Údarás Náisiúnta Iompair
National Transport Authority

Draft Transport Strategy for the Greater Dublin Area

South East Corridor Study

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1 Introduction

1.1 Background

The National Transport Authority (NTA) is preparing a new transport strategy for the Greater Dublin Area (GDA) which will consider the future of the transport system in the GDA for the period up to year 2035. As a means towards informing the direction of the new strategy the NTA has defined eight Study Areas to be assessed for this review in order to understand more fully the 2035 travel demand coming from the Study Areas, and the public transport services that will be required to effectively meet that demand.

Jacobs Engineering Ireland (Jacobs) and SYSTRA provide consultancy services to the NTA through a Modelling Services Framework. By this means Jacobs and SYSTRA were commissioned by the NTA to undertake a desktop transport assessment of six of the eight identified corridors within the GDA.

This report focuses on the **South East Study Area**. There are also Study Areas being examined by Jacobs / SYSTRA covering the South West, West, North West, Navan and Inner Orbital. Reports considering the role that Park and Ride and Demand Management can play in increasing public transport usage will also be informing the transport strategy for the Greater Dublin Area.

1.2 Study Objectives and Principles

This study examines the future transport needs of the South East Study Area. Consideration is given to the role and function of the strategic road network as well as the performance of existing public transport provision.

A particular aim of the study is to explore and identify public transport options that could effectively meet the growth in travel demand to the year 2035, between the South East Study Area and Dublin City Centre (within the Canal boundary). Additional demand for internal travel within the corridor has also been considered when reviewing both travel demand and potential public transport schemes. The review also takes cognisance of through trips that can increase demand on current and future public transport services.

The study objectives for the South East Study Area were outlined by the NTA and have guided the study and assessment process. These objectives include developing public transport measures that will:

- cater for existing public transport usage;
- cater for 100 per cent of future demand growth to Dublin City Centre; and
- cater for more of the existing car-based demand, if feasible.

The focus is placed on meeting the demand of those trips that are greater than 3km in distance, as it has been assumed that the majority of trips less than 3km may be taken via active modes such as walking or cycling.

Based on the level of demand that is identified, and considering functionality and cost, a set of appropriate public transport solutions are presented. Packages may include bus, bus rapid transit (BRT), light rail, metro and heavy rail. Interchange between public transport modes has been considered. The public transport options identified are considered to offer the most effective, efficient and sustainable solution to serve growth in transport demand and to provide the best means of contributing to an integrated public transport strategy for the GDA.

This study has considered the existing road network in the Study Area and has included the various significant road proposals that are under consideration. Discussions have been held by the NTA with the National Roads Authority and local authorities to establish the likely road network changes that will be required during the period of the transport strategy. While many of these road proposals have not yet been developed in detail, and designs are not available, the impacts of these proposals have been accounted for in the analysis of the public transport requirements. Accordingly, while the analysis of the public transport necessary for the future is the focus of this study, it has involved a composite consideration of the road network.

1.3 Study Methodology

The study has been undertaken in four stages;

- Stage 1 established travel demand within the 2011 base year and 2035 forecast year using the demand from the Greater Dublin Area Regional Model (GDARM);
- Stage 2 identified public transport options that have the potential to meet the demand identified in Stage 1 based solely on capacity thresholds by public transport mode (e.g. rail, light rail, BRT and bus);
- Within Stage 3 the most appropriate public transport options that meet the demand requirements were scored and sifted based on functionality (journey time and ability to meet demand) and cost (capital cost as related to service level); and
- Stage 4 tested the preferred option in the GDARM to confirm its viability.

These stages are discussed in the following sections.

1.3.1 Stage 1 - Establish Demand

To forecast the strategic public transport needs for each of the Study Areas in 2035, demand was established using the GDARM, which has a base year of 2011. To produce the 2035 forecast, planning data was provided by the NTA based on the 2035 population and employment projections.

The 2011 demand outputs were generated for the GDA for the AM peak hour (08:00–09:00) for all trips greater than 3km within these time periods. The same process was applied for the 2035 demand. The AM peak hour was chosen for the demand analysis because this is when the travel demand is at its highest over the day. The PM peak was not used for this stage of review, as demand tends to be spread over a longer time and it also does not typically cater for both work and school trips.

Screenlines were used to develop a broader understanding of travel demand passing through the Study Area. This analysis is primarily used to help inform the capacity requirements for future public transport options for the Study Area.

The study aims to cater for growth in public transport demand to 2035. This target was identified for each screenline. For the South East Study Area the public transport demand target is defined to cater for all growth in demand with a destination within Dublin City Centre, all growth in demand with a destination within the Study Area, and 30 per cent of growth in demand with other destinations. The target is an upper bound of the growth in demand that has potential to use public transport in the future if suitable services were to be provided.

1.3.2 Stage 2 - Public Transport Option Development

The second stage of the study focuses on developing public transport options to meet the public transport demand growth from 2011 to 2035, through the Study Area during the AM peak hour (08:00-09:00).

Catchment bands for existing public transport services were defined and applied to identify growth within the catchment of existing service areas and to identify areas where the level of service provided by public transport is low or where no service is provided.

Service capacities for possible public transport modes were then defined. This includes the definition of the seating capacity and crush capacity for DART, Commuter Rail, Light Rail, Bus Rapid Transit, Urban Bus, Intercity Bus and Shuttle Bus. For the purpose of option development for the 2035 transport strategy, public transport options are considered based on design capacity which is equivalent to an operating level of service that is at or below 85 per cent of crush capacity. This ensures that at no time will the entirety of the target demand be accommodated by a service that is underutilised, or is so busy as to make the service less desirable. Crush capacity is an industry standard expression relating to the loading upper limit of public transport services that allow standing as a means of catering for higher levels of patronage. Design capacity is assumed at 85 per cent of this to allow for a more comfortable and attractive level of service to be provided.

Development of public transport options for Stage 2 of the study focused on utilising the capacity and frequency definitions to determine the appropriate public transport mode to meet AM peak hour demand.

1.3.3 Stage 3 - Public Transport Option Scoring

Stage 3 takes the output of the high level public transport options developed in Stage 2 and scores them based on categories relating to demand, functionality and cost.

The functionality scoring category analysed the capacity of the public transport option to meet the 2035 travel demand from the Study Area into Dublin City Centre during the AM peak hour. It also considered the maximum duration of the journey. This was based on the maximum length of the journey from the start to the City Centre and the average speed of the public transport mode.

The cost scoring category is based on the capital costs per option. It also considers the extent to which existing infrastructure is utilised and maximised for efficiency. Typical capital costs have been assumed, generally based on a cost per km. Typical capital costs may include a level of risk. A more detailed review would be required to confirm the likely cost, for example to account for land acquisition and all major risks. Operational costs are not considered. Despite this, the outline costs are considered to provide a reasonable estimation of costs at a suitable level of detail for comparative purposes for this stage of review.

The public transport options with the best score were recommended to be considered further as part of the larger 2035 Greater Dublin Area Transport Strategy.

The Do Minimum scenario, described in Section 2.3 is used as a basis for the development of the public transport options to serve the growth in demand to 2035 originating within the South East Corridor.

1.3.4 Stage 4 – Transport Modelling Assessment

This stage tested the preferred option in the Greater Dublin Area Regional Model (GDARM). The modelling exercise was undertaken to determine the likely viability, usage and operation of the proposed services for implementation by 2035.

In addition to the Do-Minimum scenario, the GDARM includes additional schemes assumed (described in Section 2.3) as part of the wider GDA Strategy. The modelling exercise has not included the collective benefits that could be provided by Park and Ride and demand management measures. It should be noted that because the Park and Ride facilities and Demand Management Measures were not included in the modelling stage, the actual benefits of the proposed measures are likely to be greater than reported.

1.4 Report Structure

The report is structured as follows:

- Section 2 describes the South East Study Area and outlines the Do Minimum scenario;
- Section 3 details the results of the demand analysis for the Study Area and identifies the 2035 public transport target demand;
- Section 4 develops the public transport options to meet the demand established in Section 3;
- Section 5 scores the public transport options developed in Section 4 outlining an emerging preferred option to be brought forward to the modelling assessment;
- Section 6 outlines the modelling assessment of the proposed public transport services;
- Section 7 describes the Preferred Emerging Scheme; and
- Annexes 1-5 provide supplementary information on capacity analysis; assumptions used in relation to capacity, cost and speed; and the scoring process.

2 Study Area

2.1 Corridor Description

The South East Study Area is bounded by the Grand Canal/R111 to the north and Greystones to the South. The coastline provides the eastern Study Area border. The Study Area is bounded to the west by R114/Rathmines Road Lower. It covers an area within the jurisdictions of Dublin City Council, Dún Laoghaire-Rathdown County Council and Wicklow County Council. It includes key growth areas such as Sandyford, Stepaside, Cherrywood, Bray, Fassaroe and Greystones.

The Study Area boundary, which is shown in Figure 2-1, was developed using the electoral division boundaries (small area boundaries) from the Central Statistics Office.

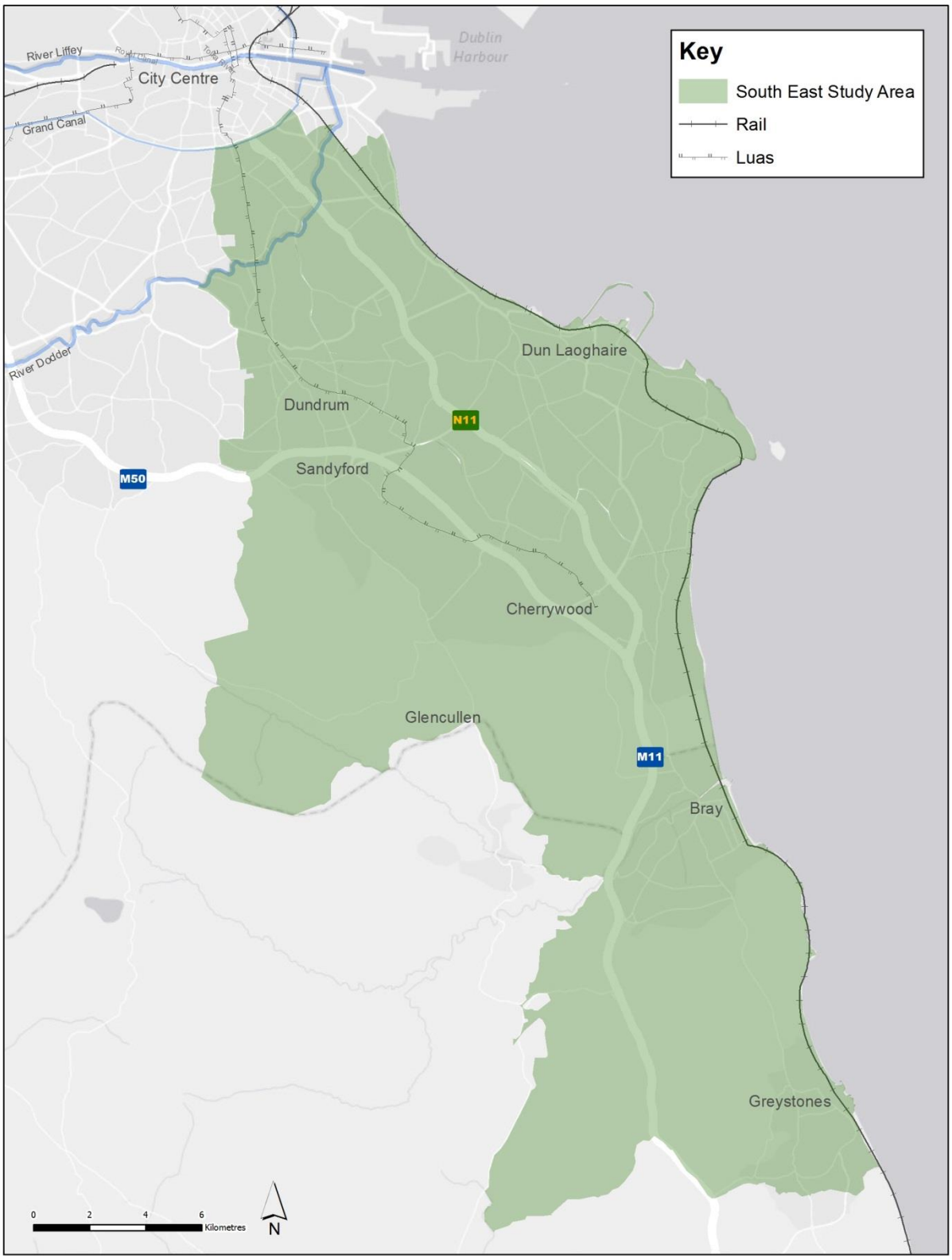


Figure 2-1: South East Study Area

2.2 Existing and Planned Strategic Road Network

The corridor contains the M50 and M/N11 primary routes which cater for significant traffic volumes. In addition, the N11 provides for a QBC thereby facilitating a high volume of bus journeys. The capacity of the M50 and the M/N11 must be protected for strategic traffic movements, including the distribution of goods.

Congestion along the M50 and the M/N11 is an increasingly serious issue, particularly around the M50/M11 merge at peak times and on the N11 section between the Killarney Road junction, to the south of Bray and Kilmacanogue. As the critical link to the south east from Metropolitan Dublin, this will need to be addressed in the Strategy.

On the M50 corridor, there is the potential to upgrade the South Eastern Motorway route to provide additional capacity as far as the M11 at Wilford, to the north of Bray. There is limited opportunity for significant road capacity enhancements on the N11 corridor from the perspective of both physical constraints and environmental considerations. Road improvement measures along this corridor will focus on removing local existing bottlenecks and managing demand more efficiently through measures such as Intelligent Transport Systems. Therefore, providing for increasing transport demand through alternative modes, such as public transport, will be necessary to protect the function and operation of the N/M11 as a strategic corridor.

2.3 Existing and Planned Public Transport Provision

The South East Study Area is currently served by the Luas Green line, the DART, Irish Rail Commuter Trains and a wide number of bus services including the N11 QBC and the Rock Road QBC.

2.3.1 Luas

The Luas Green Line extends through the Study Area as shown in Figure 2-2.

There are 20 operational Luas Green Line stops within the Study Area between Charlemont and Brides Glen. Additionally, there are two stops that are built, but not currently in use; one at Leopardstown Racecourse; and one between Carrickmines and Laughanstown.

2.3.2 DART/Irish Rail

Figure 2-2 illustrates the existing heavy rail network within the Study Area.

There are 15 DART stations within the Study Area between Sandymount and Greystones. Commuter Rail and Intercity services also operate along the corridor. These are limited stop services generally serving Blackrock, Dún Laoghaire, Bray and Greystones Stations.

Figure 2-2: Existing Rail Services

2.3.3 Bus

The Rathmines and Tallaght QBCs are located at the western boundary of the Study Area and are served by Dublin Bus Routes 140, 14, 15, 15a, 15b and16.

The N11 QBC extends radially within the Study Area from the City Centre between the Luas Green Line and DART corridors. It is primarily served by Dublin Bus Routes 46A and 145 with additional peak hour services such as the 7A and 7B.

The Rock Road QBC extends radially from the City Centre in parallel to the coastline at the eastern side of the Study Area. It is served primarily by Dublin Bus Routes 4 and 7.

Other notable bus routes which operate between the study area and the City Centre include Routes 11, 44 and 61 which serve Ranelagh, Route 39A which serves Baggot St and UCD and Route 1 which serves Sandymount.

Orbital routes include the 114 operating between Sandyford and the Blackrock DART Station, and the 75 operating between Rathfarnham, Dundrum, Sandyford and Dún Laoghaire. The 47 also operates from Stepaside and Sandyford to the City Centre linking to the Luas Green Line at Stillorgan and the DART at Sydney Parade. The 17 operates between Blackrock Station and Churchtown to Rialto. The 18 operates orbitally from Sandymount through Ranelagh towards Palmerstown. The 111 operates between Cherrywood and Dún Laoghaire, on a limited commuter schedule, and the 63 serves some of the more rural areas south of the M50 and connects to the Carrickmines Luas Stop and Dún Laoghaire.

Greystones and Bray are served by the bus as well. The 84A operates between Bray and Blackrock. The 84 operates between Greystones and Blackrock. The 184 operates between Bray and Greystones. The Bus Éireann 133 also operates between Greystones, Bray and the City Centre. Finnegan Bray provides scheduled services that link the Southern Cross area of Bray with Bray DART and Sandyford Luas.

There are a number of dedicated airport services operated by Air Coach which link the Study Area to Dublin Airport. Route 700 serves Leoparstown/Sandyford, Route 702 extends to Greystones and serves Bray and Route 703 operates to Killiney/Dalkey.

Figure 2-3 illustrates the existing bus services network.

Figure 2-3: Existing Dublin Bus and Bus Éireann Services

2.4 Do Minimum Network

The Do Minimum Scenario includes public transport improvements within Dublin City Centre that have a high degree of certainty for completion before the Forecast Year. The Do Minimum public transport improvements include the following:

- Phoenix Park Tunnel;
- Dublin City Centre Rail Re-Signalling Project; and
- Luas Cross City.

In addition, the following road schemes, located in the South East corridor, are included in the Do Minimum scenario:

- Braemor Road Improvement Scheme;
- Sandyford junction upgrades;
- Leopardstown Link Road Phase 1 and roundabout reconfiguration;
- Link Road from Leopardstown to Carrickmines Interchange; and
- M50 Junction 14 diverge, ESB Link Road and Link to Arena Road.

Further details of the major public transport improvements assumed as part of the Do Minimum network are outlined below and illustrated in Figure 2-4.

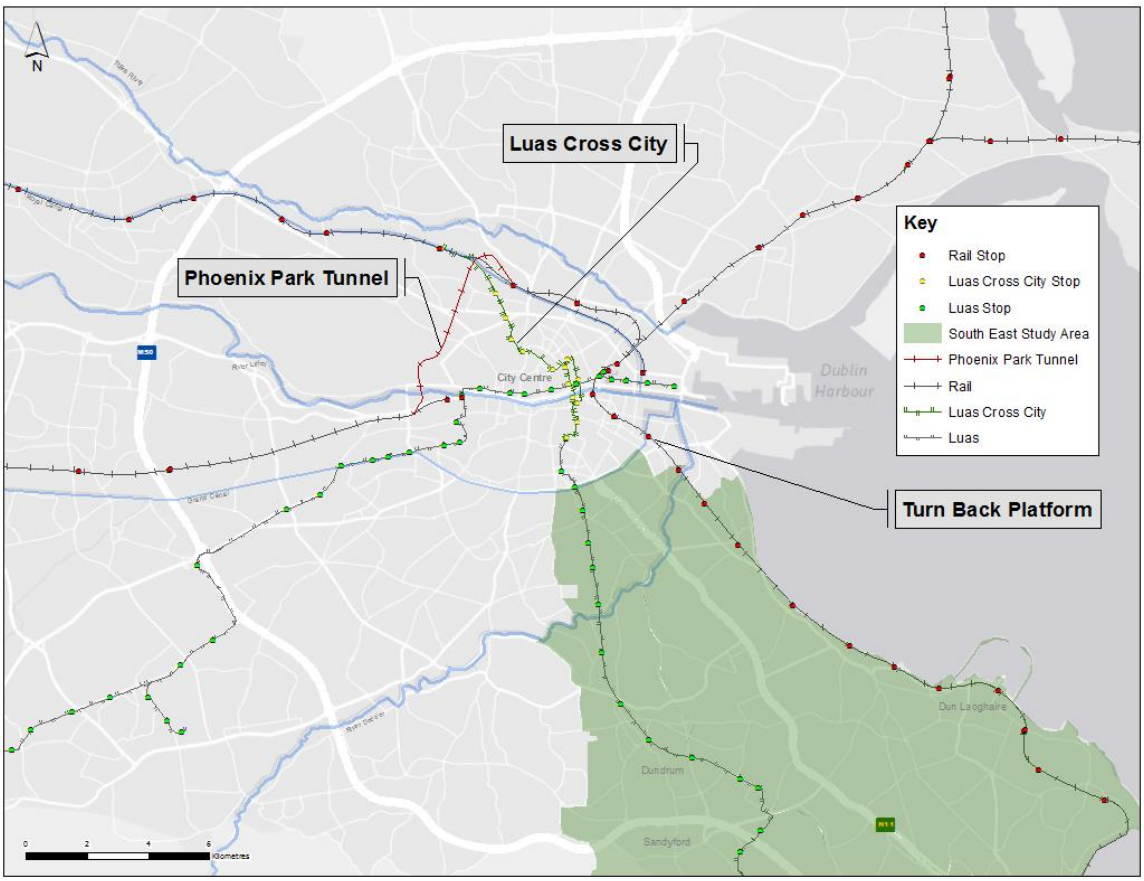


Figure 2-4: Do Minimum Proposed Public Transport

2.4.1 Phoenix Park Tunnel

The re-opening of the Phoenix Park Tunnel will allow for rail connectivity from the South West Rail Line to the South East Rail Line serving Drumcondra, Connolly, Tara Street, Pearse and Grand Canal Dock Stations. The trains using the Phoenix Park Tunnel will not stop at Heuston Station.

