Údarás Náisiúnta Iompair
National Transport Authority

Draft Transport Strategy for the Greater Dublin Area

North West Corridor Study

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Contents

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 **North West Study Area**. There are also Study Areas being examined by Jacobs / SYSTRA covering the South East, South West, West, Navan, and Inner Orbital.

1.2 Study Objectives and Principles

This study examines the future transport needs of the North West 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 North West 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 North West 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 by 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 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 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 inform the capacity requirements for future public transport options in 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 North West 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 average duration of the journey for trips within and out with the catchment bands of the public transport services proposed.

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 costs 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 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 2.4 is used as a basis for the development of the public transport options to serve the growth in demand to 2035 originating within the North West 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 2.4) as part of the wider GDA Strategy.

1.4 Report Structure

The report is structured as follows:

- Section 2 describes the North West 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; and
- Section 7 describes the Preferred Emerging Scheme.

2 Study Area

2.1 Corridor Description

The North West Study Area extends North West of Dublin City and traverses the M50 north of Finglas. It encompasses the areas of Finglas, Cabra, Glasnevin and Phibsborough south of the M50 and Ashbourne, Tyrrelstown and Ballycoolin north of the M50. The area is segmented by the Royal Canal, as well as the Tolka River and its banks, which run parallel to each other in a south east direction within the southern end of the Study Area. The Study Area includes part of Dublin Airport and culminates at Ashbourne in County Meath.

The Study Area boundary, which is shown below in Figure 2-1, was developed using the electoral division boundaries from the Central Statistics Office. The area south of the M50 is comprised mainly of a number of large residential suburban estates, but with a significant area of undeveloped land to its south west. Meanwhile, the area north of the M50 is characterised primarily by agriculture and amenity space, but with a number of large industrial developments centred on Ballycoolin. Tyrellstown and Ashbourne are the main settlements in the study area to the north of the M50.

The Tolka Valley Park and the National Botanic Gardens are located within the southern section of the Study Area; both of which are located on the banks of the Tolka River.

2.2 Existing and Planned Strategic Road Network

The corridor contains the M50 major national inter urban route which caters for significant traffic volumes orbiting Dublin City Centre. In addition, the M/N2 national primary route extends radially through the Study Area. This strategic road connects the City Centre with the Monaghan via Castleblayney, Carrickmacross, Ardee and Ashbourne.

The capacity of the M50 and M/N2 must be protected for strategic traffic movements, including the distribution of goods. Congestion along the M50 is an increasingly serious issue, particularly at peak times between the N2 and N81.

There is limited opportunity for significant road capacity enhancements in the Study Area from the perspective of both physical constraints and environmental considerations. Therefore, providing for increasing transport demand through alternative modes, such as public transport, will be necessary to protect the function and operation of the M50 and M/N2 as strategic corridors.

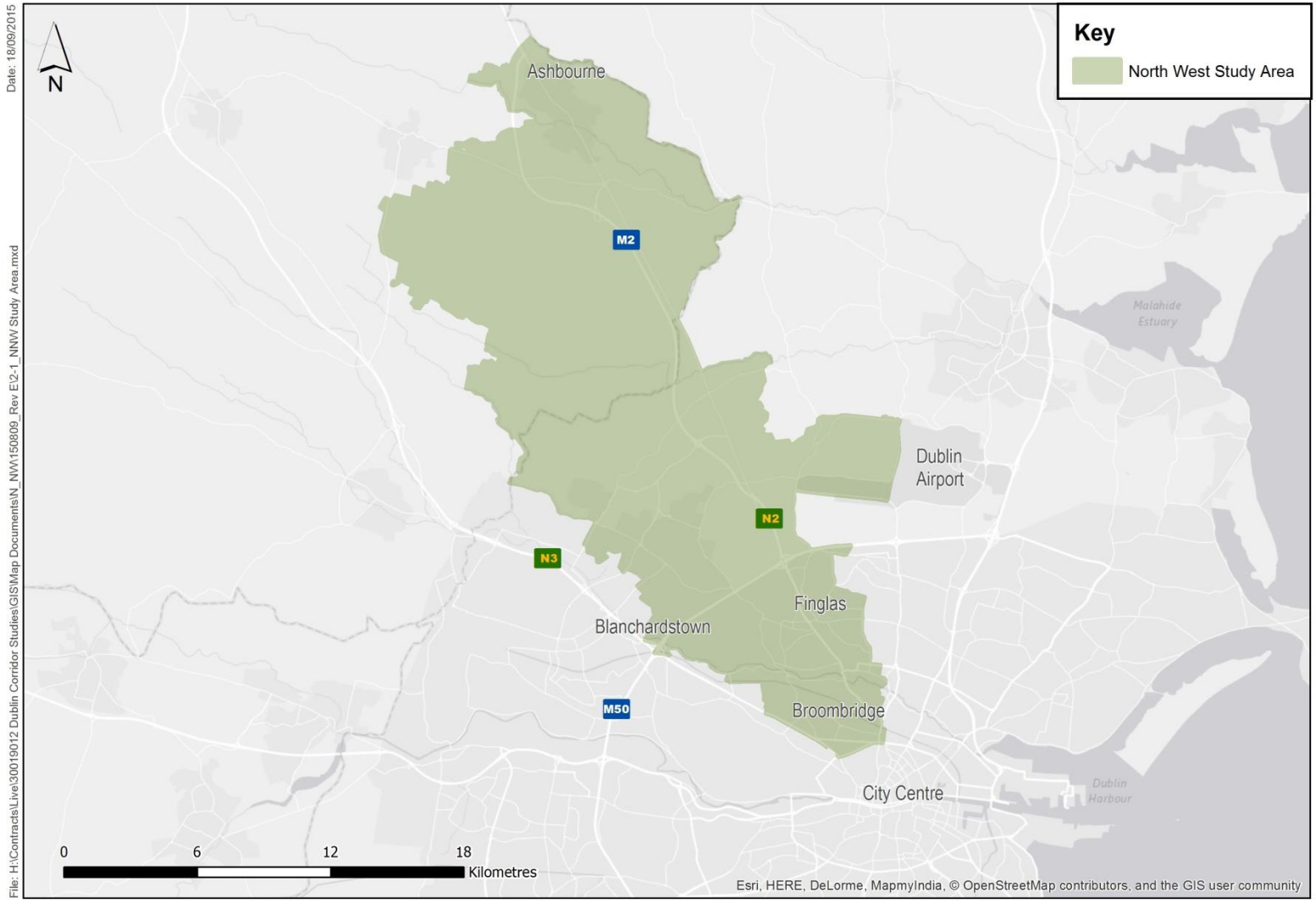


Figure 2-1: North West Study Area & Surrounding Areas

2.3 Existing and Planned Public Transport Provision

The dominant mode of public transport within the North West Study Area is bus and the Finglas Quality Bus Corridor (QBC) was one of the 9 initial QBCs developed in Dublin. As it enters the City, the Finglas QBC merges with the Swords QBC. In the 2011 QBC Monitoring Report, the mode share for bus at the canal crossing along the combined corridors was just over 45 per cent for bus and 38 per cent for car. Bus journey times are quicker than car journey times during the AM peak.

The existing public transport provision in the Study Area consists predominantly of radial services that cater for demand to Dublin City Centre, as well as through trips. Dublin Bus route 17A does provide for orbital movements to Blanchardstown and Kilbarrack. Harristown bus depot is located within the Study Area.

The Maynooth Rail line traverses through the southern part of the Study Area with one station, Broombridge, located within the boundary. Broombridge Station is served by western commuter services that operate between Maynooth, M3 Parkway, Pearse and the Docklands Stations.

Luas Cross City, which is currently under construction, will extend to Broombridge and also serve the Study Area at Cabra. The scheme will bring significant additional public transport capacity between the Study Area and the City Centre, and onto the southern suburbs, as well as providing direct links to key destinations such as the new Dublin Institute of Technology campus at Grangegorman. It is anticipated that Luas Cross City will be operational in 2017.

2.3.1 Irish Rail

There is only one operational commuter rail station in the Study Area at Broombridge. Passenger volumes at this station are low.

The Maynooth Rail Line is currently operating at the maximum level of frequency possible; there is a service frequency limitation of seven trains per hour, caused by signalling and level crossing constraints. Therefore, the opportunity to increase the frequency of service at Broombridge is limited without addressing these issues.

2.3.2 Luas

Luas Cross City, which is currently under construction, extends into the Study Area. Three stops will be located in the Study Area at Phibsborough, Cabra, and the Luas Cross City terminus at Broombridge. Services are scheduled to be in operation by the end of 2017. It will take approximately 21 minutes for the Luas to travel from Broombridge to St Stephen's Green.

The Broombridge Stop will be located adjacent to the Irish Rail Broombridge Station and interchange opportunities between the two modes will be provided for. The Broombridge Stop will also serve the surrounding residential and commercial areas.

The Cabra Stop will be located within the former Broadstone Railway Cutting, north of the Fassaugh Road overbridge. Access to the stop will be provided from Fassaugh Road and via Mount Bernard Park serving the surrounding residential community.

The Phibsborough Stop will be located within the former Broadstone railway cutting between North Circular Road and Cabra Road. Access to the stop will be provided from both North Circular Road and Cabra Road. This stop will serve the surrounding residential areas and facilitate interchange with bus services on North Circular Road and Cabra Road.

The existing and proposed rail network serving the study area is shown in Figure 2-2.

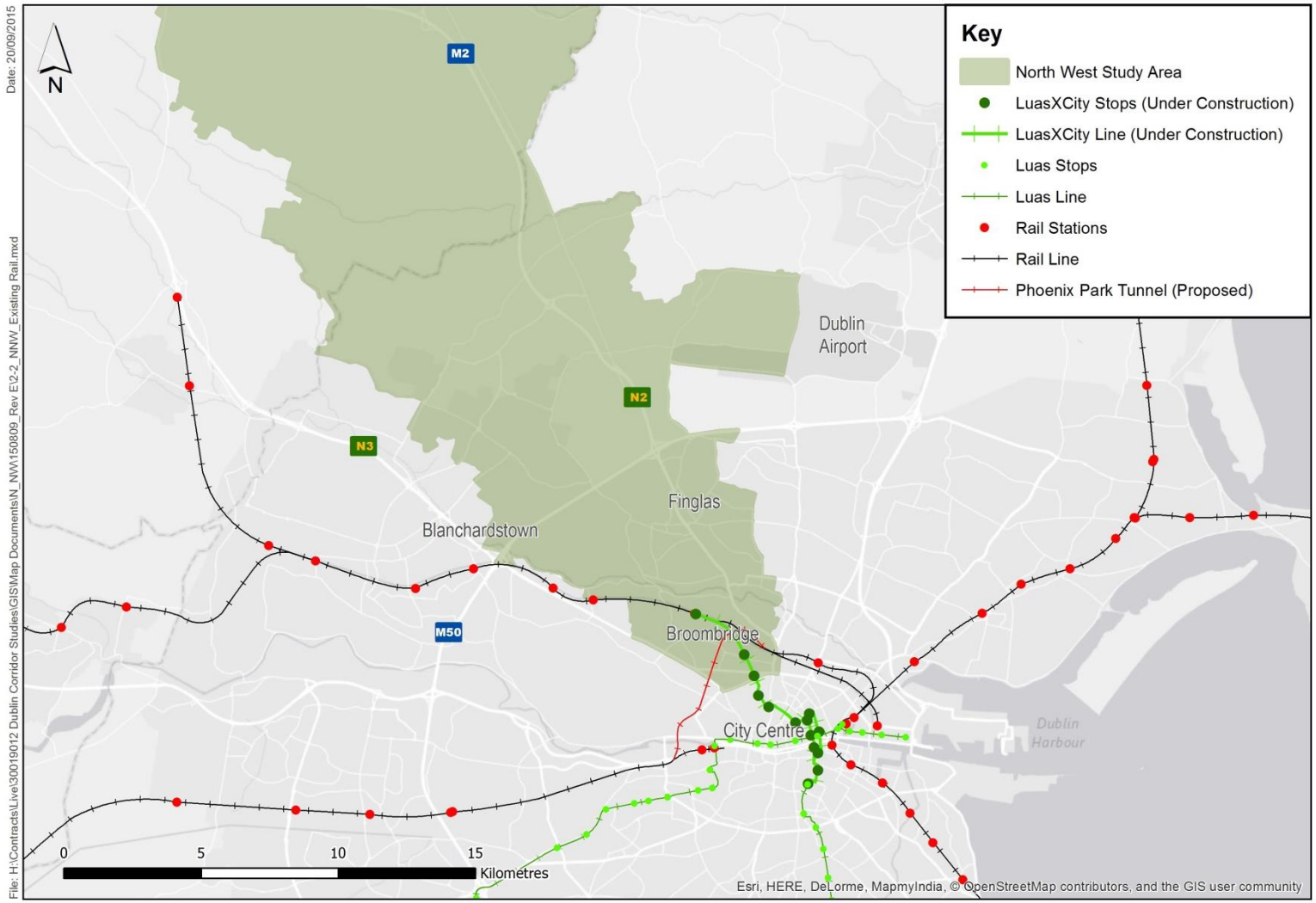


Figure 2-2: Existing and Proposed Heavy Rail and Light Rail Services

2.3.3 Bus

The Study Area is served by a number of Dublin Bus routes particularly the 40, 40D, 140 service group that operates along the Finglas QBC on Finglas Road. These services provide for demand along the radial corridor towards the City Centre. The 38/A/B service group also extends within the Study Area, notably serving Ballycoolin (peak hours only) and Cabra. Orbital movements are provided for by the 17A which operates between Kilbarrack and Blanchardstown.

