Iarnród Éireann
Irish Rail

AECOM

DART+
PROGRAMME

PRELIMINARY BUSINESS CASE

SEPTEMBER 2021

Table of Contents

Glossary of Terms

Acronym	Description
AACE	Association for the Advancement of Cost Engineering
AC	Alternating Current
AD	Assistant Director
BCR	Benefit to Cost Ratio
BEMU	Battery Electric Multiple Unit
bn	Billion
BRP	Benefits Realisation Plan
CAF	Common Appraisal Framework
CAP	Climate Action Plan
CapEx	Capital Expenditure
CBA	Cost Benefit Analysis
CCRP	City Centre Resignalling Programme
CI	Capital Investment
CIE	Córas Iompair Éireann
CME	Chief Mechanical Engineer
CO2	Carbon Dioxide
CSO	Central Statistics Office
CWMF	Capital Works Management Framework
DART	Dublin Area Rapid Transit
DASH	Dublin Area Suburban Enhancement
DC	Direct Current
DM	Do Minimum
DMU	Diesel Multiple Unit
DoT	Department of Transport
DPER	Department of Public Expenditure and Reform
DS	Do Something
EMRA	Eastern and Midland Regional Assembly
EMU	Electric Multiple Unit
Eq.	Equivalent
ERM	Eastern Region Model
ESB	Electricity Supply Board
ETS	Emissions Trading System
EU	European Union
FLU	Full Length Unit
FPA	Focused Policy Assessment
FTE	Full-Time Equivalent
GDA	Greater Dublin Area
GRIP	Governance for Railway Investment Project
GVA	Gross Value Added
HGV	Heavy Goods Vehicle
HICP	Harmonised Index of Consumer Prices

HLU	Half Length Unit
IAR	Integrated Assurance Reviews
ICR	Intercity Railcar
IÉ	Iarnród Éireann
IM	Infrastructure Manager
IMMAC	Infrastructure Manager Multi-Annual Contract
IMP	Interface Management Plan
IRR	Internal Rate of Return
K	Kilo
Km	Kilometre
LDA	Land Development Agency
LGV	Light Goods Vehicle
LPM	Logic Path Model
LUAS	Dublin Light Rail System
m	million
M+E	Monitoring and Evaluation
MAC	Multi-Annual Contract
MASP	Metropolitan Area Strategic Plan
MCA	Multi-Criteria Analysis
MDC	Multi-Disciplinary Consultants
MGWR	Midland Great Western Railway
NDFA	National Development Finance Agency
NDP	National Development Plan
NGT	Next Generation Ticketing
FLTIF	Future Land Transport Investment Framework
NPF	National Planning Framework
NPV	Net Present Value
NSMED	North Sea-Mediterranean
NSO	National Strategic Outcome
NTA	National Transport Authority
NTCC	National Train Control Centre
O&M	Operations and Maintenance
OECD	Organisation for Economic Co-operation and Development
OHLE	Overhead Line Equipment
OJEU	Official Journal of the European Union
OLE	Overhead Line
Opex	Operating Expenditure
PABS	Project Appraisal Balance Sheet
PBC	Preliminary Business Case
PPP	Public Private Partnership
PPT	Phoenix Park Tunnel
PSC	Public Spending Code
PSO	Public Service Obligation
PV	Present Value

PVB	Present Value of Benefit
PVC	Present Value of Cost
QCRA	Quantitative Cost and Risk Assessment
QRA	Quantitative Risk Assessment
QSRA	Quantitative Schedule Risk Assessment
RO	Railway Order
RSES	Regional Spatial and Economic Strategy
RU	Railway Undertaking
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SDZ	Strategic Development Zone
SEAI	Sustainable Energy Authority of Ireland
SET	Signalling, Electrification and Telecoms
SIFLT	Strategic Investment for Land Transport
SME	Small and Medium Enterprise
Sq	Square
STK	Single Track Kilometre
TEN-T	Trans-European Transport Network
TOD	Transit-Oriented Development
TPS	Train Protection System
TSS	Train Services Specification
TSSSA	Technical Support and Spares Supply Agreement
TUBA	Transport Users Benefit Analysis [application]
UK	United Kingdom
UN	United Nations
V	Volt
VAT	Value After Tax

EXECUTIVE SUMMARY

01

DART+ PROGRAMME

AECOM

PROGRAMME AIM:

Support urban compact growth and contribute to reducing transport congestion and emissions in the Eastern region by enhancing the heavy rail network between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones, providing a sustainable, safe, efficient, integrated and accessible public transport service along these corridors.

PROGRAMME IMPACTS:

46%
rail patronage increase one year after implementation (including existing background growth trends)

650,000
tonne reduction in greenhouse gas emissions due to modal shift and increased electrification of the rail fleet

2.3 : 1
Benefit Cost Ratio

134%
increase in residents located within **1km** of a high frequency DART service

1km

100%
increase in the capacity of the rail network in the Eastern region by 2028

2028 **56%** 2043
forecast increase in public transport patronage with DART+ in place between 2028 and 2043

40%
40% improvement in the arrival time reliability of train services operating on the DART+ network

€3bn
CAPITAL INVESTMENT COSTS
2019 Values

43%
Increase in the number of people interchanging between different public transport services, and travelling by foot or by bicycle for part of their trip

Inclusivity in public transport

Improvement in access to services and opportunities for the **45,000** people living in socially deprived areas within the extended DART catchment

1. Executive Summary

1.1 Introduction

The DART+ Programme represents the largest heavy rail investment scheme in the history of the State, providing a transformational increase in capacity and frequency of the existing system between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones. The DART+ Programme, or simply DART+, is a fundamental transport commitment in Project Ireland 2040.

DART+ is a central pillar in a future integrated sustainable transport system in Dublin City Centre and across the Eastern Region[1]. In the context of the State's climate action plans, investment in transport infrastructure is vital. DART+ will be essential to the reduction in transport emissions: firstly, through the procurement of a low emissions fleet and, secondly, through reducing emissions from road congestion by encouraging and enabling people to choose public transport.

DART+ will optimise the value of the existing heavy rail network, an important State asset, by creating a mass transit system capable of transporting large volumes of passengers, which is heavy rail's unique advantage.

By leveraging the full transport capability of heavy rail, DART+ will facilitate compact, high-density, transit-oriented, residential and commercial development along its corridors. This will have a dynamic impact on land use and spatial planning for the Eastern Region. Transport influences how cities grow, making DART+ vital to sustainable future population and economic growth. As recognised by Project Ireland 2040, the Eastern region is Ireland's economic engine. Therefore, addressing its public transport deficit is essential to developing an attractive and liveable region that will sustain national prosperity and economic competitiveness.

DART+ provides a transformational upgrade change to the future public transport network in two ways; firstly, through infrastructure improvements, including electrification, removal of level crossings, a new depot, and other works, and secondly; through additional rolling stock, combining to double the peak passenger capacity of the heavy rail system into Dublin City Centre from approximately 25,000 passengers per hour in 2019 to over 50,000 by 2028. Services will increase by two and threefold on the newly electrified lines, so that a consistent, high-frequency timetable can be operated across the whole network, not just the existing DART line. Additional capacity will also be created through DART+ for longer distance Intercity and regional services, bringing connectivity and accessibility benefits beyond the DART+ network.

This Preliminary Business Case has been prepared by AECOM on behalf of Iarnród Éireann, who are the Sponsoring Agency of the DART+ Programme. This Preliminary Business Case (PBC) has been developed to:

- Outline the problems that DART+ aims to solve and the strategic case for change
- Define the objectives of DART+
- Appraise the options for change
- Set out the impacts of DART+
- Outline next steps

1.2 Need for intervention

The rationale for DART+ is driven by the need to upgrade the existing heavy rail network in the Eastern region to facilitate the growth in demand for public transport, population and economic growth, and the need to decarbonise transport as part of wider climate change targets. Demand for rail travel is currently significantly reduced due to the COVID-19 pandemic and in the short-term capacity will be significantly reduced due to the need to maintain social distancing on trains. The current assumption is that demand will recover and that the long term need for investment in the heavy rail network remains. COVID-19 also does not alter the requirement to encourage and enable modal shift from the private car and the need to address carbon emissions. It is therefore deemed not to be material to the need for the investment in DART+.

[1] *The Eastern Region refers to the area encompassed by Dublin, Louth, Meath, Kildare and Wicklow.*

The assessment of COVID-19s impact on rail demand and on the economic performance of the investment is covered in Chapters 7 and 9 of this PBC.

Table 1.1 – Key drivers for change

Driver for change	Indicators
Facilitating growth in demand	• Heavy rail network operating at near capacity • Year on year growth in passengers • Need to expand the high frequency rail network to meet projected growth in demand
Supporting economic and population growth	• The need to support land use policy including high-density development within the Eastern region • High-quality efficient transport required to reduce congestion • Supporting the movement of the workforce
Enabling compact growth	• Need to support the ambition for long-term concentrated development along largely established population centres • Need to ensure the dynamic impact of transport and land-use planning maximised
Assisting in achieving environmental targets	• Help in the achievement of decarbonisation targets • Need to reduce emissions from private cars • Requirement to create a high-efficiency low-emissions mass transit system
Encouraging and enabling modal shift	• Create an attractive integrated transport system • Provide a real alternative to the private car • Increase frequency and reliability • Investment to allow heavy rail to reach its mode share potential • Improve customer experience and ease of use
Modernising the railway	• Deliver a significant long-term reduction in diesel-fuelled trains in the Eastern region • Elimination of most level crossings in the Eastern region • Need to realise the potential of the existing heavy rail in asset in a thriving and attractive city

1.3 Key Impacts

The key impacts are;

- DART+ will deliver a 'turn up and go' service to over 600,000 people living within a 1-kilometre catchment of its stations.
- DART+ will double passenger capacity across the heavy rail network into Dublin, creating a high frequency standard of service to Drogheda, Maynooth, Dunboyne, Celbridge and Greystones.
- Compared with now, there will be up to three times as many services on parts of the network.
- Upon opening, DART+ will deliver initial year-on-year passenger growth of 46 per cent.
- The number of people using public transport is forecast to grow by 56 per cent between 2028 and 2043 with DART+ in place
- Increased frequency will lead to a more dynamic public transport system resulting in a 43 per cent increase in people interchanging between services, encouraging multi-modal travel across the public transport system.
- Heavy rail services will become more reliable reducing the variability in end to end journey times by up to 40 per cent.
- The delivery of the DART+ Fleet Project will reduce greenhouse gas emissions by moving from diesel to electric/battery electric trains and by transferring trips away from private vehicles, leading to a reduction of some 650,000 Tonnes of CO_2 over 60 years. Some of the existing diesel fleet will be reallocated to improve services in other parts of the heavy rail network.

- The number of residents located within 1km of a high frequency DART service would increase by 134 per cent, from approximately 250,000 today to over 600,000.
- DART+ will bring the DART service to within 1km of an additional 85,000 people living in areas to the west and the north defined as 'below average or worse' by Pobal's index of social deprivation.
- DART+ will be a good use of public money. The value of the socio-economic benefits it brings is over double the costs, resulting in a Benefit to Cost Ratio of 2.3 to 1. This accounts for the impact across all modes.
- DART+ is an incremental programme over ten years. Benefits will start to be realised as soon as each element is complete.
- Capital expenditure on DART+ will create a total of €1 billion in Gross Value Added (GVA) between 2019 and 2030
- DART+ will generate 14,200 annual Full-Time Equivalent (FTE) jobs during construction[2].

1.4 Background and Rationale

Creating a high capacity heavy rail network and expanding the extent of electrified services in the Dublin area has been an objective of Iarnród Éireann (IÉ) and the Government since the 1970s. The opening of the Howth-Bray section of the Dublin Area Rapid Transit (DART) system in the 1980s was to be the first phase of a multi-phase programme based on the outputs of the 1975 Dublin Area Rapid Transit Study. Since then there has been some on-going investment in the heavy rail network. The enhancements have contributed to the increased popularity of the railways and strong growth in passenger numbers. It is time for a fully integrated programme to upgrade and modernise the railway by expanding DART throughout the Eastern region through a new DART+ network. As recently as 2015, the initial multi-phase programme included the DART Underground tunnel to connect the two parts of the railway. The tunnel is still a long-term ambition, but it is not part of the current DART+ programme.

1.4.1 Project Ireland 2040

Project Ireland 2040 is the Government's plan for shaping the future growth and development of Ireland out to the year 2040. It is a framework to guide investment, to create and promote opportunities for the people of Ireland and to protect and enhance its environment. It sets out a single vision and shared set of goals for every community across the country. These are expressed as National Strategic Outcomes (see Figure 1.1).

Figure 1.1 – National Strategic Outcomes of Project Ireland 2040

Project Ireland 2040 is underpinned by the United Nations' 17 Sustainable Development Goals. It defines Sustainable Mobility as a National Strategic Outcome (NSO4). NSO4 will be enabled by DART+, along with BusConnects, MetroLink and other transport investments, all of which are specified in Project Ireland's National Development Plan for the period 2018 – 2027.

DART+ will also play an important supporting role in the National Strategic Outcome (NSO) 1: Compact Growth and a direct role in NSO 8: Transition to a Low Carbon and Climate Resilient Society.

[2] *These are annual jobs. For example, someone employed by the programme for three years would count as three FTE.*

1.4.2 Greater Dublin Area Transport Strategy 2016 - 2035

The purpose of the Greater Dublin Area Transport Strategy is to "*contribute to the economic, social and cultural progress of the Greater Dublin Area by providing for the efficient, effective and sustainable movement of people and goods.*" The strategy integrates short, medium and long-term plans for light and heavy rail, bus, cycling, walking and roads. The heavy rail element of the Strategy includes DART+ which is described as "*a cornerstone project of the strategy*" that will deliver high capacity, frequent rail services. This established the basis for the DART+ Programme. It is noted that this document is currently under review with revised/updated documents expected to be published in 2022.

1.4.3 Maximising the value of existing assets

Published by the Department of Transport (DoT) in 2015, the report *Investing in our transport future: Strategic Investment for Land Transport* (SIFLT) prioritised the need to address urban congestion and to maximise the value of existing transport networks. DART+ aligns with both these priorities.

1.5 Alternatives & Options

DART+ Programme has been developed to respond directly to the requirements of the Greater Dublin Area (GDA) Transport Strategy. The form of each element of the DART+ Programme has undergone stringent options assessment processes. These are outlined in Chapter 5 of this report.

1.6 What is DART+?

1.6.1 Programme objective

DART+ will comprehensively upgrade the existing DART and Commuter railway services in the Eastern region.

The primary objective of DART+ is *'to support urban compact growth and contribute to reducing transport congestion and emissions in the Eastern region by enhancing the heavy rail network between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones, providing a sustainable, safe, efficient, integrated and accessible public transport service along these corridors.'*

DART+ will have a transformative impact, resulting in a turn up and go, low carbon, mass transit, service across the Eastern Region. It will be achieved by electrifying existing lines, purchasing more rolling stock, re-signalling, removing the majority of level crossings, and other infrastructure works. The extent of the DART+ programme is shown in Figure 1.2.

DART+ services will be integrated with bus services, Luas services and longer distance intercity and regional rail services. The current programme does not preclude future extensions of the DART+ system beyond the current scope.

1.6.2 DART+ Elements

The DART+ Programme is divided into six separate elements which make up five discrete projects for delivery. The first Project details the programme's rolling stock requirements. Each of the remaining Projects details the infrastructure improvements required to achieve the DART+ network.

Table 1.2 – Projects Elements of DART+

	Elements	DART+ Project
1	Rolling Stock	DART+ Fleet
2	City Centre capacity Enhancements and the Maynooth Line	DART+ West
3	Kildare Line	DART+ South West
4	Northern Line	DART+ Coastal North
5	South East Line	DART+ Coastal South

IÉ are responsible for the delivery of all the DART+ Projects. Furthermore, although outside the scope of the business case for the DART+, the DART Underground tunnel route will be considered by the National Transport Authority (NTA) so that it can be protected for future delivery.

Each Project contributes towards the overall objectives of the DART+ Programme and each will deliver incremental operational benefits in its own right, albeit at a sub-optimal level until the entire Programme

is delivered. This is a positive characteristic of DART+ that benefits will be realised incrementally as each Project is delivered.

DART+ Programme elements

The Programme consists of numerous interrelated elements including:

- Increased rail capacity in the city centre through enhancement works in the Connolly/Docklands environs, including a new replacement Docklands Station at Spencer Dock.
- Removal of level crossings, re-signalling and extension of electrified services on the Sligo Line as far as Maynooth and M3 Parkway
- Extension of 4-tracking on the Kildare Line from Park West to Heuston, re-signalling and electrification from Hazelhatch to Heuston and re-signalling and electrification on the Phoenix Park Tunnel Line. Development of new Heuston West station
- Re-signalling and extension of electrification on the Northern Line from Malahide to Drogheda
- Provision of improved turnback facilities on the Southern Line at Dun Laoghaire and/or Bray
- Removal of level crossings on the DART Coastal South Line and provision of alternative pedestrian and cyclist crossing infrastructure. Alternative infrastructure for all modes will be implemented at the Merrion Gates level crossing.
- Procurement of additional rolling stock to increase train capacity and level of service
- Provision of maintenance and stabling facilities for an increased fleet size
- Facilitation of an interchange with MetroLink at Glasnevin
- Other infrastructure to allow for increased service frequency on the DART network.

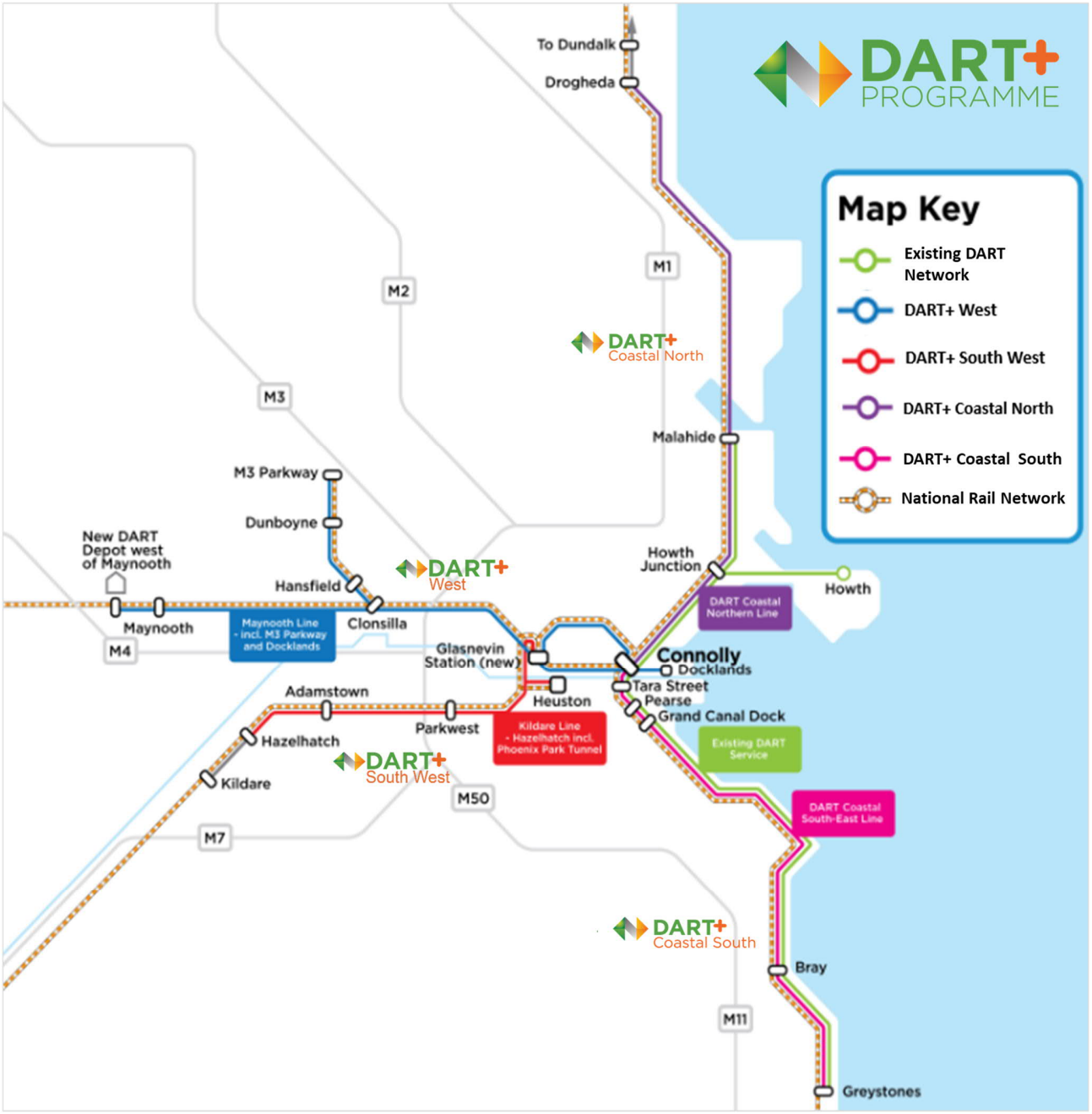


Figure 1.2 – The extent of DART+

1.6.3 Delivery schedule

Projects will be delivered sequentially as shown in Figure 1.3. All projects under DART+ will be fully operational by 2028. The delivery mechanism chosen for DART+ ensures that it can be delivered sequentially. The delivery mechanism will provide some flexibility for elements of the programme, as whilst each Project will deliver benefits in its own right the sequential delivery will ensure the benefits of the programme as a whole will be greater than the sum of its individual elements.

This approach to delivery minimises financial risks. It provides the opportunity for funding to be accessed incrementally prior to the commencement of works.

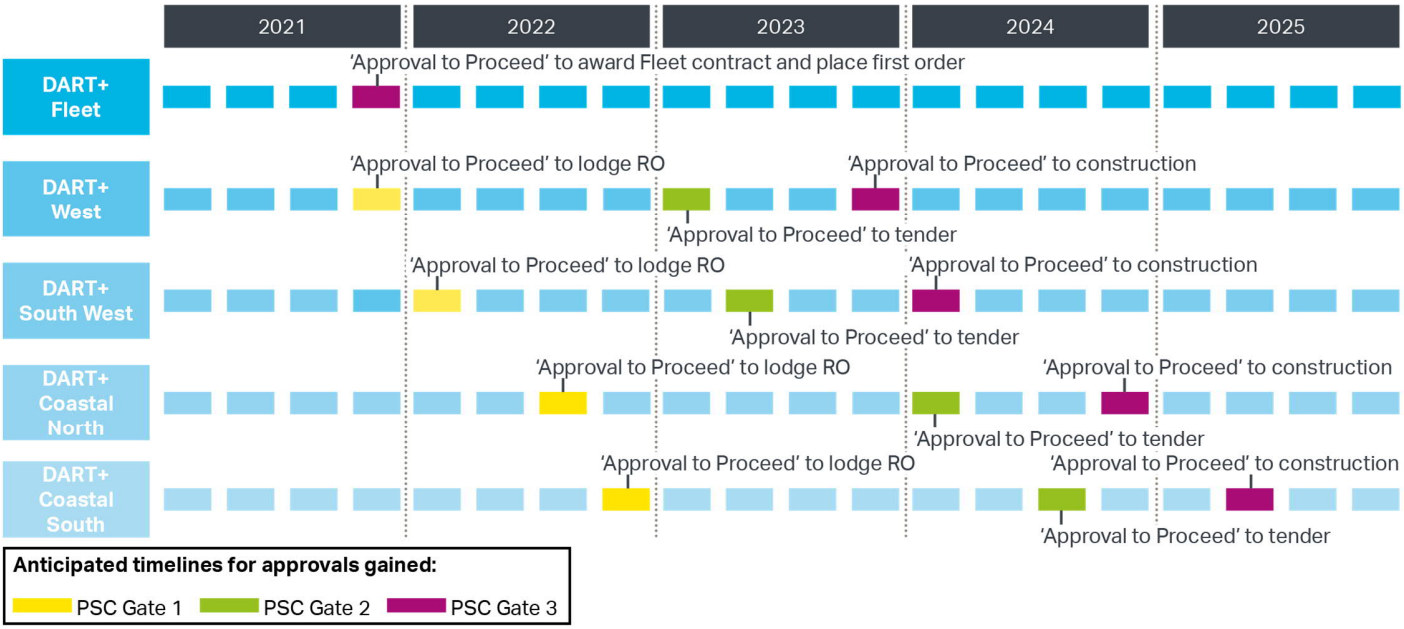


Figure 1.3 – Planning and Approvals schedule for DART+

1.6.4 Approval sought

The PBC will inform two imminent decisions:

- Gate 3 approval for DART+ Fleet which will allow contract award and the first fleet order to be placed within the fleet cost envelope set out in this PBC.
- Gate 1 approval for DART+ West to progress to Gate 2, allowing for progression towards submission of its Railway Order application

Gate 0 Approval to procced with PBC	Gate 1 Approval in Principle	Gate 2 Pre-Tender Approval	Gate 3 Approval to Proceed
Strategic Assessment Report	Preliminary Business Case	Detailed Project Brief & Procurement Strategy	Final Business Case

Figure 1.4 – Public Spending Code Decision Gates

Future iterations of the PBC will inform future approvals as the other Projects progress through their Gates.

1.7 Programme impacts

DART+ will provide benefits throughout the Eastern region. These were quantified using the NTA Eastern Region Model, a long-term forecasting tool, and other analytical methods. The current impact of COVID-19 on public transport demand and operations is significant but is assumed to be short-term. COVID-19 also does not alter the requirement to encourage and enable modal shift from the private car and the need to address carbon emissions. It is therefore deemed not to be material to the need for the investment in DART+. The impact of alternative futures where travel behaviours change has been assessed in Chapter 9.

1.7.1 Service frequency and capacity

By adding more services, DART+ will double the peak passenger capacity of the rail system into Dublin city centre from about 25,000 passengers per hour in 2019 to over 50,000 in 2028. The planned train service pattern is shown in Figure 1.5. The increase in services will be most marked on DART+ South West services with over three times more peak hour services compared with today, and on DART+ West with more than twice as many. DART+ Coastal will have approximately 50% more services than the current DART and Commuter service levels.

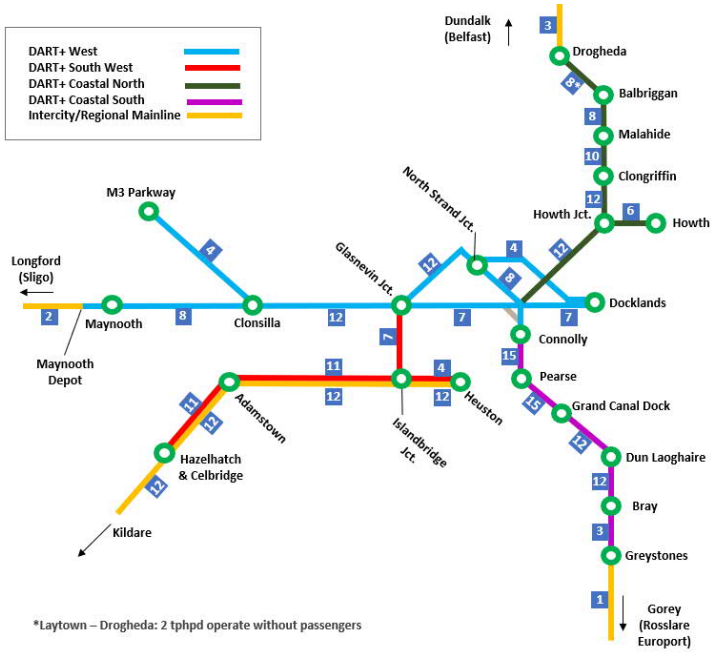


Figure 1.5 – DART+ service pattern in 2028 (services per hour in the peak period)

1.7.2 Reliability

DART+ will reduce the potential for services to be delayed, making them more punctual and offering customers journey times that are up to 40 per cent more reliable.

1.7.3 Interchange and integration

The improved timetables will lead to a 43 per cent increase in the number of people interchanging between different public transport services. Over 10,000 additional interchanges between rail services are forecast, 13,000 additional interchanges between bus and rail, and over 4.500 between rail and Luas. By 2043, 93,000 public transport interchanges every day are forecast.

1.7.4 Access to opportunities and services

Extending DART to a wider catchment will increase the number of people who have access to frequent rail services. This in turn will improve access to opportunities and services for those who are reliant on public transport. Some 258,000 people live within a one-kilometre catchment of the stations on the existing DART network. The extended DART network will serve a population of over 600,000, an increase of 57 per cent on the existing DART catchment.

1.7.5 Social impacts

The existing DART network travels through areas which are largely classed as 'affluent' in the Pobal Deprivation Index. It also travels through some areas defined by Pobal as 'disadvantaged' or 'very disadvantaged' particularly in the city centre. The extension of the DART network will open the DART service to an additional 85,000 people living in areas to the west and the north defined as 'below average or worse' by Pobal.

Literature and academic research affirm the close link between the accessibility to transport and social improvement, and therefore DART+ will act as a significant catalyst to improved opportunities for many along the expanded DART network.

1.7.6 Impacts on business

By improving rail journey times, DART+ will generate benefits to business primarily by increasing their labour market catchment. Increased labour supply will also increase the Dublin region's competitiveness as a location for Foreign Direct Investment.

1.7.7 Local economic impact

The economic impact of the direct investment in DART+ over the ten years of implementation is significant. Capital expenditure on DART+ will create a total of €1 billion in Gross Value Added (GVA) between 2019 and 2030, made up of €467 million in direct GVA and €531 million in indirect/induced GVA.

DART+ will generate 14,200 annual Full-Time Equivalent (FTE) jobs over the decade. Approximately 7,700 FTE jobs will be directly created during the planning and construction phases of the programme, while another 6,500 will be supported in the wider Irish economy.