The proposed improvements will accommodate four trains per hour (tph) in one direction and 3tph in the other direction. It is likely that the 4tph would travel eastbound from the South West line using the tunnel in the AM peak and westbound in the PM peak to cater for the peak tidal demand into and out of the City Centre.

2.4.2 Dublin City Centre Rail Re-Signalling Project

The Dublin City Centre Rail Re-Signalling project will enable increased train path capacity across the City on the Loop Line Bridge over the Liffey. The current capacity constraint of 12tph will be raised to 17tph. It is considered possible to operate with 20tph but operational resilience may be compromised at this level. A new turn-back platform at Grand Canal Dock is proposed, providing turn-back facility for 9tph, leaving at least 8tph to carry on southbound

2.4.3 Luas Cross City

The Luas Cross City is an extension of the existing Luas Green Line beginning at its current terminus at St. Stephen's Green, interchanging with the Luas Red Line at O'Connell Street / Abbey Street and continuing northbound to the DIT Grangegorman Campus, Phibsborough and terminating at the Broombridge Rail Station on the Maynooth line. A loop is included at O'Connell Street and Marlborough Street to enable northbound services to return south.

Luas Cross City is currently under construction and the planned operation is for 10 trains per hour extended from the increased 20 trains per hour Green Line service using lengthened 53m long trains. This will provide a design capacity of approximately 3,000 in the peak hour. As demand increases, frequency of service can be increased to 20 trains per hour, with a maximum design capacity of approximately 6,000.

2.5 Additional Schemes

The Do Minimum represents the future network supply based on current commitments. However, for the purpose of this study the additional schemes of the DART Expansion, Metro North and the M50 multi-point tolling are also considered to be part of the future network for the Greater Dublin Area. Although these schemes are not fully committed, they have been considered as these could influence the choice of schemes that could evolve from the study. All of these schemes will increase the attractiveness of public transport within the GDA and are therefore tested with the preferred public transport option for the South East Study Area through the GDARM (please refer to Chapter 6: Transport Modelling Assessment).

The specifics of these additional schemes are still yet to be finalised but for the purposes of this study it is assumed that Metro North would connect the City Centre to the Airport and Swords and would connect with the Luas Green Line. DART Expansion is assumed to be a tunnel linking Heuston Station to St. Stephen's Green and Pearse Stations, electrification of the commuter sections of the Maynooth and Cork lines, extension of electrification on the Northern line and an expansion of fleet and depot facilities. The M50 multi-point tolling scheme is assumed to consist of the proposals contained with the M50 Demand Management Report, published by the NRA (now Transport Infrastructure Ireland, TII) in April 2014. Strategic Park and Ride locations within the Greater Dublin Area have also been identified are considered to be a component of the public transport system. Locations within the South East Study Area include Greystones, Bray, and Carrickmines/Cherrywood. It should be noted that demand management measures and Park and

Ride are not included in the modelling exercise described in Section 6 of the report. It is assumed that with the addition of these measures, the benefits of the proposed options will be greater than those reported.

The introduction of the DART Underground is a step change in capacity for the heavy rail network in Greater Dublin. Increased electrified services are made possible in a more efficient manner across the City with more connectivity and a much increased capacity. With 12tph through the tunnel in each direction a design capacity of 14,400 is available on 8-car DART trains.

With the introduction of Metro North it should be possible to operate northwards of Sandyford with 30 services per hour, reducing to 20 services per hour in tunnel just south of St Stephen's Green, leaving the currently planned 10 services per hour for the Luas Cross City route. The metro trains would be designed for in-tunnel operation.

In a scenario without DART Underground and without Metro North we would consider expanding on the Do Minimum through electrification of the Maynooth Line followed by the electrification of the Kildare Line to Hazelhatch and through the Phoenix Park Tunnel to Connolly Station. The benefits of electrification in terms of operating efficiency are well known and by using DART rolling stock the crush capacities are more than doubled compared to Commuter DMU stock.

The upgrade of the Green Line would proceed as in the Do Minimum and the increased services on the south east DART line would be as before to make full use of the increased City Centre capacity of 20tph. The use of EMU DART trains on the newly electrified lines would enable much improved connectivity between South East and North West corridors.

3 Demand Analysis

3.1 Establishing Demand

3.1.1 Establishing Base Year and 2035 Forecast Demand

The demand data utilised for this study considers assessment of a typical AM (08:00 – 09:00) peak hour. The assessment considers the 2011 base year and a 2035 forecast year.

The trip end data for the GDA was derived from planning data for both the base year and 2035 forecast scenarios. The base year data is based on Small Area Population Statistics available from the Central Statistics Office, as well as a combination of NACE building data (which provides economic data within the European Union) and POWSCAR variables. This data has been used in the calibration of the base year trip end model and demand model. The forecast data has been prepared by the NTA based on their most up to date forecasted land use assumptions which cover the entire country.

Having derived trip ends, the GDA demand model applies destination choice algorithms to derive travel matrices which have been calibrated in the base year to replicate observed mode shares and trip length distributions. For this analysis, only trips with a distance of longer than 3km were considered as it is assumed that trips with a distance of less than 3km will be provided for predominantly through walking and cycling and local public transport. As such these trips were not considered in the assessment of the strategic public transport requirements for the Study Area.

3.1.2 Establishing Radial Movements

The focus of the demand analysis was to identify northbound radial trips in the AM peak hour. This accounts for the following movements:

- trips generated internally destined for the City Centre;
- trips generated internally and destined internally; and
- trips originating south of the corridor travelling to and through the Study Area, and to the City Centre.

Destinations other than the City Centre and the Study Area were identified as 'through trips' and were not the examined in detail for this study.

Identifying demand for these movements provides a suitable estimate of demand within and through the Study Area. However, to establish the critical levels of demand at key points in the Study Area, a screenline analysis was conducted that provides an estimate of demand across screenlines at key Study Area settlements. The results of this process will be discussed in Section 3.2.

3.1.3 Target Demand Level

To determine the growth in public transport demand within the South East Study Area a screenline assessment was undertaken of the total demand to the City Centre, the Study Area and other destinations. As part of the screenline demand analysis, the following demand levels have been identified:

- 2011 total screenline demand;
- 2035 total screenline demand;
- growth in screenline demand from 2011 to 2035; and
- 2035 public transport target demand.

The 2035 public transport target demand is derived to represent the growth in public transport demand in 2035 by applying mode share factors to the demand growth. This is an aspirational target and represents the upper bound estimate of demand growth that can be expected to be served by public transport in 2035.

The mode share assumptions are as follows:

- 100 per cent of demand growth with destinations in the City Centre;
- 100 per cent of demand growth with destinations within the Study Area; and
- 30 per cent of demand growth passing through the Study Area to other destinations.

It is assumed that there will be no growth in car use to the City Centre. It is also assumed that there will be no growth in car use to the Study Area.

Existing public transport provision is generally operating within the maximum levels of service possible. Therefore, for the purpose of this review, it is assumed that to attract additional public transport trips, new public transport services will be required to meet the target demand.

3.2 Demand Assessment

3.2.1 South East Study Area Screenlines

In order to determine the level of demand to be accommodated by public transport during the 'options development' stage, six screenlines were applied to the Study Area. The screenline demand only takes into account radial trips by all modes moving northbound during the AM peak hour that are greater than 3km in length. Orbital trips were not included. The screenline demand is cumulative moving northbound, with screenline 0 at the southern end of the Study Area and screenline 5 at the canal cordon entering the City Centre.

3.2.2 Screenline Demand

The figures below, Figure 3-1, Figure 3-2, and Figure 3-3, illustrate the level of demand crossing the six screenlines for the 2011 base year, 2035 forecast year, and the demand growth from 2011 to 2035.

The base year demand within Figure 3-1 indicates that at the southern end of the corridor, there are approximately 6,800 trips entering the corridor within a single hour of the AM peak period. This level continues to rise through the corridor to a level of 21,200 trips through screenline 4 and 21,500 at the screenline on the boundary with the canal cordon of the City Centre.

The forecast year demand shown in Figure 3-2 indicates that at the southern end of the corridor, there are approximately 8,600 trips entering the corridor within a single hour of the AM peak period. This level continues to rise through the corridor to a level of 28,000 trips at screenline 5 entering the City Centre.

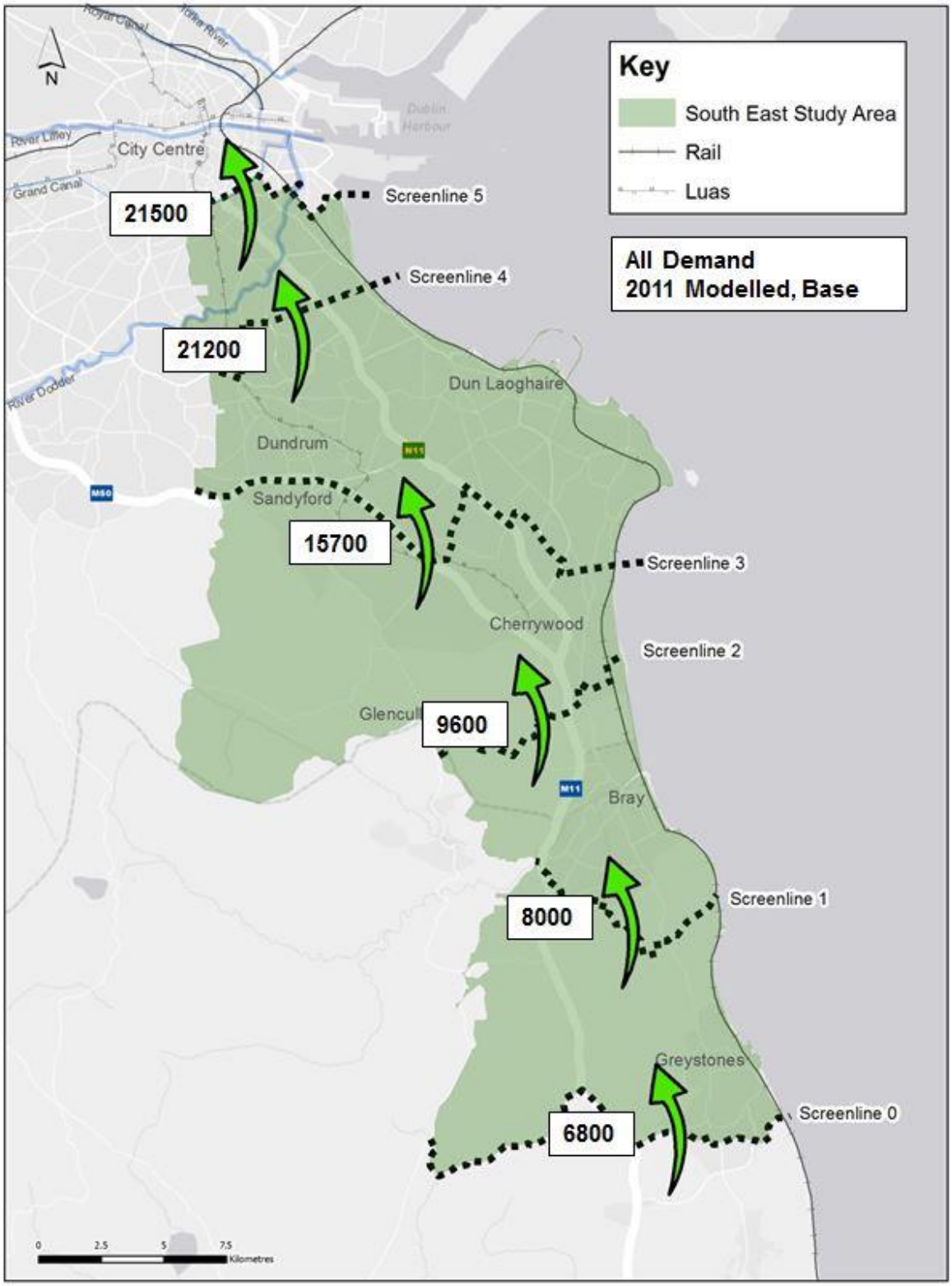


Figure 3-1: 2011 AM Peak Hour Total Screenline Demand

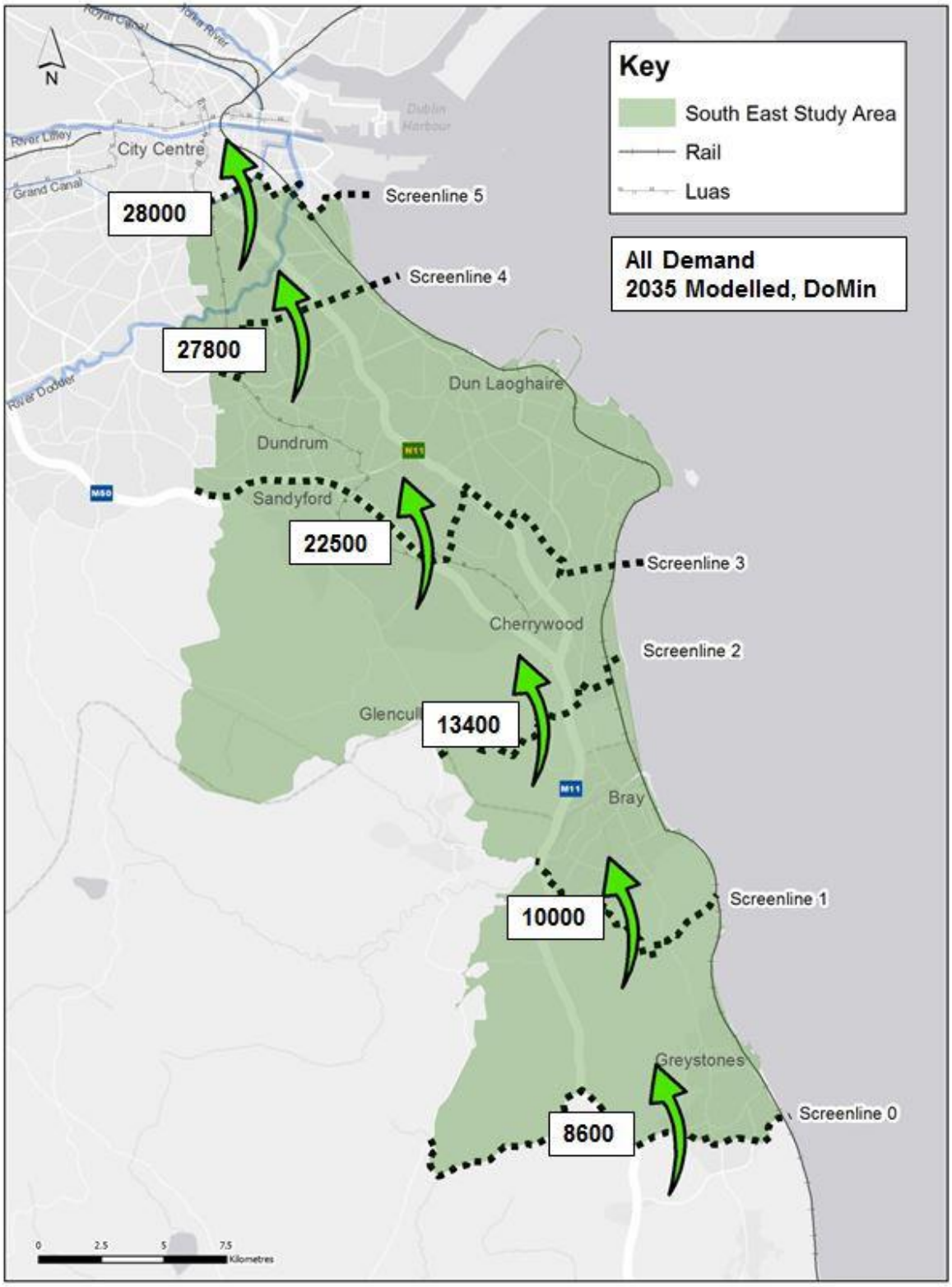


Figure 3-2: 2035 AM Peak Hour Screenline Demand

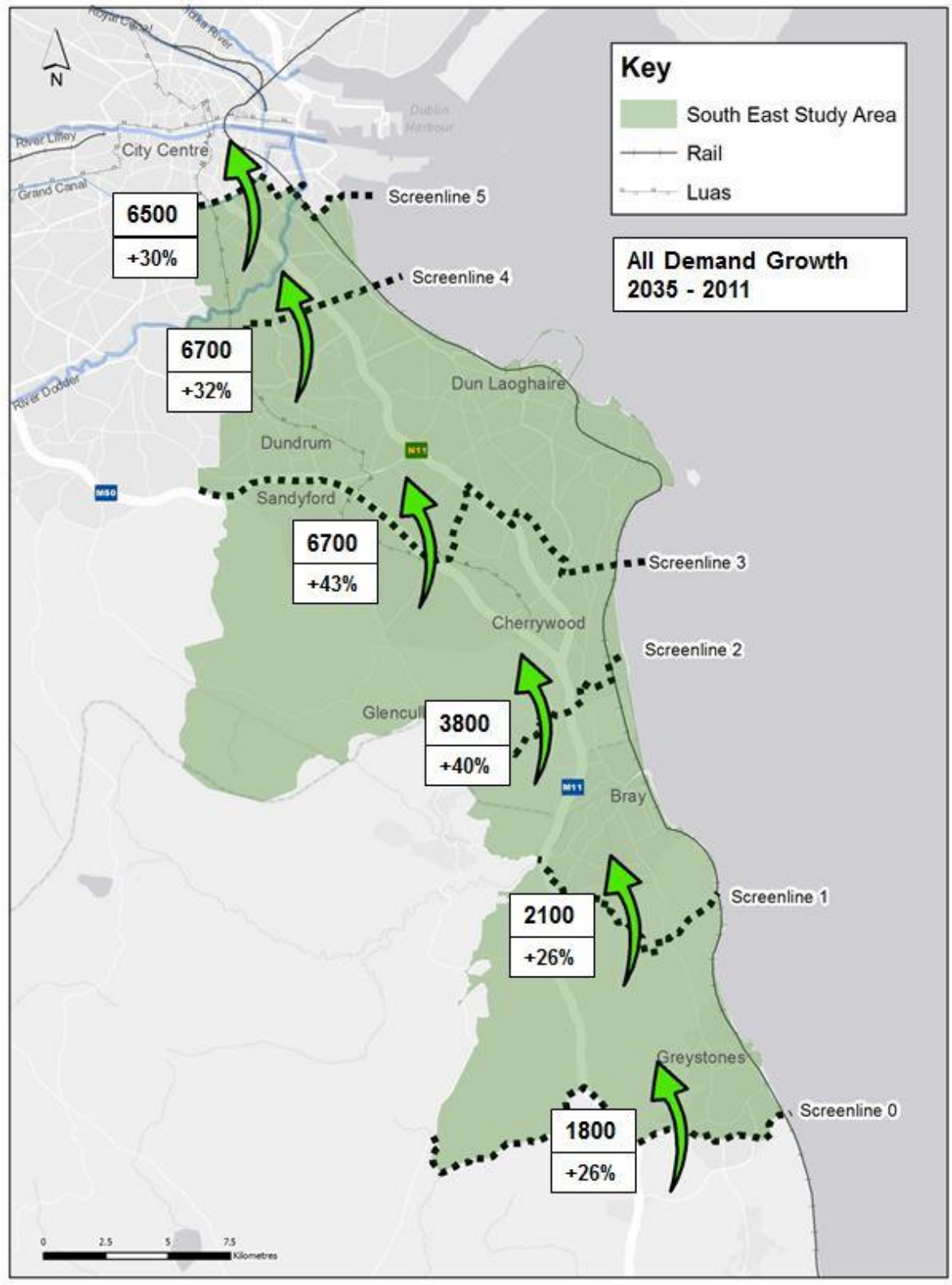


Figure 3-3: Growth (2035-2011) AM Peak Hour Screenline Demand

Figure 3-3 illustrates the potential growth in travel within the corridor. The screenline growth throughout the Study Area is between approximately 26 to 43 per cent through to year 2035. This equates to an additional 1,800 to 6,700 journeys per single hour during the peak. There is a notable increase in the level and proportion of growth north of Bray, where demand for travel will increase by 3,800 trips, a 40 percent increase. There is also a notable increase in the level and proportion of growth north of Cherrywood, where demand for travel will increase by 6,700 trips, a 43 per cent increase. At screenline 3, the change in demand is 6,700 trips. This reduces to 6,500 crossing into the City Centre. Although growth is consistent throughout, the highest per cent growth occurs in the middle of the Study Area.