Bus Éireann services also cater for demand from the Study Area to the City Centre. The 103 operates between Ashbourne and Beresford Place at a frequency of approximately three buses per hour. Additional services are provided during peak hours. The 105, which operates from Ratoath to the City Centre, is also routed along the corridor study.

Figures 2-3 and 2-4 illustrate the coverage of the Dublin Bus and Bus Éireann services within the North West Study Area.

Ashbourne Connect operate a commercially licensed bus service between Ashbourne and Dublin City Centre. The operation includes five inbound morning services which arrive in the City Centre between 07:00 and 09:00, and five return services which depart from the City Centre between 16:00 and 18:15. This service travels north through Ashbourne from the Briars before joining the M2 near the Pillo Hotel and continuing southbound towards East Wall Road and the City Centre.

In addition to PSO and commercially licensed bus services, there are a number of work shuttle services providing specific services to large employers, for example, the services provided between Dublin City Centre and PayPal.

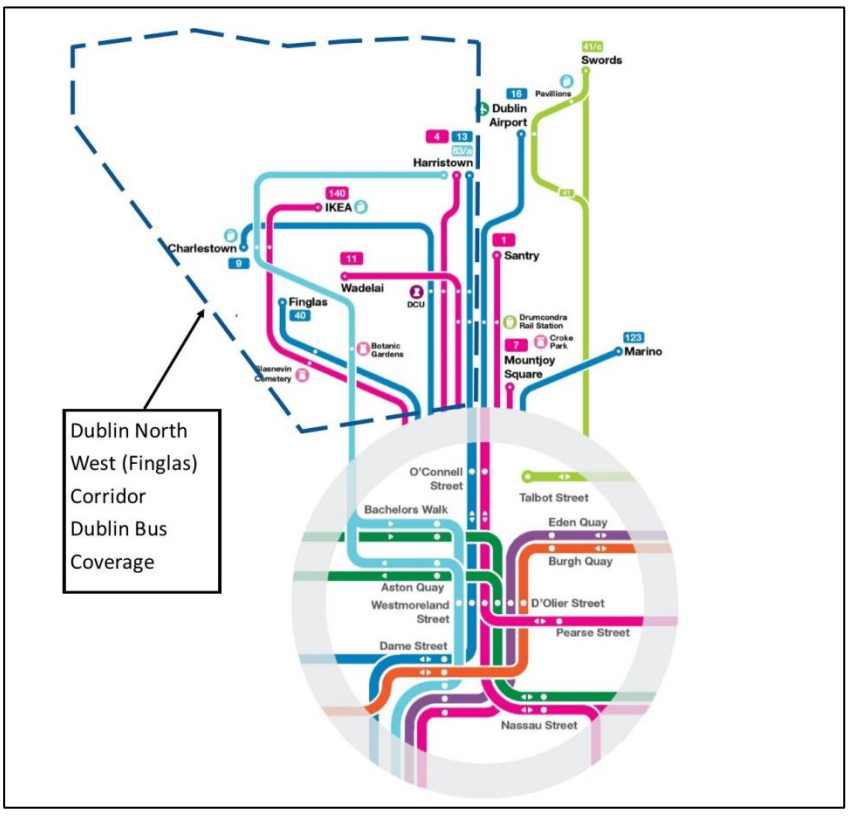


Figure 2-3: Dublin North West Study Area -Dublin Bus Core Services

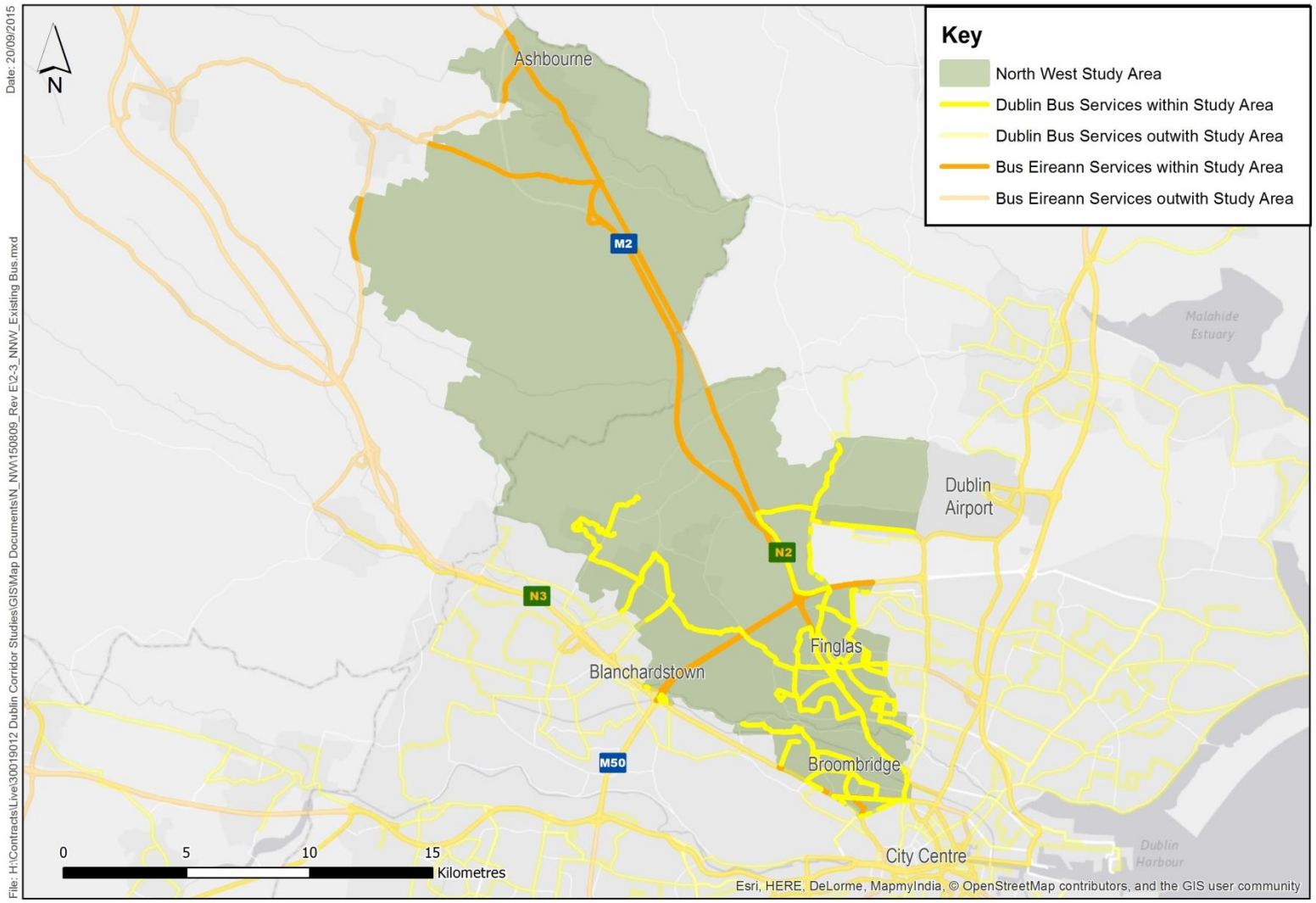


Figure 2-4: Existing Dublin Bus and Bus Éireann Services

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 Ratoath Road including Reilly's Bridge scheme is located in the North West Study Area and is included in the Do Minimum scenario.

While not all of these improvements directly impact this Study Area, they will contribute to an overall increase in public transport usage in the City and have been provided for context. Further details of the major public transport improvements assumed as part of the Do Minimum network are outlined below.

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 can 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.

The Do Minimum Scenario is illustrated in Figure 2.5.

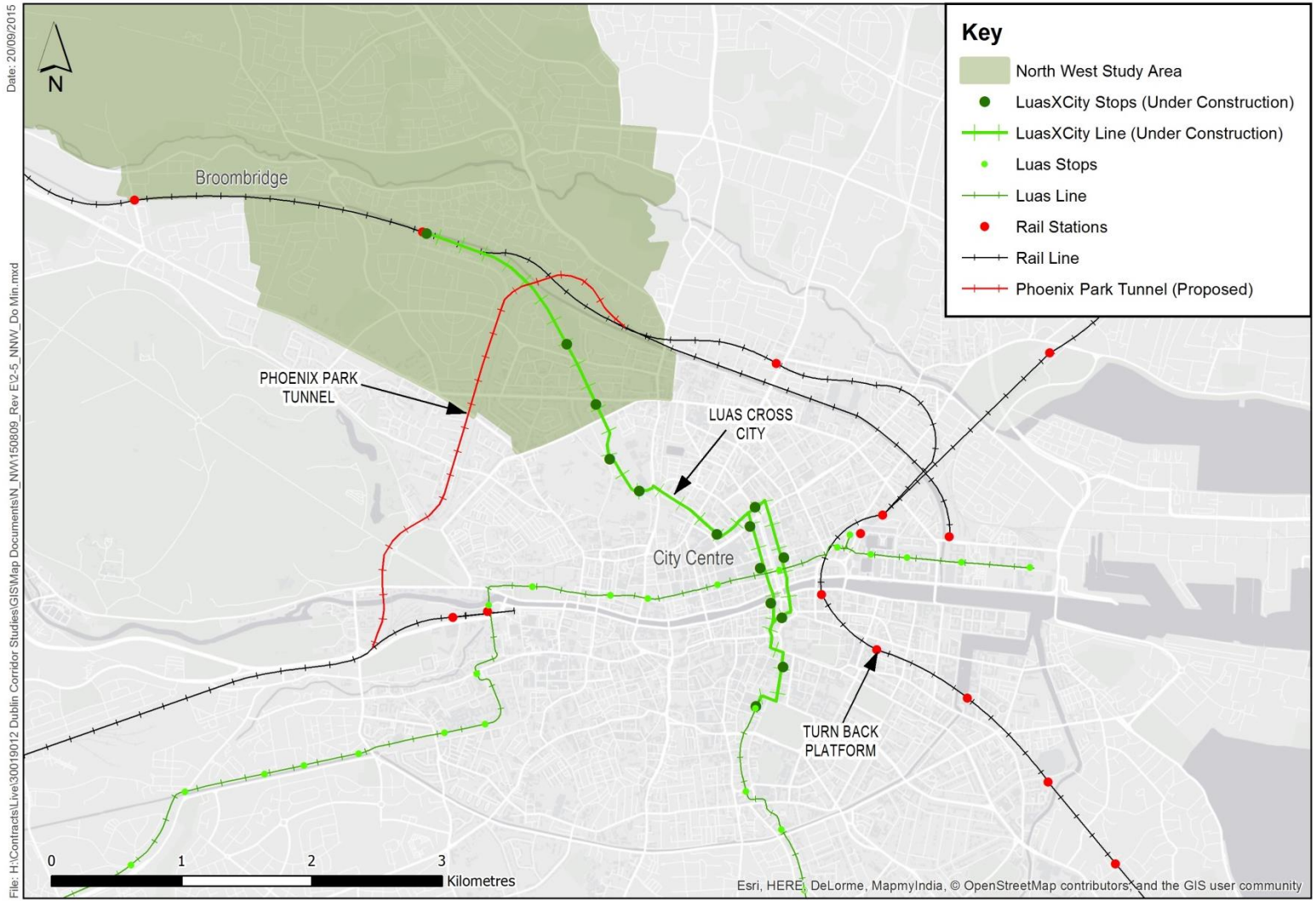


Figure 2-5: Do Minimum Proposed Public Transport

This Do Minimum scenario, above, is used as a basis for the development of the public transport options to serve the growth in demand to 2035 originating within the North West Corridor. The preferred public transport options are then further assessed within the GDARM with other additional schemes assumed (described below) as part of the wider GDA Strategy to test and fine tune the North West Corridor public transport recommendations.