1.7.8 Environment

An electric train typically emits between 20-35 percent less carbon per passenger mile than a diesel train[3]. Electric trains have zero emissions at the point of use. Their total carbon intensity should continue to reduce in line with the government's ambition for

[3] *RSSB, Rail Decarbonisation Taskforce, January 2019*

electricity production from renewable energy to reach 70 per cent by 2030. In addition, the reduction in emissions at the point of use will benefit air quality in pollution hot spots. Table 1.3 shows the forecast saving in CO_2 emissions as a result of DART+ over 60 years which is the period for the programme appraisal. The transition from diesel to electric fleet is forecast to reduce emissions by ~16,000 Tonnes of CO_2 per annum upon full transition. This represents a significant proportion of the emissions from the rail network which according to the Sustainable Energy Authority of Ireland (SEAI) emitted 137,000 Tonnes of CO_2 in 2013. A proportion of this reduction is offset by an increase in the km travelled by trains with DART+ in place however as energy generation continues to move towards renewables and we achieve 70% renewables by 2050 the difference between the positives and negatives will widen. Overall DART+ will provide the below emissions impacts over the 60-year appraisal period.

Table 1.3 – Tonnes of CO_2 saved (60 years)

Impact	Tonnes CO_2
Shift to lower emission modes	45,000
Shift to lower emission rail fleet	608,000

Source: NTA Eastern Regional Model

1.7.9 Other transport users, walking and cycling

By offering a better rail service, DART+ will result in people switching from private car to rail for some trips. This will reduce traffic congestion on the road system to the benefit of walkers, cyclists, buses, essential services, deliveries and private vehicles.

Increased rail use will increase the numbers of people walking and cycling to the station at either end of their trip.

The existing level crossings affect non-rail travellers, causing delays to all road users. The impact can be severe: at some locations the level crossings can be closed for up to 83 percent of the time during peak periods. The level crossing improvements include the provision of pedestrian and cycle bridges thus improving journey times using active modes.

The removal of level crossings and provision of alternative walking and cycling crossings will also remove the conflict between rail and road users and improve safety.

1.7.10 Health

As a secondary impact, DART+ will improve citizens' health due to increased physical activity by encouraging public transport usage which is often accompanied by increases in walking and cycling to access stations.

The increase in use of active modes subsequently has a positive effect on regional economic productivity through improved health.

1.7.11 Land use

Project Ireland 2040 emphasises the need for compact growth and densification. In Dublin and other urban centres this will require infill development and improved use of available land. This will be possible with DART+ with limited impact on community green spaces.

DART+ will immediately support the development potential of areas around the stations upon opening, ultimately housing more people in the Eastern region.

1.7.12 Benefits for visitors

Dublin is a key destination for domestic and international visitors, attracting 7.6 million visitors in 2017. Fáilte Ireland launched the Dublin Visitor Orientation Strategy in 2017 – the primary goal of which is to encourage more visitors to experience an extended city and county tourist offering, rather than just staying close to the city centre. As well as increasing access to more destinations around Dublin, the DART+ Programme will deliver an easy-to-understand network that will make it easier for visitors to access and use public transport.

1.7.13 Mode share

The introduction of DART+ is forecast to increase rail patronage by around 30 million passengers per annum across the Eastern region by 2028. Further information on the impact of DART+ on modal share is set out in Chapter 7.

1.8 Financial appraisal

1.8.1 Capital costs

The costs for DART+ infrastructure and rolling stock have been forecast throughout the full programme lifecycle. The feasibility working cost forecasts are based on concept designs, where available, for the infrastructure elements of the programme. Fleet cost forecasts are based on the median vehicle cost identified in recent rolling stock tender analysis. These forecasts will be revised as design and procurement processes advance.

Capital costs are based on 2017 market costs, adjusted to reflect 2019 market prices. Operating and maintenance costs are based upon 2019 market costs.

The forecast feasibility working cost profile for DART+, shown in Figure 1.6, gives the costs associated with each element of the programme up to 2027 and beyond, giving a total cost of approximately €3 billion inclusive of cost escalation, risk contingency and Value After Tax (VAT). Optimism bias has been factored into the contingency/risk allowances.

The costs have been benchmarked against similar upgrade programmes in the UK and the cost estimates were independently reviewed in 2014 by both AECOM and Gardiner & Theobald and more recently by AECOM through an independent Peer Review which was a separate procurement process to the AECOM PBC scope. Chandler KBS have also independently reviewed the capital costs on behalf of the NTA.

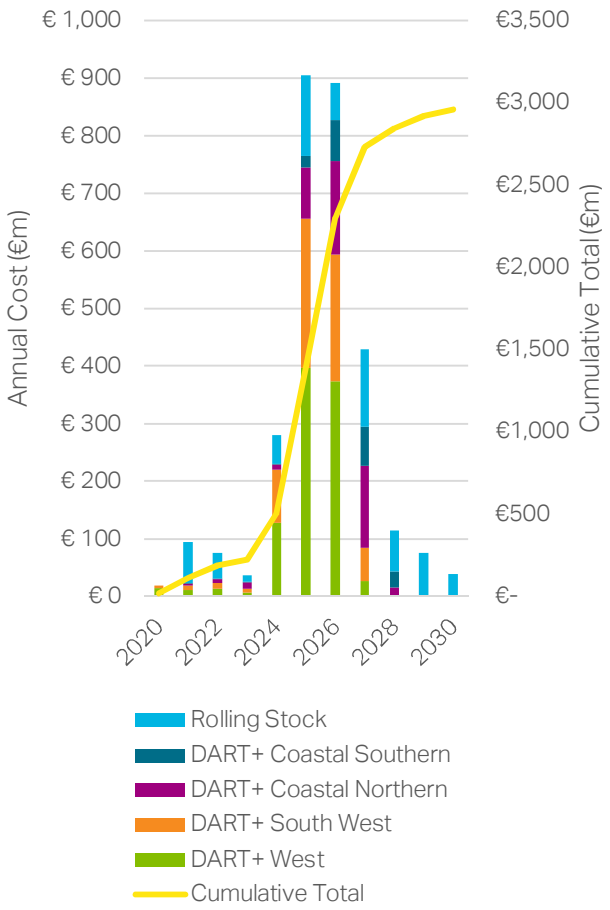


Figure 1.6 – Capital Expenditure (Capex) Cost Profile

1.8.2 Exchequer Impact

Table 1.4 shows the Exchequer Impact. This covers all elements which will impact on the Exchequer in addition to costs and revenue solely associated with the construction and operation of DART+. Indirect taxation is also included as the loss of tax revenue through modal share to public transport which is zero rated for tax results in a loss to the Exchequer of tax revenue. This shows an overall cost to the Exchequer discounted over 60 years of €3.25 billion based on the National Development Finance Agency (NDFA) advised discount rate of 2.31% per annum.

Table 1.4 – Exchequer Impacts (2019 Real Prices Discounted to 2019)

Exchequer Impacts	60 Year Present Value (PV) €m
Capital Costs	€2,280.9
Train Service Operation and Maintenance (O&M)	€1,106.8
Infrastructure O&M	€842.2
Indirect Taxation loss	€223.1
less Net Revenue generated	-€1,204.6
Net Present Value (NPV) Costs	**€3,248.5**

1.8.3 Affordability and funding

Project Ireland 2040: National Development Plan allocates €2 billion in funding for DART+ between 2018 and 2027. Expenditure to 2027 is being planned within this funding allocation, however the total cost of DART+ will exceed the allocation to 2027. Independent of exceeding the funding allocation, some elements of DART+ will be delivered post-2027.

The forecast increase in revenue and track access charges will be less than the additional ongoing costs associated with operating the additional train services and maintaining the additional infrastructure. It is envisaged that the difference will be met through an increase in the Public Service Obligation (PSO) payment from NTA to IÉ for rail service operation and an increase in the Infrastructure Manager Multi-Annual Contract for infrastructure maintenance and renewal.

1.9 Economic appraisal

An economic appraisal analyses a wide range of costs and benefits, denominated in monetary terms or for which a monetary equivalent can be estimated. The results of the appraisal indicate whether a public investment is economically viable i.e. whether the socio-economic and environmental benefits from the programme outweigh the costs to construct and maintain it. The output from economic appraisals allows governments to compare public expenditure proposals on a consistent basis.

This appraisal is informed by the requirements of Department of Public Expenditure and Reform's (DPER) Public Spending Code and the DoT Common Appraisal Framework (CAF) for Transport Projects and Programmes. The outputs from the transport modelling and cost forecasting provide the core inputs to the Cost Benefit Analysis (CBA) process. All economic appraisals are based on 2011 values and prices, according to the Public Spending Code (PSC) and CAF requirements. The economic appraisal used discount rates of 4% for years 1-30, 3.5% for years 31-60 and 3% thereafter. The appraisal was undertaken over a 30-year period with a further residual value period of 30 years.

1.9.1 Economic impacts

Economic benefits were captured for the below impacts:

- User travel time benefits - Improved services for existing users and the subsequent impact on other passengers through modal shift.
- Greenhouse gas benefits which arise from changes due to modal shift, changes in congestion on the road network and changes in the rolling stock fleet from diesel to electric.
- Taxation - DART+ has a negative impact on the tax payment to the Exchequer as shown in Table 1.4 through changes in fuel duty revenues and shift to public transport which is exempt from VAT.
- Revenue from public transport and road tolls: DART+ also leads to an increase in revenues from fares and ancillary sources such as advertising on trains and in stations. Bus and Luas revenues and road toll revenues will fall where people transfer to rail. Overall, net revenue will increase by €651m over the 60-year period.

The value of these benefits is outlined below.

Table 1.5 – Benefits (€ millions - 2011 values and prices)

60 Year Present Value - €m		Road user	Public Transport
Travel Time		-185.2	6351.9
Vehicle Operating Costs		-€4	-
User Charges		34.4	37.5
Greenhouse Gases	Mode Shift	€0.2	-
		-	€0.229
	Fleet Change	-	€32.7
Indirect Tax		€0.8	-

60 Year Present Value - €m		Road user	Public Transport
		-	-€98.1
Revenue	Rail (Farebox and Ancillary)	-	€1,100
	Abstraction from bus and Luas	-	-€395
	Abstraction from Toll Roads	-€58	-
Sub-Total by mode		-211.8	7029
Present Value of Benefits		€6,817	

1.9.2 Costs

Total costs of DART+ include the capital cost, the cost of renewals and refurbishment of assets over their lifecycle, the cost of maintaining the assets and the cost of operating services. They are shown in Table 1.6.

Table 1.6 – Costs (2011 values and prices)

Costs	60 Year Present Value €m
Capital Costs	€1,742.5
Capital Cost - Renewals and Residual	€84.6
Train Service Operating Costs	€638.6
Infrastructure Maintenance Costs	€485.9
Present Value of Costs	€2,952

1.9.3 Cost Benefit Analysis summary

The total value of the benefits of DART+ over 60 years are around €6.8 billion, well in excess of the total value of the costs which are around €3 billion. This gives a Net Present Value of €3.9 billion and a benefit/cost ratio of 2.3, indicating that **DART+ represents good value for money and will give a strong return on investment.**

Table 1.7 – CBA Summary (2011 values and prices)

	60 Year PV €m
User Benefits	€6,234.6
Greenhouse Gases	€32.8
Revenue	€647.0
Indirect Tax	-€97.3
Present Value Benefits	**€6,817**
Present Value Costs	**€2,952**
NPV	**€3,865**
Benefit to Cost Ratio (BCR)	**2.3**

**Above values include residual value for 30 years*

Sensitivity testing

Sensitivity tests were undertaken to understand the effects of reduced growth demand for services; reduced realisation of programme benefits; and/or cost increases. One of these scenarios seeks to ascertain the potential longer-term changes in travel demand and behaviours associated with COVID-19 which may accelerate certain behaviours in relation to flexible working. Further detail in provided in Sections 3.7 and 9.4. There were also tests examining the impact of an increase in contingency allowance, the inclusion of reliability benefits and the impact of alternative future scenarios post-coronavirus. The outcome was a range of benefit cost ratios from 2.0 to 2.6 indicating that the economic case for DART+ is robust, even if current assumptions change.

1.10 Risk management

1.10.1 Risk management process

Risk management processes have been designed to consider strategic, programme, programme element and operational risks.

The risk analysis informs the economic and financial appraisal of the programme through the quantification of the probability and severity of each risk to determine the risk-adjusted programme costs and benefits.

1.10.2 Top risks identified at programme level

The strategic level risks which could impact the delivery of the overall programme have been identified and catalogued within the programme risk register.

The risk register has also identified risk owners and mitigation actions for each of these risks.

The critical risk categories identified to date include:

- Budget shortfall where there is a difference between funding and cost estimates
- Rolling stock procurement delay or cost variability
- Infrastructure programme delays due to design or planning issues
- Scope change concerning station upgrades, fleet requirements, train service specification or network upgrades
- Uncertainty of cost estimates
- Existing overhead line equipment capacity and issues regarding energy requirements
- Delays arising from introduction of new technologies such as the new Train Protection System (TPS) and the National Train Control Centre (NTCC)
- Timely system and programme integration
- Timely approvals by various stakeholders involved in the DART+.

1.11 Governance and assurance

1.11.1 Sponsoring and Approving Authority roles

Iarnród Éireann is the Sponsoring Agency for DART+ with responsibility for proposing and implementing the programme. It has primary responsibility for evaluating, planning and managing DART+ and engaging at the Decision Gates with the Approving Authority for Approval in Principle and/or Approval to Proceed to the next stage of the project lifecycle.

The NTA is the Approving Authority with ultimate responsibility for DART+. It is responsible for granting approval for DART+ to proceed under the management and oversight of another body.

As stated in the Public Spending Code, Government approval is required for proposals with an estimated cost over €100million. As the estimated cost of DART+ is over €100million, Government approval will be required at PSC Decision Gates 1, 2 and 3. The PSC states that it is the responsibility of the parent Department, in this case the Department of Transport, to facilitate seeking that Government approval.

1.11.2 Governance structure

Each DART+ programme element will have a programme management office. The elements report up to the DART+ Assistant Director's (AD) office which is responsible for ensuring the overall programme is effectively delivered.

The Assistant Director of DART+ reports to the DART+ Programme Board, which comprises Iarnród Éireann and NTA members and also serves as the Iarnród Éireann/NTA Programme Steering Group. An Expert Challenge Panel is being established to support the Programme Board.

The Iarnród Éireann Executive provides strategic overview and challenge to DART+. The Iarnród Éireann Board provides ultimate oversight and authorises the release of submissions to third parties including the Approving Authority. A Capital Investment Advisory Group is being established to support the Board in its decision-making.

In line with the PSC, the NTA approves the submission of documentation to the Department of Transport for review at the relevant Decision Gates prior to the Department seeking Government approval to proceed. The governance structure is shown in Figure 1.7.

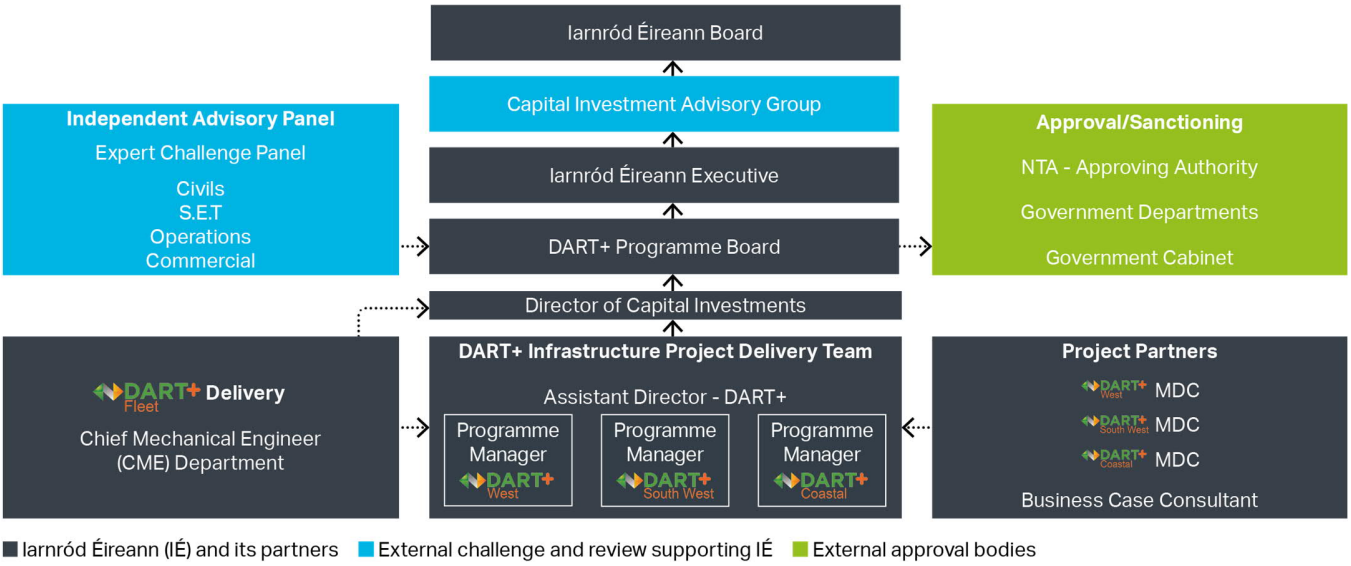


Figure 1.7 – Programme Governance

1.11.3 Gateway reviews

Gateway reviews will operate at the Project level. They are initiated at the end of each phase of the project lifecycle, in accordance with IÉ's project lifecycle and gate system. The gateway review allows the relevant governance body to decide that:

- The project has met the necessary requirements for that phase and that there is evidence to support this.
- The project remains value for money, deliverable within the baseline schedule and within the cost constraints.
- The project is set up, prepared and ready to proceed, with evidence to support this.

1.11.4 Assurance framework

IÉ is developing a risk-based programme assurance framework to provide independent oversight of the programme's progress. It will deploy the Three Lines of Defence model:

- First Line: the management and internal controls of the IÉ DART+ programme team / external organisation carrying out the work
- Second Line: assurance is undertaken through regular oversight by Capital Investment (CI) Managers, technical leads/authorities (including Infrastructure Manager and Railway Undertaking) and CIE group functions
- Third Line: independent assurance will be provided by third parties, and through Integrated Assurance Reviews by the Expert Challenge Panel.

1.12 Conclusion

Ireland is at a tipping point in terms of its approach to sustainable land-use and transport planning and tackling the environmental challenges of climate change. Investment in transport infrastructure is essential to fulfilling the Governments National Strategic Outcomes of Project Ireland 2040.

DART+ represents a significant investment in transport infrastructure by the State. It will upgrade the heavy rail network in the Eastern region, providing a network of low emissions, high frequency, high capacity rail services giving a growing population better access to opportunities and services across the region. The heavy rail network, which is already a valuable State asset, will be able to achieve its full mass transit potential through DART+, offering more people a real alternative to the private car. This is essential to avoid the urban sprawl and subsequent growth in emissions which will occur without attractive alternative mobility options. It will contribute to Dublin's continued development and competitiveness

as an attractive, thriving city and the engine of economic growth for Ireland.

By 2040, there will be roughly an additional one million people living in Ireland. This population growth will require hundreds of thousands of new jobs and homes. As explained by Project Ireland 2040, if we fail to plan for this growth and the demands it will place on the environment, society and the economy, we will fail in our responsibility for future generations. DART+ is an essential enabler for Project Ireland's goals of future Compact Growth, Sustainable Mobility and Transition to a Low Carbon Economy.

1.13 Next steps

The next steps are to submit the PBC to the Approving Authority and seeking:

- Gate 3 approval for DART+ Fleet which will allow contract award and the first fleet order to be placed within the fleet cost envelope set out in this PBC.
- Gate 1 approval for DART+ West to progress to Gate 2, allowing for progression towards submission of its Railway Order application.

Future iterations of the PBC will inform future approvals as the other Projects progress through their gates.

The current status of each Projects, in terms of the Public Spending Code process, is presented in Figure 1.8. Approval is not being sought to move all Projects within the DART+ Programme through the next PSC Gate. Approvals being sought by this iteration of the PBC are set out above.

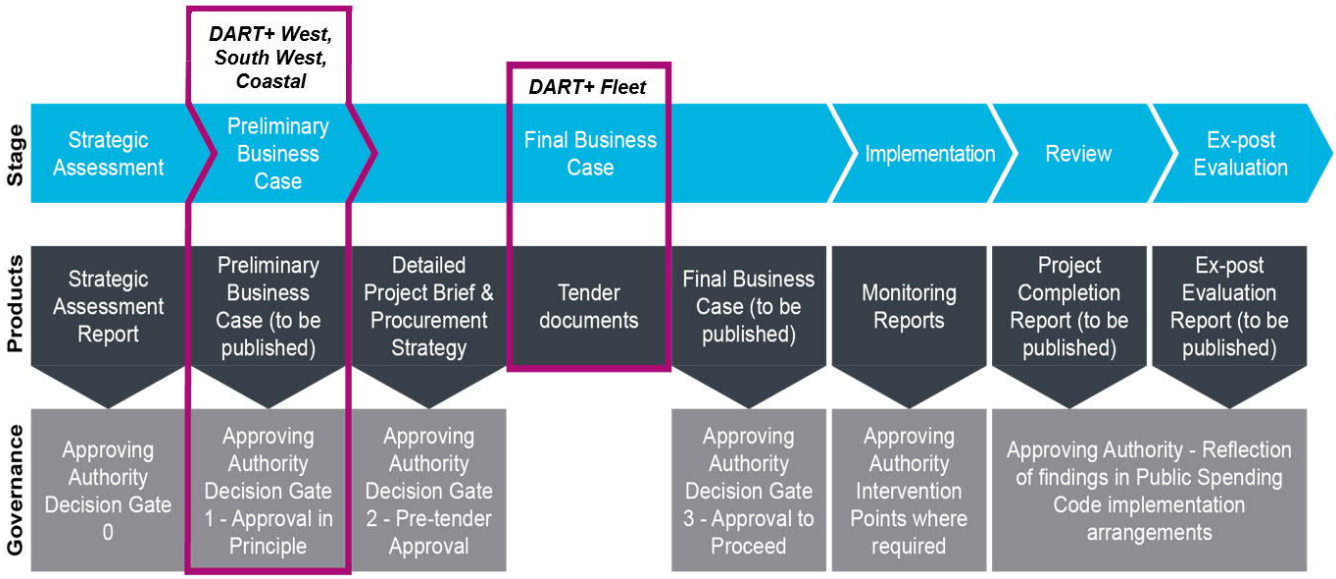
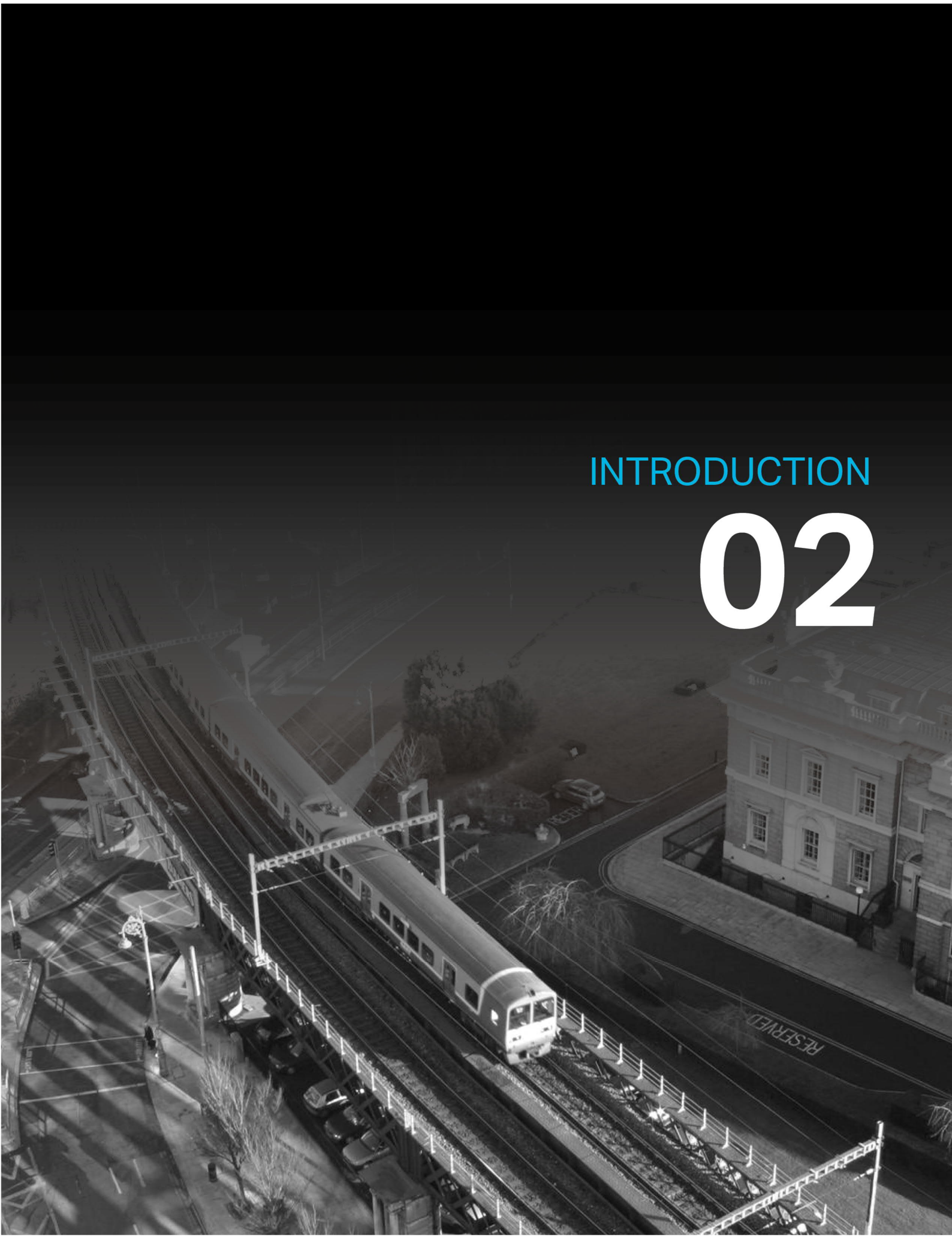


Figure 1.8 – Public Spending Code Progress



INTRODUCTION

02

2. Introduction

2.1 Overview

AECOM have been commissioned by Iarnród Éireann to prepare the Preliminary Business Case (PBC) for the DART+ Programme. The PBC follows on from the Strategic Assessment Report (SAR), the final version of which was submitted to the National Transport Authority (NTA) as the Approving Authority in August 2020, and which was subsequently approved by the Approving Authority in March 2021 for submission to the Department of Transport (DoT).

2.2 Purpose

This PBC has been developed to:

- Outline the problems that the DART+ Programme (DART+) aims to solve and the strategic case for change
- Define the objectives of DART+
- Appraise the options for change
- Set out the impacts of DART+
- Outline next steps.

The PBC represents the second deliverable in the lifecycle and Decision Gate appraisal process as set out in the Department of Public Expenditure & Reform's revised Public Spending Code (PSC) (December 2019).

Gate 0 Approval to procced with PBC	Gate 1 Approval in Principle	Gate 2 Pre-Tender Approval	Gate 3 Approval to Proceed
Strategic Assessment Report	Preliminary Business Case	Detailed Project Brief & Procurement Strategy	Final Business Case

Figure 2.1 – PSC Decision Gates

The purpose of the PBC is twofold. Firstly, for the Sponsoring Agency (Iarnród Éireann) it provides a framework to assess costs, benefits, affordability, deliverability, risks and sensitivities associated with potential project options. Secondly, for the NTA, as Approving Authority, it provides the information required to inform decisions on the viability and desirability of public spending proposals. It does this by demonstrating that there is a clear understanding of the problem it is intended to solve, that different options have been considered, that the interventions address stated objectives, that the forecast benefits outweigh the forecast costs, that the proposed expenditure is affordable and that there is a plan for implementation. The PBC ultimately informs a decision to commit public expenditure.

2.3 Background

Boosting the capacity of the heavy rail network and supporting land use policy through the expansion of the extent of electrified services in the Dublin area has been an objective of Iarnród Éireann (IÉ)[4] and the Government since the 1970s. The opening of the Howth-Bray section of the Dublin Area Rapid Transit (DART) in the 1980s was to be the first phase of a multi-phase programme. However, sustained Exchequer funding to progress the full 1970s plan has been impacted by spending constraints and prevailing economic cycles. In 2000, the DART was extended to Greystones and Malahide and construction of several new stations took place.

In the intervening period there has been some investment in the Eastern region heavy rail network through Dublin Area Suburban Enhancement Programme (DASH), the upgrade of the Maynooth Line in 2000, the completion of the Dunboyne Rail Line in 2010 and the Kildare Route Project Phase 1 which was completed in 2010. There has also been investment in Park & Ride and Cycle & Ride facilities on the network. Phase 2 of DASH is the City Centre Resignalling Project (CCRP) which is still ongoing. Further details are provided in Section 3.1.6.

As recently as 2015, DART+ included the DART Underground rail interconnector. However, following direction from Government, IÉ and the NTA together rescoped the programme to devise a lower-cost solution that would provide the necessary

[4] *Although originally proposed by CIÉ*

passenger capacity in the short to medium term. This version of the DART+ will progress on a phased basis to incrementally increase capacity on the heavy rail network. The route for the last phase of the overall DART+ Programme, the DART Underground Tunnel, will be established and protected to allow for its future delivery. DART Underground could progress in the future as passenger demand dictates.

2.4 Programme Approach to Appraisal

The business case for DART+ is being progressed as a co-ordinated programme of integrated projects extending over several years for the following reasons:

- DART+ is intended to transform the Eastern regions heavy rail system as a whole: a programme facilitates a focus on this holistic intention.
- The programme involves the upgrade of a live rail network, elements of which are inextricably linked. A programmatic approach is required to maintain passenger service operation.
- The overall benefit of DART+ is more than the sum of its constituent parts because a programmatic approach optimises the value from the investment through cross-package efficiencies and savings.
- The programmatic management of inter-relationships between each of the Projects ensures that the programme delivers value for money on a network basis.
- A programmatic approach will promote integration with the rest of the transport system and with other planned investments including the BusConnects programme and MetroLink as they develop.