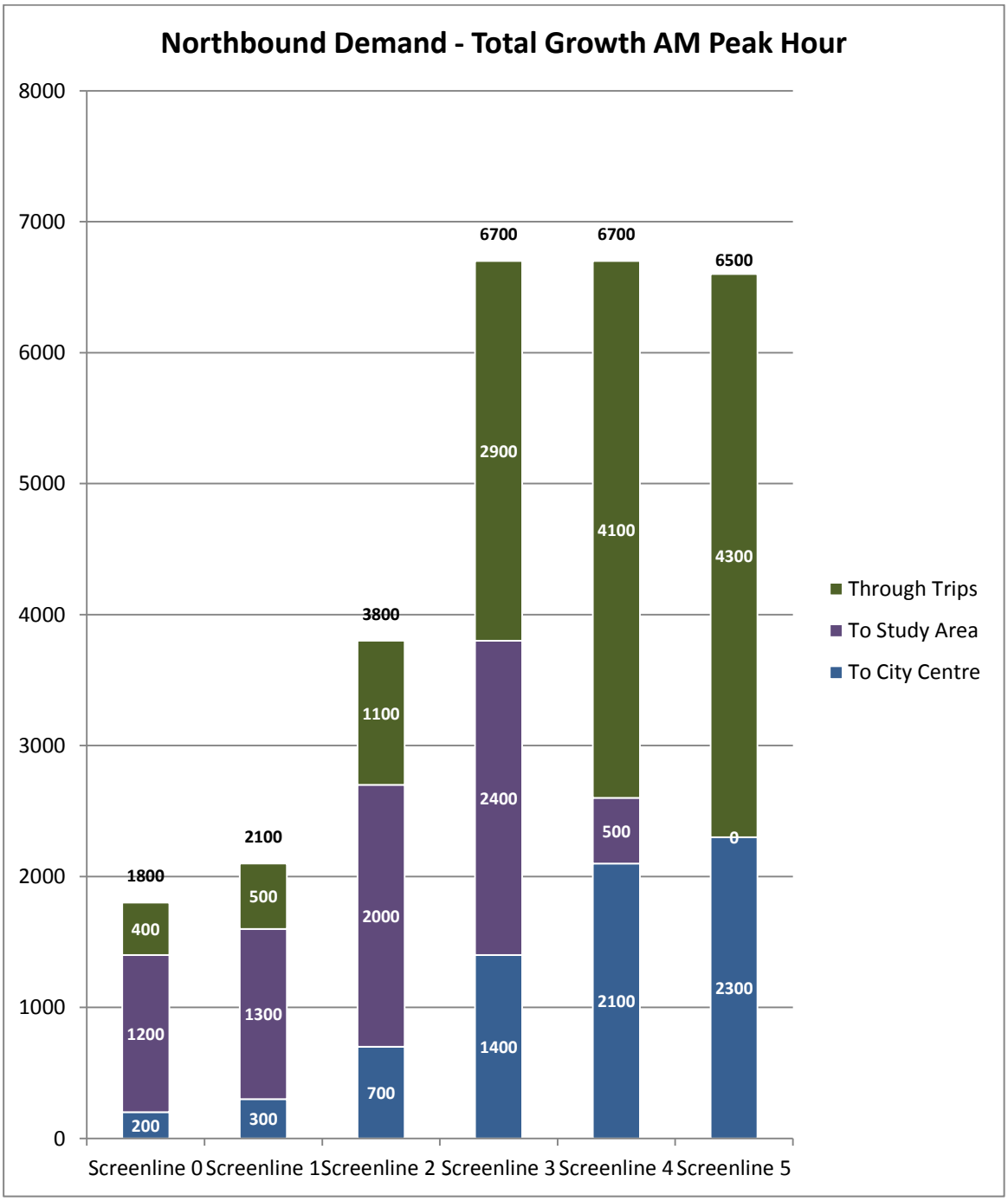


Figure 3-4: Screenline Demand Growth by Destination

Figure 3-4 further details the trip destinations for each screenline. Destinations are sectored by trips to the City Centre, Study Area, and through trips passing through the Study Area destined to the wider GDA. Predictably, demand for the City Centre increases through each screenline. There is relatively small demand from the area south of Bray, including Greystones, to the City Centre. At screenlines 0 and screenline 1 there are approximately 300 trips with destinations in the City Centre. The majority of trips passing through these screenlines have destinations within the Study Area. Crossing screenline 2 there are 700 trips destined to the City Centre, and 2000 trips with destinations within the Study Area. Crossing screenline three the City Centre demand increases significantly, although a higher per cent still remains within the Study Area. Crossing screenline 4 and 5, the majority of demand remains in the City Centre or travels through the City Centre to destinations outside the City Centre.

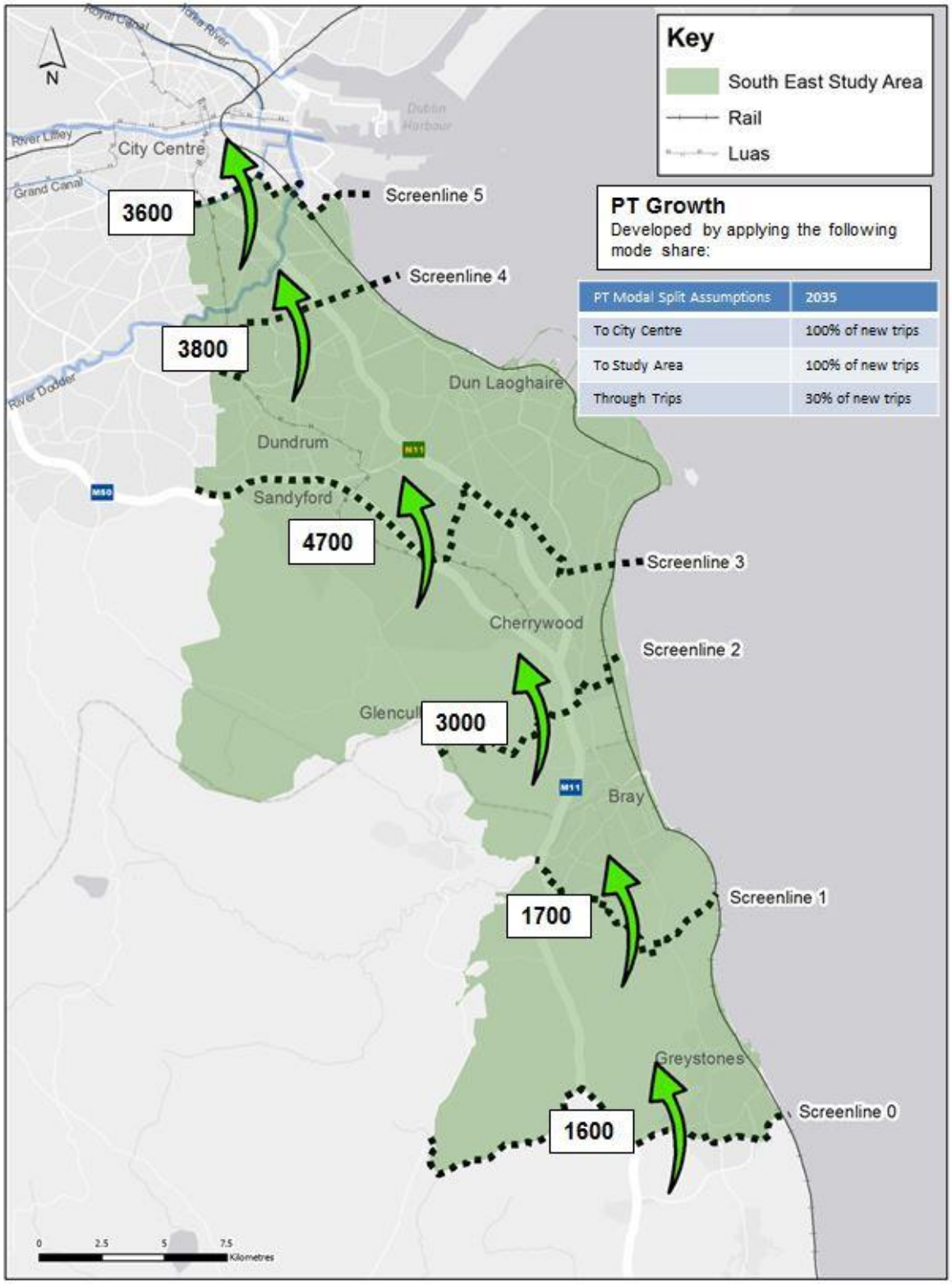


Figure 3-5: Target Demand for PT

Figure 3-5 illustrates the target demand level that was used for the development of public transport options. This target was developed to identify the level of demand that will need to be catered for by new or upgraded public transport services in the forecast year 2035. The target is derived by applying mode share assumptions to the demand growth as described in Section 3.1.3.

The target demand entering the Study Area at screenline 0 is 1,600 trips. This demand continues to increase through screenlines 1-3 with a peak demand crossing screenline 3 of 4,700. The Target demand decreases crossing screenlines 4 and 5 to 3,600. The target demand at each screenline represents an upper bound of demand growth that could be attracted to public transport services.

4 Public Transport Option Development

4.1 Introduction

This section outlines the development of various public transport options at a high level in order to meet the target demand crossing the screenlines. The target demand is based on the demand analysis in Section 3 and illustrated in Figure 3-5. From Section 3, the level of demand growth to be accommodated by public transport is 3,600 AM peak hour trips at screenline 5 (the canal) entering the City Centre. The peak level of public transport demand in the Study Area is 4,700 crossing screenline 3. However this demand decreases through screenlines 4 and 5. This decrease is due to trips remaining in locations such as Dun Laoghaire, Dundrum, and sections of Ballsbridge. The overall target demand for the purpose of public transport option development has been defined as 4000 new AM peak hour trips to be served by public transport for the South East Study Area. This will serve the 2035 PT demand to the City Centre crossing screenline 5, and towards the City Centre crossing screenline 3.

For the purposes of the assessment it is assumed that during the AM peak hour the current public transport services are generally operating close to or at maximum possible levels of service and therefore can attract little or no increase in demand. The overall target is designed to meet the full demand crossing into the City Centre and a high portion of the demand crossing screenline 3. Not all demand crossing screenline 3 is met in the overall target because to do so would inflate the demand into the City Centre. Although the overall target demand is 4000, effort has been made within Section 4.4 of the report to include public transport options that meet the full screenline demand for each screenline.

This section uses the target demand to generate likely public transport options that can provide a level of service to accommodate this overall target demand level. The options, in the first instance, were generated by focussing solely on the proposed public transport services/modes ability to accommodate the screenline demand. This method was adopted so that the option generation process was not restricted by current network constraints that could be removed in the future.

As mentioned previously in Chapter 2, the Do Minimum Network is used as a basis for the development of the public transport options to serve the South East Study Area. The recommended public transport option is then assessed further within the GDARM with other additional schemes such as DART Underground and Metro North which will have an impact on the demand for public transport in the South East Study Area.

4.2 Design Capacity of Public Transport Modes

The following lists the potential Public Transport Modes that were considered to meet the target demand:

- Heavy Rail (DART and Commuter);
- Light Rail (Luas and Metro);
- Bus Rapid Transit (BRT);
- Urban Bus Services (including feeder and express bus services);
- Intercity Bus Service; and
- Shuttle Bus.

Each mode has a predefined seated capacity and crush capacity, which is the maximum capacity that can be achieved with people standing. In order to ensure that a quality level of service is

provided by the proposed options, design capacities for each of the above service type were developed (Annex 1). Design capacity is assumed to be 85 per cent of crush capacity or 100 per cent of seated capacity, whichever figure is greater. This ensures that at no time will the entirety of the target demand be accommodated by a service that is underutilised or is so busy as to make the service less desirable.

Table 4-1 details the design capacity for each of the services and outlines the peak hour design capacity for each service based on the frequency of the service. The highlighted capacities show the frequency at which the service type meets the targeted demand entering the City Centre from the Study Area.

Frequency	Design Capacity (per service vehicle/train)							
	DART	Commuter	Light Rail	LRT Segregated	Bus Rapid Transit	Urban Bus	Intercity Bus	Shuttle Bus
60 min	1,190	410	260	300	100	70	50	30
40 min	1,780	610	390	450	150	110	70	40
30 min	2,380	820	520	600	200	150	100	60
20 min	3,570	1,230	780	900	310	220	150	90
15 min	4,760	1,630	1,040	1,200	410	300	200	120
12 min	5,950	2,040	1,300	1,500	510	370	250	150
10 min	7,140	2,450	1,560	1,800	610	450	300	180
8 min	8,920	3,070	1,940	2,300	760	560	370	225
6 min	11,900	4,090	2,590	3,050	1,020	740	500	300
5 min	14,280	4,910	3,110	3,650	1,220	900	600	360
4 min	17,850	6,130	3,890	4,550	1,530	1,120	750	450
3 min	23,800	8,180	5,180	6,050	2,040	1,500	1,000	600
2 min	35,700	12,270	7,780	9,100	3,060	2,240	1,500	900

Table 4-1: Design Capacity and Peak Hour Service Frequency

Note: The highlighted text above indicates where the target demand of 4,000 trips could be provided by a single public transport mode operating at the specified service frequency

*For Fully segregated Metros, longer and higher capacity vehicles can b2 provided

4.3 High-Level Public Transport Options

Table 4-2 illustrates the high level coverage of the proposed service for possible options that could meet the targeted demand of 4,000 trips in the AM peak hour. The chart also identifies the service frequency required to meet the screenline demand. Each option is described in more detail below.

Target: 4000 trips in AM peak

Public Transport Option	Capacity	Service to Meet Capacity	Option 1 Enhance LUAS + DART, New LRT Line, Extend LRT	Option 2 Enhance LUAS + DART, New BRT Line, Extend LRT/BRT	Option 3 Enhance DART, Upgrade LUAS to Light Metro	Option 4 New Heavy Rail	Option 5 New Light Rail	Option 6 LRT Extension, 3 BRT Lines	Option 7 New LRT, LRT Extension	Option 8 3 BRT Lines
Rail	10,000	1 Rail Line				X				
Rail Enhancement	2,000		X	X	X					
LRT	4,000	1 LRT Line	X				X		X	
LRT Enhancement	1,500		X	X						
LRT Extension			X	X				X	X	
BRT	2,000	2-3 BRT Routes		X				X		X
QBC	1,500	3 QBC Routes								
QBC Enhancement										
Bus	500	8 Bus Routes								
Metro	7,800	1 Metro Line			X					
Total New Capacity			7500	4000	5300	10,000+	4000 +	4000	4000+	4000

Table 4-2: Public Transport Options to Meet Target Demand

The following lists the eight public transport options considered that are able to meet the target demand of 4,000 AM peak hour trips. Details of the options include packages of measures in addition to single mode options:

- ***Option 1: Enhance existing Luas Green Line and DART, new LRT Line from City Centre to Dundrum, and Extend Luas Green Line southward to Bray***
    - DART enhancement will provide capacity of 2000+ peak hour trips with 11 trains in the peak hour (5 to 6 min frequency). This is an increase of four DART trains with a capacity factor of only 0.35 over the peak hour as calculated from the 2013 Rail Census. The peak within peak capacity factor will be nearer 0.85. Currently there are six DARTs and one commuter train;
    - Luas enhancement will provide capacity for 1500 peak hour trips with 20 trains that are 53 metres long during the peak hour (3 minute frequency). This is an increase of two trains per hour, and also an increase in the size of each train from 43 metres to 53 metres;
    - New LRT line from Dundrum to City Centre via Harold's Cross will provide capacity of 4500 peak hour trips; and
    - Extend LRT southward to Bray.
- ***Option 2: Enhance existing Luas Green Line and DART, new BRT Line from City Centre to Cherrywood, and extend LRT or BRT southward to Bray***
    - Same as option 1 for DART and Luas; and
    - BRT at 8 min frequency will provide capacity for 770 peak hour trips.
- ***Option 3: Enhance DART and upgrade Luas Green Line to a metro with option to extend southward to Bray***
    - Same as Option 1 for DART;
    - Metro at two to five minute frequency as needed. This will provide total capacity of 8,000-9,000 in the peak hour peak hour based on the use of 53m long Type 502 trams. It can be possible to consider consistency with Metro North trams and platform length described below; and
    - This option is to be considered as a component of a Metro North scenario. Metro North is planned to open with a capacity of 8,000 passengers per direction per hour (ppdph). Capacity can be increased incrementally through the procurement of additional vehicles. The ultimate capacity, based on a two minute headway would be up to 20,000 ppdph. This is based on two 45 metre train sets with 94 m long platforms.
- ***Option 4: New Heavy Rail Line (alignment undetermined)***
    - Would provide 10,000+ new peak hour trips. But to meet the demand frequencies would be between 40 minutes at screenline 0 and 15 minutes at screenline 3 and northward.
- ***Option 5: New Light Rail Line (alignment undetermined)***
    - Would provide 4,500+ new peak hour trips.
- ***Option 6: LRT extension, three BRT Lines (alignment undetermined. This option does not enhance existing services)***
    - Three BRT Lines at four to five minute frequencies would provide 1,200-1,500 trips in the peak hour for each line resulting in a total capacity of 4,500.