2.4.4 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 Underground, 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 North West Corridor 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 Underground is assumed to be a tunnel linking Heuston Station to St. Stephen's Green and Pearse Stations. The M50 multi-point tolling scheme is assumed to be as per the proposals contained with the M50 Demand Management Report, published by the NRA (now Transport Infrastructure Ireland, TII) in April 2014.

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 a reasonable 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.

3 Demand Analysis

3.1 Establishing Demand

3.1.1 Establishing Base Year and 2035 Forecast Year Demand

The demand data utilised for this study considers assessment of a typical AM (08:00 – 09:00) peak hour. Demand data for a 3 hour AM period and an average midday Inter Peak hour was also derived, however, these were not utilised as part of the assessment. 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, 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 radial trips headed south east in the AM peak hour towards the City Centre. This accounts for the following movements:

- trips generated internally destined for the City Centre;
- trips generated internally and destined internally; and
- trips originating north west 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 'though trips' and were not 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

As part of the demand analysis, a target demand level has been identified, which represents the catering for 100 per cent of growth to the City Centre between the years 2011 and 2035. It is therefore assumed that there will be no growth in car use for trips destined to the City Centre.

The Do Minimum and assumed 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.

In the future 2035 scenario, it was assumed that at the outer screenline (R0) of the Study Area 30 per cent of new trips were made by public transport; this represented the fact that a large number of the trips at this screenline may not be heading for the City Centre. The percentage mode shares then increased incrementally towards the City Centre, finally reaching 100 per cent of new trips being taken by public transport by the inner screenline (R4). These assumptions were used to calculate a target public transport demand to develop the strategy are shown in Table 3-1 below.

Table 3-1: Mode Choice

Origin-Destination PT-Car Modal Split Assumption	2035 PT Mode Share of Additional 'New' Trips
Screenline R0 (Outer Study Area)	30%
Screenline R1	40%
Screenline R2	60%
Screenline R3	80%
Screenline R4 (Inner Study Area)	100%

3.2 Establishing Study Area Demand

3.2.1 North West Study Area Screenlines

In order to determine the level of demand to be accommodated by public transport during the 'options development' stage options, five screenlines were applied to the Study Area. The screenlines were developed to address the radial demand through the Study Area moving towards the City Centre and through the City Centre to the wider GDA. These trips may have destinations within the Study Area, within the City Centre, or they may pass through the Study Area to other destinations. The screenline demand takes into account all trips greater than 3km in length moving south east across the screenline during the AM peak hour. The screenline demand is cumulative moving to the south east, with Screenline 0 at the northern end of the Study Area and Screenline 4 at the canal cordon entering the City Centre.

3.2.2 Screenline Demand

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

The base year public transport demand within Figure 3-1 indicates that at the north western end of the corridor, there are approximately 550 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 3,700 trips at the screenline on the boundary with the City Centre.

As per the study assumptions, these figures include only journeys that are greater than 3km in length, and include journeys through the corridor, internal to the Study Area and also those that originate or terminate within the area.

Figures 3-2 and 3-3 show moderate potential growth in demand for travel within the corridor. Growth across the south eastbound screenlines is approximately 9 to 38 per cent through to year 2035. This equates to an additional 50 to 1,050 journeys per single hour during the peak across

the study screenlines. The level of growth leaving the Study Area across the City Centre screenline is 1,050 trips; this is the highest absolute level of growth in terms of trip numbers.

Figure 3.4 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 updated public transport services in the forecast year 2035. The target is derived by applying mode share assumptinos to the demand growth as described in section 3.1.3.

The target demand entering the Study Area at screenline R0 is 15 trips rising to 1050 trips at Screenline R4. The target demand at each screenline represents an upper bound of demand growth that could be attracted to public transport services.

