non-infrastructure) CMATS measures.

5.12.2 CMATS Supporting Measures - Mode Share Results

To assess the impact of the supporting measures, the Mode Share statistics have been extracted from the SWRM for the Do-Strategy with Supporting Measures model run. The mode share results for the Base model, Do-Minimum, Do-Strategy and Do-Strategy with Supporting Measures model runs is presented in Table 5-18 below.

Table 5-18 AM Peak Hour Mode Shares for Do-Strategy Scenario with Supporting Measures

Scenario	Car	PT	Walk	Cycle
Base (2011)	65.9%	10.3%	20.5%	3.3%
Do-Minimum	56.7%	13.0%	26.5%	3.9%
Do-Strategy	52.9%	20.5%	22.2%	4.5%
Do-Strategy with Supporting Measures	48.6%	23.0%	23.9%	4.5%

As shown in the table above the CMATS supporting measures are shown to have a very positive impact on sustainable mode share levels. Public transport mode share is shown to increase further from 20.5% to 23% with the inclusion of the supporting measures. The Car mode share across the CMA is shown to reduce below 50% to 48.6% - representing a very low average car mode share across the CMA.

6 Conclusions

A detailed assessment of the transport proposals outlined as part of the Cork Metropolitan Area Transport Strategy (CMATS) was undertaken using outputs from the South West Regional transport model.

As a result of this assessment, the main impacts of the Strategy can be summarised as follows:

- A substantial proportion of projected growth in travel demand in the CMA will be accommodated by sustainable transport modes;
- The Strategy is forecast to provide an increase in mode share for sustainable transport modes and a reduction in the demand to travel by private car;
- The public transport network is forecast to have very high usage with a significant increase in total passenger boardings;
- Travel times on the road network are forecast to reduce as a result of the Strategy – compared to the Do-Minimum;
- The Strategy is forecast to reduce transport related emissions;
- The Strategy is forecast to improve accessibility by reducing severance and increasing the accessibility to public transport, particularly from socially deprived areas across the CMA;
- A more integrated public transport network provided by the Strategy results in an increased level of public transport interchange; and
- The Strategy represents a worthwhile investment with transport user benefits forecast to exceed the outline estimate cost of delivering the Strategy.