- ***Option 7: New LRT, LRT extension (alignment undetermined. This option does not enhance existing services)***
    - New LRT line at four minute frequencies would provide approximately 4,000 new peak hour trips.
- ***Option 8: Three new BRT Lines (alignment undetermined. This option does not enhance existing services)***
    - As option 6 without the LRT extension.

4.4 Capacity Assessment of and Sifting of Proposed Public Transport Options

The following section details the capacity assessment undertaken for 100 per cent of demand growth for the Study Area (2035 demand minus 2011 demand for the AM peak hour).

For this exercise a number of assumptions were made in recognition of the high level nature of this study. Firstly, demand for the base year public transport was assumed to be catered for by existing public transport services. Secondly, it was assumed that there is no excess capacity for existing services during the AM peak hour. The following is outlined for each of the eight options considered:

- brief description of the option;
- a determination of whether the option would be taken forward for further review;
- rationale for the above decision;
- proposed service type and frequency at each screenline;
- comparison of proposed service design capacity and maximum screenline demand Annex 2; and
- a conceptual map/schematic of the option.

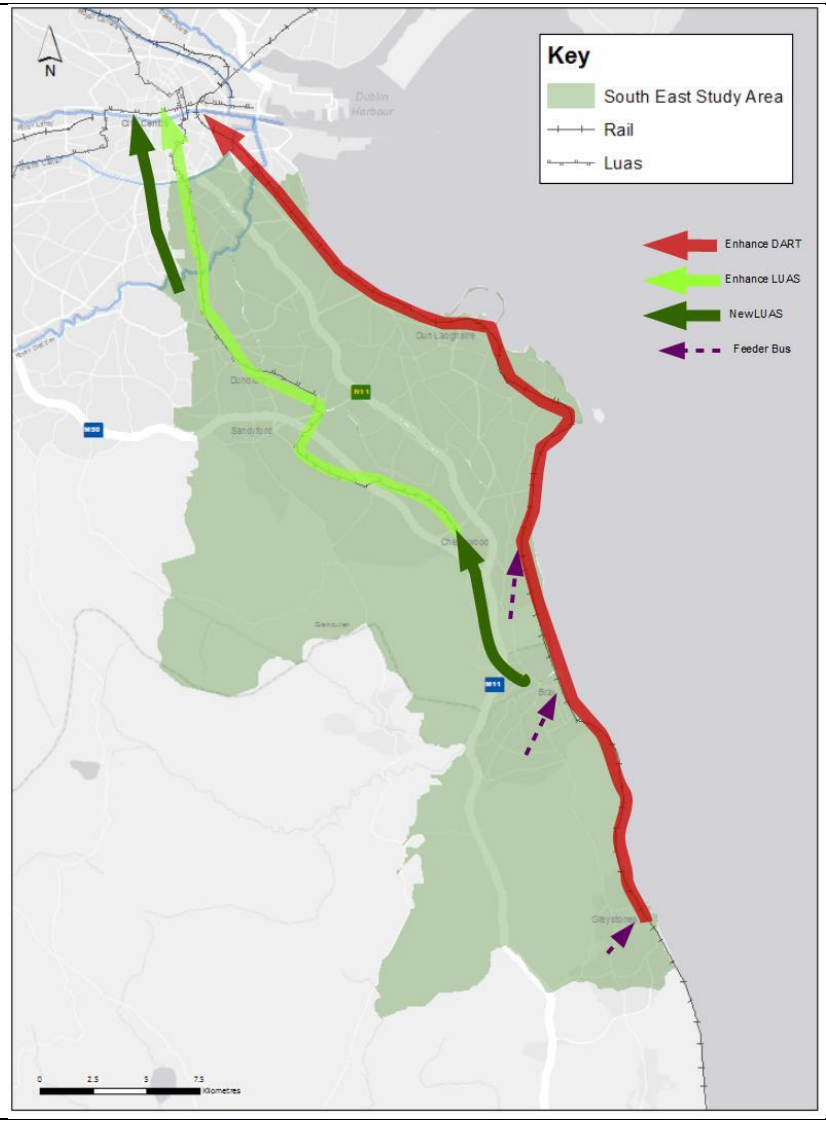
Option 1: Enhance Luas and DART, new LRT Line from City Centre to Dundrum, and extend LRT southward to Bray

Decision: Taken Forward

Decision Rationale:

This option was chosen to be brought forward for further scoring. It meets the demand target for all screenlines.

The Luas extension southward to Bray caters for the growth in demand south of screenline 2. Screenlines 0 and 1 are served by the DART. The New LRT line west of the existing Luas frees up capacity on the existing line and provides additional capacity. There are approximately 3,000 trips crossing screenline 2 (just north of Bray). These trips cannot all be accommodated on the DART. Another service is required. A possible option is a Luas extension; however the exact location and level of service will be evaluated during the modelling phase.



Option 1 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600					2000			2000	-400
Screenline 1	1700					2000			2000	-300
Screenline 2	3000					2000	1500		3500	-500
Screenline 3	4700				1296	2000	1500		4796	-96
Screenline 4	3800				778	2000	1500		4278	-478
Screenline 5	3600				778	2000	1500		4278	-678
Total	18400	0	0	0	2852	12000	6000	0	20852	-2452

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0						6 min				
Screenline 1						6 min				
Screenline 2						6 min	3 min			
Screenline 3					12 min	6 min	3 min			
Screenline 4					20 min	6 min	3 min			
Screenline 5					20 min	6 min	3 min			

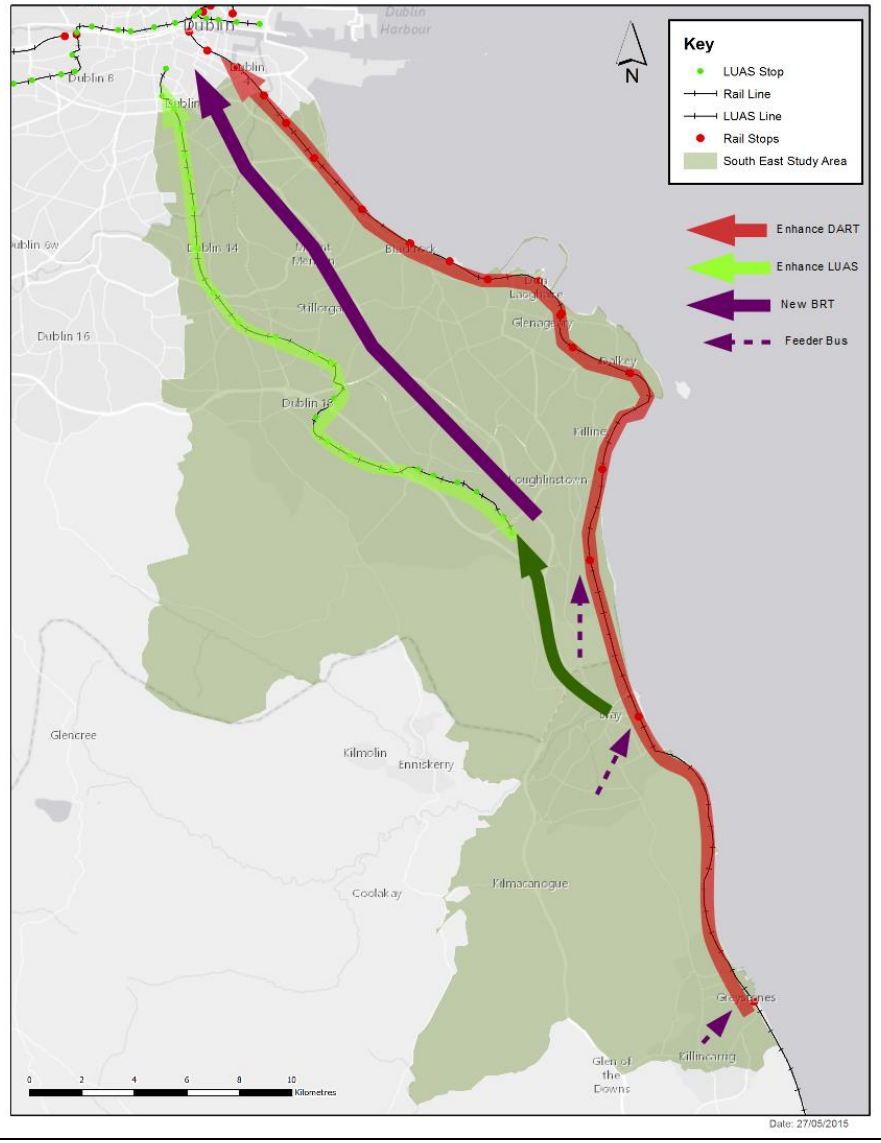
Option 2: Enhance Luas and DART, new BRT Line, and extend LRT/BRT southward to Bray

Decision: Taken Forward

Decision Rationale:

This option was chosen to be brought forward for further scoring. It meets the demand target for all screenlines.

A BRT or Luas extension southward to Bray caters for the growth in demand south of screenline 2. Screenlines 0 and 1 are served by the DART. There are approximately 3,000 trips crossing screenline 2 (just north of Bray). These trips cannot all be accommodated on the DART. Another service is required. A possible option is a Luas or BRT extension.



Option 2 Demand Assessment and Service Frequency:

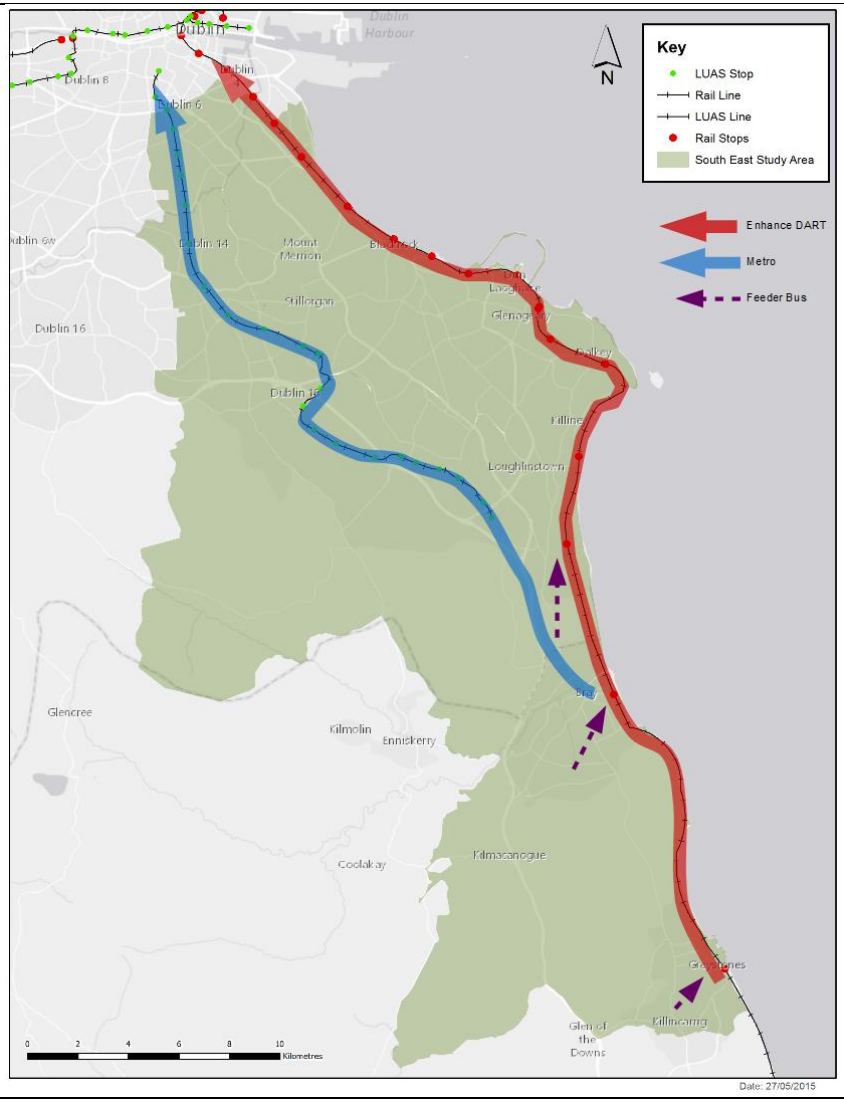
Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600					2000			2000	-400
Screenline 1	1700					2000			2000	-300
Screenline 2	3000					2000	1500		3500	-500
Screenline 3	4700	1224				2000	1500		4724	-24
Screenline 4	3800	765				2000	1500		4265	-465
Screenline 5	3600	765				2000	1500		4265	-665
Total	18400	2754	0	0	0	12000	6000	0	20754	-2354

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0						6 min				
Screenline 1						6 min				
Screenline 2						6 min	3 min			
Screenline 3		5 min				6 min	3 min			
Screenline 4		8 min				6 min	3 min			
Screenline 5		8 min				6 min	3 min			

Option 3: Enhance DART and upgrade Luas to light metro with option to extend southward to Bray
Decision: Taken Forward
Decision Rationale: This option was chosen to be brought forward for further scoring. It meets the demand target for all screenlines, This option is viable based on the "Do Minimum" scenario without Metro North. When considering the option in light of the additional scheme of Metro North, the option would become even more attractive. There are approximately 3,000 trips crossing screenline 2 (just north of Bray). These trips cannot all be accommodated on the DART. Another service is required. A possible option is a metro extension; however, the exact location, level of service, and cost benefit analysis should be evaluated further.



Option 3 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600					2000			2000	-400
Screenline 1	1700					2000			2000	-300
Screenline 2	3000				3278	2000			5278	-2278
Screenline 3	4700				3278	2000			5278	-578
Screenline 4	3800				3278	2000			5278	-1478
Screenline 5	3600				3278	2000			5278	-1678
Total	18400	0	0	0	13112	12000	0	0	25112	-6712

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0						6 min				
Screenline 1						6 min				
Screenline 2					2 min	6 min				
Screenline 3					2 min	6 min				
Screenline 4					2 min	6 min				
Screenline 5					2 min	6 min				

Option 4: New Heavy Rail Line	
Decision: Not Taken Forward	
Decision Rationale: A new heavy rail line along the length of corridor would meet the target demand. However a new rail line is likely to have considerable cost and difficulty in obtaining an alignment without significant land take and environmental impacts. The target level of demand is lower than that which would require such a significant investment. Additionally due to the location of the exiting DART line and Luas line, siting a new rail line within the Study Area without overlapping the catchment area of the existing services would be challenging.	*Conceptual alignment was not produced for this option*

Option 4 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600					1785			1785	-185
Screenline 1	1700					2380			2380	-680
Screenline 2	3000					3570			3570	-570
Screenline 3	4700					4760			4760	-60
Screenline 4	3800					4760			4760	-960
Screenline 5	3600					4760			4760	-1160
Total	18400	0	0	0	0	22015	0	0	22015	-3615

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0						40 min				
Screenline 1						30 min				
Screenline 2						20 min				
Screenline 3						15 min				
Screenline 4						15 min				
Screenline 5						15 min				

Option 5: New Light Rail Line	
Decision: Not Taken Forward	
Decision Rationale: A new light rail line along the length of the corridor would meet the target demand. However a new light rail line is likely to have considerable cost and difficulty in obtaining an alignment without significant land take and environmental impacts. The target level of demand is lower than that which would require such a significant investment. Additionally due to the location of the existing DART line and Luas line, siting a new rail line within the Study Area without overlapping the catchment area of the existing services would be challenging.	*Conceptual alignment was not produced for this option*

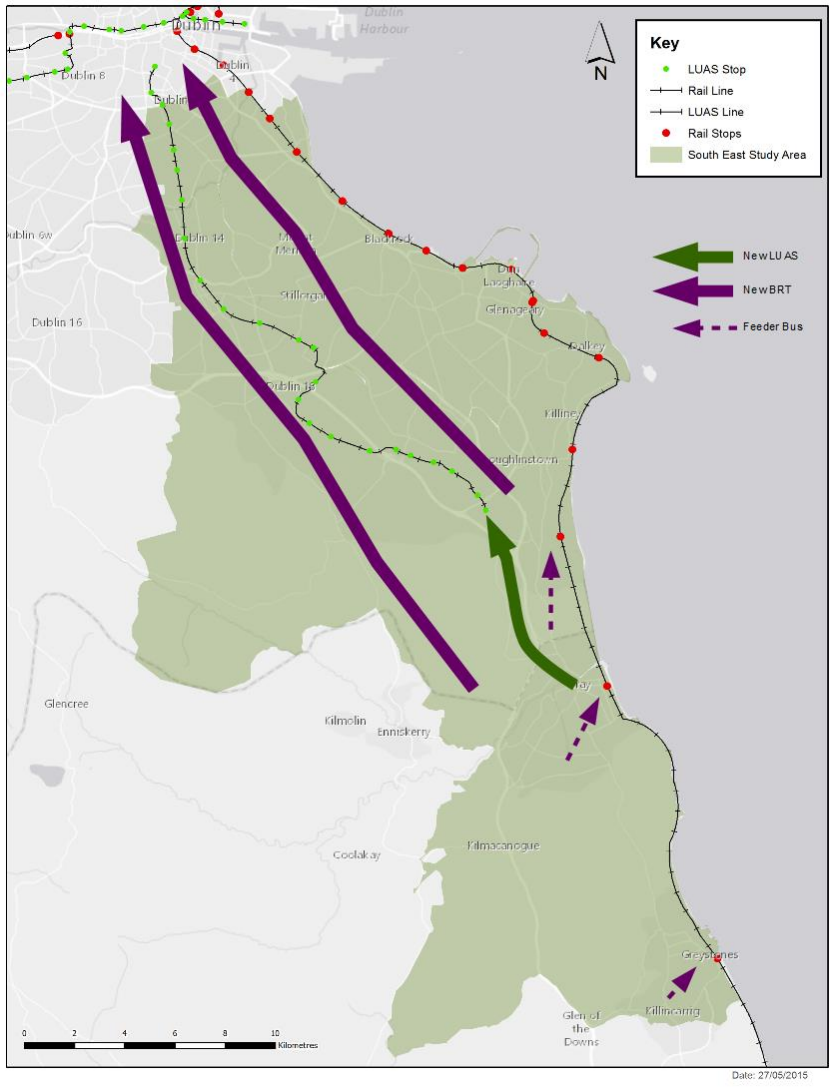
Option 5 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600				1296				1296	304
Screenline 1	1700				2593				2593	-893
Screenline 2	3000				3111				3111	-111
Screenline 3	4700				5185				5185	-485
Screenline 4	3800				5185				5185	-1385
Screenline 5	3600				5185				5185	-1585
Total	18400	0	0	0	22555	0	0	0	22555	-4155

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0					12 min					
Screenline 1					6 min					
Screenline 2					5 min					
Screenline 3					3 min					
Screenline 4					3 min					
Screenline 5					3 min					

Option 6: LRT extension, 3 BRT Lines (This option does not enhance existing services)	
Decision: Not Taken Forward	
Decision Rationale: This option would meet the target demand. However providing BRT at the frequencies required to meet the demand will not be possible on a roadway network that is already significantly constrained.	