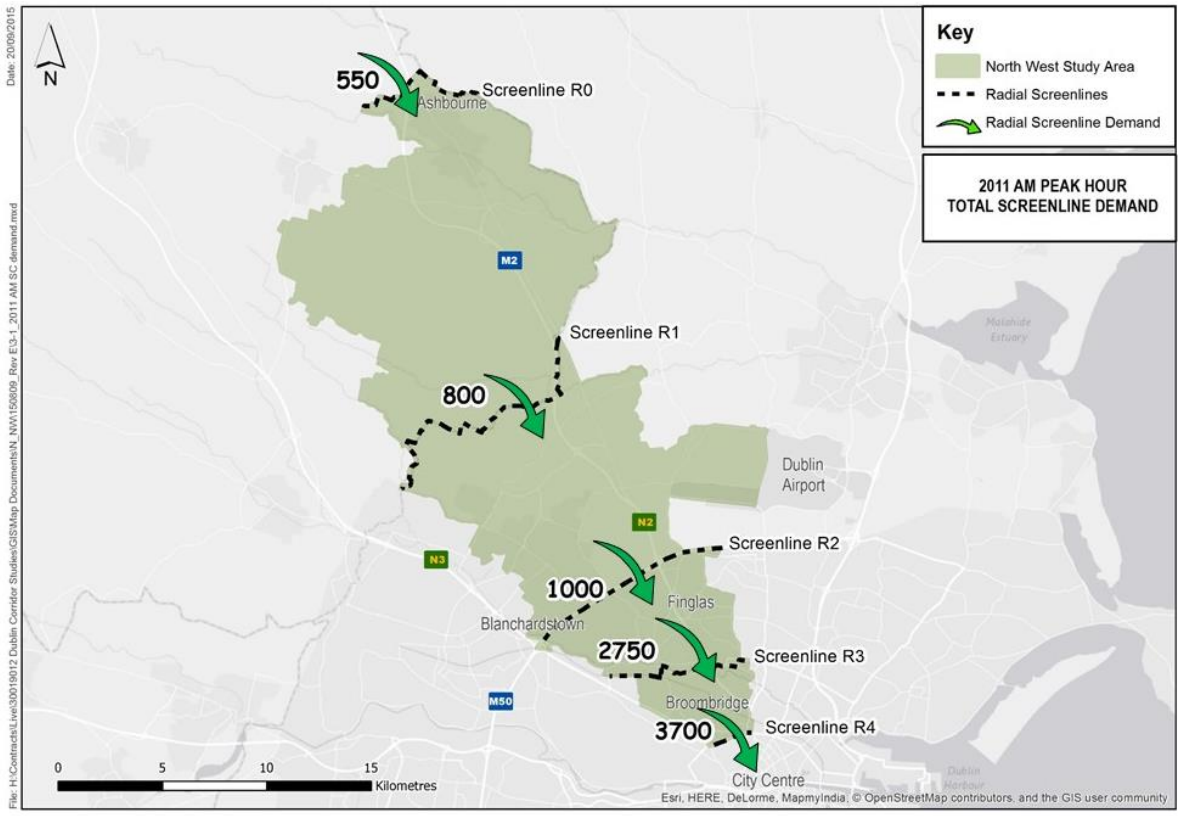


Figure 3-1: 2011 AM Peak Hour Total Screenline Demand

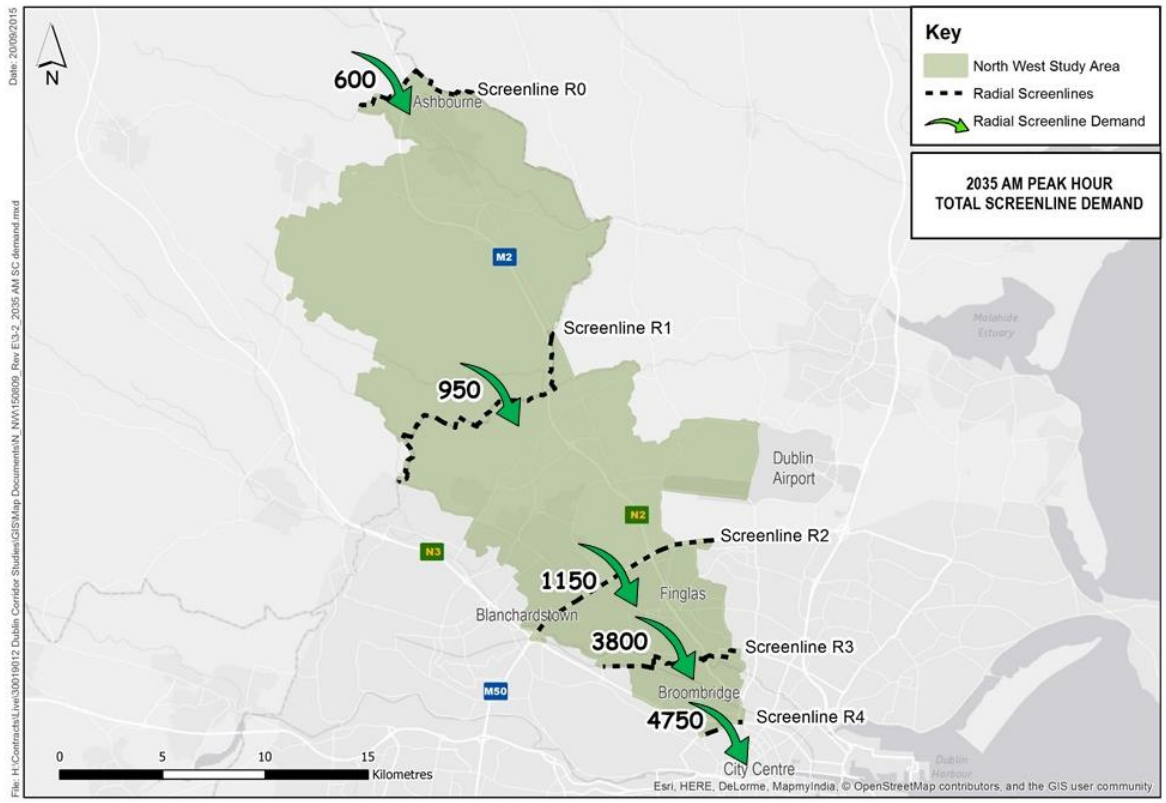


Figure 3-2: 2035 AM Total Screenline Demand

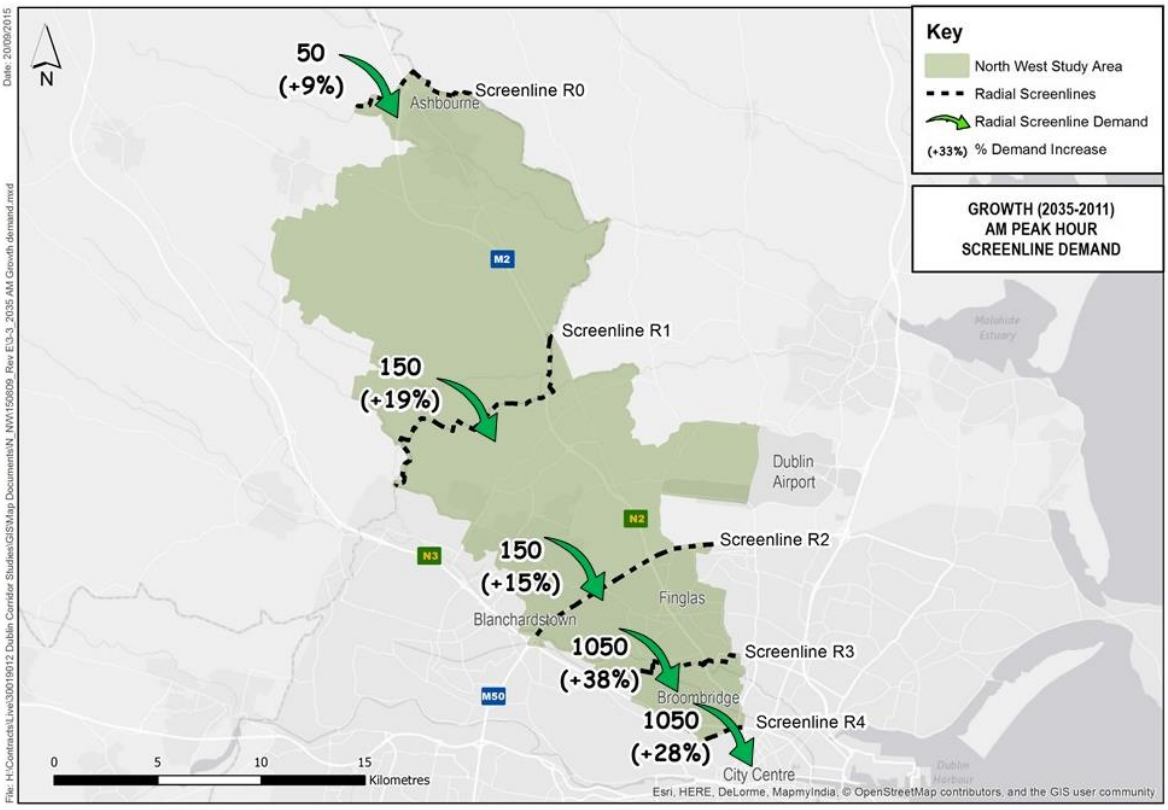


Figure 3-3: Growth in North West Screenline Demand

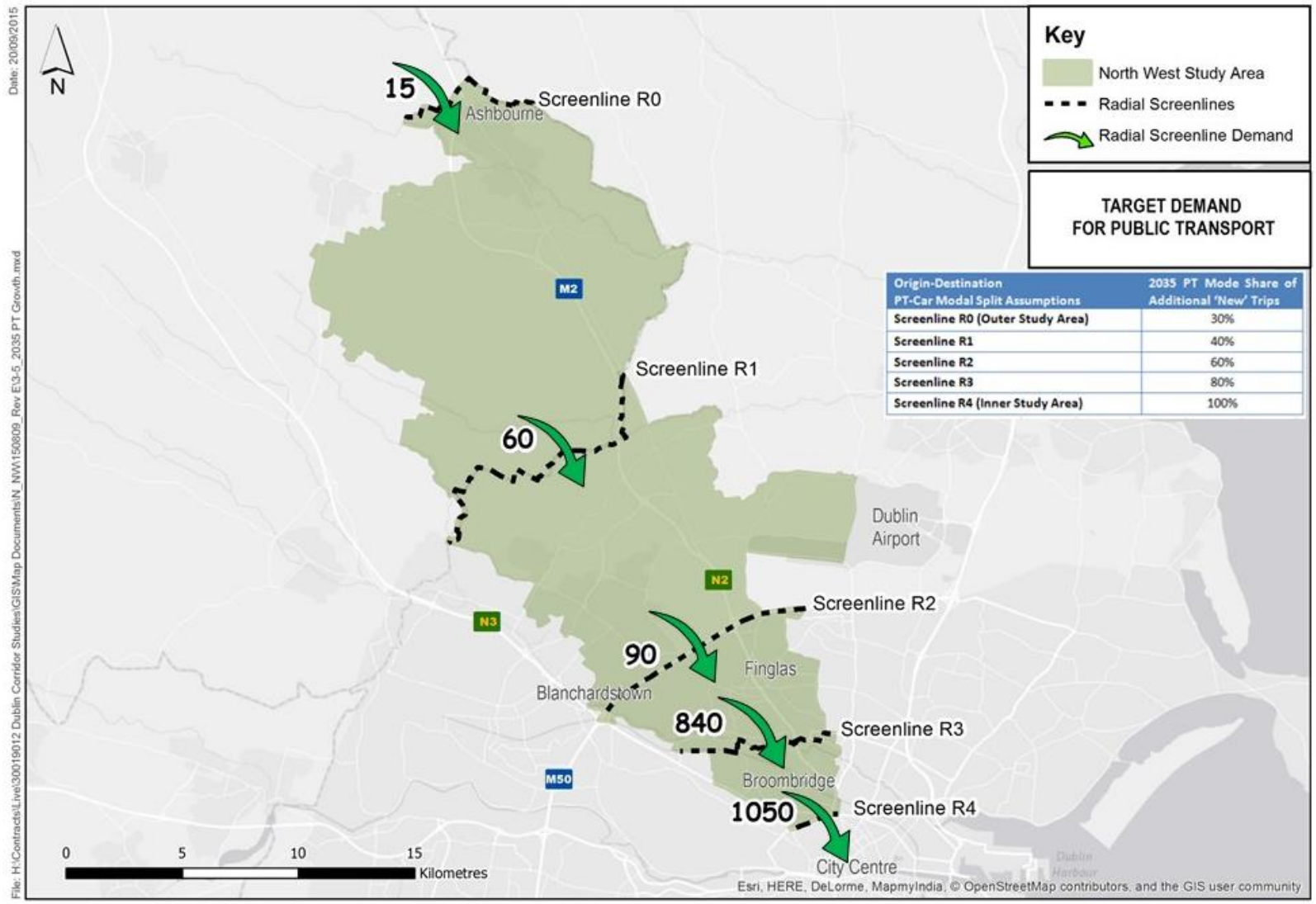


Figure 3-4: Target Demand for Public Transport

4 Public Transport Option Development

4.1 Option Development

This section outlines the development of public transport options at a high level in order to meet the target demand crossing the screenlines. From Chapter 3, the level of demand growth to be accommodated by public transport is 1,050 trips, which is the peak level of demand growth entering the City Centre inner screenline R4. 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. It is therefore assumed, for the purpose of this study, that the additional demand to be served by public transport for the North West Study Area is approximately 1,050.

It is necessary, therefore, to generate likely public transport options that can provide a level of service to accommodate this target demand level. The options, in the first instance, were generated by focussing solely on the proposed public transport services/mode's 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 North West Corridor. 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 a positive impact on the demand for public transport within the North West Corridor.

4.2 Design Capacity of Public Transport Modes

The list of potential public transport modes that were considered in order to meet the target demand within the corridor is as follows:

- 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 pre-defined seated capacity and crush capacity (peak standing capacity). 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. 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.

It should be noted that the assessment does not consider the routing that services would take or the interaction with competing or conflicting services.

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.

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

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

Note: The highlighted text above indicates where the target demand of 1050 trips could be provided by a single public transport mode operating at the specified service frequency

4.3 High Level Public Transport Options

This section outlines those different public transport options developed at a high level to cater for screenline target demand based on the service frequencies and capacities in Table 4-1.

The high level options developed do not consider network constraints and/or existing public transport services. The sole focus at this high level options development stage is to outline public transport services than can accommodate the maximum screenline demand within the North West Study Area.

Based on a comparison of the various capacity levels and the target demand of around 1,050 trips the highlighted areas within Table 4-1 shows the frequencies for each individual mode that would be necessary to meet this demand. For example Luas service frequency of one every 12 minutes would provide 1,300 capacity which would provide for the demand of 1,050 trips. For bus as an option, a higher frequency of services would be required to meet the demand.

The forecast increase in peak hour demand to Dublin is 1,050 trips and the five proposed options that were considered are now presented below.

- ***Option 1: Light Rail with Feeder Bus Services***
  - New high capacity public transport spine connecting with Dublin City Centre.
  - Extension of the Luas Cross City line beyond Broombridge to a terminus adjacent to the N2/M50 at Charlestown. This would further extend the Luas Cross City extension, providing access to the City Centre. While recognising that a 12 minute frequency (5tph) would meet the target demand, the Luas could be run at the same frequency as Luas Cross City services to Boombridge (10tph). This would provide for a design capacity of 3,000 in the peak which will cater for target

demand and existing public transport trips, as there is likely to be a degree of transfer from existing bus services to the new light rail line.

- Enhanced feeder bus services from Tyrrelstown, via Ballycoolin to the Luas.
- The proportionate deployment of feeder bus services, providing interchange opportunities every 800 metres, will provide capacity for connections from across the Study Area with radial services.

- ***Option 2: BRT with Feeder Bus Services***
  - New BRT route between Tyrrelstown and the City Centre, and interchanging with the Luas Cross City extension at Broadstone, providing a capacity of 1,500.
  - The proportionate deployment of feeder bus services, providing interchange opportunities every 800 metres, will provide capacity for connections from across the Study Area with radial services.
- ***Option 3: New Rail Line with Feeder Bus Services***
  - New rail line from Tyrrelstown, joining with the existing line between Broombridge and Drumcondra, assumed to provide capacity tailored to demand requirements (maximum capacity is noted to be far in excess of demand).
  - The proportionate deployment of feeder bus services, providing interchange opportunities every 800 metres, will provide capacity for connections from across the Study Area with radial services.
- ***Option 4: New Metro Line with Feeder Bus Services***
  - New metro line from Tyrrelstown to Drumcondra via Finglas, providing capacity tailored to demand requirements (maximum capacity is noted to be far in excess of demand).
  - The proportionate deployment of feeder bus services, providing interchange opportunities every of 800 metres, will provide capacity for connections from across the Study Area with radial services.
- ***Option 5: Enhanced Quality Bus Corridor with Enhanced Express Bus Services and Feeder Bus Services***
  - An Enhanced Quality Bus Corridor extending from Charlestown to the City Centre along the R135, with services providing a combined capacity of approximately 1100 at a 4 minute service frequency.
  - To provide improved access to radial services provided on this corridor, there would be feeder bus services provided at a level proportionate to meet demand and ensure adequate catchment coverage of the Study Area.
  - Enhanced express bus services from Tyrrelstown, via development at Ballycoolin and Rosemont Business Parks, to the City Centre. This will provide capacity of 150 to 250 additional peak hour trips.

Table 4-2 illustrates the high level coverage of the proposed service for each option and identifies the additional capacity to compare with the target growth in demand of 1050 trips.

Table 4-2: High Level Public Transport Options

North West Study Area (Finglas)

Target: 1050 trips in AM Peak Hour

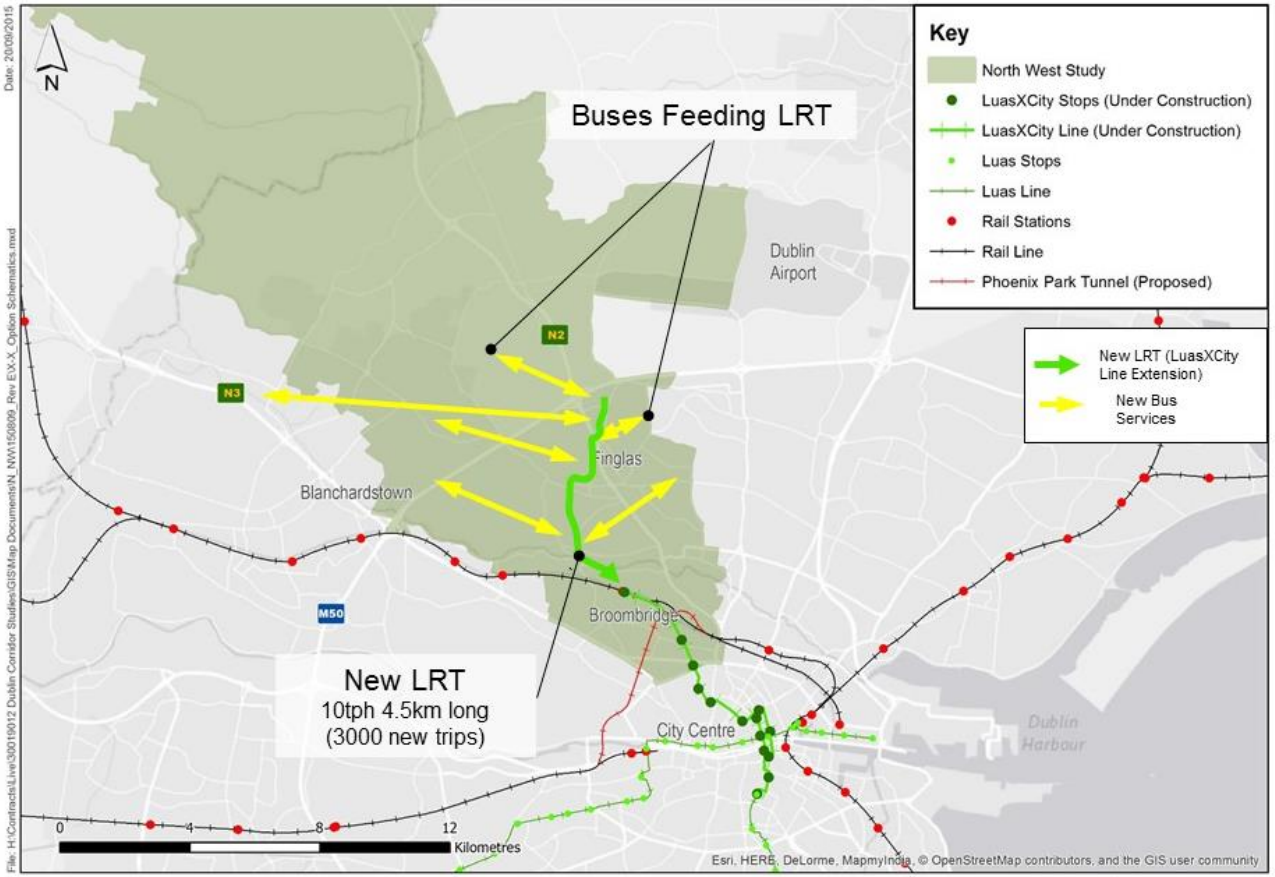
			Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Public Transport Option	Approx Capacity	Services to Meet Capacity	Luas + Feeder	BRT + Feeder	New Rail + Feeder	New Metro + Feeder	QBC & Express Bus Enhancements + Feeder	Luas & Express Bus + Feeder
New Rail Line	10,000	1 Rail Line			X			
LRT	3,000	1 LRT Line	X					X
BRT	1,500	1 BRT Route		X				
Metro	7,800	1 Metro Line				X		
QBC Enhancement	1,100	1 QBC Route Enhancement					X	
Express Bus Enhancement	150-250	1-2 Routes					X	X
Feeder Bus Services	1,000	Local bus services	X	X	X	X	X	X
Total New Capacity			3,000	1,500	10,000	7,800	1250-1350	1,500