This PBC is also undertaken at programme level so that the appraisal captures the full holistic benefit of the programme, with the aid of the NTA 's Eastern Region Model. A programmatic approach to the business case will:

- Allow all impacts across the region to be assessed as a whole using the NTA's Eastern Region Model (ERM)
- Ensure all capital, operating and whole life costs are identified and assessed
- Inform decisions on phasing of elements
- Identify those inter-dependent elements that must be linked for delivery and funding
- Allow for incremental approval through the Project Lifecycle and Decision Gate process of the Public Spending Code of each Project within an overall context.
- Include a monitoring and evaluation process that drives incremental benefits realisation and facilitates continuous improvement in planning, design and implementation based on learning as the programme progresses.

The alternative to the programmatic approach would be to appraise DART+ as a series of discrete projects. This approach was considered and rejected as:

- The rail system in Dublin city centre is an integrated network and from an operational perspective would be challenging to break down into discrete packages as optimisation for one route may hinder benefits for other lines.
- IÉ's fleet and depots similarly also serve a common purpose.
- Upgrading of separate lines at a later date would add to costs and not produce the economies of scale from large public contracts for the additional fleet required and new infrastructure construction.
- Proceeding with a discrete linear project approach could potentially prolong disruption for passengers as works will be spread out over a possible 20 year+ period.
- This approach would risk "cherry picking" elements for delivery resulting in a fragmented DART+ which fails to meet its aim.
- The holistic benefits could not be captured by a series of independent business cases.

Each Project contributes towards the overall objectives of the DART+ Programme; however, each package will deliver incremental operational benefits it its own right, albeit at a sub-optimal level until the entire programme is delivered. This is a positive characteristic of DART+ that benefits will be realised incrementally as each Project is delivered. The Projects are at different stages of the Public

Spending Code Lifecycle and Decision Gate Process with elements within each Project being assessed as they progress through the various stages. IÉ undertook an assessment of a number of scenarios to understand the impact of implementing individual Projects of the DART+ Programme.

In terms of assessing an incremental or 'Basic' Do-Something option to achieve the scheme objectives of the DART+ Programme, Iarnród Éireann believe that such an option will not achieve the primary objective of the scheme and the same level of benefits due to the interdependent nature of the DART+ Projects. The infrastructure projects and their interrelationship within the Dublin rail network can be seen in Figure 2.2.

A detailed assessment of partial implementation scenarios is provided in Appendix F and presents, at a high-level, the limitations on infrastructure and fleet in each scenario.

Consideration of the points above would be needed at Project level. The planning and design work currently underway are following the typical process of options assessment, engineering design, impacts assessment, cost forecasting and implementation planning.

2.5 Structure of the Report

The remainder of this report is structured as set out below and outlines the progression of the Programme in chronological order prior to outlining the case for the Programme.

- Rationale for Investment
- Objectives
- Alternatives and Options to Address the Problem
- Costs
- Programme Impacts
- Financial Appraisal
- Economic Appraisal
- Project Appraisal Balance Sheet
- Governance Plan
- Risk Management
- Delivery & Procurement Approach
- Monitoring & Evaluation
- Conclusion
- Next Steps

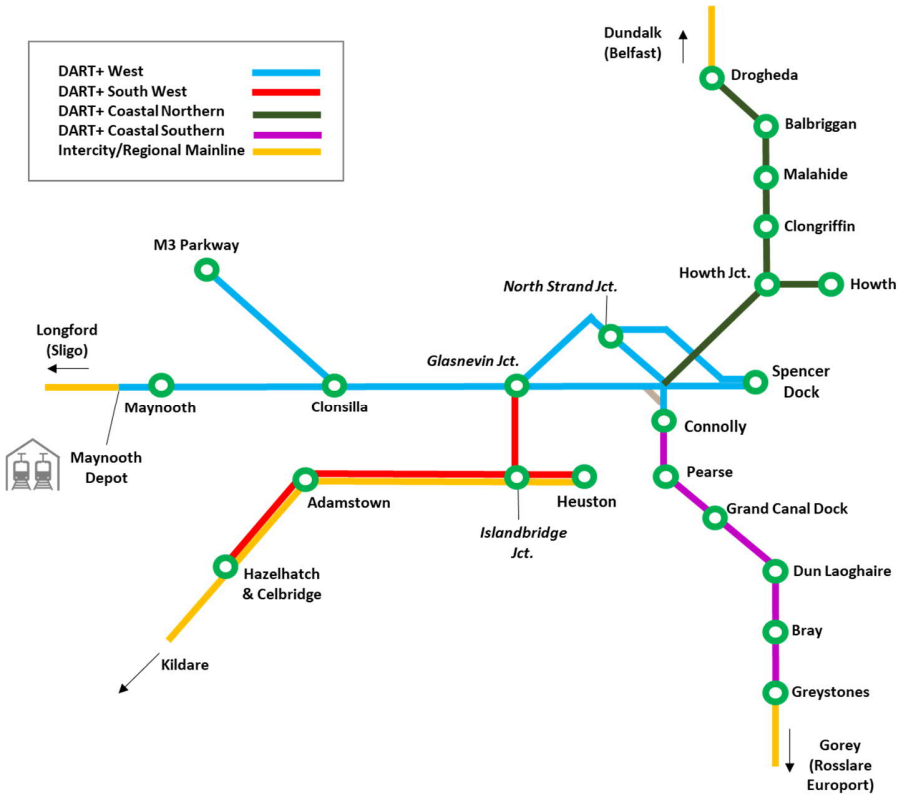


Figure 2.2 – The DART+ Programme Infrastructure Projects

RATIONALE FOR INVESTMENT

03

3. Rationale for Investment

3.1 Introduction

This chapter sets out the policy context for DART+ and outlines the key drivers for intervention.

3.2 Public Policy Context

Investment in the heavy rail network through DART+ is central to the delivery of public policy objectives at national, regional and local levels. The policy hierarchy and the relevant documents which reference and support DART+ are shown in Figure 3.1.

Tier 1: National Planning		Tier 2: Regional Planning	Tier 3: Local Planning
Project Ireland 2040: NPF & NDP		Regional Spatial & Economic Strategies	County Development Plans
SIFLT	FLTIF	Transport Strategy for the Greater Dublin Area	Local Area Plans
Climate Action Plan	National Mitigation Plan	Integrated Implementation Plans	Local Transport Plans

Figure 3.1 - Policy Hierarchy

3.2.1 Project Ireland 2040

Project Ireland 2040 was launched by the Government in February 2018 and comprises the National Planning Framework (NPF) which sets out a spatial strategy for the period to 2040, and the National Development Plan (NDP) which sets out an investment strategy for the first 10 years of the National Planning Framework.

Project Ireland 2040 is the Government's plan for shaping the future growth and development of Ireland out to the year 2040. It is a framework to guide investment, to create and promote opportunities for the people of Ireland and to protect and enhance its environment. It sets out a single vision and shared set of goals for every community across the country. These are expressed as National Strategic Outcomes (see Figure 3.2).

Project Ireland 2040 is underpinned by the United Nations' 17 Sustainable Development Goals. It defines Sustainable Mobility as a National Strategic Outcome (NSO4). NSO4 will be enabled by DART+, along with BusConnects, MetroLink and other transport investments, all of which are specified in Project Ireland's National Development Plan for the period 2018 – 2027.

DART+ will also play an important supporting role in NSO 1: Compact Growth and a direct role in NSO 8: Transition to a Low Carbon and Climate Resilient Society.

Figure 3.2 - Project Ireland 2040: NSO's[5]

National Planning Framework

The NPF will guide development and Exchequer investment up to 2040. It is a blueprint to guide public and private investments. It promotes and enhances opportunities and infrastructure for an increasing population and sets out the development principles that subsequent plans must follow. The NPF provides each region with a set of objectives and key principles from which detailed plans at a regional level are to be developed.

The DART+ Programme contributes to a number of National Strategic Outcomes. The below three NSOs in particular are linked to the rationale for investing in DART+.

[5] *Government of Ireland 2018. Project Ireland 2040 National Planning Framework. www.npf.ie*

NSO 4: Sustainable Mobility is one of the ten National Strategic Outcomes identified in the NPF. It is identified as being central to enhancing competitiveness, sustaining economic progress and enabling mobility choices for citizens. The aim is to expand the range of public transport services available and to reduce congestion and emissions. Under NSO 4, the Government plans to progress three major programmes in the Dublin area: DART+, BusConnects and MetroLink, as well as other sustainable transport programmes and projects nationally.

NSO 1 Compact Growth: aims to deliver a greater proportion of residential development within existing built-up areas. High quality transport leads to high public transport mode shares which reduces the need for parking. The need for parking provision can reduce housing density and lead to viability issues with infill development which is key to compact growth in urban areas. It also highlights the role that an integrated transport network will play in the regeneration and revitalisation of urban areas.

NSO 8 Transition to a Low Carbon and Climate Resilient Society: will be supported by the electrification of transport fleets, reducing the use of carbon-intensive propulsion and benefitting from the decarbonisation of electricity production thereby lowering pollution.

The NPF forecasts an increase in the population of one million people by 2040, leading to a total population of 5.7 million. (Figure 3.3). 2.85 million of the population will be located within the Eastern and Midlands region. Population growth will increase demand along the motorway and railway corridors connecting the region with Dublin. Well-functioning integrated public transport systems will be essential to maintain economic development and enhance competitiveness. Intercity and outer commuter services serving Dublin will be enhanced through the capacity DART+ creates, extending the benefits of the programme beyond the Eastern region by improving connections between the capital and the rest of the country.

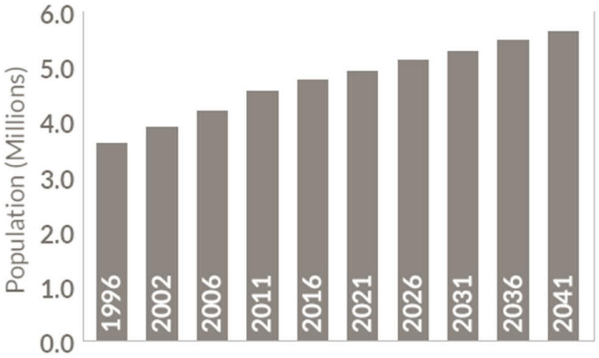


Figure 3.3 – Ireland's Population 1996-2041[6]

National Development Plan 2018 - 2027

Project Ireland 2040's NDP 2018–2027 supports the delivery of Project Ireland 2040 through public capital investment over the next ten years and guides national, regional and local planning and investment decisions in Ireland over the next two decades.

The NDP sets out the Government's investment priorities to 2027 within the context of:

- A changing demographic
- The need for Ireland to move to a low carbon society
- Brexit
- The sustainable growth opportunities brought about by a growing population.

The NDP provides Government departments with visibility of their investment capacity over the term of the NDP. It identifies €116 billion for investment in capital projects targeted at enhancing regional development and driving economic growth.

The NDP expands on the objectives of NSO 4, Sustainable Mobility and outlines how increases in passenger demand are to be catered for by a sustainable public transport system significantly less reliant on carbon-intensive propulsion systems. An amount of €2billion Exchequer funding has been allocated in the NDP towards the delivery of DART+ up to 2027. The total cost of DART+ will exceed that allocation with some elements delivered post-2027.

[6] *National Development Plan 2018-2027*

The NDP outlines the scope of the DART+ to include investment in new rolling stock, new infrastructure and the electrification of the Sligo line to Maynooth and M3 Parkway, the Northern line to Drogheda and the Kildare line to Celbridge/Hazelhatch. The scheme will create a full metropolitan area DART network with all lines linked and connected. The Plan does not make provisions for any new tunnelling but does include the utilisation of the existing Phoenix Park tunnel and requires that the route for DART Underground is protected to allow for its future delivery. It is noted that this document is currently under review with an updated development plan expected in 2021.

3.2.2 *Regional Spatial and Economic Strategy*

The Eastern and Midland Regional Assembly's (EMRA) Regional Spatial and Economic Strategy (RSES) provides regional specific policy objectives for the Midlands, Eastern and Dublin regions. It considers spatial and economic factors which relate to the future of the region and ensures that employment opportunities, services, ease of travel and the overall wellbeing of citizens is being addressed.

As a requirement of the NPF, the EMRA RSES provides a Metropolitan Area Strategic Plan (MASP) for Dublin with DART+ identified as a critical component to deliver these outcomes across four of the five corridors identified within the MASP. It highlights the DART+ Programme's role in the consolidation of Dublin City and the regeneration of locations such as Dublin Docklands and Poolbeg. The DART+ Programme's role in increasing capacity to support the ongoing development of lands adjacent to the line is emphasised.

3.2.3 *Transport Strategy for the Greater Dublin Area 2016 – 2035*

This statutory document published by the NTA lays out the transport strategy for the GDA up to 2035. The Strategy's purpose is to "*To contribute to the economic, social and cultural progress of the Greater Dublin Area by providing for the efficient, effective and sustainable movement of people and goods.*" It identified that "*significant public transport capacity deficits exist for radial trips into Dublin City Centre along a number of strategic corridors*".

The Strategy is modally balanced and designed to cater to the future needs of the Greater Dublin Area, enabling people to move efficiently around the Eastern region. It integrates short, medium and long-term plans for light and heavy rail, bus, cycling, walking and roads as shown in Figure 3.5. The heavy rail element of the Strategy includes DART+ which, with other measures, will create "a full Metropolitan area DART network". DART+ is described as "*a cornerstone project of the strategy*" that will deliver a high capacity, frequent, rail service. The Strategy sets out the transport provisions necessary to contribute to the economic, social and cultural progress of the GDA by providing for the efficient, effective and sustainable movement of people and goods which result in modal share, environmental, economic and land use benefits. It is noted that this document is currently under review with revised/updated documents expected to be published in 2021.

The way in which the Transport Strategy provides strategic context is further elaborated in Section 5.

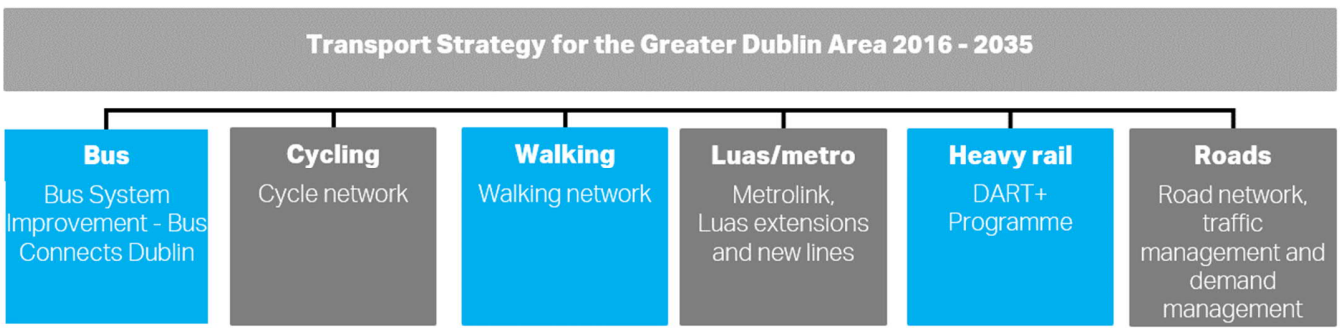


Figure 3.4 - NTA Multimodal Transport Strategy for GDA

Integrated Implementation Plan 2019-2024

The NTA's Integrated Implementation Plan 2019-2024 supports the delivery of the Strategy. It sets out the central infrastructure investment programme and overall funding provision over the six years. It identifies the key investment areas concerning bus, light rail, heavy rail, integration and sustainable transport.

Table 3.1 shows the expenditure profile for heavy rail projects which includes the DART+ Programme and other heavy rail projects such as City Centre Resignalling Project, the National Train Control Centre, delivery of 41 ICR B-cars to IÉ, and other network developments.

Table 3.1 – Proposed Investment Profile for Heavy Rail[7]

	2019	2020	2021	2022	2023	2024	Total
Heavy Rail investment (€m)	67.7	108.0	167.0	166.0	225.8	315.0	**1,049.5**

3.2.4 Climate Action Plan

The Government published the Climate Action Plan in June 2019. The Action Plan sets out actions to reduce Ireland's greenhouse gas emission across a range of sectors, including transport, to combat climate change. The realisation of the Action Plan will have positive impacts on the environment, society and economy of the country. The Action Plan states that transport accounted for 19.8% of Ireland's greenhouse gases in 2017. The impact of emissions contributes to poor local air quality which reduces people's quality of life and harms their health.

The Action Plan sets out specific timeframes and targets to meet the required level of emissions by 2030 for the transport sector, including:

- Reduce CO_2 eq. emissions from the sector by 45–50% relative to 2030 pre-NDP projections
- Set targets for the conversion of public transport fleets to zero-carbon alternatives
- Make growth less transport intensive through better planning, remote and home-working and modal shift to public transport.

A key policy to drive mode shift is the delivery of compact development and greater integration of policies for land use and transport planning. Combined, these policies will reduce the demand for commuter travel and support more efficient patterns of development and travel.

The Action Plan identifies actions (actions 72-100) for the transport sector to reduce the impact of emissions and meet the overall targets of the Climate Action Plan. Of those actions, the following are relevant to DART+:

- Implement major sustainable-mobility projects such as the DART+ Programme, Metro Link, and the Bus Connects Programme
- Commence the transition to hybrid trains to allow extended electrification of rail services
- Extend the Dublin area railway electrification for the Maynooth Line (to Maynooth), Kildare Line (to Celbridge), and Northern Line (to Drogheda)
- Review public and sustainable transport policy and develop a roadmap to electrify and decarbonise all PSO public transport
- Publish an updated strategic rail review paper
- Develop a regulatory framework on low emission zones and parking pricing policies and provide local authorities with the power to restrict access to certain parts of a city or a town to zero-emission vehicles only. Examine the role of demand management measures in Irish cities, including low emission zones and parking pricing policies. *(It should be noted that the impacts of this action would be secondary to DART+ however demand management would likely increase demand for public transport)*

Investment and improvements in the public transport system will help to realise the above policy aims. It is noted that this document is currently under review with revised/updated documents expected to be published in 2021.

[7] *NTA, Integrated Implementation Plan 2019-2024*

3.2.5 EU Policy Alignment

The DART+ Programme aligns with the EU Sustainable and Smart Mobility Strategy which sets out the below objectives:

- Increasing the uptake of zero-emission vehicles
- Making sustainable alternative solutions available to the public & businesses
- Supporting digitalisation & automation
- Improving connectivity & access

DART+ will support in the achievement of these objectives.

As a strategic benefit, the cross-border Cork-Dublin-Belfast route has been designated a part of the North Sea-Mediterranean (NSMED) Trans-European Transport Network (Ten-T) Core Network corridor. However, there is no heavy rail connectivity for commuters between the principal stations of Connolly on the Belfast Line and Heuston on the Cork Line through Dublin City. The absence of connection between these stations is the missing link on this part of the North Sea-Mediterranean Ten-T Core corridor. The island of Ireland has isolated network status within the Ten-T Regulation 1315/2013. The development of a connection through Dublin City, connecting the Cork Line and the Belfast Line will provide the missing link. The upgrade of the connection from Hazelhatch (Cork Line) to Connolly through the Phoenix Park Tunnel (PPT) and the associated enabling and reconfiguration works involving 4-tracking, electrification and re-signalling, are included in the DART+ Programme. This will provide a continuous heavy rail link along the Core Network between the 3 largest cities in Ireland and Northern Ireland (Cork-Dublin-Belfast), and realise the full potential of this expanded and improved rail network in and out of Dublin.

3.2.6 Other policy drivers

DART+ also aligns with:

- The Programme for Government: Our Shared Future (June 2020) which commits to the implementation of the Greater Dublin Area Transport Strategy and specifically states that "*the Government will prioritise plans for the delivery of Metrolink, Luas and other light rail expansion, DART+ and interconnector and Bus Connects in Dublin, Cork, Galway, and Limerick.*"
- *Investing in our transport future:* SIFLT, published by the DoT in 2015 which prioritised the need to address urban congestion and to maximise the value of existing transport networks.
- The DoT's *Smarter Travel* policy, by providing reliable public transport options, reducing the need and dependency on cars. It is noted that this document is currently under review with revised/updated documents expected to be published in 2021.
- The *National Cycle Policy Framework*[8] which aims at developing a cycling culture in Ireland and will be supported by improved cycle facilities at stations and enhanced rail services which will promote multi-modal travel

Significant investment is required to realise these policy objectives and to deliver sustainable mobility for Ireland's growing population and economy. As with all Exchequer investment, an appraisal, in line with the PSC is required before expenditure can be approved to ensure the appropriate use of funds.[9]

3.3 Sustainability Context

Sustainability is at the heart of long-term planning which aims to ensure that the decisions taken today, meet our own needs without compromising the ability of future generations to meet their needs.

Since 2015, Ireland has been a signatory to the United Nations Sustainable Development Goals (SDGs). There are 17 goals which span the three pillars of sustainability: social, economic and

[8] *http://www.smartertravel.ie/content/national-cycle-policy*

[9] *Department of Public Expenditure and Reform. The Public Spending Code. 2019.*

environmental. This frames Ireland's national agendas and policies to 2030.

There is significant alignment between the UN SDGs and Project Ireland 2040's National Strategic Outcomes (NSOs). Project Ireland 2040 provides the overall sustainability context for DART+ because it is a Project Ireland 2040 priority, specified under National Strategic Objective 4: Sustainable Mobility. As noted in Section 3.2.1, delivery of DART+ will contribute to other NSOs.

Sustainability therefore underpins the case for DART+. Several national policies will direct the sustainable development of DART+ including:

- National Policy Framework: Alternative Fuels Infrastructure for Transport in Ireland 2017 to 2030
- National Adaptation Framework Planning for a Climate Resilient Ireland, Jan 2018, (currently under review following recent Supreme Court ruling)
- Climate Action Plan 2019
- Transport Climate Change Sectoral Adaptation Plan, October 2019
- Future Jobs Ireland 2019, Department of Business, Enterprise and Innovation
- Programme for Government 2020.

The European Union has committed to implementing the UN SDGs, and they feature in all EU priorities. The sustainability context which drives the need for DART+ and the way the programme is developed and delivered will be informed by the European Green Deal. This provides a roadmap for using sustainable resources and restoring biodiversity, aiming to overcome the challenges arising from climate change and make the EU's economy sustainable. The 2030 Climate and Energy framework includes EU-wide targets and policy objectives from 2021 until 2030.

The social and economic sustainability case to upgrade Dublin's heavy rail system through DART+ is supported by the Europe 2020 strategy[10] for smart, sustainable and inclusive growth which sets targets to lift at least 20 million people out of poverty and social exclusion and to increase employment of the population aged 20-64 to 75%. The flagship initiatives of the Europe 2020 strategy, including the *Platform against Poverty and Social Exclusion* and the ***Agenda for New Skills and Jobs***, support efforts to reach these targets.

The key sustainability issues that contribute to the case for DART+ are the current climate and environmental conditions, future public transport levels of service and energy emissions.

Current climatic and environmental conditions

Our effectiveness in reducing carbon emissions is important for Ireland's long term economic and societal interests. It will boost the attractiveness of Ireland as a location for foreign investment, as a tourism destination and a source of safe, high quality agricultural food products. DART+ has a key role to play in decarbonising public transport and in shifting travel to public transport.

Ireland has committed to cutting its emissions by 51% between 2018 and 2030 and to net zero no later than 2050. DART+ will allow IE to continue to reduce carbon emissions and fuel consumption, having already achieved a 46% reduction in CO_2 between 2006 and 2018 through a series of operational and technical initiatives[11].

Public transport in the future

As widespread use of public transport helps to greatly reduce greenhouse emissions, the Government is aiming for a modal shift to public transport in the future. To encourage and enable this shift, transportation infrastructure must be developed to enable larger fleets of environmentally friendly vehicles to provide higher capacity and higher frequency transport services to a wider area and greater population. Given the capacity issues experienced on DART and commuter services pre

[10] *https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/eu-economic-governance-monitoring-prevention-correction/european-semester_en*

[11] *https://www.cie.ie/Enviromental-Corporate-Responsibility/Climate-action#:~:text=Irish%20Rail%20have%20worked%20to,to%20177%2C000%20tonnes%20for%202018*

COVID-19 this scale of growth will lead to significant capacity issues and constrain the shift to public transport. Transport services must improve accordingly. DART+ is necessary for the development of an enhanced mass transit system in the Eastern region.

Energy emissions

Heavy rail results in less emissions, less noise pollution and less vibrations than road traffic. DART+ aims to transition a significant proportion of the IÉ fleet from diesel to electric and improve the ratio of electric to diesel fleet. Existing and future DART trains produce no exhaust fumes at the point of use and emit low levels of noise during use. They have steel wheels, not rubber tyres; steel wheels are much more efficient, and when they are eventually worn out, can be recycled.

3.4 Policy Summary

Investing in our transport future: SIFLT, published by the DoT in 2015 prioritised the need to address urban congestion and to maximise the value of existing transport networks. It posited that investment in public transport is essential for Ireland to improve its competitiveness in transport relative to other countries which the World Economic Forum rankings at the time suggested was necessary.

Addressing urban congestion calls for improved public transport and public transport-oriented land development. Improved public transport requires integrated system-wide transportation across rail, light rail, bus, cycling and walking network that allows each mode to play to its strengths.

The *Greater Dublin Area Transport Strategy 2016 – 2035* examined strategic options for the Dublin area as a whole and on a corridor by corridor basis. Reflecting the SIFLT priorities, it was proposed that, on corridors where heavy rail lines already exist, investing in their upgrade was, as part of an overall set of interventions, the most effective way to cater for future transport needs, as part of an integrated strategy.

The need for action is now set against a background of a growing population and economy in the Eastern region, as forecast in *Project Ireland 2040*.

Within this context, the heavy rail network offers two distinct advantages. Firstly, the network already exists and operates successfully. It represents a very significant prior investment that now needs to be fully leveraged and built upon. Secondly, heavy rail can carry higher volumes of people, more reliably, than any other mode. Challenges facing the railway and limiting its potential include its lack of peak period capacity and low-density land use patterns that limit its catchment in some locations. It needs modernisation too: the timetable and frequency of service needs to continue to improve. Diesel-fuelled trains are increasingly unacceptable from a societal and policy perspective, as evidenced in the *Programme for Government 2020* and the *Climate Action Plan 2019.*

In summary, there is an imperative to upgrade the public transport system in the Eastern region with an integrated approach across all modes. The railway must change to play its role. Specifically, it needs to be modernised to be able to support economic and population growth, to enable compact growth, to help Ireland meets its environmental targets and to enable and encourage greater use of public transport.

3.5 Drivers for Change

The drivers for change are summarised in and explained in the rest of this section. Demand for rail travel is currently significantly reduced due to the COVID-19 pandemic. The current assumption is that demand will recover and that the long term need for investment in the heavy rail network remains. COVID-19 also does not alter the requirement to encourage and enable modal shift from the private car and the need to address carbon emissions. It is therefore deemed not to be material to the need for the investment in DART+. The assessment of COVID-19's impact on demand is covered in Chapter 9 of this PBC.

Table 3.2 – Key drivers for change

Driver for change	Indicators
Facilitating growth in demand	• Heavy rail network operating at near capacity • Year on year growth in passengers • Need to expand the high frequency rail network to meet projected growth in demand
Supporting economic and population growth	• The need to support land use policy including high-density development within the Eastern region • High-quality efficient transport required to reduce congestion • Supporting the movement of the workforce
Enabling compact growth	• Need to support the ambition for long-term concentrated development along largely established population centres • Need to ensure the dynamic impact of transport and land-use planning maximised
Assisting in achieving environmental targets	• Help in the achievement of decarbonisation targets • Need to reduce emissions from private cars • Requirement to create a high-efficiency low-emissions mass transit system
Encouraging and enabling modal shift	• Create an attractive integrated transport system • Provide a real alternative to the private car • Increase frequency and reliability • Investment to allow heavy rail to reach its mode share potential • Improve customer experience and ease of use
Modernising the railway	• Deliver a significant long-term reduction in diesel-fuelled trains in the Eastern region • Elimination of most level crossings in the Eastern region • Need to realise the potential of the existing heavy rail in asset in a thriving and attractive city

The DART+ Programme will vastly improve passenger experience and support economic development across the region. It will also lead to rail service improvement on the network beyond the Eastern region.

3.6 Problem Identification

3.6.1 Facilitating growth in demand

At 2019 levels of demand, the heavy rail system in the Eastern region was approaching maximum capacity. Prior to the COVID-19 pandemic, IÉ was operating all available fleet and approaching maximum service levels during the AM and PM peak periods. There is little or no capacity on the network to accommodate additional peak services without network investment.

The number of passenger journeys on IÉ services has increased by ~25% in the last five years, with total passenger journeys reaching a record high of just over 50 million in 2019, as shown in Figure 3.6.

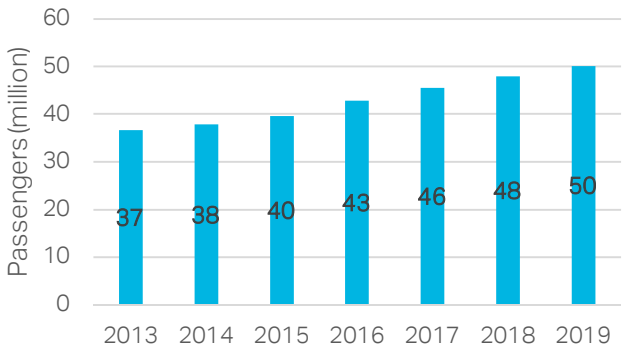


Figure 3.5 - National rail passengers (millions) (PSO Trips)[12]

DART passengers accounted for 56% of these journeys. The occupancy levels of trains in the eastern region which form part of the DART+ network[13] have risen close to theoretical capacity at peak hours. This capacity constraint is restricting the growth in public transport usage by reducing the attractiveness of the mode for potential new users. The scope to provide additional services is currently constrained on two fronts. Firstly, capacity is constrained by the infrastructure. Secondly, rolling stock utilisation is already at maximum levels. There is an urgency to increase capacity and to provide additional services to meet demand.

Demand for transport is expected to continue growing, and while the COVID-19 pandemic has slowed this growth in demand, the growth is ultimately compounding this issue. Projections indicate that the population of Ireland will grow by 1.1 million to 5.7 million people by 2040 with the Eastern and Midland Regional Assembly area growing by 17-19% to around 2.85 million[14]. Approximately 28% of the national population is in the county of Dublin, and such an increase will place further pressure on an already constrained transport network.