Option 6 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600	2040							2040	-440
Screenline 1	1700	1224	765						1989	-289
Screenline 2	3000	1224	765					4500	6489	-3489
Screenline 3	4700	1224	1224	2040					4488	212
Screenline 4	3800	1224	1224	2040					4488	-688
Screenline 5	3600	1224	1224	2040					4488	-888
Total	18400	8160	5202	6120	0	0	0	4500	23982	-5582

Service Frequency

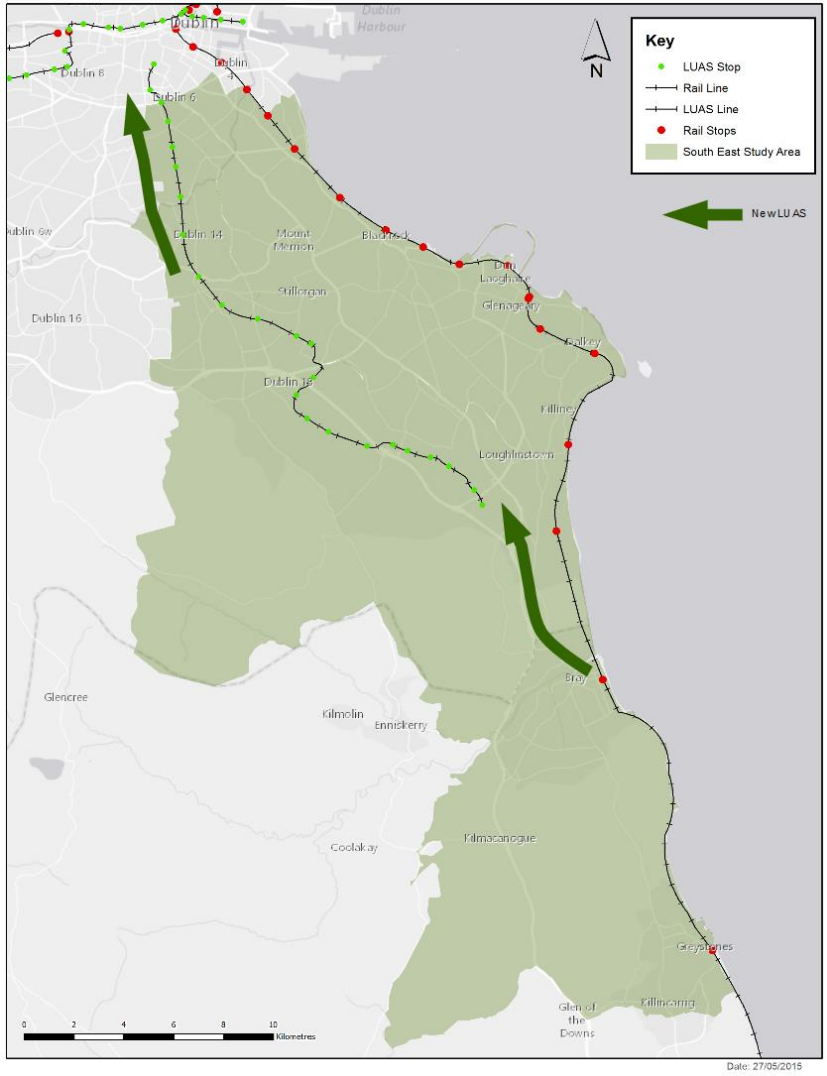
Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0		3 min			existing					
Screenline 1		5 min	8 min		existing					
Screenline 2		5 min	8 min		existing					
Screenline 3		5 min	5 min	3 min	existing					
Screenline 4		5 min	5 min	3 min	existing					
Screenline 5		5 min	5 min	3 min	existing					

Option 7: New LRT, LRT extension (This option does not enhance existing services)

Decision: Not Taken Forward

Decision Rationale:

A new light rail line along the length of the corridor would meet the target demand. However a new light rail line is likely to have considerable cost and difficulty in obtaining an alignment without significant land take and environmental impacts. The target level of demand is lower than that which would require such a significant investment.



Option 7 Demand Assessment and Service Frequency:

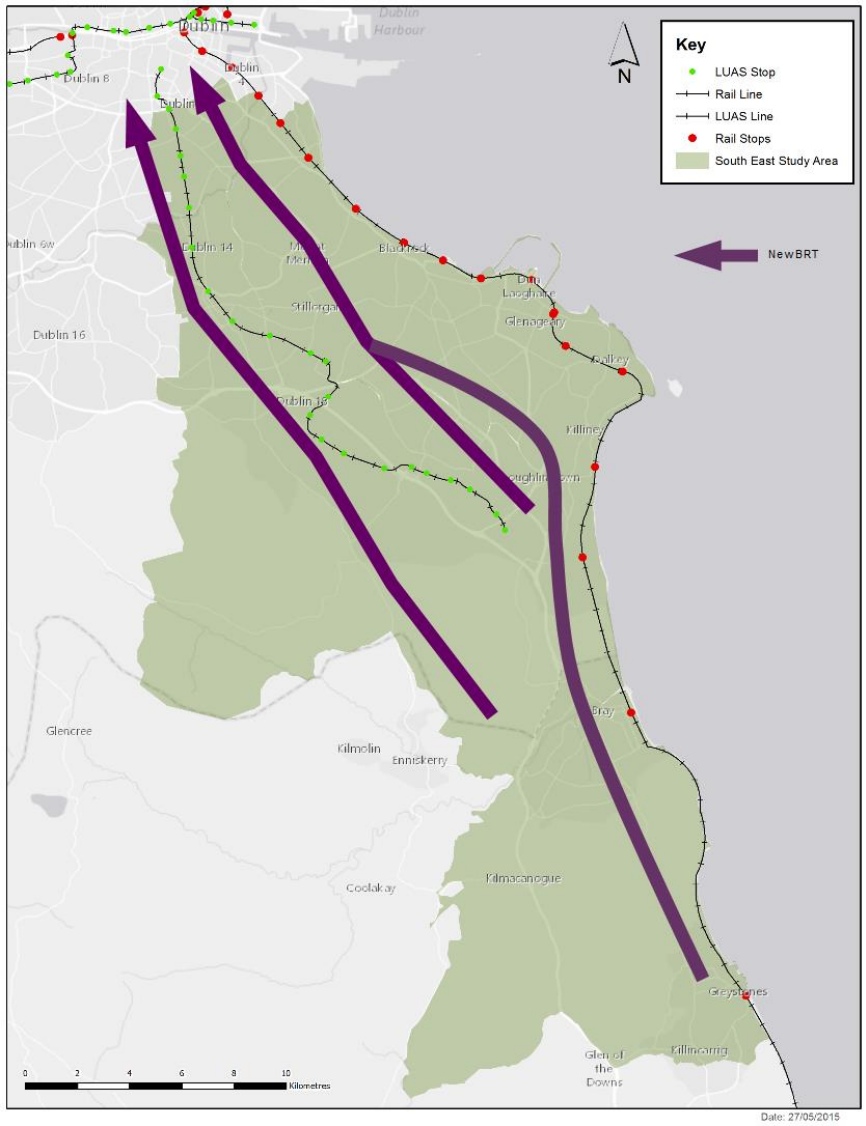
Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600								0	1600
Screenline 1	1700								0	1700
Screenline 2	3000							4500	4500	-1500
Screenline 3	4700				3889				3889	811
Screenline 4	3800				3889				3889	-89
Screenline 5	3600				3889				3889	-289
Total	18400	0	0	0	11667	0	0	4500	16167	2233

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0										
Screenline 1										
Screenline 2										
Screenline 3					4 min					
Screenline 4					4 min					
Screenline 5					4 min					

Option 8: 3 New BRT Lines (This option does not enhance existing services)
Decision: Not Taken Forward
Decision Rationale: This option would meet the target demand. However providing BRT at the frequencies required to meet the demand will not be possible on a roadway network that is already significantly constrained.



Option 8 Demand Assessment and Service Frequency:

Design Capacity

Screenline	Maximum Demand Increase	BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X	Total	Surplus
Screenline 0	1600	1224							1224	376
Screenline 1	1700	1224	1020						2244	-544
Screenline 2	3000	1224	1020	765					3009	-9
Screenline 3	4700	1224	1224	2040					4488	212
Screenline 4	3800	1224	1224	1530					3978	-178
Screenline 5	3600	1224	1224	1530					3978	-378
Total	18400	7344	5712	5865	0	0	0	0	18921	-521

Service Frequency

Screenline		BRT 1	BRT 2	BRT 3	LRT	DART	LUAS	LUAS X		
Screenline 0		5 min								
Screenline 1		5 min	6 min							
Screenline 2		5 min	6 min	8 min						
Screenline 3		5 min	5 min	3 min						
Screenline 4		5 min	5 min	4 min						
Screenline 5		5 min	5 min	4 min						

4.4 Results Summary

The capacity assessment and option sifting process resulted in advancing three options for further scoring.

- Option 1: Enhance existing Luas Green line and DART, new LRT Line from City Centre to Dundrum, and Extend Luas Green line southward to Bray;
- Option 2: Enhance existing Luas Green line and DART, new BRT Line from City Centre to Cherrywood, and extend LRT or BRT southward to Bray; and
- Option 3: Enhance DART and Upgrade Luas Green line to a metro with option to extend southward to Bray.

Five options were not taken forward for further scoring (Options 4-8).

5 Public Transport Option Scoring

This section outlines the comparison of the three options that were brought forward from the Option Development stage (Annex 5). This comparison is based on the ranking of the options against three criteria:

- demand accommodated within catchment;
- journey time; and
- cost.

The higher the ranking score, the better the option achieved the criteria. The overall ranked scores for each criterion are then summed for each option. The highest scoring option is considered as the preferred option.

The three options advancing to further scoring are:

- Option 1: Enhance Luas and DART, new LRT Line from City Centre to Dundrum, and extend LRT southward to Bray;
- Option 2: Enhance Luas and DART, new BRT Line, and extend LRT/BRT southward to Bray; and
- Option 3: Enhance DART and upgrade Luas to metro with option to extend southward to Bray.

5.1 Proposed Public Transport Options

As part of the Option Scoring assessment a more detailed approach to the public transport options was taken. The routing of the proposed public transport services was undertaken in greater detail, taking into account: proposed demand growth locations, network constraints and interchange with existing public transport. Figure 5-1 to Figure 5-3 illustrate the identified routes of the proposed public transport options.

5.1.1 Option 1: Enhance DART and Luas Green Line, New LRT line from City Centre to Dundrum, Extend Luas Southward towards Bray

Option 1 shown in Figure 5-3 proposes the following:

- Investment in DART enhancements that will lead to four additional train services in the AM peak hour and additional capacity of 2,000+ trips. Enhancements include upgrades of level crossings, upgrades to Park and Ride facilities, stock upgrades and station upgrades;
- Investment in Luas Green Line enhancements that will lead to two additional train services in the AM peak hour and additional capacity of 1,500 trips. Enhancements include upgrading from 43 to 53 metre long trams, upgrades of level crossings, upgrades to Park and Ride facilities, stock upgrades and stop upgrades;
- Extension of Luas southward to either Bray or west of Bray;
- Construct a new LRT line, west of the existing Luas, north of the M50; and
- Express feeder bus services would be provided to improve DART access for Bray and Greystones.

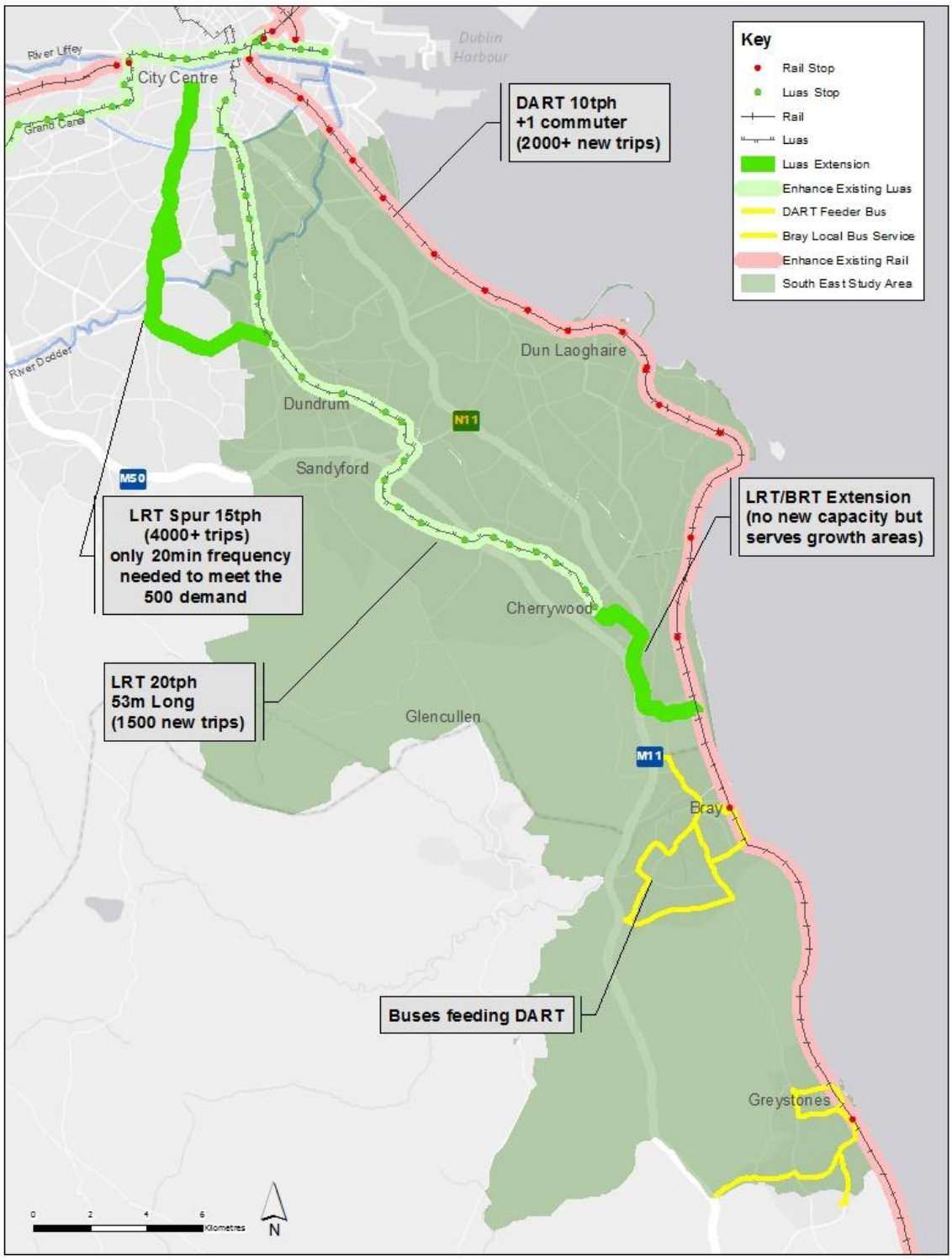


Figure 5-1 Option 1: Enhance DART and Luas Green Line + Extend Luas + LRT Spur

5.1.2 Option 2: Enhance DART and Luas Green Line, Extend Luas/BRT Southward, New BRT Line

Option 2 shown in Figure 5-2 proposes the following:

- Investment in DART enhancements that will lead to 4 additional train services in the AM peak hour and additional capacity of 2,000+ trips. Enhancements include upgrades of level crossings, upgrades to Park and Ride facilities, stock upgrades and station upgrades;
- Investment in Luas Green Line enhancements that will lead to two additional train services in the AM peak hour and additional capacity of 1,500 trips. Enhancements include upgrading from 43 to 53 metre long trams, upgrades of level crossings, upgrades to Park and Ride facilities, stock upgrades and stop upgrades;
- Extension of Luas or BRT southward to Bray or west of Bray;
- Construct a new BRT line along N11; and
- Express feeder bus services would be provided to improve DART access for Bray and Greystones.

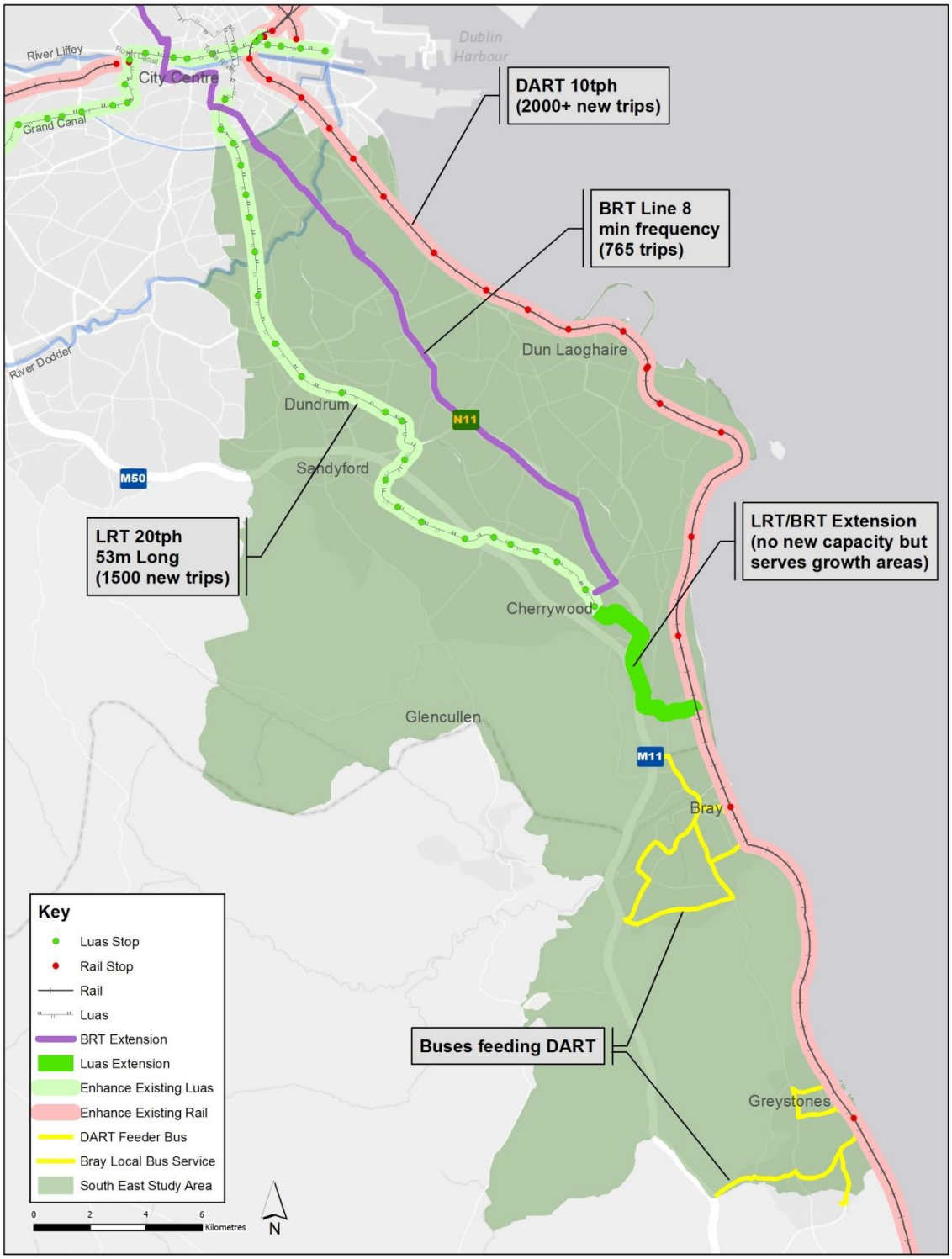


Figure 5-2 Option 2: Enhance DART and Luas Green Line + Extend Luas/BRT + BRT

5.1.3 Option 3: Enhance DART, Metro South East

Option 3 shown in Figure 5-3 has been brought forward for scoring in light of the likely scenario which includes consideration of Metro North. It is also viable under the Do-Minimum scenario without Metro North. Even without the Metro North, there is a level of demand within the corridor that justifies the provision of Metro service. The Metro North project provides options for connectivity improvements between the South East and the North West corridors and therefore justifies the development and scoring of this scenario. Option 3 proposes the following:

- Investment in DART enhancements that will lead to four additional train services in the AM peak hour and additional capacity of 2,000+ trips. Enhancements include upgrades of level crossings, upgrades to Park and Ride facilities, stock upgrades and station upgrades;
- Investment in Luas Green Line enhancements that will lead to a metro service. This can accommodate up to 3,300 additional trips (a total capacity of ~8,000 when considering the existing Luas capacity) with two minute frequencies in the peak hour. Enhancements will include grade separation of crossings, Park and Ride facilities, stock upgrades and station upgrades. This could also include extension to Bray;
- Express feeder bus services would be provided to improve DART access for Bray and Greystones; and
- The determination to extend the metro south of the existing southern terminus at Cherrywood will be made during the modelling phase of the project. This decision will consider factors such as demand levels, location of growth, and network connectivity.