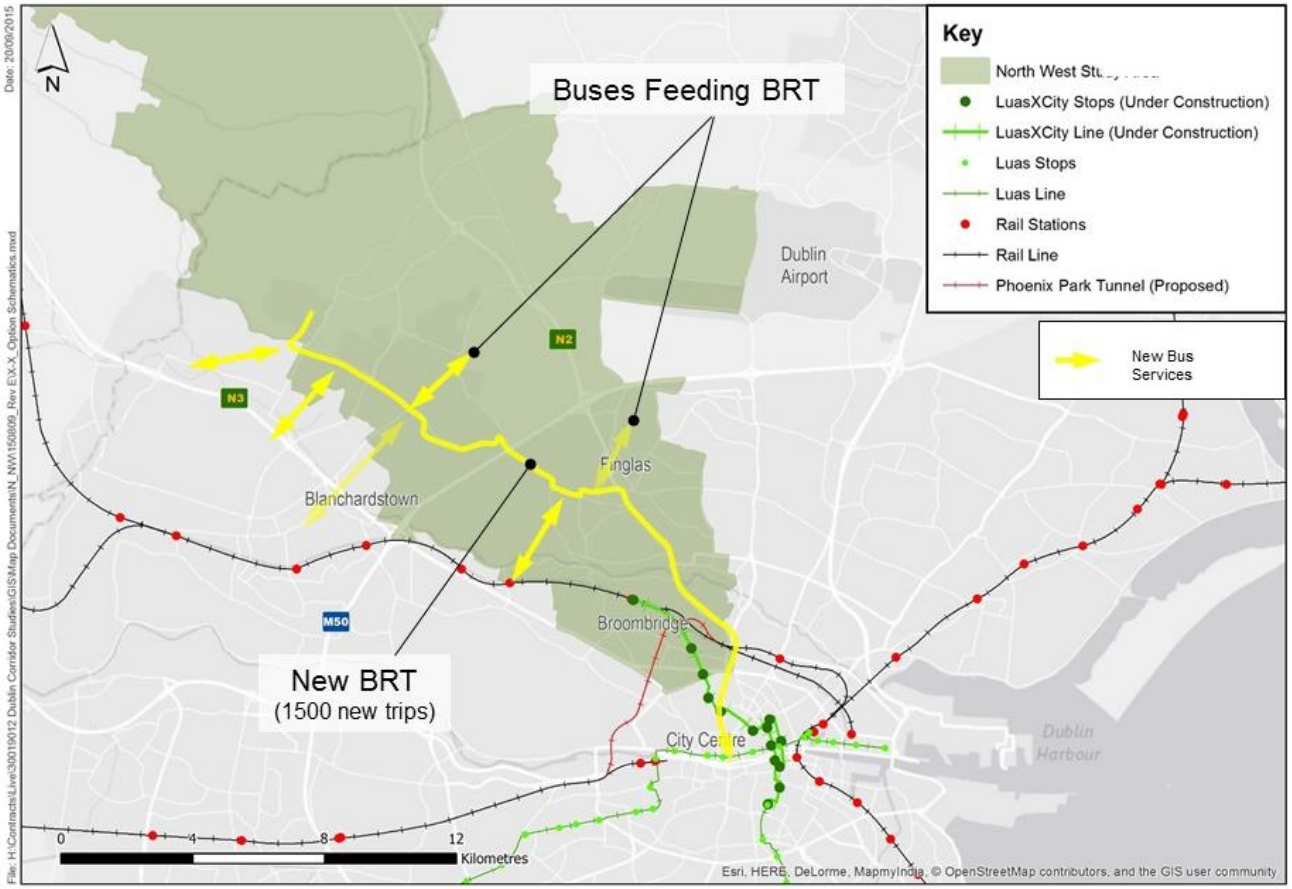
4.4 Capacity Assessment and Sifting of Proposed Public Transport Options

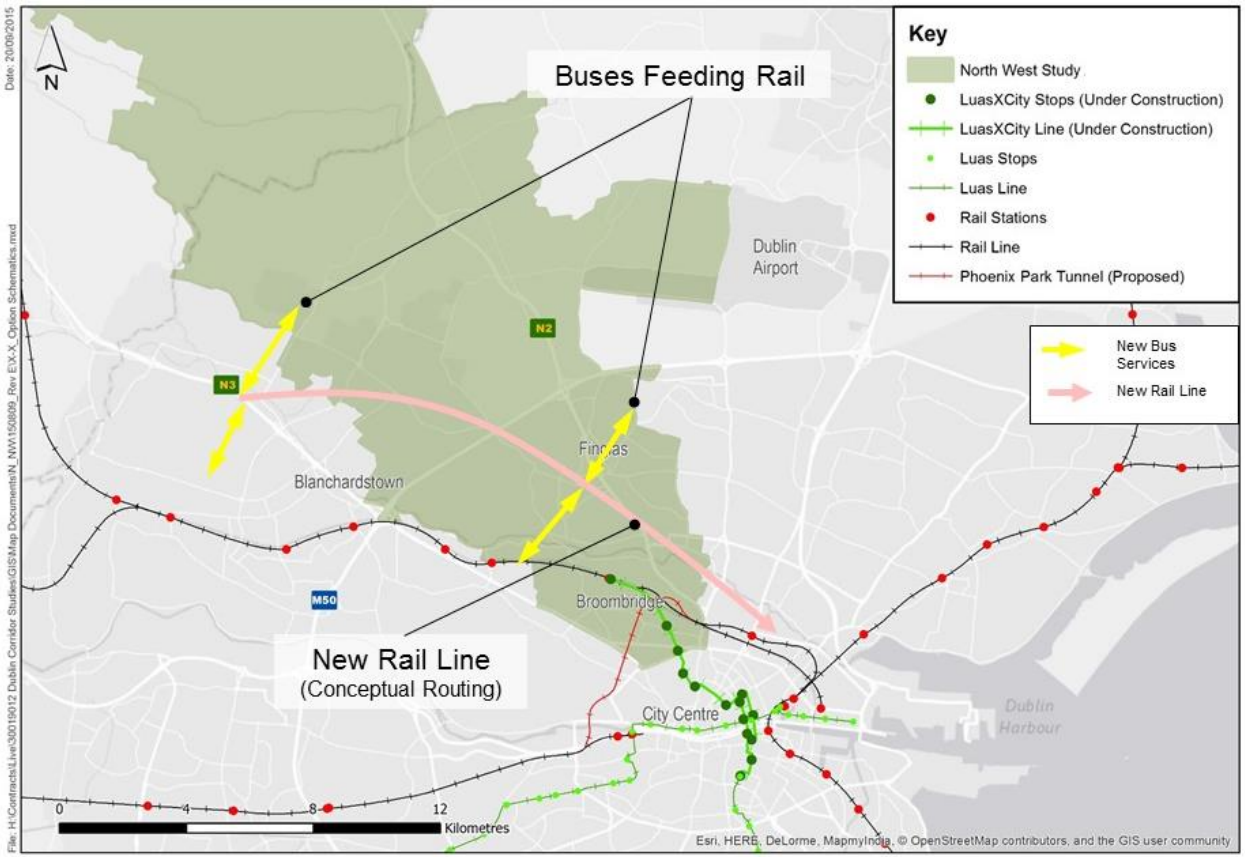
The following section details the capacity assessment undertaken for 100 per cent of demand growth for the Study Area (2035 demand minus 2011 demand for the AM peak hour).

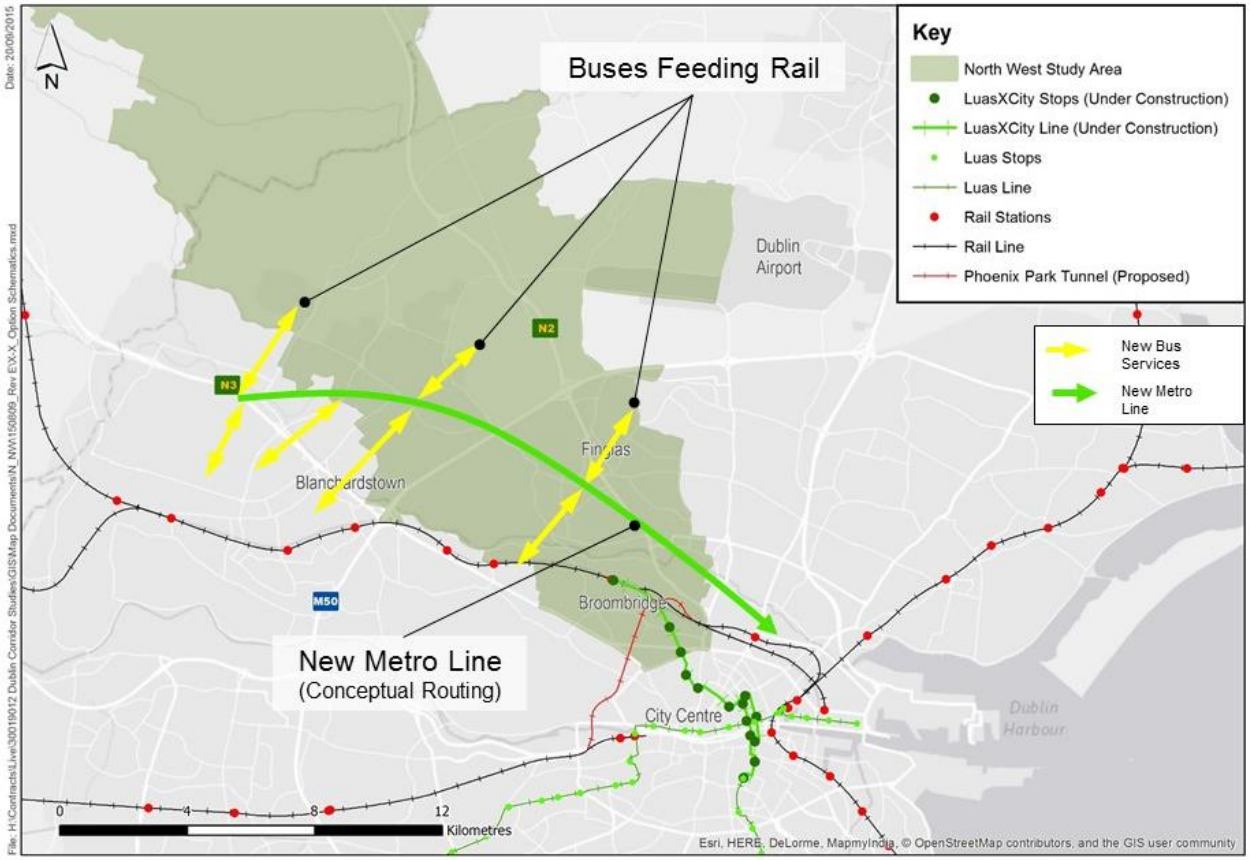
For this exercise a number of assumptions were made in recognition of the high level nature of this study. Firstly, demand for the base year public transport was assumed to be catered for by existing public transport services. Secondly, it was assumed that there is no excess capacity for existing services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