The heavy rail network in the Eastern region has the potential to reduce road congestion, in urban areas in particular, as it is the most effective mode for transporting large volumes of people. However, it currently cannot support future growth due to infrastructure and fleet constraints. The infrastructure constraints are most acute in the Dublin city centre environs of Connolly/Docklands and at Heuston Station. Examples of these constraints include:

- Connolly station operating at capacity
- Numerous flat junctions in the city centre
- Inconsistent double- and triple-tracking between Park West station and Heuston station
- Limited capacity and access to the current Docklands station
- Double-track across the Loopline bridge[15]

IE are currently constrained by capacity on some lines as set out below.

Table 3.3 – Current Single Peak Hour Capacity

Current Single Peak Hour		
Commuter route	No. of services	Capacity
DART Southbound	6	6,600
Northern Commuter	5	4,780
DART Northbound	6	6,300
Commuter South Eastern	1	300
Western Commuter	6	4,990
PPT (Hazelhatch - Connolly)	2	700
Heuston Commuter	4	1,200
Total:	**30**	**24,870**

Examples of enhancements that could unlock the potential of the heavy rail network in the Eastern region include:

- Increasing capacity and improving the utilisation of existing infrastructure to meet future demand
- Providing additional interchanges with other public transport modes which are currently inadequate
- Delivering a significant increase in the size of the DART fleet

[12] *National Transport Authority PSO Passenger Public Transport Data*
[13] *Train Occupancy in the morning peak after DART+ area reaching City Centre*
[14] *NPF, Project Ireland 2040: National Planning Framework*
[15] *A railway bridge spanning the River Liffey and several streets in Dublin. It joins rail services from south of the Liffey – including Pearse station – to Connolly Station and lines north of the Liffey.*

- Expanding the timetable to improve peak period services and services outside the traditional peak periods where people currently have less travel choices
- Removing infrastructure-related bottlenecks at stations, level crossings and rail junctions which impact on the ability to operate at higher frequencies and lead to journey time reliability issues.

Together, these actions would transform the passenger-carrying capacity across the DART network ensuring it can cater for future growth in demand.

3.6.2 Supporting economic and population growth

Project Ireland 2040: National Planning Framework forecasts that by 2040 the Eastern and Midland Region will have an additional population of between 475,000 and 500,000 people, from a population of 2.3 million people and 330,000 additional jobs from an existing quantum of 1.1 million jobs.

Project Ireland 2040 identifies the need for a high-quality public transport system as being integral to the region's attractiveness. The future of the Eastern region and Dublin in particular is reliant on its ability to attract and maintain these residents, workers, businesses and tourists. This can only be achieved if the transport infrastructure in the Eastern region continues to improve, as it remains below the European Union average level of efficiency for rail networks compared to well-developed economies with whom Ireland competes for investment[16].
Based on a survey by the World Economic Forum[17] evaluating frequency, punctuality, speed and price of train services, Ireland ranked 19th out of 26 EU countries.

The heavy rail network is one of the central arteries of the overall public transport network, providing a means of transporting large volumes of people to work, education and amenities throughout the day, especially during the peak AM and PM commuter periods. The IÉ network is segregated from the road network (except at level crossings) and, therefore, the services and travel times are not influenced by road congestion, unlike bus and light rail (Luas) services. The existing level crossings impact on other non-rail travellers and cause delays to bus passengers, walkers, cyclists, goods vehicles and private vehicles. This impact can be severe: at some locations the level crossings can be closed for up to 83 percent of the time during peak periods. 'Aggravated Congestion'[18] in the Eastern region can lead to damaging impacts on the broader economy by increasing the cost of doing business; due to time lost, increased operating costs and the impacts on health. In 2012 this was estimated to cost €358 million per year, with the potential to rise to €2.08 billion per year in 2033 should no mitigation be put in place[19].

Trains, buses, and trams are not competitors. They are meant to work together to create an effective integrated transport network. Investment in rail is a key public transport component that will help transform the current system into a fully' joined-up' network. It will represent a step-change in capacity, accessibility, efficiency, transport integration of the rail network, ultimately boosting the appeal of sustainable mobility.

DART+ aligns with government land use and spatial policies and in particular has the potential to significantly impact land use and spatial planning in the catchment area of the network. Planning authorities will find the commercial and planning proposition to deliver high-density housing developments or otherwise manage impacts of land development in the areas adjacent to the rail network increased because of the high capacity, high-frequency services it enables. By providing higher quality public transport links to Dublin city centre rail network, it will be easier to mitigate any adverse

[16] *https://ec.europa.eu/transport/facts-fundings/scoreboard/countries/ireland/investments-infrastructure_en Rating based on a survey by the World Economic Forum evaluating frequency, punctuality, speed and price of train services. EU value is calculated as a simple average*

[17] http://www3.weforum.org/

[18] *Defined as; congestion levels above those which would be expected on a properly functioning, busy road*

[19] *Department of Transport, Tourism and Sport (2019); The Costs of Congestion: An Analysis of the Greater Dublin Area*

impacts associated with new developments such as car dependency and associated increases in congestion and carbon emissions. This will remove potential barriers to planning authorities where the adverse impacts of development may not fully align with wider environmental policy objectives including sustainable growth. Residential developments in railway catchments are no longer required to provide car parking for each dwelling, in accordance with policies to reduce car dependency. This initiative will only succeed where a high standard of public transport services exists. Rail investment is a vital component to support both future growth and economic competitiveness alongside the creation of sustainable communities.

Of focus are the two Strategic Development Zones (SDZs) on the Kildare Line at Clonburris, Co. Dublin (7,000 – 9,000 residential units plus other developments[20]) and Adamstown, Co. Dublin (8,500 residential units plus other developments[21]). The success of these SDZs is reliant on increased rail capacity and frequency on the Kildare Line. Similarly, the development planned by the Land Development Agency (LDA) in Shanganagh relies on DART+ Coastal South services. Improving the transport options in SDZs where high-density housing developments will be built helps unlock more affordable housing options for prospective buyers in the Eastern region.

The unique advantage that the DART+ Programme brings to the overall public transport system is that it can carry by far the largest volumes of passengers on a corridor by corridor basis and is, with the exception of existing level crossings, fully segregated from other modes, avoiding delays from congestion. Getting passengers who will use DART+ efficiently to and from it by other modes is essential for its success. Integration across the public transport system is vital in unlocking value for money for each investment individually and holistically.

3.6.3 Enabling compact growth

Ireland and the Eastern region have suffered from a legacy of low-density urban sprawl and an over-reliance on the private car that this sprawl encourages. Project Ireland 2040 outlines the need to prioritise compact urban growth and sets a target of delivering 50% of new city housing within the existing Dublin City and suburban footprint.

The guiding principles for growth within the Dublin Metropolitan Region as outlined in the Eastern and Midlands Regional Assembly's RSES, identify Compact and Sustainable Growth as one of these five guiding principles for growth in the region.

This requires a focussed approach to compact, sequential and sustainable development of urban areas from large to small with targets for 50% of new homes to be built within or contiguous to the built-up area of Dublin City and suburbs and a target of at least 30% for other urban areas. To achieve the vision, a key policy response identified for the Dublin City and suburbs is to consolidate population and employment growth with a focus on improving housing supply and amenity provision to create sustainable communities and improve public transport and sustainable travel options.

Compact growth will allow for greater efficiency in the delivery of public services for citizens into the future. DART+ will be able to move high volumes of passengers directly between areas identified for higher-density employment and high-density residential developments, offering scope for new areas to develop along public transport corridors that can support growth into the future.

3.6.4 Assisting in achieving environmental targets

One of the greatest global challenges for this, and future generations is how we address and mitigate the effects of climate change. Ireland has committed to cutting its emissions by 51% between 2018 and 2030 and to net zero no later than 2050. The European Union's non-ETS[22] targets require a 20%

[20] http://www.clonburris.ie/documentation/chapter-1-introduction-.pdf

[21] *https://www.sdcc.ie/en/services/planning/strategic-development-zones/adamstown/adamstown-sdz-2014/section-2-0-proposals-for-development.pdf*

[22] *Any company or body within the EU that emits a large amount of greenhouse gas emissions is included in the Emissions Trading System, commonly known as the ETS for short. All greenhouse gas emissions that are not from companies in the ETS are called non-ETS emissions (SEAI, 2020).* www.seai.ie/data-and-insights/seai-statistics/key-statistics/transport/

reduction in non-ETS sector emissions by 2020 and 30% by 2030 (relative to 2005 levels). However, as estimated by the Sustainable Energy Authority of Ireland, Ireland's non-ETS emissions are likely to be just 1% less than 2005 in 2020.

In 2018 travel by private car was responsible for 40% of all transport emissions, for the same period public transport accounted for less than 4% of emissions.

The 'Climate Action Plan 2019' identifies DART+ is a pivotal investment to tackle this imbalance in emissions and facilitate and encourage a modal shift to public transport and help bring about a reduction in carbon emissions

Expanding the electrified services on the rail system will reduce the reliance on diesel trains and contribute to a decrease in total transport system's greenhouse gas emissions within the Eastern region. Expanded services will attract people away from the private motor car, reducing road traffic emissions. Further investment will allow IE to continue to improve in this area having already achieved a 46% reduction in CO_2 since 2005.

An 8-car DART can transport ~1,200 passengers using electric traction producing zero emissions at the point of use. Rail is approximately six times more energy-efficient than road-based transport. An electric train typically emits between 20 and 35 percent[23] less carbon per passenger mile than a diesel train. Electric trains have zero emissions at the point of use, and their total carbon intensity will continue to reduce as the Government's ambition is that electricity production from renewable energy will increase to 70% by 2030 in line with the Climate Action Plan. In addition, the reduction in emissions at the point of use will benefit air quality in pollution hot spots like the city centre and key stations.

3.6.5 Encouraging and enabling modal shift

While the number and frequency of public transport services can vary, in general the public transport system in the eastern region provides a reasonably high level of service for point to point journeys on many routes. However, connections between some areas requires people to interchange between various public transport modes. At present the integration of services and modes is inadequate in many cases, resulting in a continued reliance on the private car for commuting. There are limited interchange opportunities between rail services on the Heuston corridor and those on the Northern Line and the South-Eastern lines.

These problems are due to capacity constraints at Docklands and Connolly. The convergence of three rail lines to the north of Connolly limits the number of trains that can run through Connolly station to the southside of the city. DART+ eases some of the pressure on these constraints in the medium to long term and will improve the robustness of the timetable by reducing conflicts and improving infrastructure allowing more services into Connolly.

Commuter and longer distance services compete for capacity. This prevents higher frequency and higher-quality rail services along these corridors. The system enhancements included in this PBC aim to meet both commuter and longer distance customer needs through the design phase and dynamic testing of the train service specification chosen for DART+.

The annual 'Canal Cordon Count'[24] which collects data during the AM peak period (07.00-10.00), shows the declining number of people who travel to the city centre by car. However, the overall number of people crossing the canal cordon is higher than ever. There is a steady increase in public transport, walking and cycling over the last decade (see Figure 3.67). Further investment in our transport system is needed to sustain this growth.

[23] *RSSB, Rail Decarbonisation Taskforce, January 2019*

[24] *Every November a count is undertaken of the number of people crossing a cordon around the city centre, formed by the canals.*

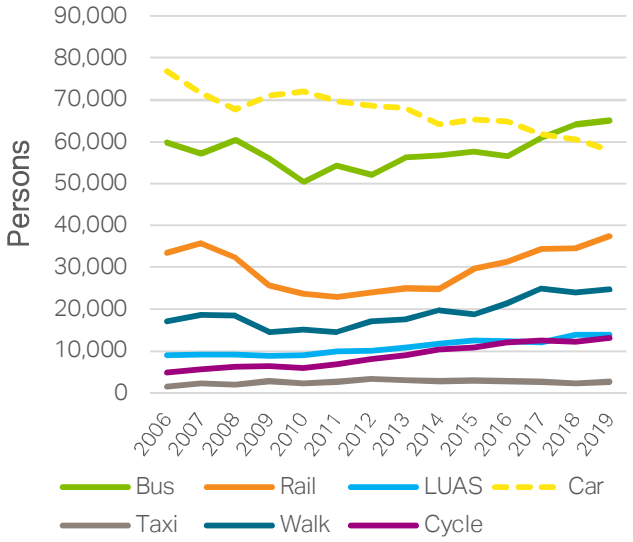


Figure 3.6 - Number of people crossing the canal cordon by mode (2019)[25]

There is an evident need to support and enable the shift to public transport by providing a significant increase in the level and quality of interchange opportunities between public transport modes. Overall the public transport system in the Eastern region needs to go from a system of individual modes to a much greater level of integration of services which benefits transport users throughout the Eastern region.

Existing data from the most recent Census in 2016 shows significantly higher rail mode shares along the higher frequency DART network compared to the Kildare and Maynooth lines. The presence of a high frequency DART service has resulted in an average rail mode share for all people living within 1km of all stations is 13% on the existing DART network compared to 8% on the non-DART network in the Eastern region. This combined with the fact that the stations on the non-DART network have a car ownership rate 3% (70% versus 73%) lower than those on the DART network, could result in a significant move to rail if a higher frequency and more attractive service was available. The existing rail mode share and percentage of households with access to a car are presented below and available in larger format in Appendix B.

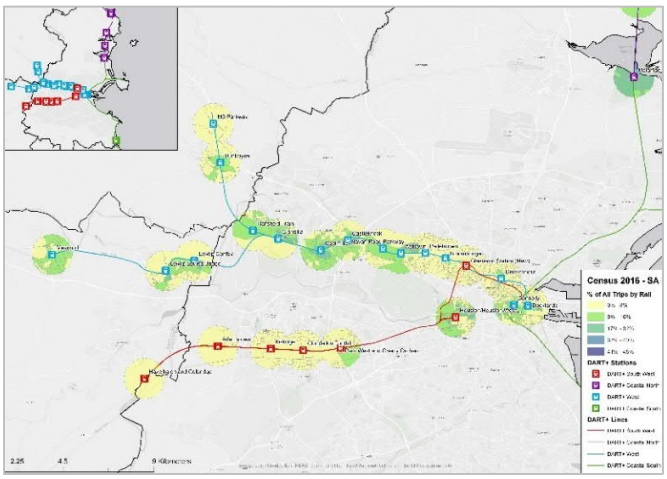


Figure 3.7 – Existing Rail Mode Share within 1km buffer of non-DART rail stations – Kildare and Maynooth Lines

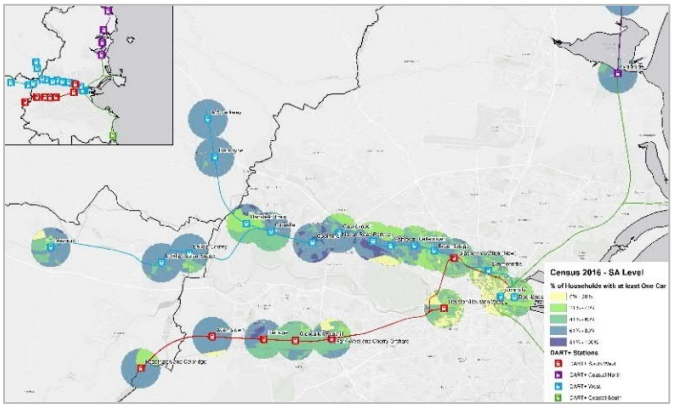


Figure 3.8 – Existing % households which own a car within 1km buffer of non-DART rail stations – Kildare and Maynooth Lines

3.6.6 Modernising the Railway

The first railway opened in Ireland in 1834 and there has been continuous investment in the network since. The first element of the DART network between Bray and Howth was opened in 1984 and was subsequently extended to Greystones and Malahide in 2000. In the intervening period there has been limited significant investment in the network with the exception of the below;

- **Dublin Area Suburban Enhancement Programme (DASH).** DASH Phase 1 was completed in 2005 involved platform

[25] *National Transport Authority, Cordon Count 2019*

extensions to facilitate the operation of 8-carriage DART and commuter trains through the entire DART area, increased from the then 6-carriage maximum; the upgrade of all stations previously without accessibility or with limited accessibility; upgrading the power supply and purchase of the 8520 Class (40 cars at 4x10). No new DART vehicles have been ordered since 2003 with the complete 8100 fleet refurbishment completed in 2007. DASH Phase 2 is the City Centre Resignalling Project (CCRP) and this is ongoing.

- Maynooth Line - The last major upgrade of the Maynooth Line was in 2000 when the section between Clonsilla and Maynooth was converted to double track, mechanical signalling was replaced and CWR laid from Connolly to Maynooth.
- The Dunboyne Rail project was completed 2010, opening the rail line between Clonsilla, Dunboyne, and M3 Parkway.
- Kildare Route Project Phase 1 was the last upgrade and was completed in 2010, boosting capacity on the Kildare Line. In addition, the Phoenix Park Tunnel was opened for use by regular passenger services in 2016.

To ensure the railway network evolves in line with the rest of the wider eastern region transport network further investment is required. In moving to a modern railway system DART+ will enhance the signalling capacity along certain sections, electrify all rail corridors into Dublin City Centre, provide new rolling stock, remove most level crossings and facilitate the reduction of diesel fuelled trains in the Eastern region.

3.7 Long term impact of COVID-19

Government restrictions to control Covid-19 have suppressed travel demand by requiring employees to work from home where possible, reducing public transport capacity, introducing remote learning and restricting travel to local areas for non-essential trips. Furthermore, people are avoiding crowded, enclosed spaces due to the risk of infection and this has reduced demand for public transport and pushed people towards greater car use. This has significantly reduced the number of people using buses to travel into the city centre or across the urban region, but it is important to acknowledge that these are temporary impacts which will shift again once the pandemic has ended.

In the long term, once restrictions are lifted, it is likely that travel demand will return to similar trends observed prior to the pandemic because demand has been artificially suppressed by Government restrictions and public health issues.

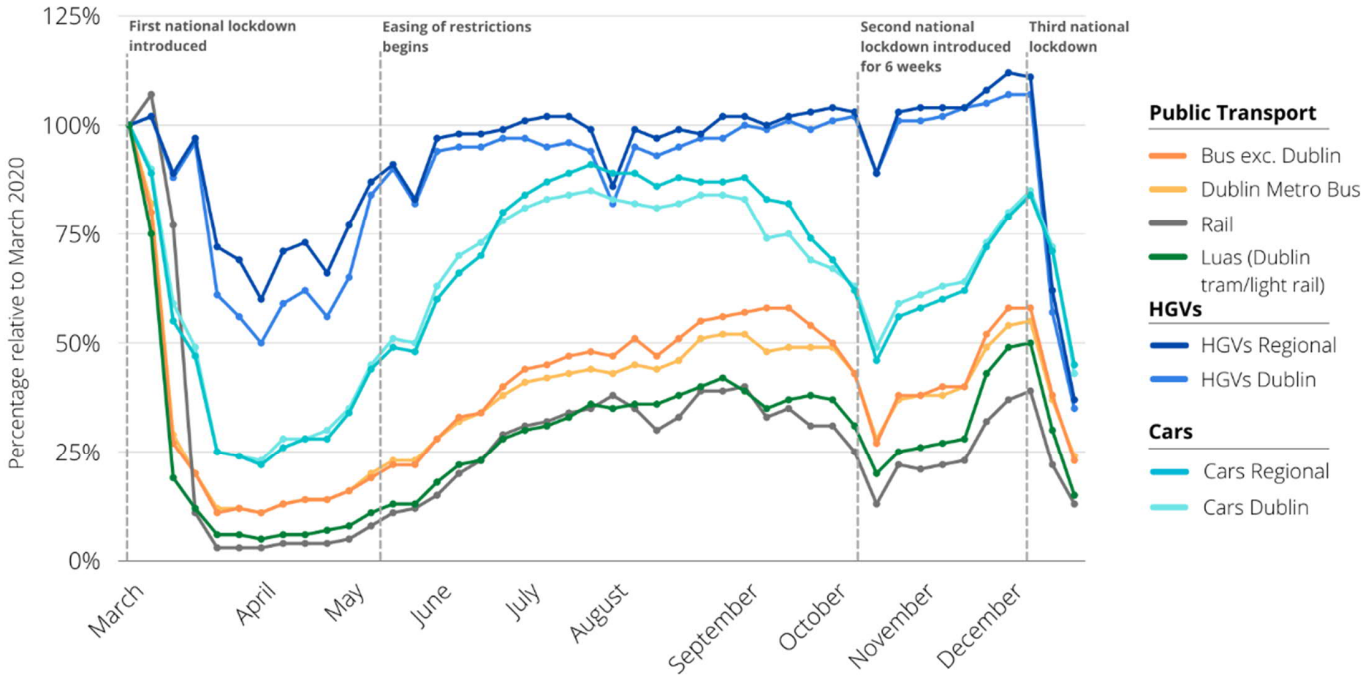


Figure 3.9 Proportion of journeys made by public transport throughout 2020 [26]

Figure 3.910 shows that demand for public transport recovered quickly in June-September and again in December when COVID-19 restrictions were eased, indicating that demand for public transport remains strong.

Yet, it is also important to acknowledge that some more permanent changes to travel behaviour have taken place, such as the accelerated acceptance of home working, teleconferencing for services and home delivery of retail goods which could cause fluctuation in trip volumes and peak times. This issue is explored as part of the appraisal process in the transport modelling sensitivity tests described in Chapter 9. While these changes may affect the demand profile across different times of day and areas of the city, it is unlikely they will substantially reduce the overall demand for public transport usage particularly as the Irish economy is expected to return to growth quickly after the distribution of vaccines, based on performance in 2020. The Economic & Social Research Institute's Quarterly Economic Commentary for Winter 2020 reports Ireland's economy to be one of few in the world to have grown in 2020, and Irish households experienced the fastest growth in disposable income in the European Union in 2020, with household savings increasing by €13 billion in 2020, according to the Central Bank. Future participation in the economy will depend on public transport to support a rapid economic, social and cultural recovery of the sectors hit hardest by the pandemic. In light of this, continued investment in the DART+ Programme is justified to improve conditions for existing rail users, and to increase the appeal of rail travel to attract mode transfer from car users to achieve sustainability policy goals in the years following the pandemic.

[26] *Sources: Public Transport - National Transport Authority (passenger journeys by public transport); HGVs – TII (Average weekly volume of heavy goods vehicles for selected traffic count sites); Cars - TII (Average weekly volume of cars for selected traffic count sites). NB: Rail data includes passenger journeys on Intercity and DART services.*

In the short term, the Government's five-level Living With COVID-19 plan includes restrictions on public transport load factors, with Levels 4 and 5 capping occupancy at 25% of capacity and Levels 2 and 3 capping occupancy at 50% of capacity. This means that service frequency and train lengths may remain unchanged to provide enough capacity for essential travel.

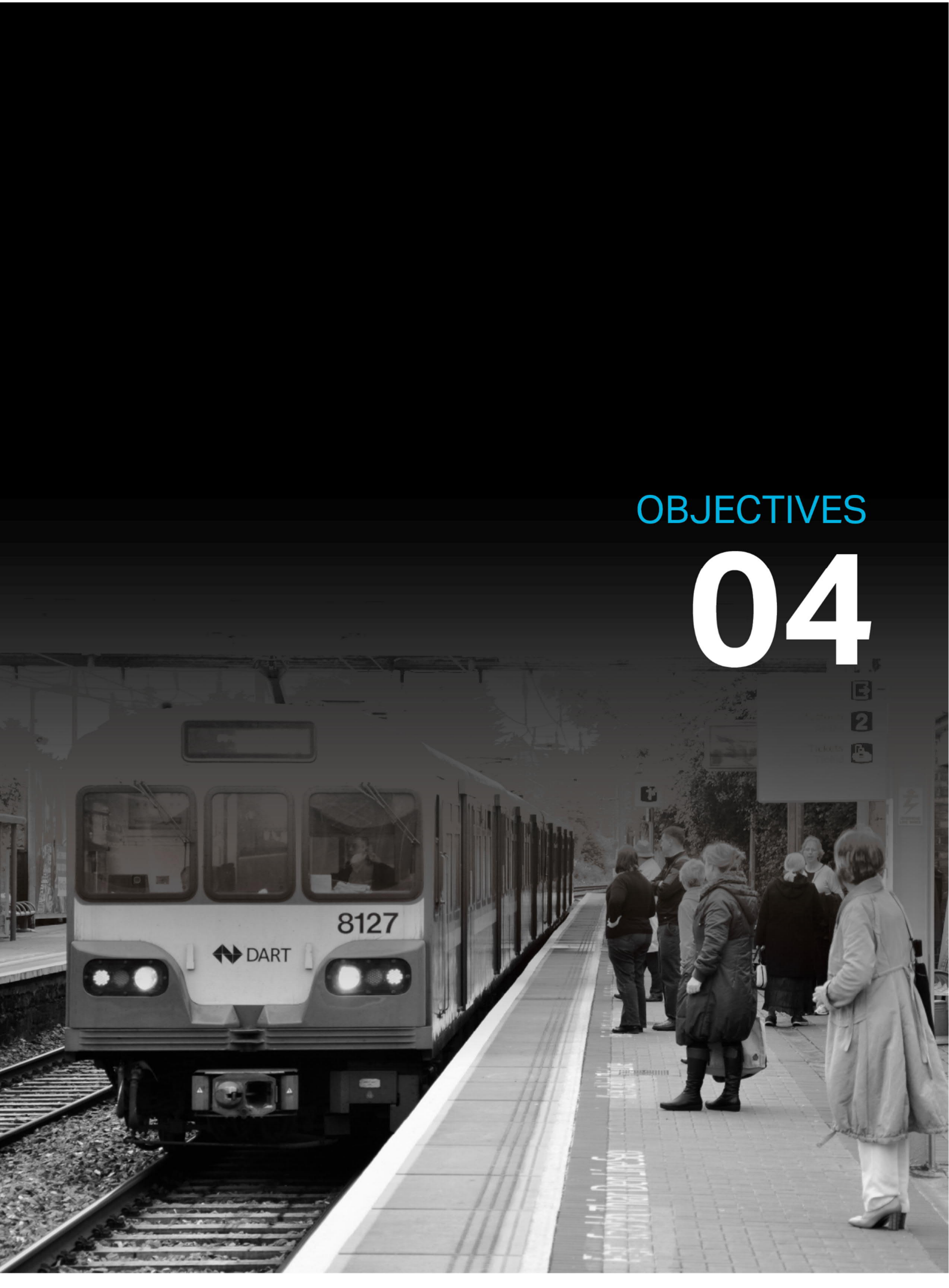
3.8 Conclusion

Ireland is at a tipping point in terms of its approach to sustainable land-use and transport planning and tackling the environmental challenges of climate change. Investment in transport infrastructure is essential to fulfilling the Governments National Strategic Outcomes of Project Ireland 2040, and the impact of the current COVID-19 pandemic is not justification to alter this approach.

Investment in our public transport network forms a key element in addressing the problems outlined in this Chapter. It is also clear that the DART+ Programme forms a key element of land use, economic and transport policy in Ireland and has the support of Government and transport authorities.

OBJECTIVES

04



4. Objectives

The objectives of the DART+ Programme were developed at the Strategic Assessment Stage in the DART+ Programme Strategic Assessment Report. This chapter reassesses these objectives and provides further detail on the performance indictors to support their monitoring and evaluation.

The **primary objective** of the DART+ Programme is to "*Support urban compact growth and contribute to reducing transport congestion and emissions in the Eastern region by enhancing the heavy rail network between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones, providing a sustainable, safe, efficient, integrated and accessible public transport service along these corridors".*

4.1 Objective setting process

Several supporting sub-objectives were defined in the Strategic Assessment Report using the objective setting process outlined below and involved extensive consultation with stakeholders; both internal and external to Iarnród Éireann

- Identified of need/problem – "where we are now"
- Rationale for change – "where we want to be"
- Objective setting – "what we need to achieve to get there"

Need for Intervention– "where we are now"
The need for intervention is set out in Chapter 2.

Rationale for change – "where we want to be"
The objectives need to capture the aims set out below and should allow the impact of DART+ to be measured against them.

- Step change in moving towards a decarbonised heavy rail transport system
- Increased heavy rail and public transport modal share and patronage
- Improved efficiency (all day usage of capacity)
- Reduced journey times for the average heavy rail passenger through higher frequencies
- Improved journey time reliability and punctuality
- Encourage improved spatial planning and densification with commercial and residential development opportunities adjacent to rail stations with higher frequency services.
- Higher standard of customer experience through additional fleet introduction and an integrated fare structure across PT modes.

Objective Setting – "what we need to achieve to get there"
The sub-objectives for DART+ are set out below. These are aligned to the primary objective and provide additional guidance to the programme workstreams. The achievement of these sub objectives will result in the delivery of the primary programme objective. The sub-objectives will form the backdrop for the appraisal of programme options, and should DART+ proceed and be delivered, they will act as a benchmark to evaluate the operational performance of the programme.

As per the guidance set out the in the Public Spending Code and the Common Appraisal Framework, the objectives of the programme are designed to be specific, measurable, achievable, relevant, and time-bound (SMART). The sub-objectives as a whole have been 'mapped' to the six CAF appraisal criteria using an initial non-exhaustive set of indicators. The sub-objectives and indicators for DART+ are set out in Table 3. These are aligned to the primary objective. The achievement of each of these sub-objectives will contribute to the delivery of the primary programme objective. The sub-objectives form the backdrop for the appraisal of programme options and act as a benchmark to evaluate the performance of the programme as part of the business case process set out in the Programme Balance Sheet (PABS) in Chapter 10. In this regard the performance indicators also included in Table 4.1 have been developed to align with the programme objectives.