Figure 5-3 Option 3: Enhance DART + Metro South East

5.2 Comparison of Target Demand Accommodated

As outlined earlier in the report, each of the remaining proposed three options provides adequate service capacity that can cater for 100 per cent of the target demand. In order to score how well each option accommodates the target demand level a catchment analysis has been undertaken.

5.2.1 Service Catchment

The catchment analysis is based on agreed catchment areas associated with the different types of public transport service. Table 5-1 outlines the catchment associated with each public transport service.

Service Type	Catchment Distance	Catchment Band Type
DART	1,000m	Radius from stop
Commuter	1,000m	Radius from stop
Light Rail	800m	Radius from stop
Bus Rapid Transit	800m	Radius from stop
Urban Bus	400m	Band out from route
Intercity Bus	400m	Band out from route
Shuttle Bus	400m	Band out from route

Table 5-1: Service Catchment

5.2.2 Public Transport Service Interchange Levels

As part of the catchment analysis the level of interchange to/from the service can also be derived. The following lists how the interchange levels are determined:

- no Interchange – trips with both origin and destination within public transport catchment;
- one Interchange – trips with either an origin or destination within public transport Catchment; and
- two Interchanges – trips with neither origin nor destination within public transport catchment.

It is unlikely that the demand that requires two interchanges to utilise the service will consider this to be a desirable route, and will potentially revert to private car usage. Considering this, the catchment assessment considers only trips that require one or no interchange as being accommodated within the public transport service catchment.

5.2.3 Catchment Analysis of Proposed Options

Table 5-2 outlines the percentage of trips that require one or no interchange to reach their destination using the public transport services for each option. The catchment analysis shows that for all options a maximum of 35 per cent of trips are catered for entirely within the catchment of the proposed public transport services. However 100 per cent of demand could access public transport with one or no interchange for all options.

The catchment assessment shows that Option 3, the Metro South East, can accommodate the highest demand with no interchange required at 35 per cent.

Demand Captured Percentage of Demand	No Interchange Required	One Interchange Required	Total Demand with One or no Interchange
Option 1 DART/Luas enhancements and extension and new LRT	18%	82%	100%
Option 2 DART/Luas enhancements, LRT / BRT extension and BRT	31%	69%	100%
Option 3 DART Enhancement and Metro South East	35%	65%	100%

Table 5-2: Demand Accommodation Analysis

5.3 Journey Time Comparison

Table 5-3 details the journey time analysis for the three options. The first column outlines the weighted average speed of trips that can be accommodated entirely within the catchment of the services proposed. This shows that the proposed metro option (Option 3) provides the quickest direct journey times. The highest direct journey time is provided by the option with the BRT along the N11.

The second and third columns outline the weighted average journey times for each option taking into account the level of interchange required. Option 3 provides the lowest weighted average journey time, with Option 2 providing the highest weighted average journey time.

	Direct Journey Time (JT) (min)	Weighted JT one or no Interchange (min)
Option 1 DART/Luas enhancements and extension and new LRT	53.7	60.6
Option 2 DART/Luas enhancements, LRT / BRT extension and BRT	62.7	68.6
Option 3 DART Enhancement and Metro South East	42.7	47.8

Table 5-3: Journey Time Analysis

5.4 Cost Comparison

The estimated cost of each option proposed was considered as one of the scoring criteria (Annex 3). Table 5-4 outlines the infrastructure unit cost for the proposed services and required infrastructure. These high level unit costs per metre of infrastructure have been based on recent schemes developed and introduced in Dublin. These are capital costs only and do not include operating costs. Detailed cost estimates would be necessary at a later stage of assessment.

Service / Infrastructure	Units	Unit Cost	Source
DART Enhancement		**641**	
Luas Enhancement		**250**	
Luas Extension	€M/km	**39.74**	Luas B1 RPA Proof of Evidence 2006
New Luas	€M/km	**54.76**	www.luascrosscity.ie
BRT	€M/km	**11.39**	NTA / RPA Presentation on BRT
Metro	€M/km	**54.76**	www.luascrosscity.ie, includes resignaling, level crossings, rolling stock, station upgrades, Park & Ride, traction power, and a depot. Details in Appendix E.
Feeder Bus	€M/km	**3.65**	Assumed 1/3 of BRT cost

Table 5-4 Infrastructure Unit Costs

Table 5-5 details the comparison of the cost estimates for each proposed option. Due to the significant costs associated with the foundation and track infrastructure associated with metro, options 3 has the highest cost estimates. The cost of upgrading DART and Luas is also significant. Option 1 provides a similar service to option 2, but is a higher cost due to the costs associated with construction of a new LRT line.

Option	Description	Cost €M
Option 1	**DART and Luas Enhancements + LRT Extension + New LRT**	1,865
Option 2	**DART and Luas Enhancements + LRT/BRT Extension + BRT**	1,613
Option 3	**DART Enhancement + Metro South East**	2,141

Table 5-5 Cost Estimate Comparison

5.5 Summary of Option Scoring

Table 5-6 outlines the summary of the option scoring process (Annex 5). For each scoring criteria the options are ranked from 1 to 3; 1 representing the lowest performance in that criterion and 3 representing the highest performance. Each criteria rank is summed to provide a total value for each option. The option with the highest score is considered to best meet the criteria.

Based on this scoring approach, Option 3 is seen to score the highest in overall terms with good demand coverage and journey times, the weakness of this option being the high cost. Option 2 scored second highest. The strength of this option is the lower cost of BRT construction, however journey times are slower. Option 1 scored the lowest. This has the high cost of new rail construction with the weakness of the lower demand coverage. As noted above, option 3 is only under consideration in light of the likely scenario which includes Metro North.

Scoring Summary	Demand Coverage Score	Journey Time Score	Cost Score	Overall Scoring
Option 1	1	2	2	**5**
Option 2	2	1	3	**6**
Option 3	3	3	1	**7**

Table 5-6 Option Scoring Summary

6 Transport Modelling Assessment

6.1 Background

Following identification of the preferred public transport option for the South East corridor, a modelling exercise has been undertaken to determine the likely usage and operation of the proposed new services that may be in place by year 2035.

The modelling testing exercise is reported within this section. The emerging measures were tested in the Greater Dublin Area Regional Model (GDARM).

This testing stage also includes the majority of initiatives that form the GDA Strategy and therefore takes cognisance of the impacts of both the corridor initiatives and interaction with those services being proposed within the overall strategy.

It should be noted that within this modelling exercise, the model testing does not include the full impact of Demand Management Measures that may be utilised to further enhance the level of journeys made by public transport. In addition, Park and Ride facilities and shuttle bus services to rail and light rail stations have not been modelled and therefore the model output is likely to under represent the actual level of use on public transport. The outcome of the current model testing, therefore, provides a conservative view of demand levels that may use the measures included within the Strategy. Implementation of strategic Park and Ride facilities, and demand management measures are likely to increase the attractiveness of the public transport measures. These benefits are not encompassed in the modelling results.

Further information on the transport modelling and strategy measures tested is provided within an overarching Transport Modelling Report.

Figure 6-1 illustrates the proposed GDA public transport proposals in the context of the South East Study Area corridor.

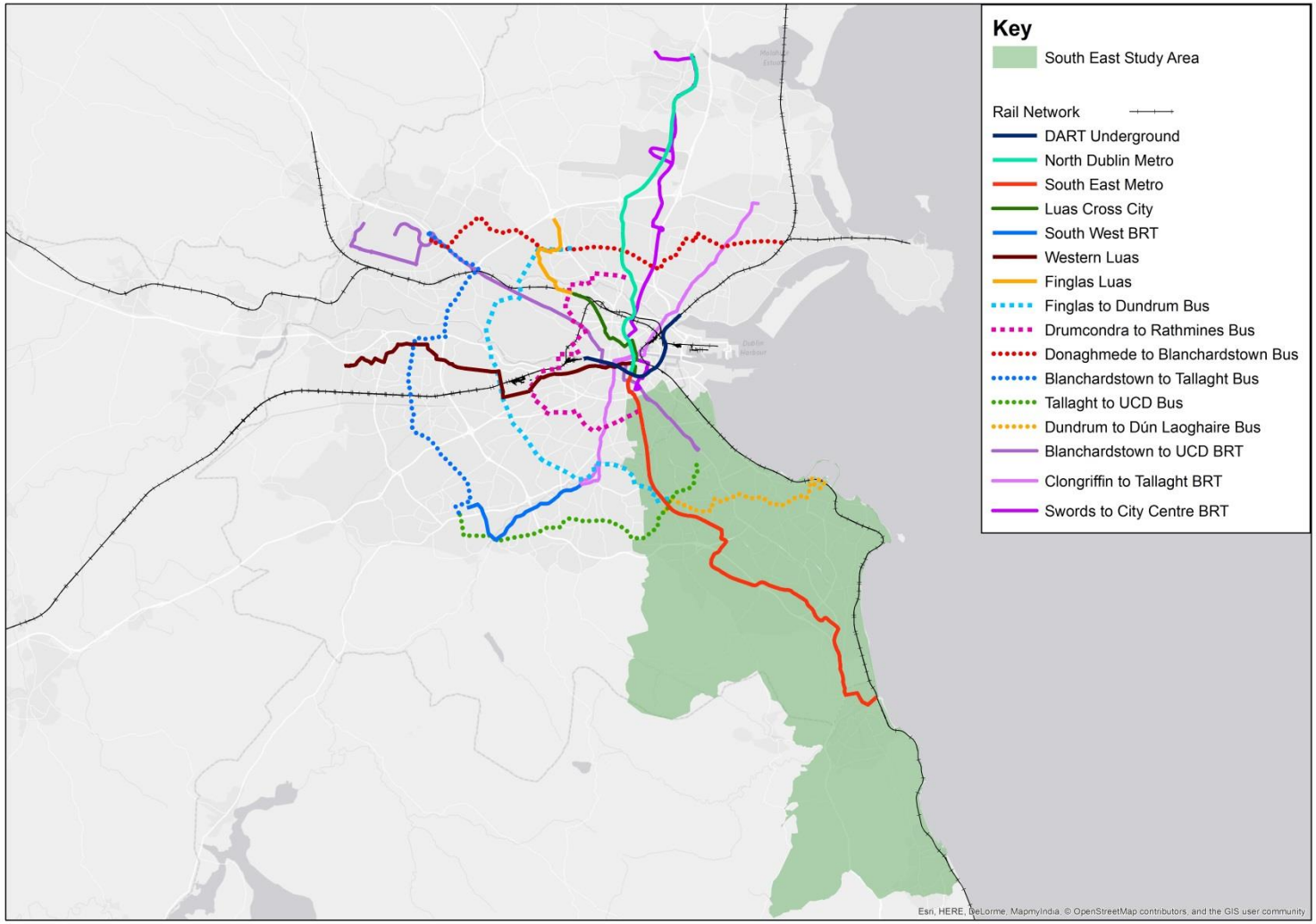


Figure 6-1: Proposed GDA Strategy Public Transport Proposals

6.2 Modelled Public Transport Proposal

The proposed transport provision for the South East Corridor tested within the GDARM includes upgrade the existing Luas Green Line to a Metro between Charlemont and Bride's Glen, with extension to Bray (as per Luas B2). The South Metro is assumed to accommodate an extension of Metro North services, with trains running from Swords to Bray.

To supplement this, proposed increases to the frequency of DART and rail services have been included, as well as increased bus services to widen the catchment providing interchange to the metro and rail services.

The upgrade of the existing Luas Green Line to metro, between Charlemont and Bride's Glen has impacts on the Luas Green Line and Luas Cross City services. It has been assumed that the South Metro will replace the Luas Green line services between Charlemont and Bride's Glen. Therefore Luas Cross City services are now assumed to operate between Broombridge and Harcourt.

These proposals are tested with the wider Strategy measures presented in Table 6-1.

Service	Vehicle	AM headway	IP headway	PM headway
South East Metro	60m tram	2	2	2
Rail / DART Services				
Maynooth to Bray – all stops	DART	10	20	10
Connolly to Bray – all stops	DART	30	60	30
Maynooth to Greystones – all stops	DART	30	60	30
Greystones to Maynooth – all stops	DART	30	60	30
Bray to Maynooth – all stops	DART	10	20	10
Bray to Connolly – all stops	DART	30	60	30
Rosslare to Connolly – all stops	Intercity	60	180	60
Connolly to Rosslare – all stops	Intercity	60	180	60

Table 6-1: Proposed Public Transport Service Plan

6.3 Modelling Assessment

6.3.1 Screenline Assessment

As described earlier in the report, the demand level was defined across screenlines within the Study Area to determine the appropriate service to accommodate the target demand growth. This assessment made the assumption that all growth to the City Centre and Study Area would use public transport if made attractive enough. Additionally, the assumption has been made that 30 percent of growth to all other destinations would use public transport if made attractive enough. For the purposes of demand assessment, this was an upper bound of possible public transport use in the forecast year 2035 for the purposes of public transport option development.

The public transport service proposals were then modelled to determine a more conservative projection of 2035 public transport usage. Figure 6-2 illustrates the forecasted 2035 AM peak hour

public transport patronage crossing each of the screenlines. This includes bus, South Metro, and rail (DART and commuter trains).

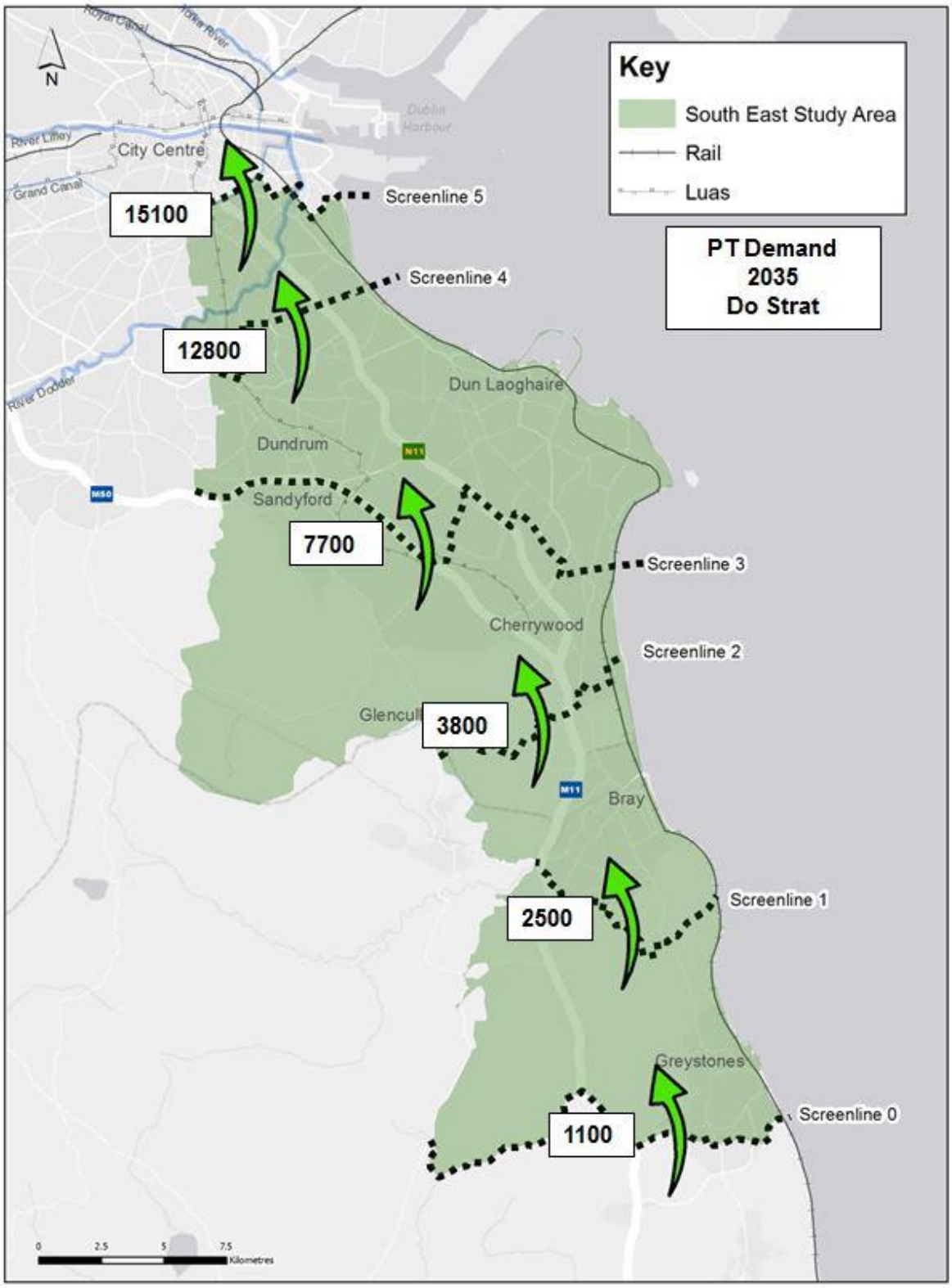


Figure 6-2: AM Peak Screenline Total Public Transport Patronage

The following figure compares the 2035 public transport target demand (this is the target public transport demand, plus existing 2011 public transport demand) against the modelling results.