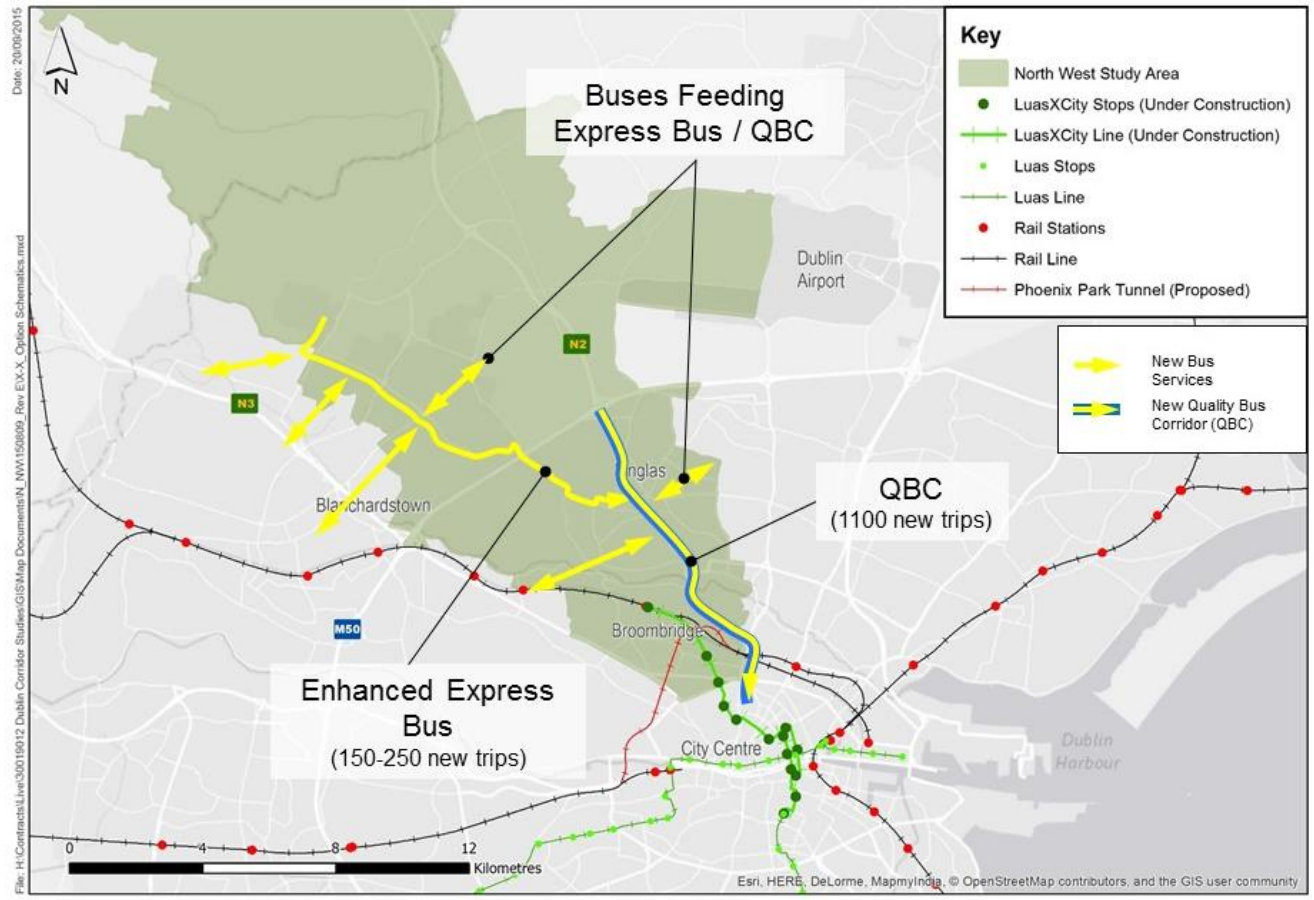
- Proposed service type and frequency at each screenline; and
- Comparison of proposed service design capacity and maximum screenline demand.

Option 1: Light Rail with Feeder Bus Services	Decision: Taken Forward for Detailed Review
Decision Rationale: This option meets the demand target across all screenlines. The public transport capacity increase is provided around the core high capacity Luas line running centrally along the Study Area between Broombridge and Charlestown via Finglas. It is provided as an extension of the Luas Cross City route, which facilitates access to the City Centre. It would be operated at 10 trams per hour using lengthened 53m long trams. In line with the Luas Cross City route this will give a design capacity of 3,000 in the AM peak hour. To provide access to this service, there would be feeder bus services provided at a level proportionate to meet demand and ensure adequate catchment coverage of the Study Area. **This option was chosen to be taken forward for further scoring.**	**Option Schematic:** 

Option 2: BRT with Feeder Bus Services	Decision: Taken Forward for Detailed Review
Decision Rationale: Option 2 proposed a new high capacity BRT between Tyrrelstown and the City Centre, providing a capacity of 1,500. The option provides similar coverage of the Study Area as Option 1. However, it connects to the Luas Cross City extension towards the City Centre at Broadstone rather than Broombridge. To provide access to this service, there would be feeder bus services provided at a level proportionate to meet demand and ensure adequate catchment coverage of the Study Area. **This option was chosen to be taken forward for further scoring.**	**Option Schematic:** 

Option 3: New Rail Line with Feeder Bus Services	Decision: Not Taken Forward for Detailed Review
Decision Rationale: Option 3 proposed a new rail service to Tyrrelstown, providing increased capacity to Dublin City Centre, joining with the existing line between Broombridge and Drumcondra. There is no clear existing geographical alignment for a new line through the area. To provide attractive journey times there would need to be a limited number of stations, requiring extensive feeder bus services to provide coverage of the Study Area. The initial screenline demand analysis showed that the capacity provided is not proportionate to the demand requirements for this area. **Due to the above factors this option was not taken forward.**	**Option Schematic:** 

Option 4: New Metro Line with Feeder Bus Services	Decision: Not Taken Forward for Detailed Review
Decision Rationale: Option 4 proposed a new metro service from Tyrrelstown to Drumcondra via Finglas, providing increased capacity to Dublin City Centre, (maximum capacity assumed to be far in excess of demand). There is no clear existing geographical alignment for a new line through the area. To provide attractive journey times there would need to be a limited number of stations, requiring extensive feeder bus services to provide coverage of the Study Area. The initial screenline demand analysis showed that the capacity provided is not proportionate to the demand requirements for this area. **Due to the above factors this option was not taken forward.**	**Option Schematic:** 

Option 5: Enhanced Quality Bus Corridor with Enhanced Express Bus Services and Feeder Bus Services	**Decision: Taken Forward for Detailed Review**
Decision Rationale: Option 5 proposed enhancements to the Quality Bus Corridor, providing capacity improvements of 1,100 at a 4 minute service frequency. To provide enhanced access to radial services provided on this corridor, there would be feeder bus services provided at a level proportionate to meet demand and ensure adequate catchment coverage of the Study Area. Enhanced express bus services will cater for development at Ballycoolin and Rosemont Business parks and Tyrrelstown (bringing service provision up to 6-7 buses per hour). This will provide capacity of 150 to 250 additional peak hour trips. **Based on the public transport demand requirements of the corridor this has been taken forward as an option.**	**Option Schematic:** 

5 Public Transport Option Scoring

5.1 Detailed Scheme Appraisal Methodology

This section outlines the comparison of the three options identified in the Option Development stage, and taken forward for detailed scheme appraisal, as follows:

- Option 1: Light Rail with feeder bus services
- Option 2: BRT with feeder bus services
- Option 5: Enhanced quality bus corridor with enhanced express bus services and feeder bus services

The comparison is based on the ranking of the options against three criteria as follows:

- Demand Accommodated;
- Journey Time; and
- Cost.

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

5.2 Appraisal of Proposed Public Transport Options

The public transport options were assessed on the basis of the Do Minimum scenario agreed at the outset on commencement of the study. However, the emerging "Do Likely" scenario (as outlined in Section 2.3) which arose in the interim period, which includes consideration of Metro North and DART Underground, has also been kept under consideration where appropriate.

5.3 Comparison of Target Demand Accommodated

As already 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, taking account of both the growth in demand and the forecast total demand. Therefore, each option has been scored in relation to appropriateness of capacity provision for the target demand level.

Table 5-1: Demand Accommodated of Proposed Options and Rank

Option	Description	Capacity Provision	Peak Level PT Demand Total / Growth	Score	Adjusted Score
Option 1	LRT	Up to 3,000	2880 / 1050	5	3
Option 2	BRT	Up to 1,500	2880 / 1050	4	2
Option 3	New Rail	Up to 10,000		1	
Option 4	New Metro	Up to 7,800		2	
Option 5	QBC & Express Bus Enhancements	Up to 1,250 - 1,350	2880 / 1050	3	1

5.4 Journey Time

A strategic assessment of the options was carried out based on average journey times by mode utilising average travel times within Dublin. The following assumptions were used:

- Proposed QBC/Expressway bus speed is 17kph, dropping to 15kph for non-express services extended past the extent of the QBC;
- Proposed LRT speed is 25kph, in line with the Green Line; and
- Proposed BRT speed is 20kph.

To undertake a detailed appraisal taking into consideration route choice, mode choice, interchange penalties, network capacities (both public transport and road capacity including levels of congestion and delays), it is recommended that a detailed study is undertaken using the Greater Dublin Area Regional Model (GDARM).

5.4.1 Journey Time Comparison

Table 5-2 shows the journey time assessment scores for the options. The factors affecting journey times within the Study Area are similar for all of the proposed options and have not been considered further within the assessment. This shows that the Luas LRT option (Option 1) provides the quickest direct journey times. The highest direct journey time is provided by the option with the QBC and express bus enhancements.

Table 5-2: Journey Time Analysis of Proposed Options and Rank

Option	Description	Direct Journey Time (min)	Score	Adjusted Score
Option 1	LRT	31	5	3
Option 2	BRT	42	4	2
Option 3	New Rail	Not analysed		
Option 4	New Metro	Not analysed		
Option 5	QBC & Express Bus Enhancements	49	3	1

5.5 Option Costs

The estimated cost of each option proposed was considered as one of the scoring criteria. Table 5-3 outlines the service and infrastructure unit cost for the proposed services and required infrastructure. The scheme costs for the three options were compared on the basis of unit cost rates.

Table 5-4 details the comparison of the cost estimates for each proposed option. The cost of building a new LRT line or BRT system is significant due to the infrastructure required.

5.5.1 Unit Cost Rates

The following table shows the unit cost rates used in the option comparison.

Table 5-3: Unit cost rates applied in scheme evaluation

Service/ Infrastructure	Units	Unit Cost	Source
Luas LRT	€M/km	**40-50**	Luas B1 RPA Proof of Evidence 2006
BRT	€M/km	**10.95**	NTA / RPA Presentation on BRT
QBC	€M/km	**1.9**	Study Area assumed 1/6 of BRT Cost
QBC/Express Bus Enhancements	€M/km	**1**	Enhancements assumed as half the cost of full QBC/Express.
Express Busway	€M/km	**1.9**	Study Area assumed 1/6 of BRT Cost
Rail Line - new	€M/km	**60-100**	Upgraded for DART Underground Study
Rail Line - Train	€M/train	**0-15**	

5.5.2 Cost Comparison

The estimated cost of each option proposed was considered as one of the scoring criteria. Table 5-4 outlines the service and infrastructure unit cost for the proposed services and required infrastructure. Bus feeder services are assumed to cost approximately €2.5m for each option based on the Study Area demand requirements.

Table 5-4: Proposed Scheme Costs

Option	Description	Cost €M	Score	Adjusted Score
Option 1	Light Rail	201	3	1
Option 2	BRT	142	4	2
Option 3	New Rail			
Option 4	New Metro			
Option 5	QBC & Express Bus Enhancements	16.7	5	3

5.6 Summary of Option Scoring

Table 5-5 outlines the summary of the option scoring process. For each scoring criteria the options are ranked from one to three; one representing the lowest performance in that criterion and three 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.

The ranking and overall scoring is based on an open and transparent addition of scores for three criteria; demand, journey times, and costs, without the application of additional weighting factors.

It is appropriate to evaluate the initial options for the North West Corridor strategic study against these criteria. Note that as a consequence the relative differences between the rankings may be much greater than implied within these scores.

Based on this scoring approach, Option 1 is seen to score the highest in overall terms with good demand proportionality, some spare capacity to accept patronage from feeder buses serving areas outside the Study Area. While travel times scored the highest, this was outweighed by the cost factor.

Option 2 scored second highest. The strength of this option is the lower cost of BRT construction compared to the Luas, however journey times will be slower and there is a requirement for interchange to access the City Centre. This option was also seen to provide capacity in excess of the corridor growth requirements.

Option 5 scored the lowest; this option is the least expensive but this is offset by providing the least additional capacity and also the longest journey times. In addition, it would not have the capacity to facilitate the provision of a strategic park & ride site at the M50 / N2 junction, which is likely to be a feature of the transport strategy.

Table 5-5: Scheme Comparison

Option	Description	Rank Score			
		Demand	Journey Time	Cost	Overall Scoring
Option 1	Light Rail	3	3	1	**7**
Option 2	BRT	2	2	2	**6**
Option 3	New Rail				
Option 4	New Metro				
Option 5	QBC & Express Bus Enhancements	1	1	3	**5**

6 Transport Modelling Assessment

6.1 Background

Following identification of the preferred public transport option for the North West 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 chapter. The emerging measures were tested 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.

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 North West Study Area corridor.