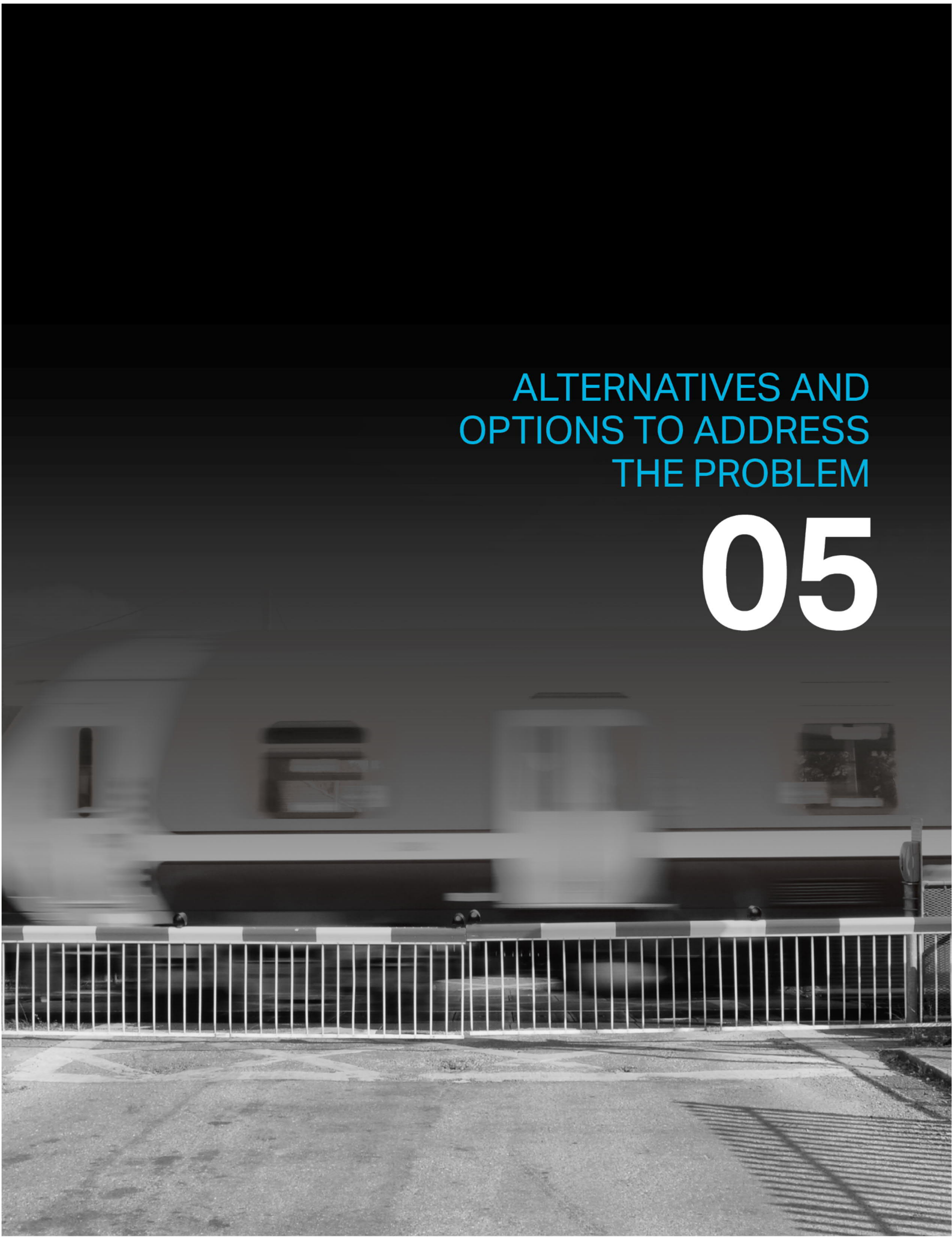
These objectives will be further enhanced as part of the Monitoring & Evaluation performance indicators. As the expected impacts of the DART+ Programme become known through the appraisal and planning processes these will be reflected in these indicators. The current indicators are discussed and presented in Section 14.4.

Table 4.1 – Objectives & Indicators

Sub-Objectives	CAF Criteria	Business Case Indicators
1. Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Eastern region through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth **2.** Improve accessibility to jobs, education and other social and economic opportunities through the provision of improved inter-rail and inter-modal connectivity and integration with other public transport services **3.** Enable further urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the eastern region, for present and future generations, through the provision of a higher capacity heavy rail network **4.** Deliver an efficient, sustainable, low carbon and climate resilient heavy rail network, which contributes to a reduction in congestion on the road network in the eastern region and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets **5.** Provide a higher standard of customer experience including provision of clean, safe, modern vehicles and a reliable and punctual service with regulated and integrated fares.	Economy	• Uplift in public transport usage compared to a counterfactual scenario • Ensure value for money (strong BCR & NPV) • Incrementally increase heavy rail capacity by up to 100% by 2030 to cater for growing transport demand across the Eastern region.
	Environment	• Reduced reliance on the private car resulting in an increase in the modal share of sustainable modes by 2040 • Reduce rail related transport emissions in the Eastern region compared to a counterfactual, at a minimum • Enable the Climate Action Plan 2019 through the delivery of the rail related actions by 2030. • Reduce private vehicle emissions through a mode shift to sustainable modes
	Accessibility and Social Inclusion	• Enhance public transport access to opportunities and services measured through an increase in the number of people within 1km of a higher frequency rail line • Deliver socially inclusive public transport – 50%+ increase in population living in areas defined as deprived, very deprived or extremely deprived by Pobal and/or areas with low car ownership levels that are within 1km of a higher frequency rail line
	Safety and Security	• Improve the safety of the transport system • Protect vulnerable road users through improvements in or removal of rail/road interactions
	Integration	• Enable Project Ireland 2040 & RSES through the delivery of one of the main elements of the transport network by 2030 • Support the development of high-density developments within the catchment of DART+. • Increase in number of trips involving interchange between PT modes by 2040
	Physical Activity	• Facilitate access to public transport by active modes through the delivery of cycle facilities at new and upgraded stations

ALTERNATIVES AND OPTIONS TO ADDRESS THE PROBLEM

05



5. Alternatives and Options to Address the Problem

This Chapter builds upon the initial consideration of alternatives and options in the Strategic Assessment Report for DART+.

The heavy rail network in the Eastern region does not operate in isolation from the rest of the transport system. The question of how to address the issues identified in Chapters 2 and 3, to meet the objectives set out in Chapter 4, must start at the level of the overall transport system. Once the overall role of the railway is confirmed with respect to the other elements of the system, including alternative, or complementary modes, then options can be explored for the railway to fulfil its role and meet its own objectives which were described in Chapter 4.

The heavy rail network in the Eastern region is a valuable existing state asset. Its value has been demonstrated previously through the numerous rail reviews published in the past decades, most recently in 2016. Subsequently the Government have committed to retain this asset and to invest to maintain and upgrade its condition to support future demand. This policy decision was reinforced by the 2015 SIFLT priorities described in Chapter 3, which in turn informed transport strategy development.

5.1 Alternatives

5.1.1 Transport Strategy for the Greater Dublin Area 2016 – 2035

The Transport Strategy for the Greater Dublin Area 2016 – 2035 proposes an integrated multi-modal network to provide for the efficient, effective and sustainable movement of people and goods. It outlines a range of infrastructure and service improvements required to achieve this.

The appraisal undertaken as part of the Strategy development indicated that, if implemented, the measures will have significant positive benefits in terms of decreasing reliance on the private car. As well as the modal shifts highlighted above, the Strategy appraisal also indicated substantial improvements in public transport journey times.

In developing the Strategy, the NTA considered alternative options for the provision of transport services along the six radial corridors into Dublin. Enhancing the existing heavy rail system was found to be the most appropriate solution to meet transport needs of the high-density population centres across the corridors it already served, compared with developing a light rail line or relying solely on bus services.

In addition to DART+, significant proposals outlined in the Strategy include:

- Redesign of the bus network with high-frequency radial and orbital bus routes
- Development of two Metro lines: New Metro North and Metro South (which entails upgrading existing Luas Green line to Metro standard)
- Development of new Luas lines and extension of existing lines and services
- Implementation of the proposals of the GDA Cycle Network plan, entailing the expansion of the urban cycle network to over 1,485 kilometres in length
- Upgraded pedestrian facilities across the region
- National, regional and local road improvements
- Demand management

The appraisal undertaken as part of the Strategy development indicated that, if implemented, the measures will have significant positive benefits in terms of decreasing reliance on the private car.

5.1.2 Role of DART+ in delivering the GDA Strategy

The DART+ Programme (outlined in detail in Section 1) has been developed to respond directly to the requirements of the Strategy and is reflective of the measures identified within it, as outlined in Table 5.1.

Table 5.1 – Role of DART+ in delivering the Transport Strategy for the GDA

Strategy Requirements	DART+ Programme
• The DART services will operate to a high frequency with adequate capacity to cater to the passenger demand. It is anticipated that DART services in the city centre section of the network will operate to a regular ten-minute service frequency in the peak hours from 2016 and will transition to a five-minute service frequency following the completion of the DART+ Programme. • Provide high-quality passenger interchange points, which facilitate convenient transfer between public transport services and modes • Provide fast and convenient access to major travel destinations throughout the region • Deliver reliable and predictable journey times	• Existing bottlenecks in improving the quality, efficiency and reliability of services will be resolved through investment in infrastructure in the form of: o Increased rail capacity in the city centre through works in the Connolly/Docklands environs o Extension of 4-tracking on the Kildare line from Park West to Heuston o Provision of improved turnback at Dun Laoghaire or Bray o Accommodation of new passenger stations based on passenger demands and facilitation of interchange with Bus, Luas and MetroLink services o Enhancements to the line between Bray and Greystones o Removal of level crossings • Significant extension of the extent of DART services through re-signalling and extension of electrification on: o Northern Line from Malahide to Drogheda o Kildare Line from Celbridge/Hazelhatch to Heuston o Phoenix Park Tunnel line o Sligo line from Docklands/Connolly as far as Maynooth and M3 Parkway • Capacity increases will be delivered through the procurement of additional rolling stock and supporting infrastructure.
• Increased passenger capacity on the DART+ Coastal South Rail Line	• DART+ will ease the pressure on some of the existing constraints and will improve the robustness of the timetable by reducing conflicts and improving infrastructure allowing more services into Connolly.

The Strategy identified corridors where enhanced rail services and capacity are appropriate and will deliver the necessary impact and benefits. Improvements to the existing heavy rail system, are only part of a multi-modal strategy. DART+ is part of plans to create an integrated public transport network which when delivered will provide opportunities for more people to travel within the eastern region by multiple modes.

5.2 Programme Infrastructure Options

5.2.1 Infrastructure options in the context of DART+

DART+ Programme is an upgrade of an existing system that includes, in the longer term, a tunnel to connect two parts of the network. Strategic infrastructure options are therefore limited to the arrangements for the tunnel, and the inclusion or not of the tunnel. These build upon the Strategy which defined the extent of the DART+ electrification however the current scope of DART+ does not hinder any future expansion of the DART network beyond the extent of that presented in this PBC.

The infrastructure upgrade presents a series of rail service pattern options. These are discussed in Section 5.3.

5.2.2 Options definition

It is necessary to consider all feasible options that exist and through which the programme objectives could be achieved. In this instance, a "Do Minimum' option was defined for comparison with 'Do Something' options to determine the optimum use of resources.

Five 'Do Something' options were developed to a feasibility stage. A detailed appraisal of the five options was undertaken and approved by the NTA in conjunction with IÉ in 2018[27]. This analysis found that all five options returned a strong Benefit to Cost Ratio and identified the best performing option against the CAF appraisal criteria of Economy, Environment, Accessibility and Social Inclusion, Safety and Security, Integration and Physical Activity.

5.2.3 Option 1: Do Minimum

Appraisal requires the development of a Do Minimum, or counterfactual, which looks at the future situation without the proposed Programme. As the heavy rail system is vital to Dublin, and the national economy, it is assumed that it would not be allowed to degrade. Instead, minimal existing network improvements will be included that maintain the existing system and services. Committed improvements to the rest of the transport system are also included in the Do Minimum in addition to the system in place in 2020. In summary, it includes:

- Various completed and committed road and traffic management schemes
- Additional completed and committed road network schemes
- Completed and committed Public Transport Schemes such as Luas Green Line Capacity Enhancements, NTCC and the CCRP.
- Continued maintenance of the network and fleet renewals.

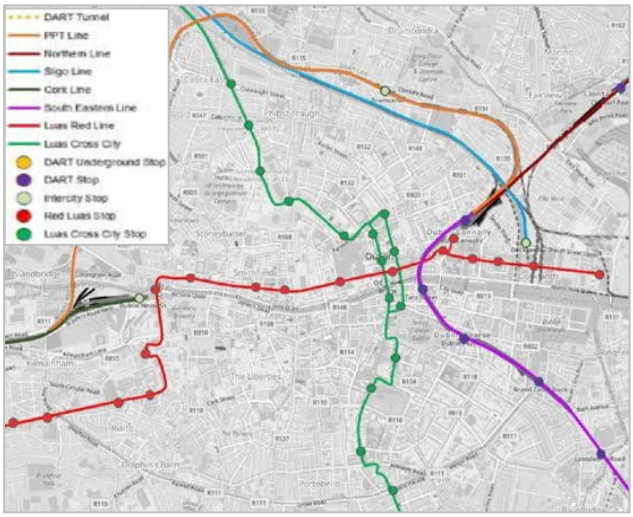


Figure 5.1 – Do Minimum Diagram

The Do-Minimum situation will improve the public transport system, in the Dublin area in particular, however it will not address the fundamental aim of the project or adequately meet the objectives or associated indicators.

All "Do Something" options include a series of heavy rail modifications, improvements and targeted interventions to expand the DART network.

[27] *DART Expansion Programme Options Assessment (NTA, 2018)*

5.2.4 Option 2: Full DART+ including DART Underground

Option 2 includes the Programme elements of DART + as outlined in Section 2.1, as well as the DART Underground elements, described in the 2015 'DART+' Business Case[28]. Option 2 includes:

- Twin bore tunnel to connect the Kildare line with the Northern line beneath city centre
- Four tracking of Kildare line from Park West to tunnel portal and resignalling and electrification from Hazelhatch to tunnel portal
- Removal of the majority of level crossings, resignalling and electrification from Maynooth to Connolly
- Extension of electrification from Malahide to Drogheda
- Delivery of maintenance depot and stabling;
- Additional rolling stock
- Construction of underground stations at Docklands, Pearse, St. Stephens Green, Christchurch, Heuston and Inchicore stations.

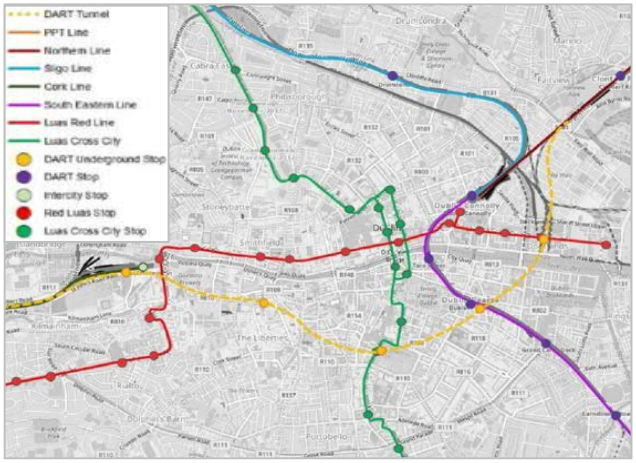


Figure 5.2 – Do Something Option 2 Diagram

5.2.5 Option 3: DART+ including Underground with Heuston Station Turnback

Option 3 is a reduced cost variant of Option 2. Costs are reduced by terminating the DART Underground tunnels at a Heuston Station turnback, as opposed to connecting the tunnels to the Kildare line. The scheme does not allow for the through running of trains from the Northern line to the Kildare line; instead, passengers can transfer from DART Underground services to street level services at a Heuston interchange station.

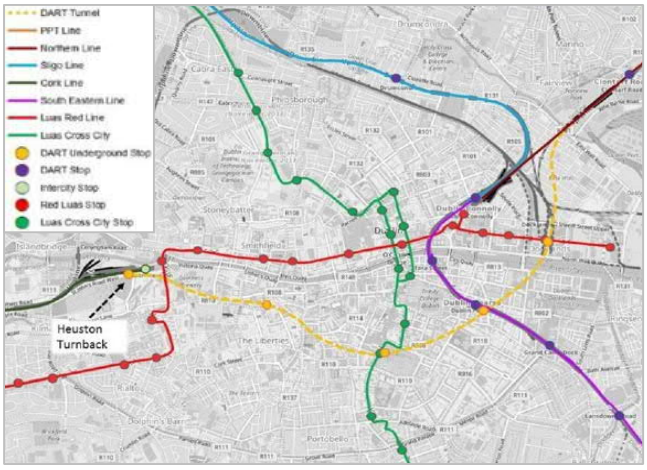


Figure 5.3 – Do Something Option 3 Diagram

5.2.6 Option 4: DART+ including Underground with Pearse Station Turnback

Like Option 3, Option 4 reduces the overall cost of the Programme by reducing the extent of tunnelling. In this variant, Kildare line train services enter the DART Underground tunnels and continue to an underground turnback at Pearse Station. Passengers can transfer from DART Underground services to street level services at a Pearse interchange station.

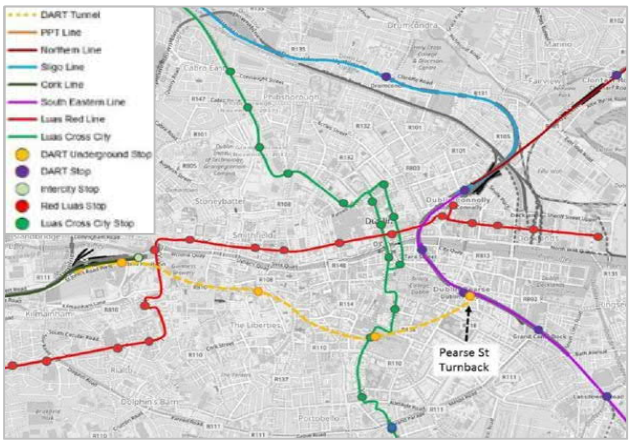


Figure 5.4 – Do Something Option 4 Diagram

5.2.7 Option 5: DART+ including Underground from East Wall to Pearse Turnback

Option 5 differs from Option 2 in that services from the Kildare Line onto the Phoenix Park Tunnel branch line are maintained. The Midland Great Western Railway (MGWR) Rail Line is connected to the DART Underground tunnels at North Wall. The DART Underground continues to an underground turnback at Pearse Station. Maynooth line DART services and Kildare Line DART services could

28 *https://www.irishrail.ie/IrishRail/media/Imported/dart_expansion_programme_revised_business_case_2015.pdfv*

access the underground tunnel. Passengers can transfer from DART Underground services to street level services at a Pearse interchange station. This option requires an interchange station at Glasnevin to allow for the transfer of passengers destined for Connolly station or the DART Underground.

To allow passengers using the Phoenix Park Tunnel line to access Connolly station a new station at Glasnevin is included. This access will enable passengers to transfer to Northern and South East services. Additionally, an improved Docklands station is included within the city centre to improve interchange with the Luas Red line at Spencer Dock.

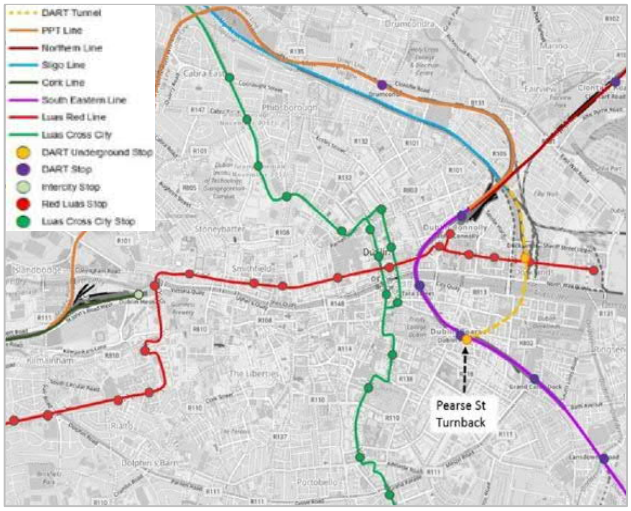


Figure 5.5 – Do Something Option 5 Diagram

5.2.8 Option 6: DART+ with Existing Network Enhancement

Option 6 is the only option with no new underground tunnel. DART services from the Kildare line are maintained through the Phoenix Park Tunnel line. The trains from the Maynooth line, the Phoenix Park Tunnel and the Northern line then converge at the northern throat of Connolly Station and Docklands Station.

This option necessitates improvements in the Connolly/Docklands environs to manage and regulate train movements into and through this congested area. This option retains the use of the Phoenix Park Tunnel and requires changes to the station layouts at Connolly station and Docklands station.

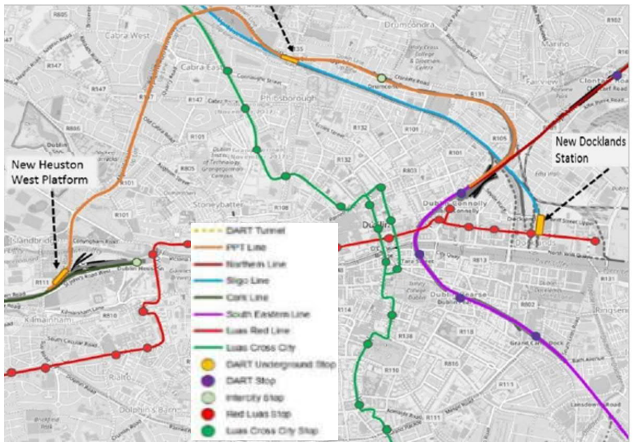


Figure 5.6 – Do Something Option 6 Diagram

5.2.9 Programme Infrastructure Options Assessment

All six options have been subject to a preliminary quantitative and qualitative appraisal to support the option sifting process (Sift 1). This is documented in the 'DART+ Appraisal Report' (AECOM, 2019), which was based on the options presented in the DART Expansion Programme Options Assessment (NTA, 2018[29]) and summarised below. The quantitative assessment of each option was supported by network modelling and TUBA[30] analysis to produce a 'Benefit-Cost Ratio' for each option, shown in Table 5.2. The BCRs ranged from a low of 1.99 to a high of 2.58, indicating that all options represented good value[31]. Options 6 and Option 2 were found to represent the best value.

Table 5.2 - DART+ Preliminary Cost-Benefit Ratios, Sift 1

Option	BCR
Option 1 - DoMin	-
Option 2	2.4
Option 3	2.0
Option 4	2.1
Option 5	2.3
Option 6	2.6

Source: NTA, 2018. DART Expansion Programme Options Assessment.
NOTE: The BCR values presented above are not linked to the BCR presented elsewhere in this report as they are based on different assumptions and economic parameters.

[29] https://www.dartplus.ie/getattachment/4019446c-6e66-4e64-877b-1c408b9900aa/Annex-3-2-DART-Expansion-Programme-Options-Assessment.pdf
https://www.dartplus.ie/getattachment/76ebbb08-391e-4ad0-a776-246921fe637a/Annex-3-2-DART-Expansion-Programme-Options-Assessment-Addendum.pdf

[30] *TUBA takes travel attributes from two scenarios which are derived from transport models and quantifies the economic impact of an intervention based on standard economic variables.*

[31] *A value above 1.5 is considered good value for money according to WebTAG standards*

A qualitative comparison of each option was undertaken via Multi-Criteria Analysis (MCA). Each option was assessed against its contribution to project objectives categorised under the CAF project appraisal criteria:

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

Each option was assessed against the five-point scale outlined in Table 5.3 below.

Table 5.3 – MCA Assessment Scale

Significant advantages over other options
Some advantages over other options
Comparable to other options*
Some disadvantages over other options
Significant disadvantages over other options

**only applied in instances where three or more options are compared against a given criteria*

The outcome of the MCA process found that both Option 2 and Option 6 offered superior outcomes when compared against the remaining options and warranted further investigation (Sift 2). These two options were found to best align with the overarching aim and objectives of the DART+ Programme.

Table 5.4 – DART+ Preliminary Multi-Criteria Analysis, Sift 1, Overall Assessment

Assessment Criterion	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Economy						
Integration						
Safety						
Physical Activity						
Environment						
Accessibility & Social Inclusion						
Overall						

Source: NTA, 2018. DART Expansion Programme Options Assessment.

Following the Sift 1 analysis, both Option 2 and Option 6 were optimised to maximise their performance and so that a fair comparison could be made between them, concerning the Do Minimum.

The Sift 2 analysis found that both options achieve strong BCRs of 2.34 and 2.55 respectively. Additionally, when subjected to sensitivity analysis, the lowest BCR for Option 6 was found to be 2.03 while the lowest for Option 2, which was 1.87.

Due to the exclusion of the tunnelling elements in Option 6, the overall capital cost assumed for the assessment was some €1.75 billion less than Option 2.

5.2.10 *Infrastructure Options Assessment Summary*

The MCA identified Option 2 and Option 6 to be the best performing options.

Option 6 compares favourably with Option 2 as follows:

- Option 6 has a BCR of 2.55 compared with 2.34 for Option 2 although the monetised benefits of Option 2 exceeded those of Option 6 reflective of the extent of the investment.
- Option 6 also showed a stronger BCR in sensitivity testing
- Option 6 is significantly more affordable than Option 2 because it excludes the tunnelled elements.

Based on this assessment, Option 6 was taken forward for further analysis and subjected to a more detailed assessment in line with the requirements of CAF and the PSC. The outcome was approved by both IE and NTA.

5.3 *Supporting Infrastructure Options*

5.3.1 *Docklands Station*

The existing Docklands station does not have the connectivity or the capacity to accommodate the planned future Train Services Specification (TSS). The station is not linked to the Northern or Phoenix Park lines and has only two platforms. A separate study to identify the preferred scope of works for Docklands station was undertaken by AECOM[32] on behalf of the NTA. The objectives were to identify

[32] https://www.dartplus.ie/getattachment/f0c43875-e8ee-43d0-8d12-8be296b5f1b5/Annex-9-2-Docklands-Station-Options-Study-Options-Sift-2-Report,-AECOM-on-behalf-of-the-NTA-14th-Feb-2019.pdf

the preferred location and layout of the station with the aim of achieving the minimum train capacity requirement, which would best serve the needs of the Docklands area and maximise interchange potential with the Luas. The study also included a comprehensive analysis of the station and how it is accessed, including all connecting rail alignments bounded by and including Newcomen, North Strand and East Wall Junctions and freight traffic from East Wall Yard.

Figure 5.7 - Preferred Docklands Station Options

The study considered a long list of 12 options for the development of Docklands station. These options included the movement of the station to alternative sites in the vicinity of the current station and an option to further develop the existing station to provide for additional capacity and connectivity. Options were then shortlisted based on feasibility and subjected to a multi criteria assessment to identify the best performing options. This identified two optimum locations for an upgraded Docklands Station. One is its current location (Option A), with new platforms, station buildings and rail connectivity. The other is at a new location adjacent to Spencer Dock Luas stop (Option B).

Further analysis of these two options has shown that Option B would provide a positive return on the additional investment costs and is aligned with long term transport policy for the region, given its close proximity to high density offices and the improved interchange with Luas and bus provided by this option.

However, considering the additional investment required to develop a new station at Spencer Dock, further optioneering analysis was undertaken by the DART+ West Multi-Disciplinary Consultant (MDC) prior to a final decision on which option to proceed with.

This study assessed five options as set out below.

Table 5.5 – Shortlisted Options for MCA1

Option	Location	Description
A1	Current Station Location	Retains existing platforms and canopy with additional platforms to east.
A2	At the end of Park Lane	New Station accessed off Sheriff Street.
A3	At the end of Park Lane	New Station accessed off Sheriff Street with Pedestrian and Cycle link to East Wall.
B1	Mayor Street Lower -	Platforms and tracks angled relative to Park Lane
B2	Mayor Street Lower	Platforms and tracks parallel to Park Lane

Source: IDOM-ROD

These five station configurations were brought forward to a MCA1 process. This process identified two preferred options – A3 and B2.

Figure 5.8 - Docklands Station Option A3

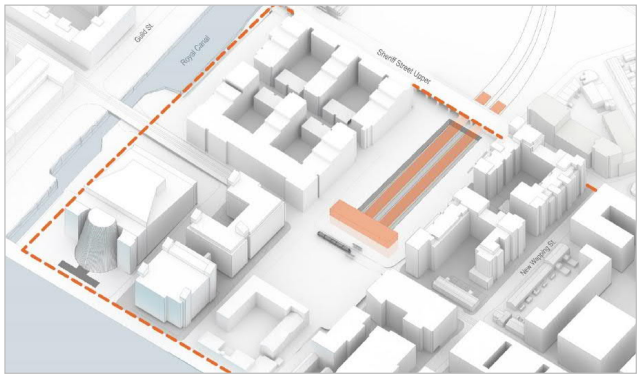


Figure 5.9 - Docklands Station Option B2

These options were subjected to further analysis which fed through to a MCA2 process, the outputs of this are presented in Table 5.6.

Table 5.6 – MCA2 Results

Criteria	Option A3	Option B2
Economy	Some comparative advantage over other options	Some comparative disadvantage over other options
Integration	Significant comparative disadvantage over other options	Significant comparative advantage over other options
Environment	Significant comparative advantage over other options	Significant comparative disadvantage over other options
Accessibility & Social Inclusion	Some comparative disadvantage over other options	Some comparative advantage over other options
Safety	Some comparative disadvantage over other options	Some comparative advantage over other options
Physical Activity	Comparable to other options	Comparable to other options
Preferred Option	No	Yes

Source: IDOM-ROD

This analysis arrived at the same conclusion that the option to relocate Docklands Station to Spencer Dock should be advanced as the preferred option for capacity enhancement in the Docklands Area with the Existing Docklands Station retained for stabling purposes. It was noted that the design progress should seek to mitigate the environmental impacts during both construction and operation.

Detailed architectural thematic proposals in respect of Options A3 and B2 are included in the appendices of the Docklands Station Options Study Report[32].

5.4 Programme Operational Options

An assessment process was undertaken in parallel with the business case to identify the optimum train services specification (TSS) to operate in 2028, both with and without the expanded DART+ network in place. This formed the basis of the Do-Minimum and Do-Something scenarios for DART+.

5.4.1 Establishing the Baseline Train Services Specification

A baseline TSS for DART+ was defined for infrastructure Option 6 at feasibility stage. The TSS adopted the "balanced city centre flow principles" which are explained in 5.4.2 Train Service Options.