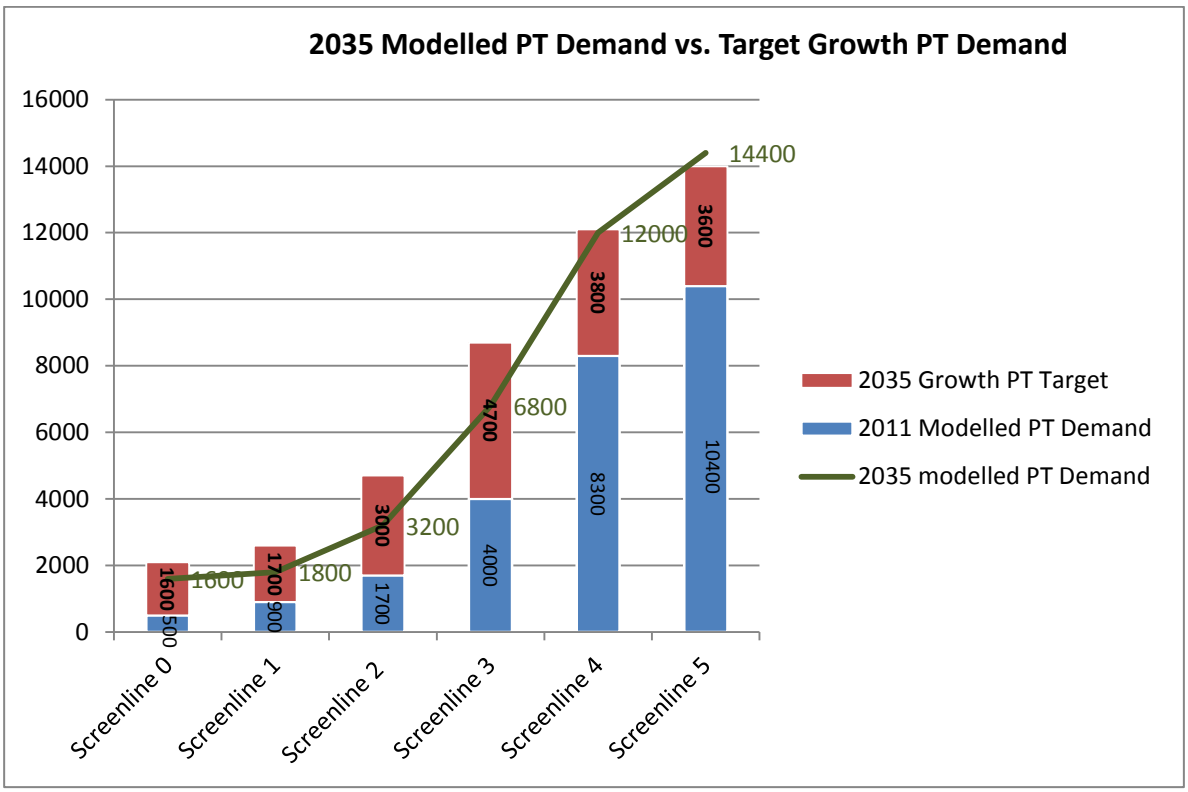


Figure 6-3: Modelled PT Demand for 2035 Compared to Target PT Growth

Comparing the preliminary demand assessment against the modelling result reveals notable differences in the south of the Study Area. In the north of the Study Area, the model results show that a large percentage of the demand uses public transport.

Through screenline 0 and 1 (Greystones and south) there are a fewer public transport users than the initial demand assessment noted (within Section 3). To meet the total demand identified in the preliminary demand assessment crossing screenline 0, the public transport would cater for a total demand of 2,100 (1,600 trips from demand growth and 500 trips from the 2011 modelled public transport demand). The model has assigned 1,600 total public transport trips crossing screenline 0 in 2035. Crossing screenline 1 the total demand identified in the preliminary assessment was 2,600, with a maximum growth in demand of 1,700. The model has forecasted 1,800 public transport trips. The relatively small difference is due to a number of factors. The feeder bus services connecting to/from the Greystones DART station were not included in the modelling exercise. Park and Ride facilities were also not included. There are also a number of trips with destinations within the Study Area or within the outer orbital where the journey time by car is faster than the public transport journey time. From the analysis provided in Figure 3-4, there are approximately 500 trips with destinations in the City Centre, the majority of the others have destinations within the Study Area.

Screenline 2 includes demand from Bray and surrounding area. The preliminary demand assessment estimated that public transport would need to cater for 4,700 trips in order to meet all demand growth in 2035. The modelling results show that the public transport attracts 3,200 trips. Again this did not include feeder bus services to the DART and metro. It also did not include Park and Ride facilities. Both of these can increase the attractiveness of the public transport service.

There are also a number of trips with destinations within the Study Area or within the outer orbital where the journey time by car is faster than the public transport journey time. From the analysis provided in Figure 3-4, only approximately 700 trips with destinations in the City Centre, the majority of the others have destinations within the Study Area.

North of Bray, Screenlines 3 to 5, public transport use indicated by the modelling is high and comes close to meeting or, in some cases, exceeding the projected growth in demand.

6.3.2 Corridor Study Area Mode Share

The introduction of the proposed public transport measures within the Study Area, and the introduction of wider GDA public transport proposals can accommodate increased public transport patronage. Figure 6-4 shows the overall mode share of the South East Study Area for trips greater than 3 km during the AM peak hour to Dublin City Centre; showing a public transport mode share of 60 per cent, and a motor vehicle mode share of 40 per cent. This is an increase in public transport ridership from the base conditions.

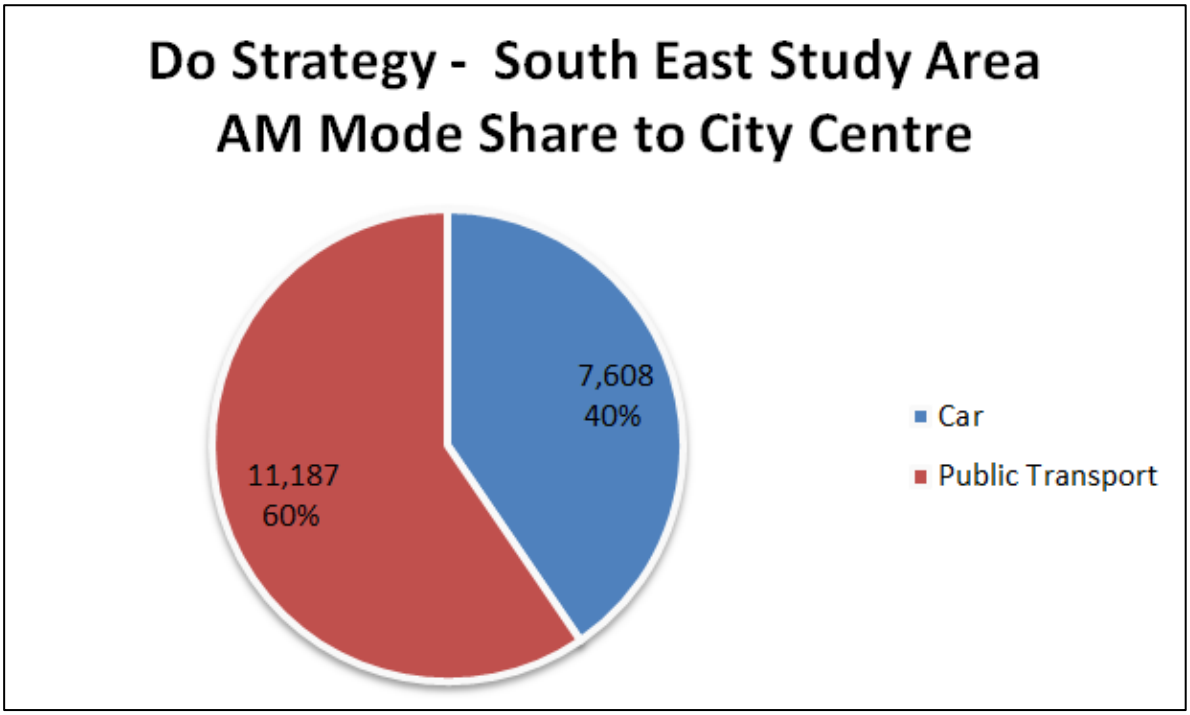


Figure 6-4: AM Peak Corridor Study Area Mode Share

6.3.3 Public Transport Boarding and Alighting Profile

Figure 6-5 and Figure 6-6 detail the boarding and alighting profiles for the metro line and the rail and DART line from the South East Study Area to Dublin City Centre in the AM peak hour. Each graph shows the boarding and alighting at each station, as well as the cumulative passenger numbers for each service, and the overall design and crush capacity modelled for these services.

The model shows that there would be a maximum of 6,400 passengers at Ranelagh stop. Seated capacity is reached northbound at Stillorgan and passengers are required to stand until after Stephen's Green. It can be seen that at no point during the AM peak hour is the metro South operating above the design capacity. The passenger numbers from Bray to Stillorgan are seen to increase at a steady rate throughout the length of the line. A total of 1,300 passengers are forecasted to utilize the metro extension to Bray, with 400 passengers boarding at Bray Interchange, 200 at Ravenswell, 400 passengers at Castle Street and almost 300 passengers at Shankhill.

Northbound ridership on the DART line also steadily increases throughout the line with maximum total passengers forecasted to be 4,000 at Lansdowne Road Station. Boarding at Greystones Station is relatively low at 85 passengers. Bray Station is forecasted to attract 700 passengers in the AM peak hour. This is the highest level of boarding along the line between Greystones and Connolly. Seated capacity is reached northbound at Dun Laoghaire Station. At no point during the AM peak hour is the DART operating above the design capacity.

It is possible that ridership can be increased by the introduction of Park and Ride facilities and feeder buses on both the DART and the metro lines.

While the boarding profile shows clear demand during the AM peak hour coming from the areas south of screenline 2, The 1,500 passengers that are forecasted to board along the extension is a significant demand. However, this level of demand alone is not strong enough to solely justify and investment at this scale. Further analysis could better asses if the cost of the extension to Bray will be justified by this level of demand. Additionally further study could also determine if phasing the implementation over time as growth is realized would be appropriate. With this approach, timing could be aligned to when growth occurs.

The above analysis indicates that the proposed improvements to the public transport services operate efficiently and effectively, and there is still adequate scope on the public transport services for further patronage increases beyond 2035. The Metro South is recommended as a preferred public transport scheme to serve the South East Study Area, as is the extension of the Metro South to Bray, and the enhancement of DART services. Although Metro South was tested in conjunction with the improvement of Metro North to Swords, the boarding and alighting profile indicates that the proposal would continue to attract adequate users independent of a Metro North improvement.

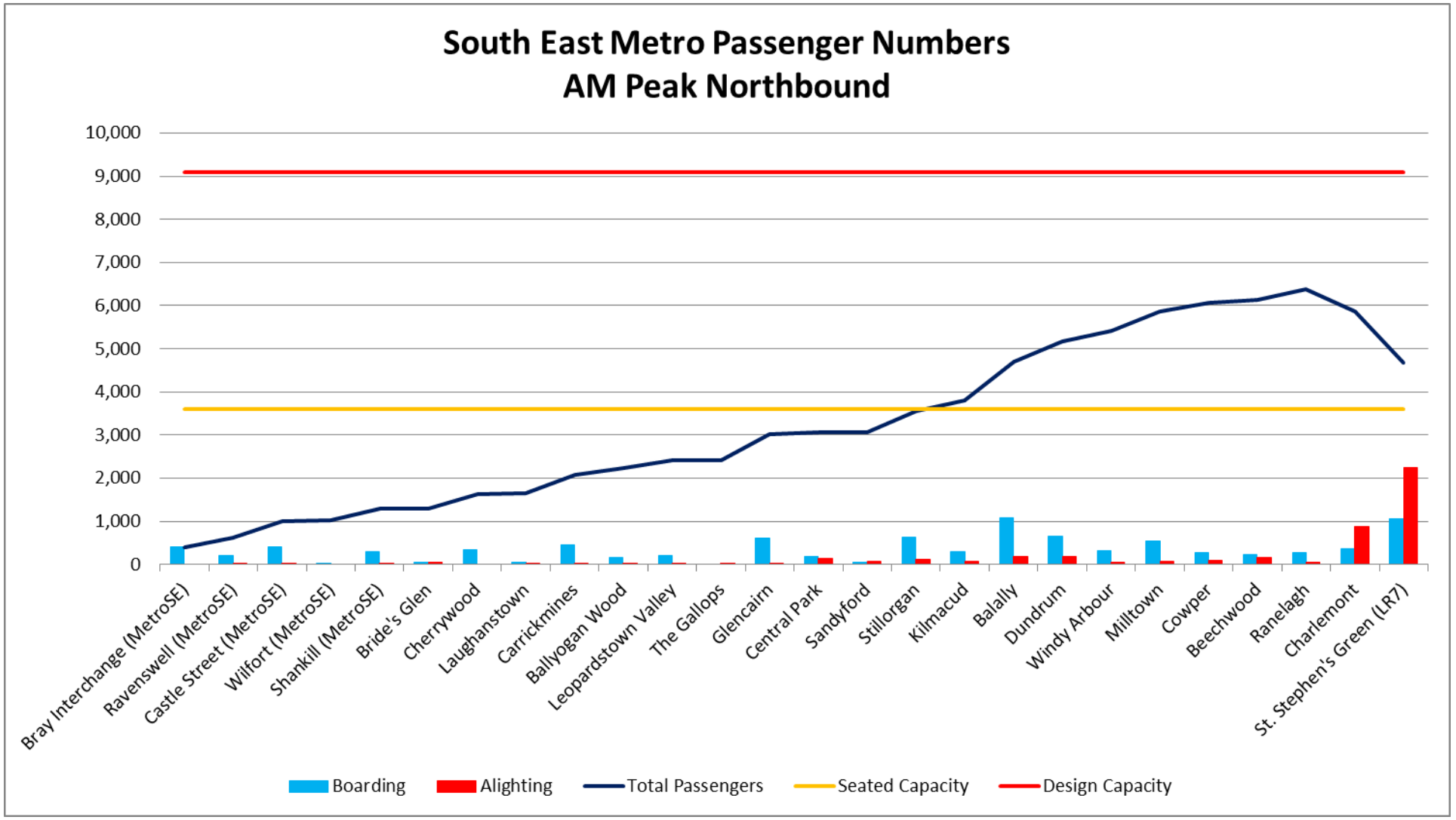


Figure 6-5: Metro Boarding and Alighting Profile

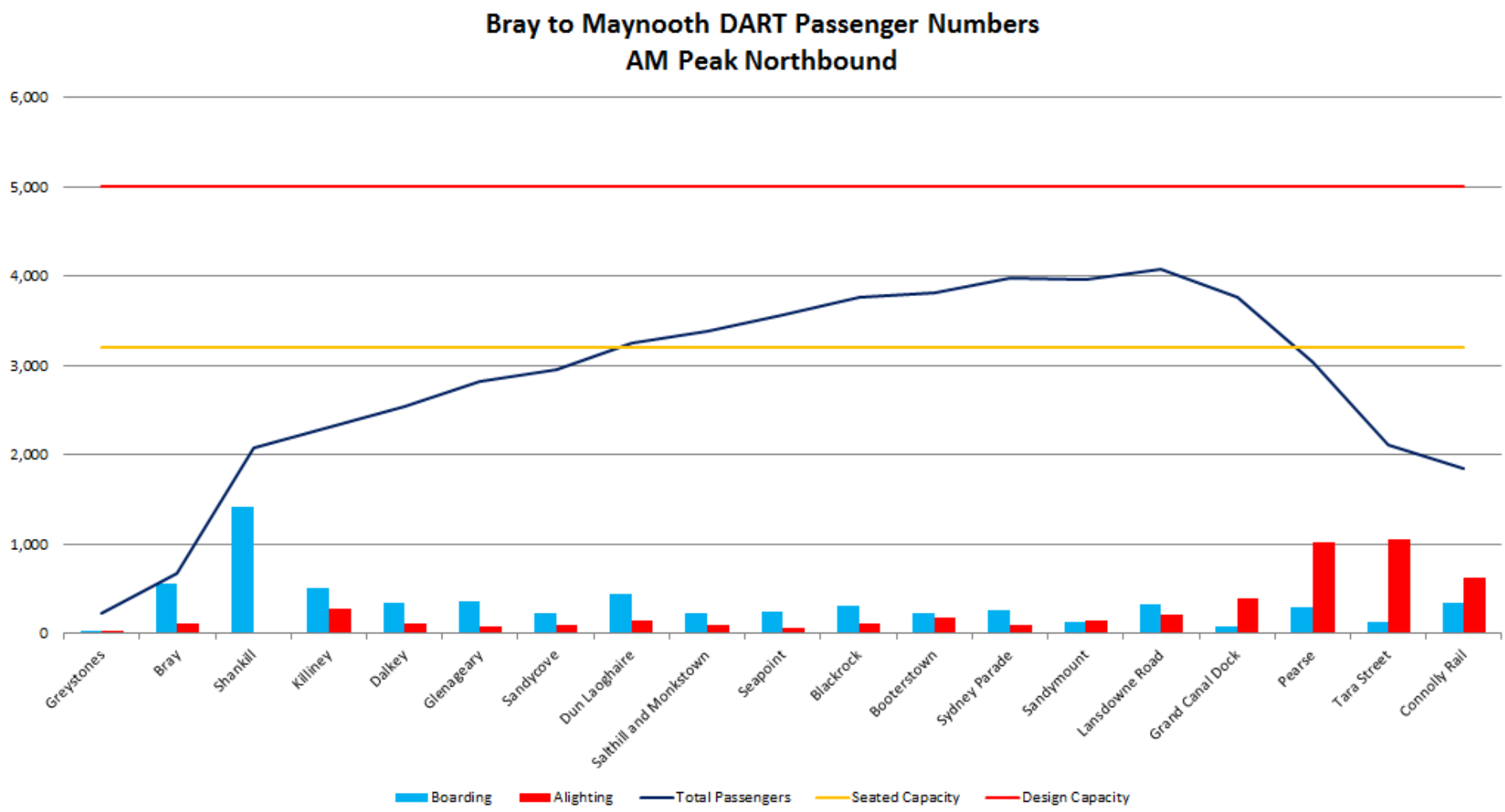


Figure 6-6: Rail and DART Boarding and Alighting Profile

6.3.4 Journey Times and Service Speeds

Table 6-2 outlines the high level journey times and average service speeds for the proposed public transport provision from Bray to Dublin City Centre in the AM peak hour. Table 6-2 shows that passengers from Bray can access Dublin City Centre in between 46 and 57 minutes providing multiple, alternative, efficient public transport routes to cater for the different origin and destination locations.

	Distance Km	Journey Time min	Speed kph	Travel Distance pas.km
Metro	23	57.00	23.3	67,869
DART	23.35	43.00	32.6	8,486

Table 6-2: Proposed Public Transport Journey Times and Service Speeds

6.4 Modelling Summary and Conclusions

The modelling assessment has shown that the patronage and passenger numbers using the proposed services mostly align with the anticipated demand. This indicates that the proposed public transport provision is of the appropriate scale to accommodate the forecast demand growth. The overall public transport mode share for trips from the Study Area to Dublin City Centre is seen to increase to 60 per cent. The comparison of the service passenger numbers against the design capacity indicates that at no point are the services overcrowded and that by 2035 there is still scope to accommodate further growth beyond 2035. The assessment also showed that journey times to Dublin City Centre from Bray are in the range of 43 minutes to 57 minutes, providing an efficient, reliable service. The boarding and alighting profile analysis indicated that even without the introduction of the Dart Underground and Metro North, the improvement of the Metro South would attract significant ridership.

The screenline assessment and the boarding and alighting profiles show that the rail and metro services have the capacity to cater for the total demand identified in the preliminary demand assessment. However, especially in the southern part of the Study Area, the proposed public transport is not attracting the demand that would be expected. There could be a number of explanations for this. As noted above the model did not include bespoke feeder bus services that quickly and efficiently bring passengers to DART and metro stations. Nor did the model include Park and Ride facilities that can provide interchange and increase public transport accessibility. The introduction of the efficient feeder services and Park and Ride facilities will increase the catchment area for the Metro South and DART and can increase PT usage. Demand management measures were also not accounted for. With demand management measures in place, PT becomes more attractive and competitive option. Lastly, there are some orbital trips, trips that remain outside the M50, and trips that remain in the Study Area that will still have a faster journey time by car. The implementation of demand management measures, bus feeder services and strategic Park and Ride locations will improve the attractiveness of the proposed option and further encourage ridership.