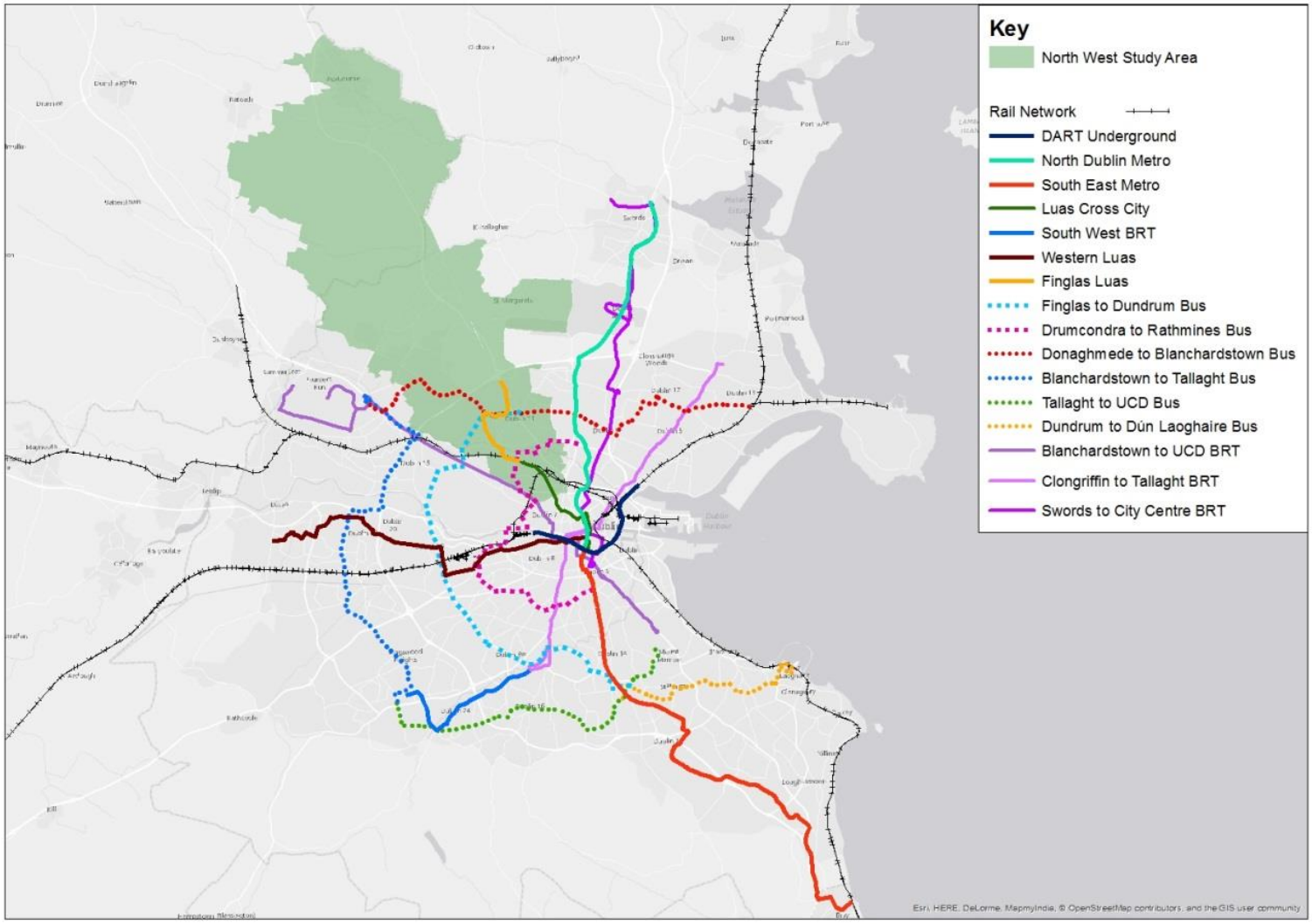


Figure 6-1: Proposed GDA Strategy Public Transport Proposals

6.2 Modelled Public Transport Proposal

The preferred public transport provision for the North West Study Area is to further extend the Luas Green line from Broombridge northwards to a terminus at Charlestown adjacent to the N2 / M50 interchange and the deployment of feeder bus services to provide connections across the Study Area.

The service frequency on the line extension is assumed to be 12 trams per hour each of 53m length.

6.3 Modelling Assessment

6.3.1 Screenline Assessment

As described earlier in the report, the demand level was defined across screenlines within the corridor Study Area to determine the appropriate service to accommodate the forecast total demand growth. This assessment made the assumption that all growth would use public transport. 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. The results of the modelling assessment are broadly in line with the target flows. It is therefore considered that the modelled level continues to support the introduction of a Luas extension, as this option provides sufficient additional capacity for both the preliminary and modelled demand.

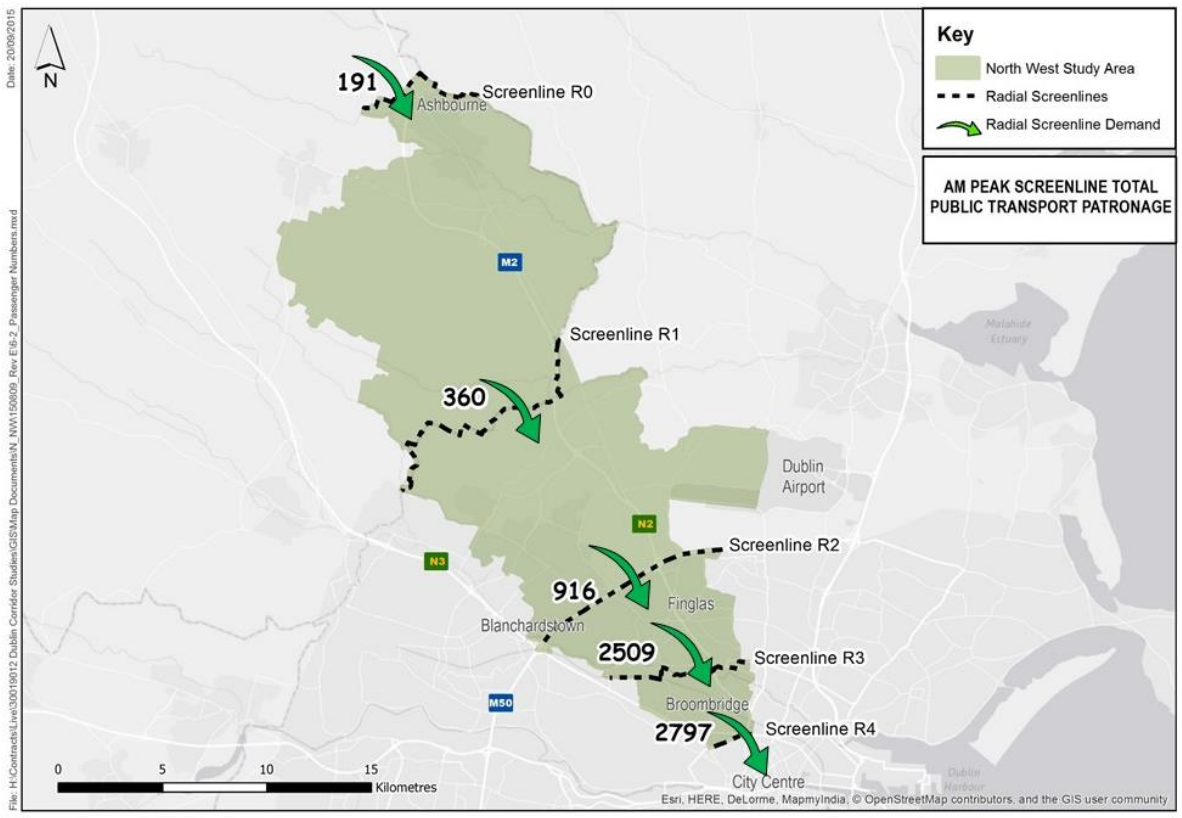


Figure 6-2: AM Peak Screenline Total Public Transport Patronage Year 2035

6.3.2 Corridor Study Area Mode Share

The introduction of the proposed public transport measures within the corridor Study Area, in conjunction with the introduction of wider GDA Strategy public transport proposals can accommodate increased public transport patronage.

The corridor strategy has focused on trips to Dublin City Centre, with Figure 6-3 below indicating the mode share from the North West Study Area to Dublin City Centre. For these movements, public transport has a mode share of 49 per cent, compared to the car mode share of 51 per cent.

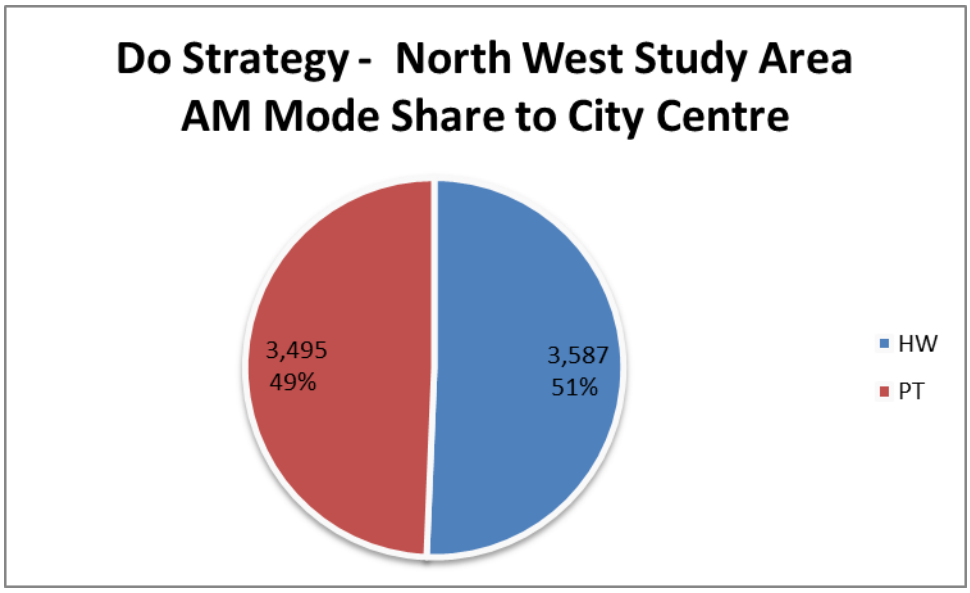


Figure 6-3: AM Peak Corridor Study Area to City Centre Mode Share

6.3.3 Public Transport Boarding and Alighting Profile

Figure 6-4 and Figure 6-5 detail the boarding and alighting profiles for the extended Luas Green line and the rail line from the North West Study Area to Dublin City Centre in the AM Peak. Each graph shows the cumulative passenger numbers for each service, as well as the overall design and crush capacity modelled for these services.

The Luas extension has a maximum occupancy at around 2,600 passengers at Broadstone stop. Seated capacity is reached at Finglas and passengers are required to stand until Dawson Street. It can be seen that at no point is the extension operating above the design capacity.

The passenger boarding profile increase at a steady rate until Broombridge. After Broombridge, passengers alight from the Luas at a broadly consistent rate through to the terminus at Hatch Street.

The rail line is seen to have a maximum passenger numbers of just over 5,000 passengers between Coolmine Station and Broombridge. Interchange occurs at Broombridge, both between Luas and DART, and DART and Luas to enable a wider variety of destinations to be accessed. The DART service operates at around design capacity through to Dublin city centre. This interchange effect can be seen in the boarding analysis of Figure 6-5.

The above analysis indicates that, while the proposed improvements to the public transport services operate efficiently and effectively, there is still adequate scope for further patronage increases beyond 2035.