The TSS was taken forward to test the maximum level of service that could be provided under the balanced city centre distribution flow principle and with the defined scope of DART+. The assessment was undertaken by the DART+ West Multi-Disciplinary Consultants (MDC) using Railsys and other analysis tools. This assessment produced the Baseline Scenario TSS for DART+. It forms the central case for the demand assessment for DART+.

The level of service by section generated in the Baseline Scenario TSS can be seen in Figure 5.2.

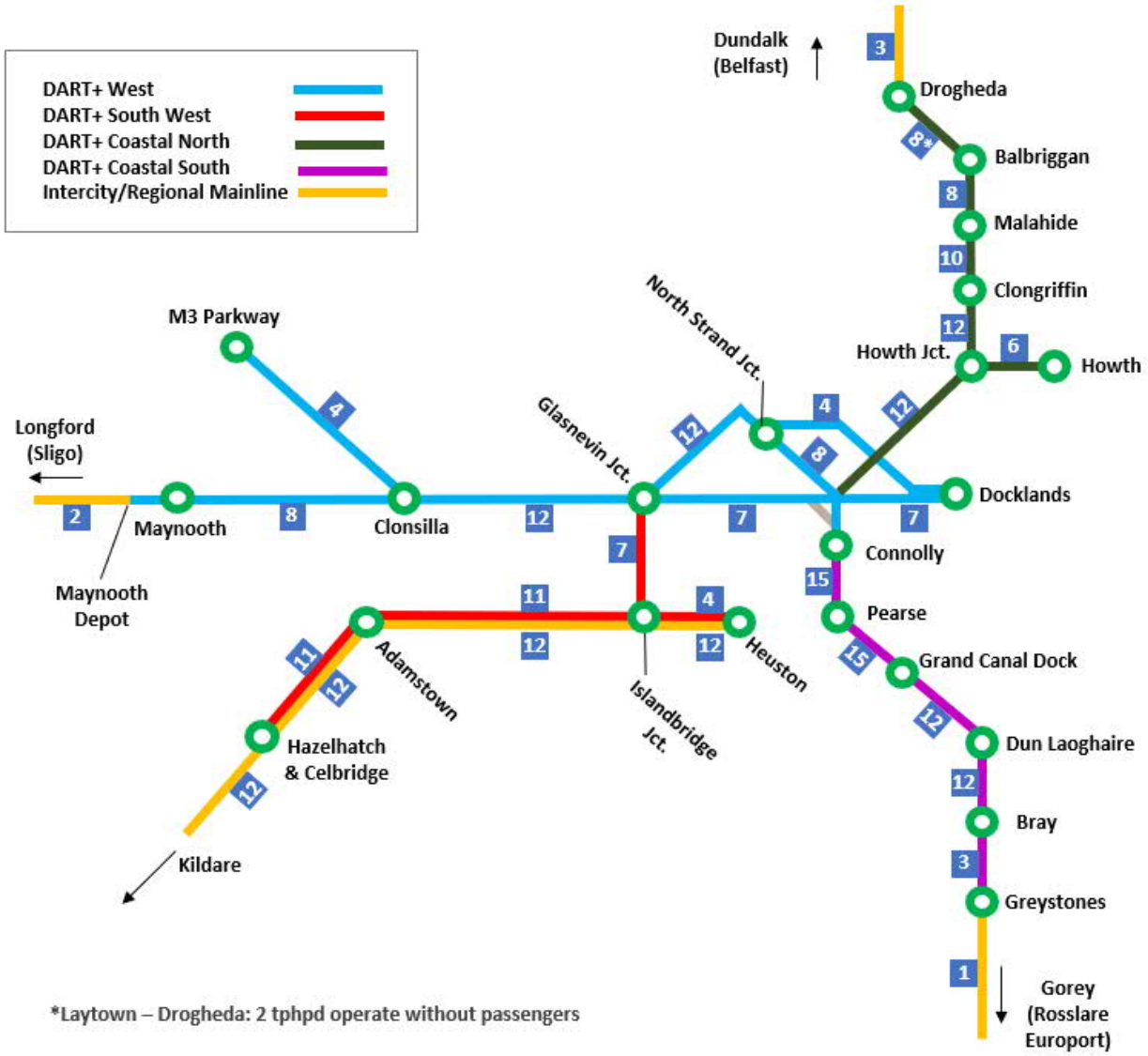


*Figure 5.10 - DART+ Programme Baseline Scenario TSS Outputs – Trains per Section***

***For demonstration of section capacity levels only by DART+ Brand. Service flow principles covered in next section.*

5.4.2 Train Service Options

Do-Minimum – The Do-Minimum TSS is the operational capability of IÉ in 2028 prior to the opening of DART+. The Do-Minimum was developed taking cognisance of the improved services that can be operated allowing for the additional 41 ICR intermediate cars on order being placed into service. The operating principles, in terms of what is the origin and destination station of each service, which services use each station and the interchange principles, have been largely retained in this Do-Minimum scenario.

Do-Something – The DART+ infrastructure enhancements and additional fleet opens up options for the operation of the expanded DART network of DART+. An overview of the options assessed, and the findings of this process are set out below:

1. Baseline Scenario – Balanced Flow Principles
   This scenario used the TSS produced by the DART+ West MDC. The key elements are as follows);

   - DART+ defined infrastructure
   - Mixed service (north and west run south) through Connolly, priority for northern

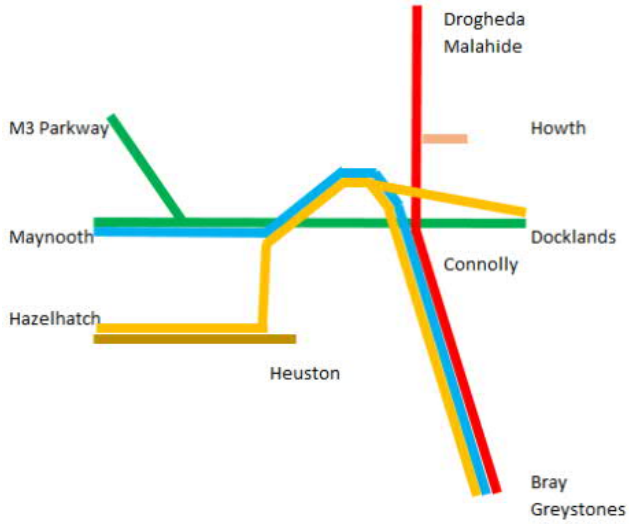


Figure 5.11 – Baseline scenario TSS flow principles

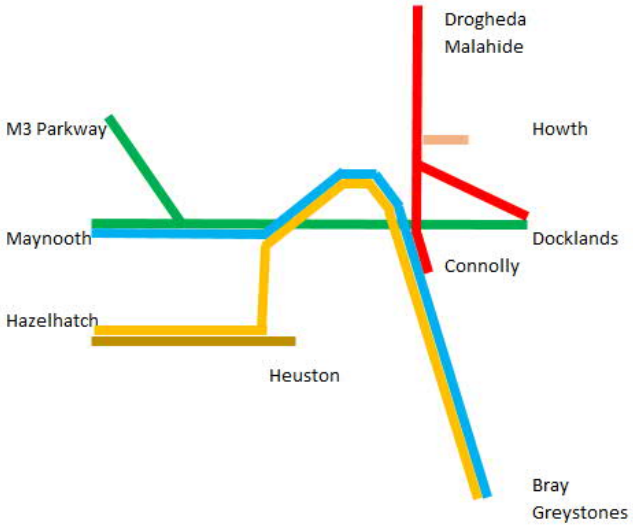


Figure 5.12 – Alternative scenario TSS flow principles

The main issues which it aimed to address were;

- The facilitation of Intercity/long-distance services in the timetable
- Minimising the impact of flat junctions on service levels
- Providing the maximum level of service within the limited capacity of certain stations such as Connolly

As part of the assessment undertaken by the DART+ West MDC, an alternative operation principle was tested using the same infrastructure as the Baseline Scenario TSS. This 'Alternative Scenario TSS' and its principles are highlighted below;

2. Alternative Scenario Flow Principles – The key elements of this scenario are as follows:

- DART+ defined infrastructure
- Separated service pattern through Connolly (west runs south, north terminates).

For completeness, a third TSS was produced by the DART+ West MDC. This was based on a scenario of enhanced infrastructure works beyond the scope and budget of DART+. This exercise tested what additional capacity could be achieved through defined additional infrastructure. The principles of the Enhanced Infrastructure Scenario are seen below;

3. Enhanced Infrastructure Scenario Principles – The key elements of this scenario are as follows;

- DART+ defined infrastructure plus a new overbridge at Connolly, a new chord at Glasnevin, and a new platform at Drogheda.
- Mixed service pattern (north and west go south, balanced numbers) through Connolly.

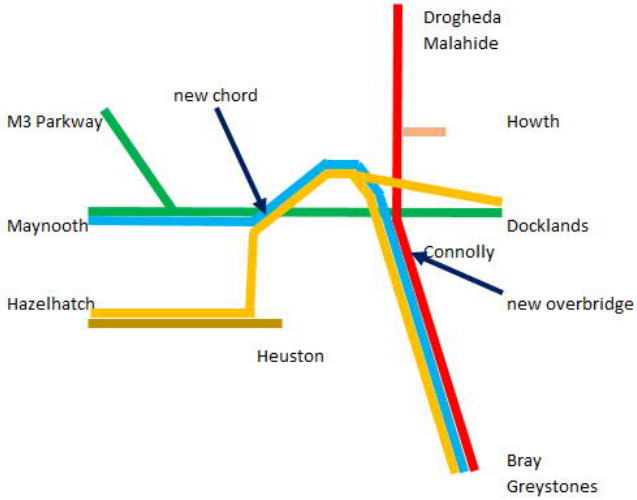


Figure 5.13 – Enhanced Infrastructure Scenario TSS flow principles

For the purposes of PBC modelling the Baseline Scenario TSS was used as the Do-Something Scenario for opening and future year as this uses "balanced city centre flow principles". This decision was based on detailed analysis using the NTA ERM to understand the impact of each TSS Scenario on passenger demand and the scale of user benefits. However, the Enhanced TSS scenario requires significant additional capex costs to deliver while both the Alternative and Enhanced scenarios cost more to operate than the Baseline scenario. Overall, when both the benefits and costs are accounted for the Baseline TSS scenario emerges as the most cost-effective option for use in the Preliminary Business Case.

The implementation of the Baseline Scenario TSS would facilitate a doubling of capacity in the Eastern Region in a single peak hour as can be seen in Table 5.7 below. The single peak hour service levels achieved by the Baseline Scenario TSS will operate over a triple peak hour instead of a single peak hour in the Do-Minimum scenario, creating a transformative capacity change for passengers and facilitating additional journeys.

Table 5.7 – Current Single Peak Hour Capacity versus DART+ Baseline Scenario TSS Capacity[33]

Current Single Peak Hour			DART+ Baseline Scenario TSS - Single Peak Hour		
Commuter route	No. of services	Capacity	Commuter route	No. of services	Capacity
DART Southbound	6	6,600	Coastal Southbound	9	10,800
Northern Commuter	5	4,780	Northern Commuter	2	1,480
DART Northbound	6	6,300	Coastal Northbound	12	14,400
Commuter South Eastern	1	300			
Western Commuter	6	4,990	Western Commuter	2	1,480
			Western DART	10	12,000
PPT (Hazelhatch - Connolly)	2	700	PPT (Hazelhatch - Connolly/ Docklands)	7	8,400
Heuston Commuter	4	1,200	Heuston Commuter	4	4,800
Total:	**30**	**24,870**	**Total:**	**46**	**53,360**

Robustness testing of the Baseline Scenario TSS has been performed, concluding it provides not only a significant capacity increase, but also a greater level of robustness than exists currently, which will benefit passengers. The adoption of the Baseline Scenario TSS as the central case for the modelling in this Preliminary Business Case does not preclude the Alternative Scenario TSS from being implemented with the current scope and budget of DART+. The impact of the implementation of the Alternative Scenario TSS versus the existing capacity is seen below in Table 5.8

[33] *Peak hour traffic to the city centre (Connolly, Docklands, Heuston)*
Capacities based on current planning capacities in the absence of any known new fleet capacities:
8-car Electric Multiple Unit (EMU) – 1200 passengers (150 passengers per car)
6-car Diesel Multiple Unit (DMU) (class 22000) – 740 passengers

Table 5.8 – Current Single Peak Hour Capacity versus DART+ Alternative Scenario TSS Capacity[34]

Current Single Peak Hour			DART+ Alternative Scenario TSS - Single Peak Hour		
Commuter route	No. of services	Capacity	Commuter route	No. of services	Capacity
DART Southbound	6	6,600	Coastal Southbound	11	13,200
Northern Commuter	5	4,780	Northern Commuter	2	1,480
DART Northbound	6	6,300	Coastal Northbound	13	15,600
Commuter South Eastern	1	300			
Western Commuter	6	4,990	Western Commuter	2	1,480
			Western DART	13	15,600
PPT (Hazelhatch - Connolly)	2	700	PPT (Hazelhatch - Connolly/ Docklands)	10	12,000
Heuston Commuter	4	1,200	Heuston Commuter	5	6,000
Total:	**30**	**24,870**	**Total:**	**56**	**65,360**

5.4.3 Other Operational Considerations

Traction Power - An NTA report[35] assessed the traction power options for the DART extension project. The report concluded that "*The best overall life cycle cost for the DART+ system is given by full electrification on all lines. This is lower than the alternatives of no additional electrification and using electric/diesel bi-modes or Electric Multiple Units (EMU)/Battery Electric Multiple Units (BEMU)".*

Electrical Current – The existing DART electrification extends from Malahide and Howth to the north of Connolly, to Greystones in the south. IÉ commissioned a number of studies/papers between 2011 and 2019 to identify the preferred option for rail electrification i.e. including:

- Electrification Study, April 2011
- Rolling Stock Options Assessment, March 2019
- Jacobs-Systra Electrification Study, April 2019

The Electrification Study supported previous findings and concluded that "*The study has determined cost savings and risk minimisation advantages in proceeding the DART+ extensions at 1500v DC.*" The main benefits of this approach were outlined as:

- Avoiding early redundancy of the existing fleet
- Avoiding change to 50km of existing line (33% of DART+)
- Minimizing service disruption and bridge adjustments over existing network.

The study also concluded that proceeding with an extension of the existing 1500v DC network for DART+ would not rule out the option of electrifying the intercity network using a 25kV AC system at a later date, if required. In terms of protecting and allowing for long term expansion of electrification to the intercity network it was concluded that dual voltage multiple units (vehicles which can operate on both 1500v DC and 25kV AC systems) are readily available and only marginally more expensive than standard units. Additionally, a 25kV AC electrified Intercity service could operate in parallel with the DART+ DC system on 4-track section between Dublin Heuston-Hazelhatch and Celbridge into Dublin Heuston. Where parallel operations are not possible e.g. Dublin-Belfast, dual voltage can be used.

The above conclusion was adopted by IÉ. It was therefore adopted as the basis for the

[34] *Peak hour traffic to the city centre (Connolly, Docklands, Heuston)*
Capacities based on current planning capacities in the absence of any known new fleet capacities:
8-car EMU – 1200 passengers (150 passengers per car)
6-car DMU (class 22000) – 740 passengers
[35] *NTA, DART Extension Traction Power Options, 2019*

specification, approved by the NTA, for the procurement of the fleet for DART+, which is currently ongoing as part of the DART+ Fleet Project.

5.5 Programme Fleet Options

An important aspect of DART+ is the decision on the type of rolling stock to be procured. The decision on which propulsion system to proceed with has an impact on the type of infrastructure required, the operational performance of the fleet and by correlation the service specification which can be delivered. Fleet selection also impacts the phasing of project delivery and the timeline for the realisation of transport user benefits.

In assessing alternative options for the additional vehicles to be procured as part of DART+ consideration has been given to the type of propulsion systems to be utilised and how the operational performance of these vehicles aligns with IÉ service and maintenance requirements across the DART+ commuter network.

In assessing fleet options, a number of solutions were identified which allowed for flexibility and which would deliver the targeted additional network capacity requirement while mitigating risks associated with construction delays or funding.

This assessment[36] has considered a variety of propulsion technologies available including;

- Diesel mechanical or hydrodynamic
- Diesel electric
- Electric
- Hydrogen fuel cell
- Diesel electric with electric (Bi-Mode)
- Battery Electric Bi Mode.

5.5.1 Diesel mechanical or hydrodynamic

The propulsion from these vehicle types is derived from a diesel engine via a mechanical or hydrodynamic transmission. This vehicle type is carbon emitting at the point of use but does not require investment in additional Overhead Line Equipment (OHLE) and can operate independently of the electrified network. While a large percentage of the Iarnród Éireann fleet (Class 2600's, 2800's, 29000's and 22000's) is made up of this proven technology, the procurement of pure diesel based rolling stock is no longer aligned to Iarnród Eireann's strategic objectives and commitments to support wider national environmental policies and the development of a low carbon transport network. As such the option of procuring this vehicle type to cater for current and future demand was dismissed.

5.5.2 Diesel Electric Vehicles

Diesel electric vehicles utilise an on-board diesel engine to drive an electric generator/alternator which produces electricity to drive onboard electric motors. They offer advantages over diesel mechanical vehicles due to their improved efficiency, simplified coupling arrangements and their ability to provide electric braking, diesel electric vehicles but they are still based on a diesel engine for their power source and are carbon emitting at the point of use. As such the option of procuring this vehicle type to cater for current and future demand was dismissed.

5.5.3 Electric Vehicles (EMUs)

Electric rail vehicles are powered by an overhead line (or 3rd rail), in this case a 1500vDC system. Power is delivered from the OHLE (Overhead line equipment) via a pantograph and traction converter to traction motors on the underside of the vehicle.

Electric rail vehicles have a number of advantages over diesel-based vehicles. As the vehicle is powered by a series of electric motors, acceleration is generally better than that of comparable diesel vehicles, as is the braking performance which benefits from the ability to operate regenerative braking. Electric vehicles are also quieter and more efficient to operate and maintain than diesel vehicles. The fuel used to power electric vehicles is drawn from the national grid where electricity can be produced by renewable sources, while the reduced number of mechanical components and the reduced reliance on mechanical braking reduces the cost and complexity of maintenance and improves vehicle reliability.

All vehicles currently in service within the existing DART fleet are Electric Multiple Units (EMUs). i.e. 8100's, 8500's, 8510's and 8520's.

5.5.4 Hydrogen fuel cell

A vehicle based on hydrogen fuel cell technology uses hydrogen carried onboard the vehicle to

[36] *Irish Rail, Rolling Stock Options Assessment, 2019*

supply the fuel cell which combines the hydrogen with oxygen to produce electricity from an electrochemical reaction. This electricity is then used to drive electric motors similarly to how traction is generated in diesel electric vehicles and electric vehicles.

While hydrogen fuel cell technology has the potential to become a sustainable and clean method to produce electricity in the future, the technology is still relatively new and limited by the cost of the generation of hydrogen and the difficulty associated with the distribution and transportation of the fuel.

5.5.5 Diesel electric with electric (Bi-Mode)

Bi-Mode diesel electric vehicles can take the power necessary to run traction motors from the OHLE or from an onboard generator and diesel engine. This is advantageous as it allows the vehicles to operate outside the confines of the electrified network. Such vehicle types provide flexibility for operators and allow for the extension of services without the need for additional investment in infrastructure. Additionally, as the vehicles are powered by electric motors while operating under the OHLE the performance characteristics are akin to that of a pure electric vehicle in terms of the rapid acceleration and deceleration required while operating a busy commuter service.

Such vehicles require the installation of electric components as well as diesel vehicle traction components. While efficiencies can be realised by the installation of smaller diesel engines than would have been otherwise fitted to pure diesel vehicles, such vehicle types have the potential to increase capital and maintenance costs as well as maintenance complexity.

Bi-Mode diesel electric vehicles are also carbon emitting at the point of use while operating outside the electrified network.

5.5.6 Battery Electric Bi Mode (BEMU)

As opposed to being solely powered by OHLE or on-board diesel engines, battery powered vehicles are powered by both the OHLE and onboard batteries which power onboard traction motors via a traction converter.

Battery electric trains can operate away from an electrified area and can assist with extending services beyond an electrified network. Similarly, to electric vehicles they provide a cleaner, low maintenance, flexible and reliable solution in comparison to diesel-based alternatives and are zero carbon emitting at the point of use.

When combined with a pantograph charging system the BEMU option provides a number of advantages. The procurement of BEMUs allows for the provision of additional services prior to the completion of OHLE extension works. This mitigates the risk of programme delays associated with construction or funding. This flexibility is also beneficial from an operational perspective as the battery propulsion capability allows for the operation of services during OHLE outages. With the provision of BEMU charging and maintenance facilities at existing and new depots the BEMU option provides a desirable level of flexibility and ability to extend services beyond the electrified network if required.

5.5.7 Assessment of options

Options have been subjected to a MCA against the criteria of:

- Electrification costs;
- Rolling stock costs;
- Operating costs;
- Operational flexibility; and
- Environmental benefits.

Each option has been scored in accordance with the ranking scale illustrated in

Table *5.9* below, with the result displayed in Table 5.10.

Table 5.9 – MCA Ranking Scale

Major Negative	1
Moderate Negative	2
Minor Negative	3
No / Negligible Impact	4
Minor Positive	5
Moderate Positive	6
Major Positive	7

Table 5.10 – Results of Multi Criteria Assessment

	Electrification costs	Rolling stock costs	Opex[37]	Flexibility	Environmental
Diesel mechanical or hydrodynamic	7	4	2	5	1
Diesel electric	7	4	2	5	1
Electric (EMU)	3	5	7	4	7
Hydrogen fuel cell	7	1	2	6	5
Diesel electric with electric (Bi-Mode)	7	2	1	6	3
Battery Electric Bi Mode (BEMU)	5	3	6	6	6

5.5.8 Fleet Options Conclusion

The output of this assessment of fleet options determined that the EMU and BEMU options performed well with regard to the assessment criteria. A combination of the two technologies is effective approach to delivering the additional services planned for the DART+ Programme while also mitigating against the risks associated with construction of the extended electrification system.

The EMU fleet was attractive from the point of view of operational costs and the environmental benefits associated with the technology. Additionally, Iarnród Éireann are experienced with the technology from operating the 8100, 8500, 8510 and 8520 fleet, thus minimising the risks to operation and maintenance of the expanded fleet. Conversely, the BEMU option offered several advantages over the other technologies particularly in allowing the delivery of services prior to the completion of OHLE construction activity.

For the purposes of this business case it is assumed that an order of 260 vehicles (or 19 Half Length Units (HLU) and 23 Full Length Units (FLU)) is progressed. This includes 52 BEMU's (or equivalent to provide 13 HLU[38]) and 208 EMU's. The proposed number of 13 HLU BEMUs is based on a direct replacement of the current number of DMUs serving the Northern Line originating or terminating at Drogheda. Further information on the rationale is provided in the Rolling Stock Options Assessment Report[39].

5.5.9 Implications on Existing Fleet

In terms of cascading of the existing fleet post-DART+ implementation, an assessment was undertaken by Jacobs[40] for the NTA to determine a cascading strategy of the Iarnród Éireann fleet to 2035. One of the key components of this assessment was the implications "phasing in a new fleet of electric vehicles to 2035, some of which are also equipped with self-power capability to operate over an extended range in the Dublin area". This report was completed in 2019. Some of the existing diesel fleet will be reallocated to improve services in other parts of the heavy rail network as part of the proposed strategy.

5.5.10 Depot and Stabling Arrangements

Given the scale of the major investment in new fleet as part of the DART+ Programme, a new depot and increased stabling is required to maintain the additional DART fleet. The following section will outline the assessments undertaken as part of DART+ to determine the optimum location and layout for the depot, and the approach for establishing the stabling.

Depot

Location MCA

In 2019, Iarnród Éireann undertook a site assessment report to detail the rationale used in determining the most appropriate strategic location on the network for locating this new maintenance depot. This assessment built upon data collated since 2007 when consideration of a new DART Depot was first assessed.

The new maintenance depot will serve to examine, maintain, and overhaul EMU rolling stock at the necessary intervals recommended by the supplier and in accordance with Iarnród Éireann safety requirements.

The report set the scope of the depot requiring it to accommodate 240 EMU DART carriages at any given time and provide all maintenance functions

[37] *Operating Expenditure*
[38] *"HLU" means a Half Length Unit; a Unit with a driving cab at both ends that, when combined with another HLU, shall have a maximum length of 168 metres from body end to body end.*
[39] *NTA, Rolling Stock Options Assessment, 2019*
[40] *NTA, Fleet Strategy, 2019*

to maintain a fleet of up to 600 EMU DART carriages.

Each of the strategic locations was subject to a preliminary pre-appraisal using the minimum functional site thresholds and satisfying a number of high-level principles. Following the pre-appraisal, a consistent set of assessment criteria was used in the formal appraisal. While this study is focussed specifically on location assessment the criteria in the main align with applicable topics that should be considered under a qualitative appraisal as identified in DoT's Common Appraisal Framework for Transport Projects and Programmes.

13 locations were assessed in the pre-appraisal stage, with four locations shortlisted for consideration in the location appraisal. The shortlisted locations are general geographic zones and not taken to individual site areas and were as follows;

- Drogheda Environs
- Maynooth Environs
- M3 Parkway Environs
- Hazelhatch Environs

The MCA appraisal was undertaken based on a 5-point scale as set out below.

Table 5.11 – MCA Assessment Scale

Score	Description
Most Preferable	Significant advantages over other options
Preferable	Some advantages over other options
Neutral	Comparable to other options
Not Preferable	Some disadvantages to other options
Least preferable	Significant disadvantages to other options

Based on the assessment criteria and the methodology applied, Maynooth West and Hazelhatch West were the two-best performance in the assessment. Maynooth West was ultimately appraised as the preferred for location of the new DART+ Maintenance Depot. Maynooth West achieved a higher ranking than Hazelhatch West by virtue of better road access and less negative impact on the delivery of DART+.

Table 5.12 –Summary of Site Appraisal

	Drogheda South	Drogheda North	Maynooth East	Maynooth West	M3 Parkway South	M3 Parkway North	Hazelhatch East	Hazelhatch West
Minimised empty running								
Maximise track access								
Complexity of access & egress								
Availability of suitable lands								
Adjacent environment								
Road vehicle access								
Transport and Land Use compliance								
Short term impact on DART+ Programme								

Further information is provided in the Depot Location Selection Report - Centre of Excellence DART Expansion Maintenance Depot – Location Assessment found in Appendix D.

Depot Options Report

In 2020, the DART+ West MDC prepared a Depot Options Report. The report included a Depot MCA with the objective to compare some key parameters for each alternative and to highlight the emerging preferred one. The report also included a Depot Road Access MCA.

For the Depot MCA, the alternatives consist of different layouts of the tracks and facilities according to the assumed depot requirements.

Table 5.13 presents the scoring of the criteria for all alternatives.

Alternative 3 was been selected as the Emerging Preferred Option and it was be taken forward in the reference design.

The main merits of this alternative are related to economy (providing the most functional layout although it supposes higher construction and long-term cost), integration (considering adaptability for link futures facilities), accessibility & social inclusion and safety.

The demerits are related to environment where land occupation and agricultural impacts are higher.

Alternative 3 Details:

- Stabling (two-ended tracks) and Main building are adjacent in the central area.
- Area: 326.389 m2
- Length along main line: 2,58 km
- Earthworks: 608 m3 cut / 587.518 m3 fill
- Tracks length: 18,7 km
- Turnouts: 76 units
- Carriageways + parking area: 33.686 m2

The layout of this arrangement is presented in Appendix C. Further information is provided in the Depot Location Selection Report - Centre of Excellence DART Expansion Maintenance Depot – Location Assessment found in Appendix D.

Table 5.13 – Depot MCA

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Economy						
Integration						
Environment						
Accessibility & Social Inclusion						
Safety						
Physical Activity						

Depot Road Access Multicriteria Analysis

The overview assessment approach is similar to the Depot Multicriteria Analysis and consists of four options. Figures for each option are included in Appendix C.

Table 5.14 presents the scoring of the criteria for all alternatives.

Option 4 was been selected as the Emerging Preferred Option and it will be taken forward in the reference design.

Option 4 provides road access from the R148 road (connecting traffic to Maynooth and Kilcock interchanges) that requires the construction of a new bridge, which is related to the operation of the mainline because of the singularity of OBG23, which has a clearance issue with the OHLE when doubling track. This is Jackson´s Bridge, and it is protected (Categories of Special Interest: Architectural Historical Social Technical). The bridge (over the Royal Canal) and the Royal Canal drop are dated from 1793. The new OBG24 enables a new connection to the R148 crossing the canal and the mainline for the depot access and for the road network located south of the mainline.

The main merits identified for Option 4 related to economy (providing clear improvements in journey time), integration with the existing road network, accessibility & social inclusion, safety and physical activity.

The demerits are related to its construction and long-term maintenance costs and the environment where excavations and works of the new bridge pose a higher potential risk to groundwater quality and soils, however some mitigation measures could keep this issue under control.

Greater detail on the alternative Options 1 to 3 can be found in Appendix C.

Table 5.14 – Depot Road Access MCA

	Option 1	Option 2	Option 3	Option 4
Economy				
Integration				
Environment				
Accessibility & Social Inclusion				
Safety				
Physical Activity				

New DART Maynooth West Depot Scope

The new depot will be constructed under DART+ West, with twin track installed between Maynooth station and the new depot to improve capacity in the section to the depot site. Resignalling from Maynooth station to the depot will also take place. Per the 2019 assessment, the depot is being designed to support the full 600 vehicles, with 40%, or 240 vehicles, of the new DART+ fleet located at the Maynooth depot each night. The depot is however, being designed to be built in

phases to accommodate the full fleet of 600 vehicles.

The depot is designed around the concept of being a centre of excellence for EMU maintenance. The depot will provide the facilities for the vast majority of light maintenance, wheel turning and all of the heavy maintenance for the EMU fleet. The train wash and service slab will be provided near the eastern mainline connection to provide a logical flow through site. The depot provides 15 stabling sidings which will each cater for 2 x FLU's (or 30 train sets) which accounts for 40% of the fleet to be utilised for passenger traffic. In addition to these stabling sidings, the depot can cater for an increased level of rolling stock within the physical depot & service roads while being maintained.