The model shows that between screenlines 0 to 2 the Metro South attracts a consistent number of public transport trips throughout the line and is likely to be a viable service. A determination of whether the volume of demand warrants the scale of investment will require further study. A phasing of the metro service to improve provision on the existing line in the near term, and providing the extension to Bray by 2035 is also an option to be considered for further study.

7 Emerging South East Study Area Public Transport Option

7.1 Recommendation

The following outlines the recommended South East Public Transport Proposal to be brought forward to be included in the GDA Strategy.

The recommended public transport proposal for the South East Study Area is as follows:

- Upgrade the Luas Green Line to a metro service to link with Metro North. This includes an option to connect with Bray or other points south of Cherrywood. The modelling exercise in Section 6 confirms that an extension to Bray would attract enough demand for a viable Metro South service. Further study is needed to confirm whether the level of demand served would justify the costs, and to determine a detailed plan for phasing the construction in line with the growth in demand;
- Upgrade the DART Line (removal of some at grade crossing, station upgrades, Park and Ride); and
- Improved bus services including feeders to metro / DART Lines and interchange with orbital bus services.

7.2 Specification of Public Transport Offering

- Metro South East – up to 30 trains of 60m+ length in the peak hour at two minute frequencies, providing a peak hour design capacity of 20,000 trips. If 53m trains are used design capacity would be 9,000;
- DART – up to 10 x 8 car DART trains with an average six minute frequency. The additional four trains per hour provides an additional design capacity of 2,000 to 4,800 (at 85 per cent of crush capacity);
- Park and Ride – Improvements at existing Bray and Greystone DART Park and Ride. Construction of a new facilities along the metro at Cherrywood and at the terminus;
- Bus – feeder buses to a number of DART stations, including Greystones and Bray; and
- BRT – Proposed BRT from Blanchardstown to University College Dublin.

7.3 Benefits

The benefits of the preferred option are as follows:

- This option meets projected demand growth to 2035 by accommodating all future growth within the area on public transport;
- 65 per cent of demand generated in the area will have access to public transport stops and stations with only one interchange. 35 per cent of demand generated by the area can access public transport with no interchange required;
- The proposed Metro South would connect with Metro North allowing trips to the North City Centre, northern suburbs, Dublin Airport and Swords by metro from the South East Study

Area. Similarly, public transport access to the key employment centres in the South East Area (e.g. Sandyford) will be opened up to people who have access to Metro North;
- The proposed Metro South will complement Metro North (and vice versa) and will become a key cross-city public transport corridor for the GDA;
- Improving the South East DART line will complement DART Underground;
- As the design capacity of metro is 20,000 for 60m+ trams or 9,000 for 50m+ trams this option can support significant additional demand above 2035 levels, thereby future proofing the investment in the area;
- Can support further concentration of employment in Dublin City Centre and residential development along the metro and DART corridors, in line with planning policy;
- Significantly opens up public transport access to/from South East to/from North East of the City;
- Because of the significantly increased capacity and frequency, Park and Ride becomes more attractive and feasible;
- The modelling exercise hasn't included the collective benefits that could be provided by Park and Ride and demand management measures. Benefits of the proposed measures are likely to be greater with the introduction of Park and Ride and demand management;
- Park and Ride improvements in the Study Area at Greystones, Bray, and Cherrywood would improve access to public transport and further increase public transport usage; and
- Implementation of GDA Demand Management measures will also further encourage the use of the public transport in the South East Study Area.

7.4 Risks

This section describes risks associated with the recommended South East Corridor Study public transport improvements.

Design Risk:

- Design is subject to detailed design and appraisal of emerging schemes;
- Design capacity is based on current public transport modes (crush load, design load and peak spreading);
- Interchange with high capacity core services based on detailed design, planning and level of service of feeder bus services;
- Detailed design of priority QBC and BRT priority may conflict with other modes and movements;
- Forecast infrastructure costs will be based on extrapolation of current costs;
- Disruption caused to existing Luas Line during upgrade to metro and the general construction and operational impacts associated with upgrading the Luas Line to metro;
- Disruption caused to existing DART line during construction work improvements and to the road network (e.g. removal of at grade crossings – Merrion Gates);
- Creation of a barrier to east/west travel through the introduction of a high capacity, high frequency metro corridor, including the impact on cycling and walking. Remedial measures to provide numerous crossing points will be required;
- Remodelling of track layouts and stations might be necessary with resulting disruption; and
- Timetable recast may be disruptive.

General Uncertainty and Economic Risk:

- On-going availability of funding and securing funding allocation;
- Right of way acquisition for Bray connection;
- Full integration and adoption of strategic development plan; and

- Competing public transport funding requirements.

7.5 Cost

Below is a conceptual high-level capital cost estimate for the recommended public transport option for the South East Study Area. These costs were estimated using per/km costs derived from similar recent projects, details of which are included in Annex 3 and Annex 5.

Metro	€1.5 Billion
DART Upgrade	€641 Million
Total Cost	c. €2.1 Billion

Annex 1 Capacity Assumptions

Capacity Assumptions	Seating Capacity	Crush Capacity	Design Capacity	Source
DART (EMU 8500 series, 2x4 car@160 seats)	320	1400	1190	www.irishrail.ie/about-us/dart
Commuter (DMU Class 2900, 2x4car@185 seats)	370	481	409	www.irishrail.ie/about-us/dart
Light Rail (401 & 402 Citadis - 40m tram)	70	305	259	RPA Report - Luas Patronage Gorwth - Average of Green and Red Luas
Light Rail (402 Citadis - 53m tram)			303	
Bus Rapid Transit	60	120	102	From CCIP Model
Dublin Bus	74	88	75	From GDA Model
Intercity Bus	50	53	50	From GDA Model
Shuttle Bus	30	30	30	Notional
Assumed Design Capacity reduction factor of	**85%**	**or 100% of seated capacity, whichever is larger**		

Table 7-1 Capacity Assumptions

Annex 2 Capacity Assessment

Table 7-2 details the capacity assessment undertaken for the target demand and outlines the following for each of the five options considered:

- **Right:** Proposed service type and frequency at each screenline; and
- **Left:** Comparison of proposed service design capacity and maximum screenline demand;

It can be seen in Table 7-2 that a small number of screenline demands are not entirely met by the design capacity. A maximum of 100 screenline crossing trips is not catered for by the design capacity. However, this surplus demand is more than accommodated for if crush capacity is considered. As 100 screenline trips is approximately the capacity of a single bus service, it was not considered appropriate to provide a short segment of bus services to cater for this localised issue, especially when the crush capacity can accommodate this demand.

Option Sifting for Growth (2035 - 2011)
Design Capacity

[Option 1 Enhance Existing + LUAS extension+new LRT]

Option 1	Maximum	LRT	DART	LUAS		
Screenlines	Demand					Surplus
Screenline 0	1600		2000			-400
Screenline 1	1700		2000			-300
Screenline 2	3000		2000	1500		-500
Screenline 3	4700	1296	2000	1500		-96
Screenline 4	3800	778	2000	1500		-478
Screenline 5	3600	778	2000	1500		-678
Total Surplus						-2052

Proposed Service Frequency

Option 1	LRT	DART	LUAS	
Screenlines				
Screenline 0		6 min		
Screenline 1		6 min		
Screenline 2		6 min	3 min	
Screenline 3	12 min	6 min	3 min	
Screenline 4	20 min	6 min	3 min	
Screenline 5	20 min	6 min	3 min	
Total Surplus				

[Option 2 Enhance Existing + LUAS extension+new BRT]

Option 2	Maximum	BRT	DART	LUAS		
Screenlines	Demand					Surplus
Screenline 0	1600		2000			-400
Screenline 1	1700		2000			-300
Screenline 2	3000		2000	1500		-500
Screenline 3	4700	1224	2000	1500		-24
Screenline 4	3800	765	2000	1500		-465
Screenline 5	3600	765	2000	1500		-665
Total Surplus						-1954

Option 2	BRT	DART	LUAS	
Screenlines				
Screenline 0		6 min		
Screenline 1		6 min		
Screenline 2		6 min	3 min	
Screenline 3	5 min	6 min	3 min	
Screenline 4	8 min	6 min	3 min	
Screenline 5	8 min	6 min	3 min	
Total Surplus				

[Option 3 Metro + DART Enhancement]

Option 3	Maximum	LRT	DART			
Screenlines	Demand					Surplus
Screenline 0	1600		2000			-400
Screenline 1	1700		2000			-300
Screenline 2	3000	3278	2000			-2278
Screenline 3	4700	3278	2000			-578
Screenline 4	3800	3278	2000			-1478
Screenline 5	3600	3278	2000			-1678
Total Surplus						-6312

Option 3	LRT	DART		
Screenlines				
Screenline 0		6 min		
Screenline 1		6 min		
Screenline 2	2 min	6 min		
Screenline 3	2 min	6 min		
Screenline 4	2 min	6 min		
Screenline 5	2 min	6 min		
Total Surplus				

Option 4: [New Heavy Rail]

Option 4	Maximum	DART				
Screenlines	Demand					Surplus
Screenline 0	1600	1785				-185
Screenline 1	1700	2380				-680
Screenline 2	3000	3570				-570
Screenline 3	4700	4760				-60
Screenline 4	3800	4760				-960
Screenline 5	3600	4760				-1160
Total Surplus						-3430

Option 4	DART			
Screenlines				
Screenline 0	40 min			
Screenline 1	30 min			
Screenline 2	20 min			
Screenline 3	15 min			
Screenline 4	15 min			
Screenline 5	15 min			
Total Surplus				

Option 5: [New Light Rail Line]

Option 5	Maximum	LRT				
Screenlines	Demand					Surplus
Screenline 0	1600	1296				304
Screenline 1	1700	2593				-893
Screenline 2	3000	3111				-111
Screenline 3	4700	5185				-485
Screenline 4	3800	5185				-1385
Screenline 5	3600	5185				-1585
Total Surplus						-4459

Option 5	LRT			
Screenlines				
Screenline 0	12 min			
Screenline 1	6 min			
Screenline 2	5 min			
Screenline 3	3 min			
Screenline 4	3 min			
Screenline 5	3 min			
Total Surplus				

Option 6: [LRT Extension + 3 BRT Lines]

Option 6	Maximum	LUAS X	BRT	BRT	BRT	
Screenlines	Demand					Surplus
Screenline 0	1600		2040			-440
Screenline 1	1700		1224	765		-289
Screenline 2	3000	4500	1224	765		-3489
Screenline 3	4700		1224	1224	2040	212
Screenline 4	3800		1224	1224	2040	-688
Screenline 5	3600		1224	1224	2040	-888
Total Surplus						-5142

Option 6	LUAS X	BRT	BRT	BRT
Screenlines				
Screenline 0		3 min		
Screenline 1		5 min	8 min	
Screenline 2		5 min	8 min	
Screenline 3		5 min	5 min	3 min
Screenline 4		5 min	5 min	3 min
Screenline 5		5 min	5 min	3 min
Total Surplus				

Option 7: [LRT Extension + New LRT]

Option 7	Maximum	LUAS X	LRT			
Screenlines	Demand					Surplus
Screenline 0	1600					1600
Screenline 1	1700					1700
Screenline 2	3000	4500				-1500
Screenline 3	4700		3889			811
Screenline 4	3800		3889			-89
Screenline 5	3600		3889			-289
Total Surplus						633

Option 7	LUAS X	LRT		
Screenlines				
Screenline 0				
Screenline 1				
Screenline 2				
Screenline 3		4 min		
Screenline 4		4 min		
Screenline 5		4 min		
Total Surplus				

Option 8: [3 BRT Lines]

Option 8	Maximum	BRT	BRT	BRT		
Screenlines	Demand					Surplus
Screenline 0	1600	1224				376
Screenline 1	1700	1224	1020			-544
Screenline 2	3000	1224	1020	765		-9
Screenline 3	4700	1224	1224	2040		212
Screenline 4	3800	1224	1224	1530		-178
Screenline 5	3600	1224	1224	1530		-378
Total Surplus						-897

Option 8	BRT	BRT	BRT	
Screenlines				
Screenline 0	5 min			
Screenline 1	5 min	6 min		
Screenline 2	5 min	6 min	8 min	
Screenline 3	5 min	5 min	3 min	
Screenline 4	5 min	5 min	4 min	
Screenline 5	5 min	5 min	4 min	
Total Surplus				

Table 7-2: Target Demand Assessment for the Proposed Option

Annex 3 Cost Assumptions

This section details the cost assumptions and sources that were used for the estimation of capital costs for the option development.

Service Type	Name	Cost over 30 year operational period				Length	Capital Cost per km	Source	Notes
		Capital	Operation	Renewals	Revenue				
		€m	€m	€m	€m	km	€m		
Heavy Rail New Line - Rural	Double Track						5.50	Irish Rail 2030 Rail Network Strategy Review	include construction and land acquisition
	Single Track						3.50	Irish Rail 2030 Rail Network Strategy Review	include construction and land acquisition
Heavy Rail New Line - Urban / Sub-Urban	Metro North	3800				18	211.11	RPA Metro North Updated Business Case 2010	include construction and land acquisition
	Metro Tunnel	2546				7	363.71	assuming that tunnel cost twice as much as non tunnel	
	Metro Non-Tunnel	1254				11	114.00	assuming that tunnel cost twice as much as non tunnel	
Heavy Rail Upgrade - Sub-Urban / Rural	Kildare Route Project	420				13	32.31	Irish Rail Kildare Route Project SDCS 2007	include construction and land acquisition
Heavy Rail - New Station	Adamstown Station						6.20	http://www.punchconsulting.com/our-projects/civil-infrastructure/adamstown-railway-station-dublin/	
New Train									
Light Rail General	UK Costs						18.30	UK Trams - Cost of Light Rail 2012	x 1.5 currency conversion to euro
	Europe Costs						23.85	UK Trams - Cost of Light Rail 2012	x 1.5 currency conversion to euro
	Luas Red & Green	775				25	31.00	wikipedia	
Light Rail in Urban Area	Luas Docklands	90				1.5	60.00	boards.ie	
	Luas Cross City	368				6.72	54.76	https://www.luascrosscity.ie/	
Light Rail in Sub-Urban / Rural Area	Luas B1	302	131	91	281	7.6	39.74	RPA Proof of Evidence Luas Line B1 2006	includes some large bridge infrastructure
New Luas Tram									
BRT in Sub-Urban / Urban Area	BRT Lucan	121	9.8	32		12	10.08	RPA Lucan Luas Demand Appraisal 2012	
	Blanch - UCD	188				16.5	11.39	NTA / RPA Presentation 2012	
	Clong - Tallaght	264				23.2	11.38	NTA / RPA Presentation 2012	
New BRT Vehicle									
Quality Bus Corridor							3.65	Assumed 1/3 BRT cost	
New Bus									
Bridge Crossing	Taney bridge (21.5, 108m)	11					84.94	http://www.irishtimes.com/news/bridge-due-to-be-completed-in-october-1.1089164	
	Suir Bridge (90m, 225m)	29.8					94.60	Waterford Bypass presentation to engineers ireland Feb 2010	

Table 7-3 Capital Cost Assumptions and Sources

Annex 4 Speed Assumptions

This section details the speed assumptions and sources that were used for the estimation of average speed in kilometres per hour for the public transport option development.

Service Type	Speed kph	Source	Comment
DART	32	GDA PT Lines	Overall average of all DART lines
Commuter South East	35.1	GDA PT Lines	Bray line
Commuter West	33.5	GDA PT Lines	Maynooth line
Metro	70	RPA Metro North Updated Business Case 2010	Likely an upper limit speed, not operational speed
Luas Red	22.2	GDA PT Lines	Not segregated for most of route
Luas Green	24.8	GDA PT Lines	Segregated for most of route
BRT	20	NTA / RPA Presentation 2012	Minimum requirement set. Can be up to 25kph
QBC	17.19	NTA / RPA Presentation 2012	Stillorgan QBC. Probably an efficient QBC?
Bus	15	Notional speed	

Table 7-4: PT Speed Assumptions

Annex 5 Scoring Summary

This section details the scoring process that was used for the estimation of capital costs for the option development. Table 7-5 includes the scoring and ranking for the three options brought forward to the scoring phase. Options were scored based on demand coverage, journey time, and cost. Table 7-5 is the summary of the detail provided in Table 7-6. They were then ranked with the lowest ranking number being the best, and the highest ranking number the worst.

Scoring Summary		Demand Coverage	Weighted JT 1 Interchange	Cost
		%	min	€M
Option 1	DART Enhancement + LUAS Enhancement + LRT Spur + LRT Extension	82%	60.6	1,865
Option 2	DART Enhancement + LUAS Enhancement + BRT + LRT Extension	69%	68.6	1,613
Option 3	DART Enhancement + Metro	65%	47.8	2,141

Scoring Summary	Ranking Table	Demand Coverage	Weighted JT 1 Interchange	Cost	Scoring
Option 1	DART Enhancement + LUAS Enhancement + LRT Spur + LRT Extension	3	2	2	9
Option 2	DART Enhancement + LUAS Enhancement + BRT + LRT Extension	2	1	3	10
Option 3	DART Enhancement + Metro	1	3	1	8

Table 7-5: Scoring Summary and Ranking Table

Option 1	DART Enhancement + LUAS Enhancement + LRT Spur + LRT Extension									
Service	Distance	Coverage	Demand Coverage	Demand Coverage	Speed	Journey Time	JT %age Diff	Weighted JT 1 Interchange	Unit Cost	Cost
	km	km^2	trips	%	km/hr	hrs	%		€M/km	€M
DART Enhancement	51	56.5			32	01:35:37		1013		641
LUAS Enhancement	27	48.3			24.8	01:05:19		1841		250
LRT Spur	9.8	12.1			23	00:25:34		110	54.76	537
LRT Extension	11	12.1			24.8	00:26:37		168.42	39.74	437
Total	**98.8**	**128.9**	**3,700**	**100%**			**#DIV/0!**	**60.6**		**1,865**

Option 2	DART Enhancement + LUAS Enhancement + BRT + LRT Extension									
Service	Distance	Coverage	Demand Coverage	Demand Coverage	Speed	Journey Time	JT %age Diff	Weighted JT	Unit Cost	Cost
	km	km^2	trips	%	km/hr	hrs	%		€M/km	€M
DART Enhancement	51	56.5			32	01:35:37		495		641
LUAS Enhancement	27	48.3			24.8	01:05:19		900		250
BRT	25	46.2			20	01:15:00	100%	1537	11.39	285
LRT Extension	11	12.1			24.8	00:26:37		82.35	39.74	437
Total	**114.0**	**163.1**	**3,700**	**100%**			**#DIV/0!**	**68.6**		**1,613**

Option 3	DART Enhancement + Metro									
Service	Distance	Coverage	Demand Coverage	Demand Coverage	Speed	Journey Time	JT %age Diff	Weighted JT	Unit Cost	Cost
	km	km^2	trips	%	km/hr	hrs	%		€M/km	€M
DART Enhancement	51	56.5			0	01:35:37		422		641
METRO	35	94.24778			70	00:30:00		1606	54.76	1,500
Total	**86.0**	**150.8**	**3,700**	**100%**			**#DIV/0!**	**47.8**		**2,141**

Table 7-6: Scoring Details