Figure 6-4: Western Luas Boarding and Alighting Profile

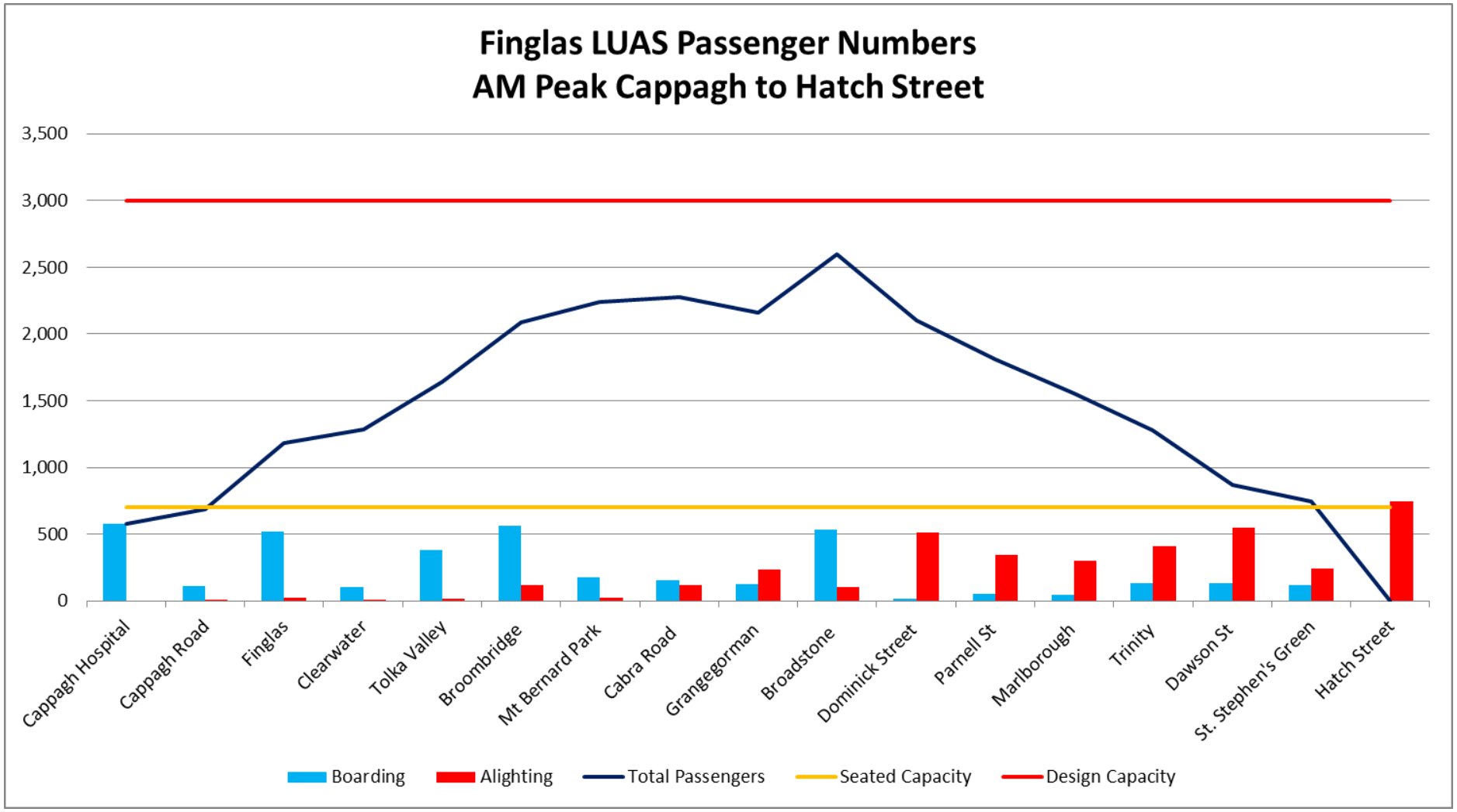
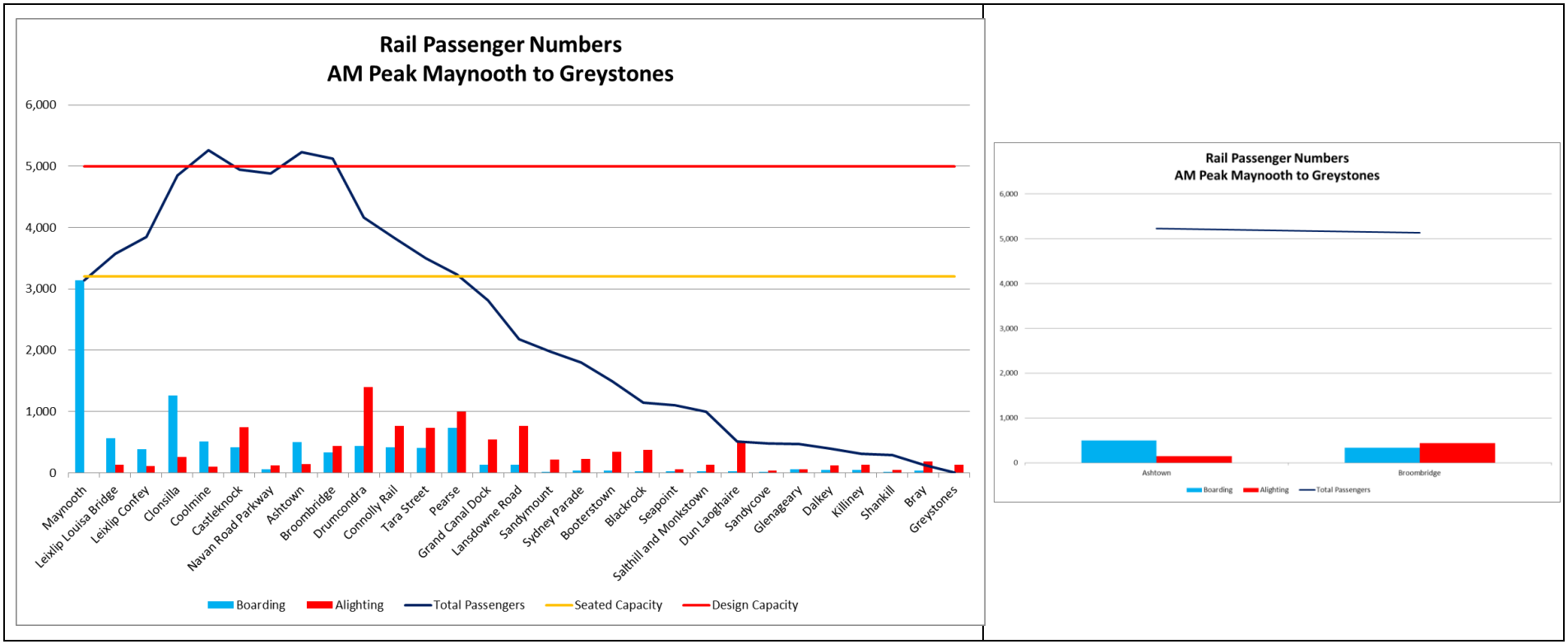


Figure 6-5: Rail Boarding and Alighting Profile



6.3.4 Journey Times and Service Speeds

Table 6-1 outlines the high level journey times and average service speeds for the proposed public transport provision from Cappagh Hospital to Dublin City Centre in the AM peak hour. Table 6-1 shows that passengers from the Finglas area can access Dublin City Centre in around 35 minutes. Interchanging at Broomsbridge onto the Maynooth to Bray services allows for access to the wider conurbation providing multiple, alternative efficient public transport routes to cater for the different origin and destination locations.

Table 6-1: Proposed Public Transport Journey Times and Service Speeds

	Distance Km	Journey Time Min	Speed kph	Travel Distance pas.km
Cappagh Hos. to City Centre Luas	17	35	19	17,893

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, indicating 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 North West Study Area to Dublin City Centre is seen to increase to 49 per cent. The comparison of the service passenger numbers against the design capacity indicates that at no point are the services over-crowded and that by 2035 there is still scope to accommodate further growth. The assessment also showed that journey times to Dublin City Centre from Cappagh are approximately 35 minutes, providing an efficient, reliable service.

We see that through both the screenline assessment and the boarding and alighting profiles that the rail and Luas services have the capacity to cater for the total demand identified in the preliminary demand assessment.

The model shows that the extension to the Luas Cross City line attracts a sufficient number of public transport trips throughout the line and is likely to be a viable service. There is scope for additional patronage through Park and Ride measures and through additional local bus services feeding the system north of the M50.

A determination of whether the volume of demand warrants the scale of investment will require further study.

7 Emerging North West Public Transport Option

7.1 Recommendation

The following outlines the recommended North West Study Area public transport proposal for the 2035 GDA Strategy. This has been developed from the Do Minimum scenario and further assessed with the wider GDA Strategy measures using the GDARM.

The public transport recommendations for the North West Study Area are as follows:

- Extension of the Luas Green line from Broombridge to a terminus close to the N2/M50 junction;
- Park and Ride provision to be catered for at this terminus;
- Proportionate deployment, with stops every 800 metres, of bus feeder services to support access to the corridor services across the Study Area catchment; and
- Feeder buses from Tyrrelstown to the terminus in the period until 2035.

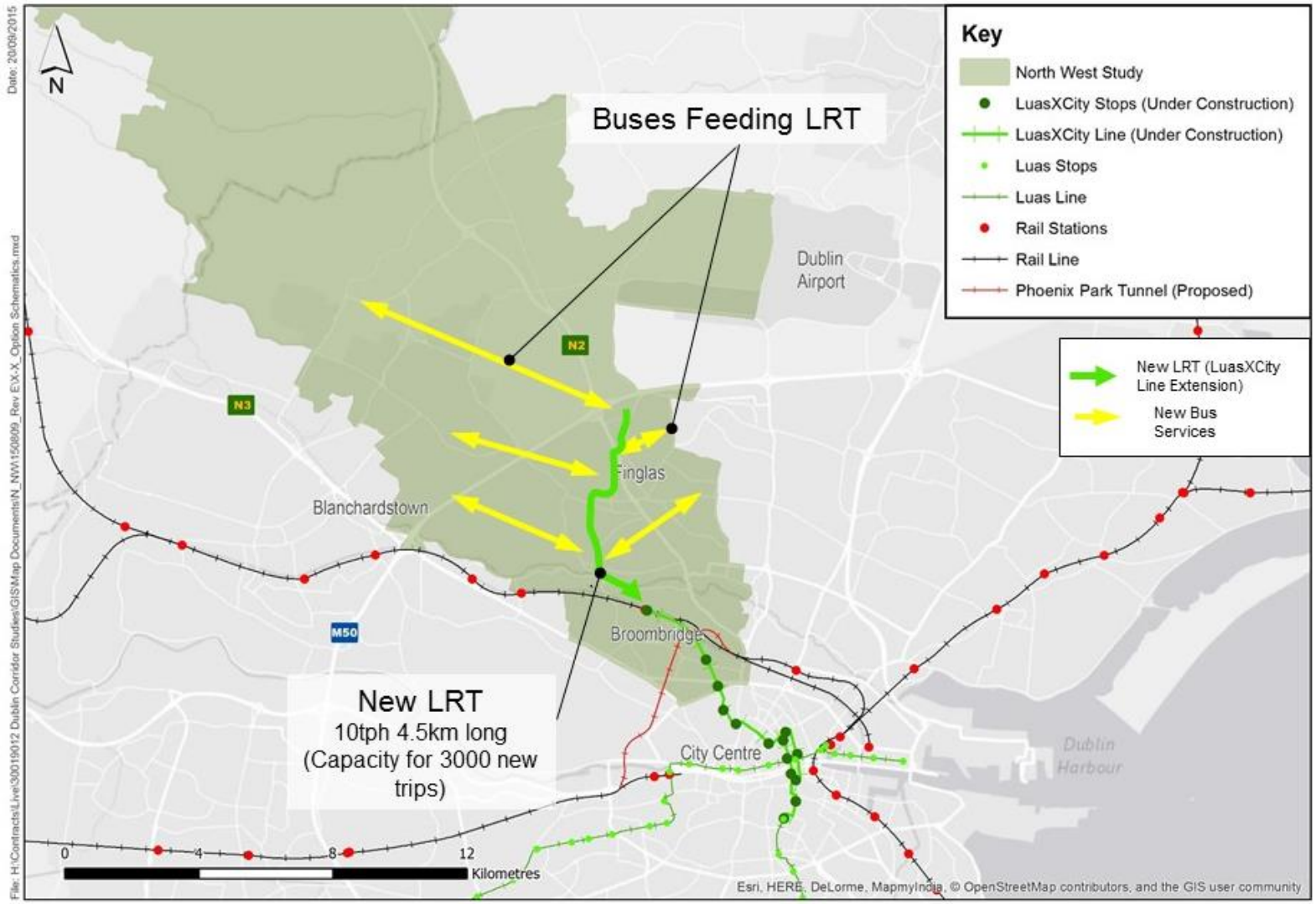


Figure 7-1: Option 1

7.2 Benefits

The benefits of the Do Strategy Scenario are as follows:

- Proportionate and appropriate mode choice for demand along the corridor, meeting projected demand growth to 2035 (i.e. all future growth to the City Centre can be accommodated on public transport from and through the area);
- This option is projected to capture future growth targets providing 43 per cent public transport mode share at the City Centre screenline. It has the ability to deliver higher capacity via increased frequency or higher capacity vehicles depending on future demand management policies;
- While not providing excessive capacity for the requirements, the option facilitates sufficient additional capacity to deal with periodic fluctuations in demand;
- Ensures effective coverage of development in the Study Area;
- Reinforces the investment made in the Luas extension to Broombridge; and
- Provides interchange with inner orbital movements and other public transport services towards the City Centre, strengthening the core public transport network, and making overall public transport use a more attractive option.

7.3 Cost

Table 7-1: Scheme Costs

Luas extension from Broombridge to M50	€196.0 million
Feeder Bus Services	€5.0 million
Total Cost	**€201.0 million**

7.4 Risks & Considerations

This section describes risks associated with the recommended North West Corridor Study public transport improvements.

- Design Risk
  - Design subject to detailed design and appraisal of emerging schemes;
  - Emerging design proposals based on high level strategic model forecasts and GDA model forecasts;
  - Design capacity based on current public transport modes (crush load, design load and peak spreading);
  - Interaction with inner and outer orbital travel demand and demand associated with wider area economic growth subject to detailed wide area modelling;
  - Interchange with high capacity core services based on detailed design, planning and level of service of feeder bus services;
  - Detailed design of Luas may conflict with other modes and movements;
- General Uncertainty and Economic Risk
  - On-going availability of funding and securing funding allocation;
  - Full integration and adoption of strategic development plan; and
  - Competing public transport funding requirements.