The depot is now in Preliminary Design phase with development ongoing.

Existing Commuter and DART Depots

The DART+ Coastal MDC will determine the extent of the modifications required at the existing DMU depot at Drogheda and the existing DART depot at Fairview to support DART+.

Stabling

The DART+ West MDC is developing a Stabling Strategy for the DART+ Programme. It will determine the stabling and sidings required to accommodate the DART+ fleet which will operate the Train Service Specification for DART+ discussed in Section 5.4.1. The outcome of this strategy can be inserted in a later iteration of this Preliminary Business Case when the assessment is concluded.

5.5.11 Overview of DART+ Programme

The above options assessment process identified a preferred scope for the DART+ Programme. An overview of the DART+ Programme which forms the basis of this Preliminary Business Case is provided below.

DART+ will comprehensively upgrade the DART and Commuter railway services in the Eastern region. It will have a transformative impact, resulting in a lower-carbon and higher capacity heavy rail system with more attractive, frequent and reliable passenger services which integrates with the wider transport network. It will be achieved by electrifying the lines, purchasing more rolling stock, re-signalling, removing majority of level crossings and other infrastructure works. Iarnród Éireann (IÉ) have divided the DART+ Programme into five separate "Projects" based on the following considerations;

- The type of design work needed for each element and where efficiencies could be identified by grouping certain elements.
- The interdependencies where elements are reliant on others i.e. City Centre and Maynooth line which form part of one corridor. The City Centre element is reliant on the Maynooth Depot whilst Maynooth is dependent on station capacity delivered by City Centre enhancements.
- Sequencing – No trains could be added to the other lines until electrified access to the Maynooth Line depot was provided – this dictated that this line was the first to be electrified.
- The need for investment – initial demand modelling had shown that highest latent potential capacity requirement was on the Maynooth line. This in turn influenced the sequence of the other elements with the Kildare line having the next highest latent potential capacity requirement.

The first Project, DART+ Fleet, details the rolling stock requirements of the Programme. Each of the remaining Projects details the infrastructure improvements required to achieve the expanded DART network.

Table 5.15 – Projects of the DART+

	Elements	DART+ Project
1	Rolling Stock	DART+ Fleet
2	City Centre capacity Enhancements and the Maynooth Line	DART+ West
3	Kildare Line	DART+ South West
4	Northern Line	DART+ Coastal North
5	South East Line	DART+ Coastal South

As Sponsoring Agency, IÉ are responsible for the delivery of all Projects.

Additionally, and outside the scope of the business case for DART+, the alignment for the DART Underground will be considered by the NTA in parallel and the corridor required for its future delivery protected. A summary of the elements within the scope of DART+ are outlined below.

Table 5.16 – Projects of the DART+

	Deliverables
DART+ Fleet	• Procurement of 260 vehicles (or 19 HLU's and 23 FLU's) • Provision of train simulators to support driver training • Provision of an Automated Visual Inspection System for Fleet Monitoring and Maintenance • Provision of a Technical Support and Spares Supply agreement for the first 15 years of the unit's life
DART+ West	• Electrification between Maynooth/M3 Parkway and Connolly/Docklands • Re-signalling between Maynooth and Connolly • Upgrades at Connolly and Docklands • Relocation of Docklands station to a new site at Spencer Dock • Removal of level crossings • Construction of new depot west of Maynooth with twin track installed and resignalling from Maynooth Station to the depot • Construction responsibility for a new DART station and alignment work at Glasnevin[41].
DART+ South West	• Extension of 4-tracking on the Kildare line from east of Park West station to Heuston station • Re-signalling and electrification from Hazelhatch & Celbridge station to Heuston station and re-signalling and electrification on the Phoenix Park Tunnel (PPT) line (Islandbridge Junction to Glasnevin Junction) • Upgrade of 6 bridges along the line for clearances. Studies required for others on PPT line • New station at Heuston West
DART+ Coastal North	• Electrification from Malahide to Drogheda • Track reconfiguration at Clongriffin and Howth Junction & Donaghmede stations • Bridge reconstructions and civil works to support the electrification and capacity increase. • Re-configuration and upgrading of the existing depot at Fairview
DART+ Coastal South	• Turnback facility at either Dun Laoghaire or Bray • Removal of level crossings • Bray-Greystones enhancements

DART+ will increase peak passenger capacity of the rail system into Dublin City Centre from circa 26,000 passengers per hour in 2019 to circa 50,000 in 2028. Expansion of DART services will address capacity constraints across the Dublin commuter/DART network. The extent of DART+ is shown in

Figure 5.14. DART+ is a vital element of the NTA's Transport Strategy for the Greater Dublin Area 2016-2035 and of Project Ireland 2040. As part of an integrated transport system, DART+ will provide options to citizens and encourage a move away from private cars to public transport. This programme will contribute to the reduction in greenhouse gas emissions and support a transition to a low carbon and climate-resilient society in alignment with the Climate Action Plan 2019.

Figure 5.14 – Extent of DART+

[41] *Glasnevin interchange design and Railway Order with TII*

COSTS
06

6. Costs

6.1 Introduction

This Chapter deals with the costs associated with the construction, maintenance, operation, and renewal of DART+ Programme.

6.2 Capital Costs

The costs for DART+ infrastructure and rolling stock have been forecast throughout the full project lifecycle. The Feasibility Working Cost Estimates are based on high-level Phase 2 concept designs, where available, for the infrastructure elements of the programme. Costs estimates have allowed for all aspects of the planning and delivery of DART+ including:

- Railway Order and Planning
- Programme management
- Detailed Design
- Signalling
- Electrification
- Building and Civil Works
- Rail Works
- Rolling stock
- Property

Fleet costs are based on the actual costs from the preferred bidder in the recent rolling stock tender.

The infrastructure cost forecasts will be revised and updated in line with section 4.7 of the public spending code (a Guide to Evaluating, Planning and Managing Public Investment) as the assumptions on which these forecasts are based become clearer and as design and procurement processes advance.

Costs have been based on 2017 market costs which have been adjusted and re-baselined to reflect 2019 market prices and include risk contingency provisions appropriate to the programme.

Costs have been developed in line with PSC guidance based on conceptual design information and a mixture of top down and bottom up costing of the various elements.

The Feasibility Working Cost Estimate for DART+ is illustrated in Table 6.1.

This profile shows the costs associated with each element of the programme, giving a total cost of approximately €2.960 billion **inclusive of risk contingency, VAT and cost escalation.** The total risk contingency provision is €441 million, the total VAT provision is €335 million, and the total cost escalation provision is €474 million.

Component	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total (000's)
DART+ West	14,025	10,537	13,137	6,249	128,148	396,671	373,425	27,391	-	-	-	969,582
DART+ South West	4,175	7,425	10,351	6,532	90,995	259,158	220,093	57,424	-	-	-	656,153
DART+ Coastal Northern	-	4,736	7,170	11,777	10,492	88,719	162,733	142,000	14,643	-	-	442,269
DART+ Coastal Southern	-	861	895	1,271	471	20,733	70,761	67,677	28,990	167	-	191,826
Rolling Stock (EMU/BEMU)	-	70,206	44,323	10,640	50,573	139,357	64,514	135,051	71,065	75,840	38,669	700,239
Total	**18,200**	**93,764**	**75,876**	**36,469**	**280,678**	**904,638**	**891,526**	**429,543**	**114,698**	**76,007**	**38,669**	**2,960,069**

Table 6.1 - Feasibility working cost profile (€ 000's)

Note: Values may not add up exactly due to rounding

Cost benchmarking

As part of the AECOM cost peer review (2020), a high-level cost benchmarking exercise was carried out by AECOM on behalf of IE on a number of comparable projects including Network Rail's (NR) National Electrification Railway Programme in the United Kingdom which was delivered over the period 2010 to 2014. The programme is an appropriate comparator to DART+ as it includes the electrification of nine rail lines as part of a high capacity 'electric spine' passenger and freight route from Yorkshire and West Midlands to Southampton with total cost of £4.2 billion.

This review provided early sight of any potential risks surrounding the cost forecasts, this includes COVID-19 impacts where possible. The review focused on the areas outlined below.

- Checking the broad magnitude of quantities alongside the project scope
- Checking that unit rates are appropriate
- Reviewing mark-ups and ensuring necessary allowances are included
- Reviewing price bases and escalation assumptions to ensure all costs are quoted in a consistent price base
- Benchmarking and reference class forecasting based on comparable projects from other jurisdictions.

The UK NR benchmark project costs were escalated 27.7% from Q4 2014 base cost to Q4 2019 using the BCIS Infrastructure Tender Price Index and converted to Euro (1.15 exchange rate). The direct costs were then compared at all elemental level based on Single Track Kilometres (STK).

Both DART+ and the National Electrification Programme share comparable cost rates for electrification and signalling upgrade of existing rail lines and Supervisory Control and Data Acquisition (SCADA) costs and temporary and enabling works. The building and civil engineering works (bridge works, level crossing & retaining structure) in the NR programme were less extensive than DART+. Consequently, the DART+ Programme costs are significantly higher on a cost/km basis for Maynooth and Kildare lines but similar for the Coastal Line.

For example, the Maynooth Line cost/km under 'Building & Property' element is significantly higher than the NR cost/km due to the new depot west of Maynooth. Kildare line civils and permanent way cost/km is higher due to the amount of bridge works and the addition of 5km of new double track between Parkwest and Heuston station, which is provided to increase capacity from two/three track to four tracks.

The AECOM cost peer review (2020) focused on an elemental review of the project costs, key unit rates, preliminaries, project management allowances, escalation, risk/contingency and a benchmarking study. In addition, the peer review compared the costs across the DART+ Projects and found they had been developed in a consistent manner with respect to cost rates used and the approach to estimating items such as design, management, and inflation.

The elemental costs and key unit rates were benchmarked against other major infrastructure projects including HS2 and local costs on Luas projects.

The following is an extract from the benchmarking section of the peer cost review;
'In March 2019 the UK Railway Industry Association published a major report on the Electrification projects in the UK and made comparisons between them and some relevant European Projects. In the report named RIA Electrification Cost Challenge (Mar 2019), it noted the difficulty with undertaking benchmarking and ensuring consistency in scope across the comparisons. They noted there was a significant variation between projects and therefore, they focused on the 'core electrification' items which are less variable namely the Overhead Line (OLE), Power and Distribution and the relevant proportion of design and project delivery costs, which we have focused on for the DART+ benchmarking analysis. The report outlined three separate categories and the associated cost ranges per STK;

- *Low (simpler) £825k - £1,100 /STK*
- *Medium (complex) £1,100k- £1,650/STK*
- *High (abnormal) £1,650k-£2,750/STK*

The RIA report does not specify a baseline date for the costs, but we have assumed the costs are Q1 2018 as the report was developed in 2018. When adjusting for currency and escalation, the DART+ costs fall within the upper range of the medium

category at £1,600/STK for the same scope which includes supply, install of OHLE and associated Design, Management and Risk provision.'

As the DART+ programme is not considered to be technically complex, this benchmarking exercise gives confidence that the cost forecasts are robust for this stage of design.

The cost estimates were also independently reviewed in 2014 by both AECOM and Gardiner & Theobald and recently by NTA, the Approving Authority. The outcome of the Approving Authority's consultant review was confirmation of a "*reasonable degree of confidence in the cost estimate prepared by Irish Rail*".

6.3 Risk & Contingency

Risk and Contingency has been included based on a percentage of direct and indirect costs and varies across the different Projects. The AECOM cost peer review (2020) included a top down assessment of risk and contingency requirements with reference to the following as the basis for the assessment:

- DART+ current estimate stage
- Network Rail Governance for Railway investment Projects (GRIP) stage
- AECOM Recommended Estimating Contingency Allowances table
- NTA Cost Management Guidelines

An overview of the table used in deriving a recommendation for calculating a risk contingency to be applied to projects across the five cost estimate stages is provided in Table 6.2. The rows are represented as follows:

- Green: Maps UK Parliamentary design across the development stages i.e. CP1-6 up to G3. This has been used only to provide a reference guide as to the current equivalent stage of development of DART+
- Light Blue: Maps the AACE estimate stages across the development stages. This has been used only to provide a reference guide as to the current equivalent stage of development of DART+
- Dark blue: Maps the Network Rail GRIP stages across the development stages. This has been used only to provide a reference guide as to the current equivalent stage of development of DART+
- Grey: This maps the AECOM Estimating stages across the development stages. These Risk and Contingency guide ranges have been developed through our team's involvement in many infrastructure projects over a significant period of time and reflect primarily linear assets such as railway and highway projects

The conclusion of the AECOM cost peer review (2020) was that the current DART+ Estimate represents an AACE Class 4 Estimate. A Class 4 Estimate is used for project screening, determination of feasibility options, concept evaluation and a preliminary budget approval.

Table 6.2 – Contingency applied to DART+ elements

Development Stage

UK Parliamentary Design Checkpoint Stages	Parliamentary Design		Programme & Project Development		
Stages	CP1-6	CP7-8	G1	G2	G3
AACE Class of Estimate	5	4	3	2	1
Level of Project Definition (i)	0-2%	1-15%	10-40%	30-70%	50-100%
Network Rail GRIP Stages	1	2	3	4	5
Recommended Max Allowance (ii)	60%	40%	QCRA	QCRA	QCRA
AECOM Estimating Recommended Contingency Allowances	5	4	3	2	1
Land & Property	+40% to -20%	+20% to -15%	+15% to -10%	+10% to -5%	+5% to -3%

Development Stage

UK Parliamentary Design Checkpoint Stages	Parliamentary Design		Programme & Project Development		
Civil Engineering	+100% to -50%	+50% to -30%	+30% to -20%	+20% to -15%	+15% to -10%
Stations (Surface)	+60% to -30%	+40% to -20%	+30% to -15%	+20% to -10%	+15% to -5%
Depots & Stabling	+60% to -30%	+40% to -20%	+30% to -15%	+20% to -10%	+15% to -5%
Railway Systems	+50% to -25%	+30% to -20%	+25% to -15%	+15% to -10%	+10% to -5%
Rolling Stock	+60% to -30%	+40% to -20%	+30% to -15%	+20% to -10%	+15% to -5%
Corporate Overheads / Indirect Costs	+25% to -20%	+20% to -15%	+15% to -10%	+10% to -5%	+5% to -3%

Notes:

i. *This is used to show how the class of estimate compares to other comparator stages. It does not reflect a contingency calculation. It is included for guidance only.*
ii. *Recommends using judgement to explain if application of percentages vary across different assets due to complexity, design development etc.*
iii. *AACE Class of Estimate refers only to project definition and is not a contingency allocation guide.*
iv. *The vertical column shaded grey represents our view as to the current development stage of DART+ and the range of applicable Risk and Contingency percentages.*

The current Feasibility Working Cost Estimates are based on concept designs with varying levels of definition. The basis of the risk/contingency allowances noted above is a top down assessment of each of the Projects undertaken as part of the cost peer review. The cost peer review of the DART+ contingency considered the DART+ current estimate stage, NTA contingency cost guidance included in their 2020 Cost Management Guidelines (Draft), the AECOM Recommended Estimating Contingency Allowances and the Network Rail Governance for Railway Investment Projects (GRIP) gateway process used for managing project delivery. The Estimate stage is considered level 4 in line with AACE International Estimate Classification System. The majority of the current level of design definition is aligned to the GRIP stage 2, with some elements stage 1 and some stage 3. Taking the above into consideration, we developed a range of contingency costs across each of the direct and indirect elemental costs for each Project which resulted in some projects having a higher contingency allowance due to the risk profile being greater. The variance in the contingency across the different Projects is outlined in Table 6.3. The blended contingency allowance is 35% and the total risk contingency budget is €435m (before VAT and Inflation).

Table 6.3 – Contingency applied to DART+ elements

Project	Element	Lower bound -15%	General Risk / Cont.	Upper bound +20%
DART+ West	Maynooth Line	8%	23%	43%
	City Centre	28%	43%	63%
	Depot	18%	33%	53%
	Glasnevin	18%	33%	53%
DART+ South West	Kildare Line	28%	43%	63%
DART+ Coastal North	Northern Line	18%	33%	53%
DART+ Coastal South	Southern Line	18%	33%	53%
DART+ Fleet	Fleet	Costs based on tendered rates		
	Total Blended	**20%**	**35%**	**55%**

Optimism Bias is the demonstrated systematic tendency for appraisers to be over optimistic about key project parameters, including capitals costs, operating costs, project duration and benefits delivery.

The NTA Project Approval Guidelines (December 2020) note that for preliminary cost estimates, the risk of optimism bias should be minimised through

the use of appropriate tools, such as external peer review, benchmarking and reference class forecasting. In arriving at the risk contingency percentages noted above, considerations include the current stage of DART+ estimate development, the robustness of unit rates and allowances used in developing the cost estimates. The cost estimate has also been informed by two recent independent cost peer reviews which included benchmarking and referencing outturn costs of other major infrastructure projects.

The guidance in the HM Treasury Green Book suggests a total risk provision (contingency, risk and optimism bias) range between 40 and 57% for Rail projects. The DART+ risk provisions are in line with this guidance with the upper bound costs having a total risk provision of 55% based on the blended allowances across all projects per Table 6.1. In developing the costs, the PBC assumes there will be no exceptional capacity or capability concerns with the supplier market. Therefore, any potential demand pressure is considered to be an inflationary risk. Given the absence of data the long-term impact of COVID-19 or any other such pandemic have not been assessed at this point in time.

As the programme progresses a Quantitative Cost and Schedule Risk Assessment (QCRA/QSRA) will be undertaken on both the programmatic risks and the specific risks included in each package's risk register. Additional benchmarking/reference class forecasting will also be undertaken to mitigate against optimism bias in the cost estimate. This will allow for the refinement of the contingency/risk budgets.

6.4 *Inflation*

The forecast inflation included in the cost forecasts are as follows; 5% in 2020, 4% in 2021, 4% in 2022, 3% in 2023 and 2.5% between 2024 and 2029.

These allowances have been compared against the inflation provisions included in two other major UK rail infrastructure programmes and are broadly in line with these examples. However, considering the implications of COVID-19 and the potential impact of complying with associated Government health and safety measures on construction tender price inflation this will need to be kept under review.

The cost estimate is highly sensitive to the assumptions around forecast inflation. The inflation assumptions are estimates based on current trends in the market, though there is an absence of any definitive construction inflation forecasting for rail-specific infrastructure in Ireland.

6.5 *Lower and Upper Bound Costs*

Lower and upper bound costs were developed for the capital costs based on varying levels of contingency and inflation in line with AACE International recommended practices.

Table 6.4 – DART+ Cost Ranges

Component	Lower Bound @ 20% contingency and -1% inflation	Base Case @35% blended contingency	Upper Bound @ 55% contingency and +1% inflation
	Total (€, million)		
DART+ West	€806	€970	€1,190
DART+ South West	€564	€656	€806
DART+ Coastal Northern	€368	€442	€543
DART+ Coastal Southern	€159	€192	€236
Rolling Stock (EMU/BEMU)	€683	€700	€718
Total	**€2,580**	**€2,960**	**€3,493**

The lower and upper bound costs have been appraised in the economics appraisal chapter of this PBC to provide the Approving Authority with the implications of a fluctuation in scheme costs.

6.6 *Cost assumptions*

The cost forecasts are underpinned by several assumptions as outlined in Table 6.5. These assumptions will be updated as additional information becomes available and as design and procurement activities advance.

Table 6.5 – Assumptions

Category	Assumption Detail
Infrastructure works cost basis	Cost estimates for infrastructure works are based on Feasibility Working Cost Estimate reports already prepared by IÉ (price base date Q4 2019 after escalating previous baseline Q4 2017 prices by 5% per annum).
Rolling stock cost basis	Cost estimates for rolling stock are based on the preferred bidder costs for an EMU/BEMU (costs of car units and capital spares) within the new fleet tender analysis. As set out in Section 5.5.8, the base case scenario assumes the fleet order consists of 19 HLU's and 23 FLU's. As part of DART+ IÉ will enter into a Technical Support and Spares Supply Agreement (TSSSA) which sets rates for the maintenance of the fleet. The spares supply agreement is averaged out over the life of the agreement and is based on vehicle mileage. The costs do not change based on the condition of the asset. This means that the cost of parts and overhauls does not change as the yearly requirements for overhauls change throughout the life cycle. The indexation associated with the Spares Supply is 1% per year. This could be used for the Maintenance element of the O&M throughout the assessment period. Fleet renewals assumed every 35 years. Further information is provided in Chapter 8.
Contingency	Base costs include a 23% / 43% depending on level of uncertainty per cost element. Blended contingency of 35% across all projects. Lower and upper bound costs are based on -15%/+ 20% on the base costs and -1%/+1% inflation allowances.
Escalation (inflation) on infrastructure costs	The price base date of Q4 2017 used for some elements of DART+ and re-based to Q4 2019 using 5% cost inflation per annum for 2018 & 2019. Forecast inflation is included as follows: 5% (2020), 4% (2021), 4% (2022), 3% (2023), 2.5% (2024 to 2029). (*Discussed below)*
Escalation (inflation) on rolling stock costs	Price base date of Q4 2017 re-based to Q4 2019 using 5% cost inflation per annum for 2018 & 2019. Forecast inflation is included as follows: 5% (2020), 4% (2021), 4% (2022), 3% (2023), 2.5% (2024 to 2029).
Programme	The cost profile illustrated in Table 6.1 is based on current Project programme as outlined in Figure 13.3.
Scope	Cost estimates includes the scope as defined in Appendix A. The Capex and Opex costs of the enhancements between Bray and Greystones have been included in the cost presented in this Chapter. It should be noted that no benefits have been captured for the improved services between these stations in this iteration of the PBC. DART+ scope and budget does not currently include any costs to upgrade the existing OHLE network of the DART. A requirement of DART+ will be to assess the existing power capacity of the network. The costs of any such upgrade will come into budget for DART+ once known. No provision is currently made of this element in our costs however it likely to fall well within range of our cost sensitivity tests.

6.7 Operating Costs

6.7.1 Train Operating Costs

Train operating costs cover IÉ's Railway Undertaking's Chief Mechanical Engineers (CME) departments costs and traction costs for both diesel and electric and drivers' hours.

The cost forecasts are based upon information received from IÉ.

Costs associated with the Do Minimum and Do Something scenarios have been calculated with the incremental costs due to DART+ being the difference between the two. These are shown in Table 6.6. Negative figures in the incremental costs show cost savings, whereas positive numbers show cost increases.

Table 6.6 – Annual operating cost forecasts Including VAT (2019 Prices)

Line	Do Minimum (000's)	Do Something (000's)	Incremental
Traction (Diesel)	€ 10,164	€ 5,339	-€4,826
Traction (Electricity)	€ 5,110	€ 25,339	€20,229
CME (DMU/IICR)	€ 17,039	€ 10,231	-€6,808
CME(EMU)	€ 8,383	€ 36,243	€27,860
Staff Costs - Drivers	€ 7,945	€ 17,493	€9,549
Total	**€ 48,641**	**€ 94,645**	**€ 46,004**

Source: IE

The costs provided are inclusive of VAT as this was the standard reporting process used for the raw data which formed the basis of these costs.

To ensure consistency with PSC guidance on Financial Appraisal VAT was removed based upon standard rates for heavy fuel oil and electricity. For CME costs, a weighted average was calculated based upon the broad split between labour and materials costs. Labour was treated as zero rated with materials based upon the heavy engineering applicable rate of 23%.

The costs with VAT excluded are shown in Table 6.7.

Table 6.7 – Annual operating cost forecasts excluding VAT (2019 Prices)

Line	Do Minimum (000's)	Do Something (000's)	Incremental
Traction (Diesel)	€ 8,264	€ 4,340	-€3,923
Traction (Electricity)	€ 4,502	€ 22,325	€17,823
CME (DMU/IICR)	€ 14,324	€ 8,601	-€5,724
CME(EMU)	€ 7,047	€ 30,469	€23,421
Staff Costs - Drivers	€ 7,945	€ 17,493	€9,549
Total	**€ 39,540**	**€ 81,548**	**€ 41,146**

The PSO impacts are set out in Section 8.8.2 of this report.

6.8 Maintenance Costs

There will be an additional maintenance and lifecycle cost associated with the additional infrastructure and the increased use of existing infrastructure as a result of the DART+ programme.

Cost forecasts have been estimated for the incremental maintenance costs for the following reasons:

- PSC requires all cash inflows and outflows to be considered and the maintenance costs are a key component of this
- These costs will help inform a view on how the Infrastructure Manager (IM) Multi-Annual Contract (IMMAC) costs could be impacted. This is further discussed in Section 8.8.2.

The main impacts on annual maintenance costs as part of the DART+ Programme are as follows.

- Expansion of extent of network requiring maintenance as a result of the electrification which will increase the existing 53km of electrified route to approximately 150km
- Additional track maintenance due to increase in train mileage operating on existing track and new track required for upgrading to 4-tracks between Park West and Heuston station.
- Potential cost savings through closing level crossings

Although the capital works include depot upgrades, the ongoing costs are captured within the CME element of the train services costs.

The approach, source data and indicative costs for these three areas are outlined below.

6.8.1 OHLE Maintenance Costs

This captures a high-level annual maintenance forecast associated with the additional electrification infrastructure and the additional maintenance through increased intensity of use of the existing OHLE infrastructure

For the new OHLE assets, the core source of this data is the current annual costs associated with the current OHLE electrification infrastructure on the IÉ network which are shown in Table 6.8.

Table 6.8 – Annual Total OHLE Maintenance Costs for existing DART network (2019 Prices)

Item	Cost
Maintenance & Repair based on Estimated Annual Quantities	[redacted]
Disruptive Possession Renewals Based on 10Km/year	
Piecemeal Renewals Based on Estimated Annual Quantities	
Disruptive Possession Renewals Planning - Year 1 only	
Signalling, Electrification and Telecoms (SET) Costs	€ 1,316,158

Source: IÉ

These unit rates are based upon an average figure derived from ongoing maintenance of electrified lines on the existing DART network.

In order to derive a standard cost per km, adjustments were made to account for some of these costs were not necessarily annual costs incurred across the whole network.

Disruptive possession renewals are based upon renewing 10km per year therefore for an annual comparative cost on a track km basis this would need to factor in the whole network.

Based upon the total track length this means that on average each 10km section is renewed approximately every 14 years. This was adjusted to derive an average across the whole network as shown in Table 6.9.

Table 6.9 – Current IE OHLE Maintenance Costs Per Km (2019 Prices)

Item	Cost Per Km (000's)
Maintenance & Repair based on Estimated Annual Quantities	[redacted]
Disruptive Possession Renewals Based on 10Km/year	
Piecemeal Renewals Based on Estimated Annual Quantities	
Disruptive Possession Renewals Planning - Year 1 only	
SET Costs	
Total	

To generate total annual costs, th electrification of the DART+ Programme was applied to generate incremental maintenance costs per Projects for the OHLE. Route length was converted to track length consistent with the methodology used to derive the costs. The total costs associated with this used are shown in Table 6.10.

Table 6.10 – DART+ New OHLE Maintenance Costs (2019 Prices)

Item	Track Length of New OHLE	Cost per Track Km (000's)	Total (000's)
DART+ West	79.6km	[redacted]	
DART+ South West	44km		
DART+ Coastal North	74km		
DART+ Coastal South	7.8km		
New OHLE Maintenance Cost			

The costs associated with the incremental train kilometres on the currently electrified network between Malahide, Howth and Greystones have been based upon the approach used for the calculation of access charges.

This covers the Infrastructure Manager's operating, maintenance and renewal OHLE costs that vary with traffic. In economic terms it represents the short run incremental costs which is more appropriate for the calculation of the costs associated with additional usage of existing

infrastructure. The derivation of these costs is shown in Table 6.11.

Table 6.11 – DART+ Incremental Maintenance Costs for Existing OHLE (2019 Prices)

Item	Cost
DM Gross Tonnage - Electrified Kms (000's)	[redacted]
DS Gross Tonnage - Electrified Kms (000's)	
Gross Tonnage Km Change - Electrified (000's)	
Access Charge per Gross Tonnage Kilometre	
Total Annual Cost (000's)	

The total annual maintenance costs associated with OHLE covering both new and existing infrastructure therefore is €15.6M.

6.8.2 Track Maintenance Costs

The increased service frequency due to DART+ will increase the maintenance requirement on the existing tracks on the network and deliver some additional new track.

The four-tracking between Park West Station and Dublin Heuston will also deliver an extra 5km of double track. There will also be an additional 2.5km of track to connect the current infrastructure to the new Maynooth Depot, and costs associated with the Bray to Greystones improvements.

Track maintenance costs for the new track was forecast based on IÉ's current track maintenance costs. The total incremental costs associated with track maintenance are shown in Table 6.12.

Table 6.12 – DART+ Incremental Track Maintenance Costs (2019 Prices)

Item	Track Length of New Electrification	Cost per Track Km	Total (000's)
Kildare Line - Additional Four Tracking	10	64,545	€645
Maynooth - Additional New Track to Depot	5.0	64,452	€322
Bray to Greystones - Additional Track	7.8	64,545	€503
New Infrastructure Track Maintenance Costs			**€1,471**

The costs associated with the incremental train kilometres on the existing network have been based upon the approach used for the calculation of access charges.

The incremental track maintenance costs cover the IM's operating, maintenance and renewal costs, all of which vary with traffic. Consistent with the approach to the existing OHLE usage, in economic terms it represents the short run incremental costs which is appropriate for the calculation of the costs associated with additional usage of existing infrastructure.

The derivation of these costs is shown in Table 6.13.

Table 6.13 – DART+ Incremental Maintenance Costs for Existing Infrastructure (2019 Prices)

Item	Quantity
DM Gross Tonnage (000's)	1,805,951
DS Gross Tonnage (000's)	3,682,224
Gross Tonnage Km Change (000's)	1,876,274
Access Charge per Gross Tonnage km	€0.0077
Total Annual Costs (000's)	**€14,447**

The total annual additional cost forecast for track maintenance covering new and existing infrastructure is €15.9M. A summary of the combined incremental maintenance costs is presented below.

6.9 Level Crossing Costs

DART+ West includes the closure of six level crossings on the Maynooth Line. A further five (out of seven) will be closed as part of DART+ Coastal South in the section between Merrion Gates level crossing and Lansdowne Road station level crossing. The cost of operating these would therefore be saved through the delivery of DART+.

Information on IÉ's existing average costs per level crossing, shown in Table 6.14 have been used to calculate the savings due to closure of level crossings.

Table 6.14 – Level Crossing Maintenance Costs Per Crossing (2019 Prices)

Line	Materials (000's)	Labour (000's)	Total (000's)
DART+ Coastal South	€2.9	€2.5	€5.4
DART+ West	€6.6	€27.3	€33.9

Source: IE

The total incremental cost savings associated with these level crossing closures are shown in Table 6.15.

Table 6.15 – DART+ Incremental Level Crossing Costs Avoided (2019 Prices)

Line	Number of Crossings	Costs Saved Per Crossing	Total Annual Cost Saving (000's)
DART+ Coastal South	5	€5,400	€27
DART+ West	6	€33,900	€203
Total Costs Avoided			**€230**

6.10 Cost Summary

The overall present value of all cost elements is summarised in Table 6.16 below.

Table 6.16 – DART+ Cost Summary (2019 values and prices)

Costs (€millions)	60 Year Present Value
Capital Costs	€1,999.6
Train Service Operating Costs	€698.9
Infrastructure Maintenance Costs	€531.8
Present Value of Costs	€3,230.2

The profile of the capital, operating and maintenance cost expenditure is presented below **inclusive of cost escalation, risk contingency and VAT.**

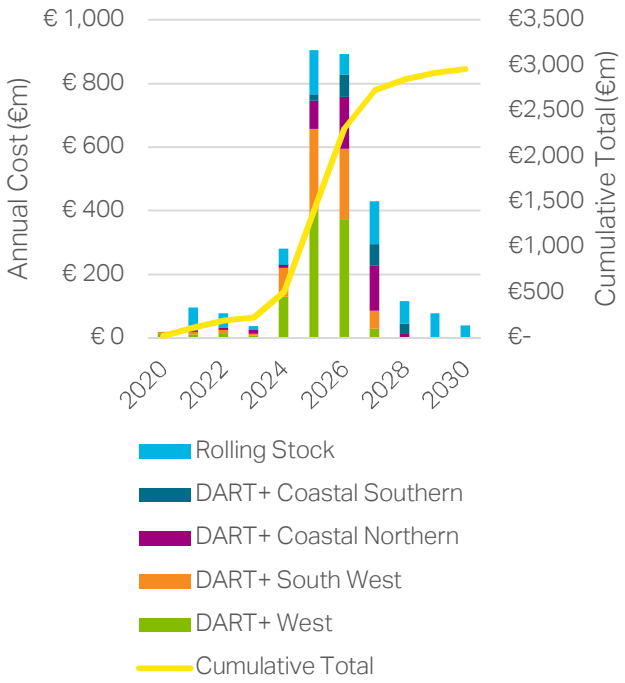


Figure 6.1 – DART+ Costs – Capex

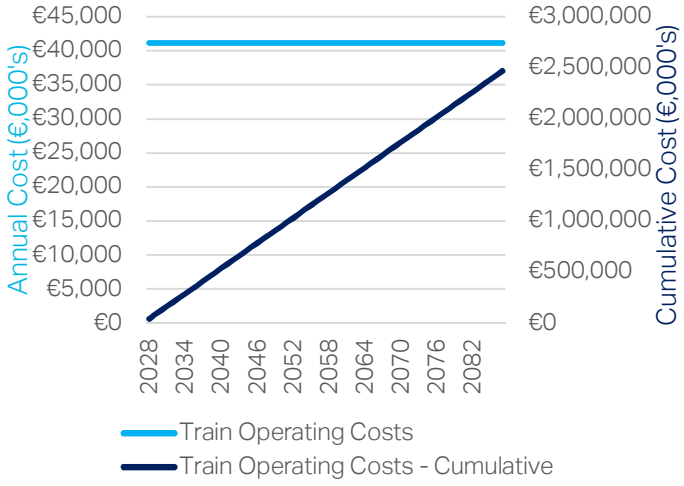


Figure 6.2 – DART+ Costs- Opex

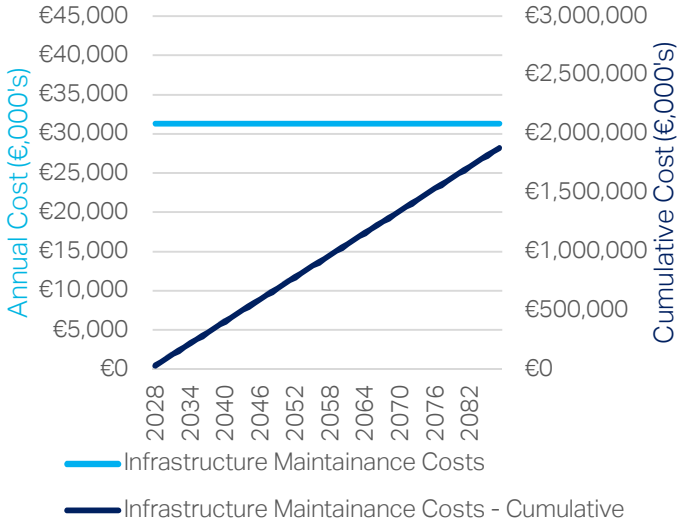


Figure 6.3 – DART+ Costs – Maintenance

PROGRAMME IMPACTS

07

7. Programme Impacts

7.1 Introduction

DART+ is a programme of enhancements to transform the heavy rail network to provide more frequent higher capacity rail services to more people.

This chapter focuses on the benefits that the programme will provide, outlining the benefits to the Eastern region and specifically for passengers, businesses, cyclists, visitors, the environment and other road users.

To aid in the quantitative elements of the assessment the NTA's Eastern Region Model (ERM) has been used to determine the impacts (positive and negative) of the proposed programme. The ERM was used to forecast the impacts of DART+ for the opening year of 2028, the mid-term horizon year of 2043 and 2058 (growth flatlined post 2058). For the purposes of this Chapter the results have been provided for 2043 to ease understanding and reference to current conditions however the scale of the impact on a percentage basis is relatively constant for each of 2028, 2043 and 2058.

7.2 Impact of COVID-19 on future growth

No one knows how COVID-19 will affect long term travel behaviour. Anecdotal evidence has shown that flexible work location and hours can result in fewer trips at peak times, and greater off-peak travel. Historically, public transport revenue is reliant on peak commuting, but work-related travel changes could warrant higher frequencies outside peak times to capture this demand, help maintain revenue and facilitate social distancing. At present, public transport patronage is 15-50% of normal levels. AECOM's own recent market research has found that in the longer term 71% of people want to change their travel behaviours for a better work/life/health balance. In some respects, COVID-19 has accelerated existing trends towards flexible working arrangements.

COVID-19 also does not alter the requirement to encourage and enable modal shift from the private car and the need to address carbon emissions. It is therefore deemed not to be material to the need for the investment in DART+.

The Preliminary Business Case will include a sensitivity scenario where people do not return to the pre-COVID-19 demand behaviours and consider the implications for investment. The impact of this scenario on DART+ is considered in Chapter 9.

7.3 Impacts on passengers

7.3.1 Service Frequency and Capacity

The existing heavy rail network has constraints that limit the frequency of services. Station capacity improvements at Connolly Station and Docklands, along with the line capacity improvements and the additional fleet, will allow for more effective timetabling and better services. As shown in Figure 7.1 frequencies on some lines such as DART+ West and South West will increase by 200-300%.

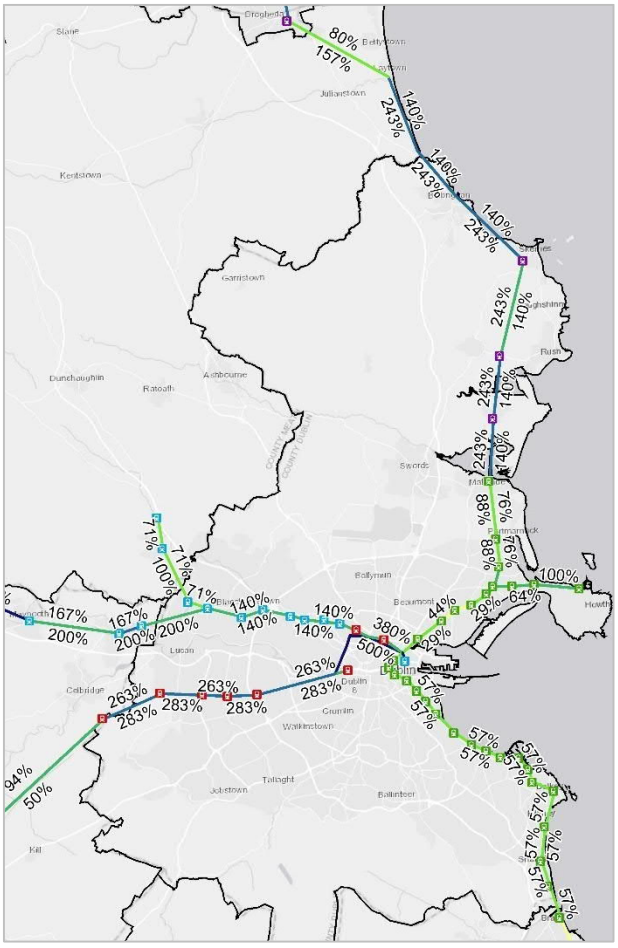


Figure 7.1 – DART+ Percentage Increase in AM Peak Hourly Service Frequencies – Do-Minimum vs. Do-Something

7.3.2 Reliability

DART+ will deliver a more reliable and efficient network through extended electrification, re-signalling works and the removal of level crossings.

This infrastructure will improve headway control, reduce the level of interaction between trains and general traffic and improve journey time reliability.

Poor reliability, also known as journey time or punctuality variability from a passenger's perspective, is recognised as causing considerable inconvenience to travellers and as an influencing factor for rail travel demand.

Reliability benefits are those which are attributable to the improved confidence in arrival time at users' destinations and capture the perceived benefit from reduced uncertainty and stress that users experience with less variation in their journey duration.

Improving the reliability of journey times allows users to better plan and make use of their time in transit, for example, providing more consistent travel times to work, or for better use of time before leaving one's home for education or recreation. Data from IE's train tracking system was used to understand the existing end-to-end journey times and variability (expressed as standard deviation in journey times) along the rail network in the Eastern region. This data was extracted daily over an extended period and assessed in terms of minimum and maximum journey times, standard deviation and deviation to planned journey time.

In understanding the impact of DART+ on journey time reliability detailed information on scheduled versus actual time of train services was provided by IE for a two-month period between 1st January 2020 and 3rd March. This dataset provided information on the variance on both departure and arrival time at the origin and destination station of all services – in total this information was provided for nearly 10,000 services over the 2-month period. A sample output presenting the distribution of variance in departure times is provided below.

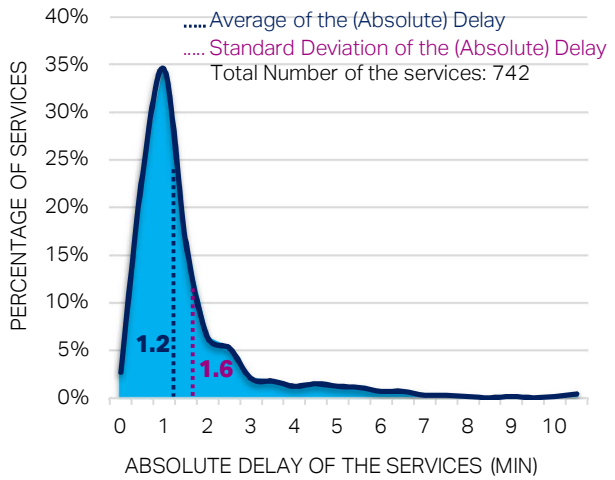


Figure 7.2 – Sample Output - Departure Delay for Services between Malahide and Greystones

The PBC takes a conservative approach assuming all DART services can achieve the 10th percentile reliability performance currently being achieved on the existing DART network. Overall the DART+ Programme will significantly improve the reliability in heavy rail services by approximately 40% on average as set out below.

Table 7.1 – Change in DART reliability

Service Reliability	Arrival Time Variance	Departure Time Variance
Improvement in variance weighted by demand	43%	39%

7.3.3 Transport Interchange and integration

DART+ will improve the interchange opportunities with other public transport modes, encouraging and enabling modal shift from the private car. This will lead to increased patronage on other public transport modes besides heavy rail as the levels of interchange increase. Overall, DART+ will lead to a 43% increase in the number of people interchanging between different public transport services. Interchange between rail services will increase by 10,000 interchange trips a day whilst Rail to Luas and Rail to Bus interchange trips will increase by 4,500 and 13,000 trips a day respectively. The impacts are presented on a percentage basis below for year of opening 2028.

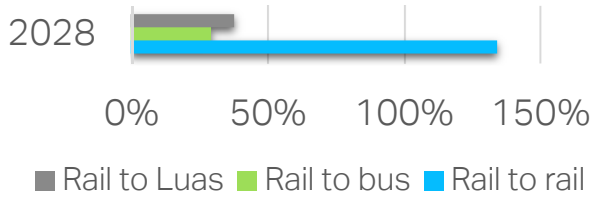


Figure 7.3 – 2028 - Change in Interchange (24 hour) as a result of DART+

Interchange trips are predicted to grow further by 2043 with a total of 93,000 interchange trips on a daily basis.

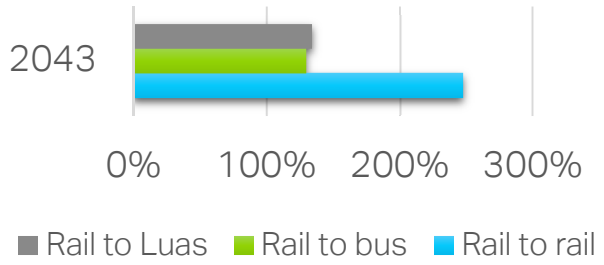


Figure 7.4 – 2043 -Change in Interchange (24 hour) as a result of DART+

7.3.4 Access to Higher Quality Public Transport

Extending DART services to a wider catchment, will increase the number of people who live within easy access of more frequent rail services. This in turn will improve access to opportunities and services for those who are reliant on public transport.

Some 258,000 people live within 1km catchment of the stations on the DART network prior to DART+, as shown in Figure 7.5. (Larger versions of the figures below are provided in Appendix B).

Figure 7.5 – Total Population – 1km buffer from DART stations pre-DART+

The extended DART network will serve a population of 602,707 within a 1km catchment, an increase of 134% on the DART catchment without DART+ in place. It will serve some high-density areas where densities exceed 1,600 people/sq. km, far in excess of the maximum densities on the DART network pre-DART+ of 1,100 people/sq. km. The catchment of future DART+ stations is shown in Figures 7.5, 7.6 and 7.7.

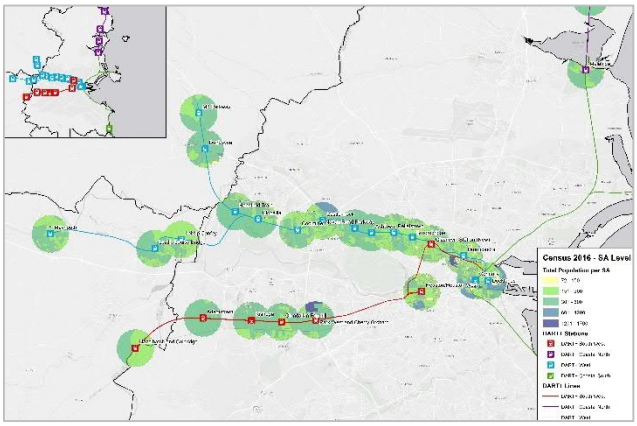


Figure 7.6 – Total Population – 1km buffer from future DART stations

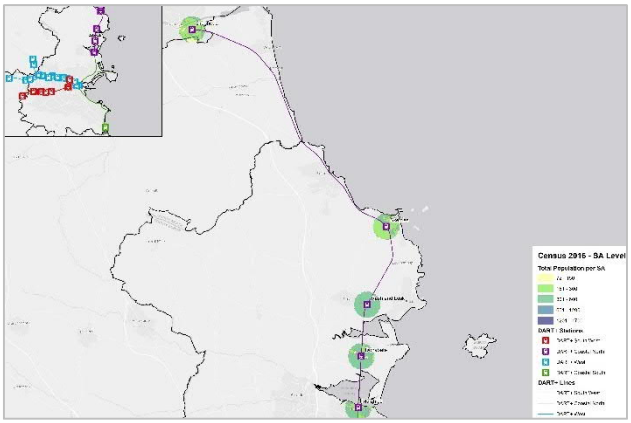


Figure 7.7 – Total Population – 1km buffer from future DART stations

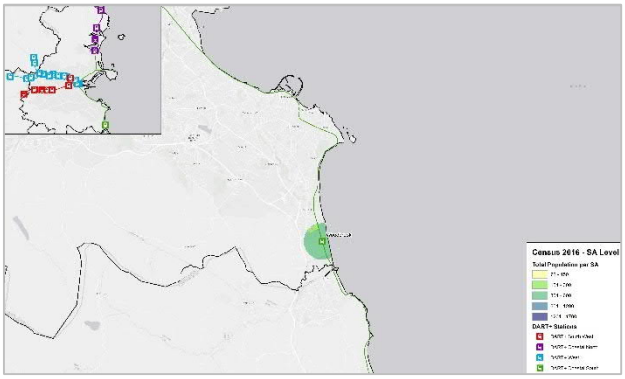


Figure 7.8 – Total Population – 1km buffer from future DART stations

The relationship between land use and transport is dynamic with both having the ability to impact on the other. Transport infrastructure sets the patterns in which cities grow. Residential location decisions are made primarily on access to work,

and commercial location decisions are based on access to labour and customers.

DART+ will facilitate transit-oriented development (TOD). TOD is an approach to urban development that provides residential, business and leisure space within walking distance of public transport and has been used successfully internationally to enhance development around major transport hubs. This will be beneficial around the stations that will have reduced parking provision owing to reduced car dependency.

Project Ireland 2040 emphasises the need for compact growth and densification. In Dublin and other urban centres this will require infill development and improved use of available land. This will be possible with DART+ with limited impact on community green spaces.

DART+ will immediately support the development potential of surrounding areas upon opening. Any redevelopment of existing sites and those beyond 1km from stops will further enhance the development opportunity provided by heavy rail, ultimately housing more people in the Eastern region.

7.4 Social Impacts

The existing DART network travels through areas which are largely classed as 'affluent' in the Pobal Deprivation Index. It also travels through some areas defined by Pobal as disadvantaged or very disadvantaged particularity in the city centre. The current classification of the areas within 1km of the existing DART and the future DART+ network is presented below whilst larger versions of the figures are provided in Appendix B. The population classifications will alter over time as the areas around the new stations are developed leading to new types of housing.

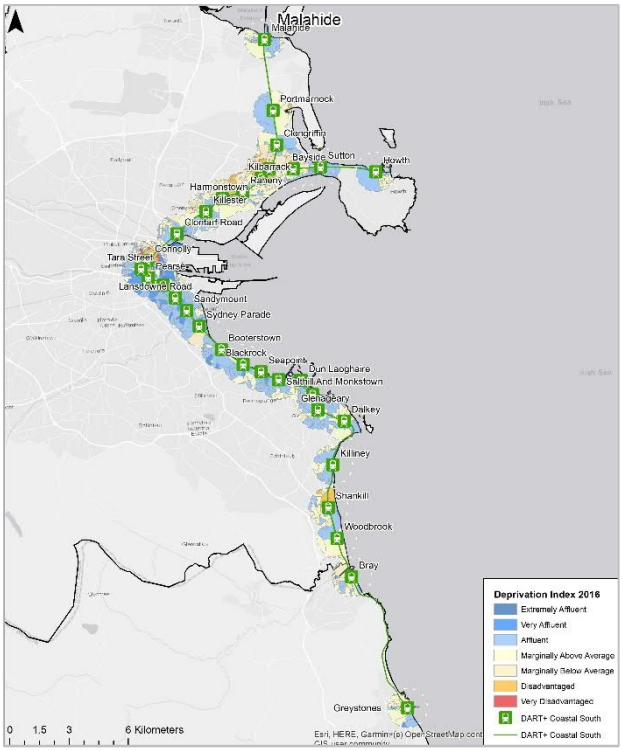


Figure 7.9 – Deprivation Index – 1km buffer from existing DART stations

The extension of the DART network westwards will open up the DART service to areas that are defined as below average by Pobal especially on the Kildare Line where large areas defined as very disadvantaged will now have access to a high frequency DART service.

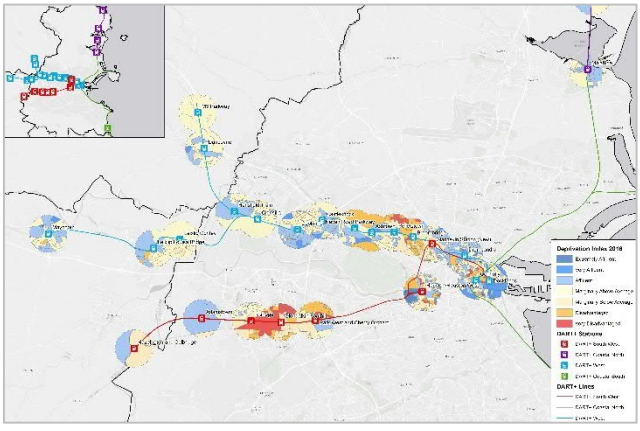


Figure 7.10 – Deprivation Index – 1km buffer from future DART stations

The extension of the DART network northwards to Drogheda will open up the DART service to areas that are largely affluent or marginally above average, but it will serve some areas in Skerries and Drogheda which are categorised as disadvantaged.

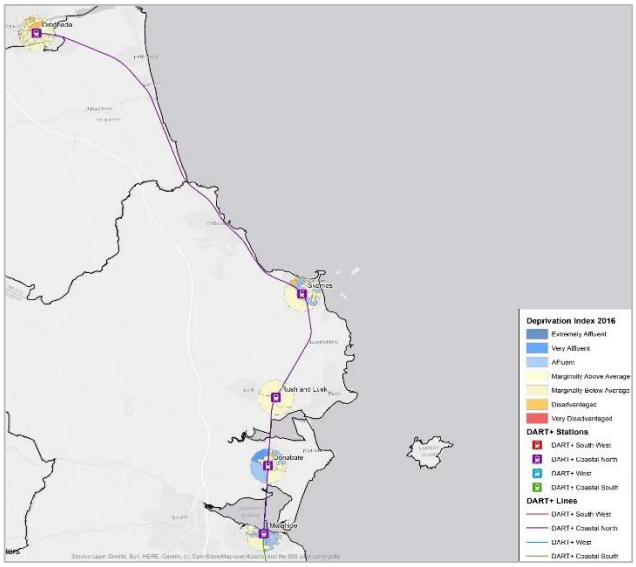


Figure 7.11 – Deprivation Index – 1km buffer from future DART stations

To the south DART will now be available to people living near the new Woodbrook Station which will be opened prior to DART+. Woodbrook is an area which is currently defined as above average or affluent by Pobal.

Figure 7.12 – Deprivation Index – 1km buffer from future DART stations

The impact of DART+ in terms of expanding the reach of high frequency, high capacity DART services is tabulated below which shows that DART+ will reach an additional ~85,000 people living in areas defined as below average or worse by Pobal.

Table 7.2 – Deprivation Index Impact

	Deprivation Index 2016	Existing DART	Total DART+
	extremely affluent	1,000	2,700
	very affluent	24,200	43,600
	affluent	108,900	204,600
	marginally above average	81,400	189,600
	marginally below average	38,000	78,000
	disadvantaged	21,300	51,100
	very disadvantaged	5,500	20,300
	extremely disadvantaged	-	100
	Total	280,320	589,970

Developing and constructing the DART+ Programme will support improvement in the levels of affluence through increased accessibility to work, education and community facilities. Literature and academic research affirm the close link between the accessibility to transport and social improvement, and therefore DART+ will act as a significant catalyst to improving the opportunity of many along the expanded DART network.

7.5 Impacts on business

By improving rail journey times, DART+ will generate benefits to business primarily by increasing their labour market catchment.

7.5.1 Wider Economic Impact - Agglomeration

Agglomeration is a spatial effect where firms derive a productivity benefit from locating in close proximity to individuals and other firms. The benefits are the product of increased labour market, knowledge spill overs and strengthened linkages between suppliers.

Outputs from the transport model in the form of travel cost and demand skims have been used to ascertain the potential scale of agglomeration benefits. The process makes use of a similar approach taken by AECOM in developing an agglomeration tool for TII and based on extensive agglomeration parameters concerning productivity, density, job type, elasticities and distance decay. This is discussed further in Chapter 9.

7.6 Local economic impact

The local economic impact of GVA and employment benefits from DART+ can be calculated using Economic Impact Assessment (Input-Output models, built on the Central

Statistics Offices supply-use tables[42]. There are also indirect and induced employment effects, an estimation of which have been calculated through economic multiplier analysis and validated by information on the accompanying or ancillary employment that is created throughout the delivery.

The economic impact of the direct investment of over €2.6 billion in DART+ over ten years of implementation is significant. Using the information provided on forecast costs of DART+ and the national input-output tables from the Central Statistics Office, local output and employment multipliers were developed to demonstrate how the planned expenditures would impact on the national economy.

Gross Value Added (GVA) – 'Gross Value Added' refers to the value of output minus the cost of intermediate consumption. GVA is often used as a proxy for productivity in conjunction with Gross Domestic Product (which is a metric for economic activity), meaning that GVA can provide an indication of how much an activity is expected to contribute to the broader national economy. Capital expenditure on DART+ will create a total of **€1 billion in GVA** between 2019 and 2030, made up of **€467 million in direct GVA** and **€531 million in indirect/induced GVA**.

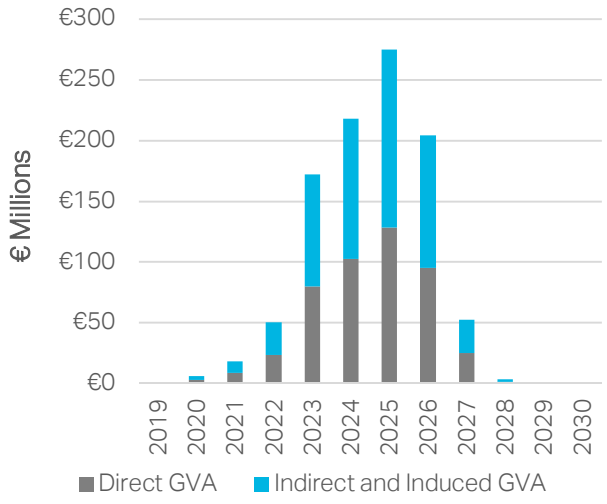


Figure 7.13 – Sequencing of DART+ direct and wider GVA

Employment - DART+ will generate **14,200 FTE jobs** over the decade. Approximately 7,700 FTE jobs will be directly created during the planning and construction phases of the programme, while another 6,500 will be supported in the wider Irish economy. Based on the planned construction programme, the majority of these jobs will be created between 2023 and 2026, with direct and indirect/induced FTE employment as a result of DART+ peaking at approximately 3,900 jobs in 2025. It should be noted that the number of FTE jobs does not necessarily equal the *number of people* who will be employed, as these are counted over the entire 10-year period (i.e. if the same person is employed for 3 years on the Programme, this would be the equivalent of 3 FTE jobs).

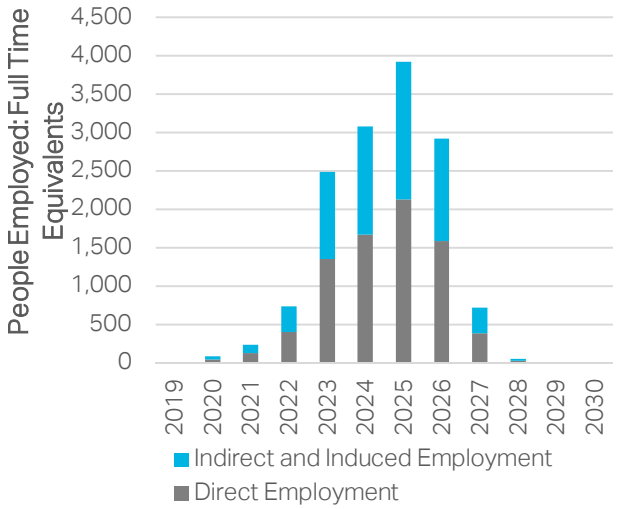


Figure 7.14 – Sequencing of DART+ direct and wider employment)

7.7 Impacts on environment

DART+ will have a positive impact on emissions through the shift to lower emission modes of transport and through the use of new low emission rolling stock.

An electric train typically emits between 20 and 35 percent less carbon per passenger kilometre than a diesel train. Electric trains have zero emissions at the point of use, and their total carbon intensity will continue to reduce as the Government's ambition is that electricity production from renewable energy will increase to 70% by 2030 in line with the Climate Action Plan. In addition, the reduction in emissions at the point of use will benefit air quality in pollution hot spots.

The impact of the shift away from private cars to public transport, in terms of reduced vehicular

[42] www.cso.ie/en/statistics/nationalaccounts/supplyandusetablesforireland/

emissions, has been captured through the TUBA programme based on outputs from the transport model.

The rolling stock CO_2 impact, in terms of emissions from trains, has been calculated based upon changes in vehicle kilometres split between diesel and electric for both the Do Minimum and Do Something scenarios. Both the emissions factors for diesel and electric and the associated monetised CO_2 costs for traded and non-traded carbon have been based upon assumptions and sources in the 'Public Spending Code Supplementary Guidance - Measuring & Valuing Changes in Greenhouse Gas Emissions in Economic Appraisal'.

The transition from diesel to electric fleet is forecast to reduce emissions by ~16,000 Tonnes of CO_2 per annum upon full transition. This represents a significant proportion of the emissions from the rail network which according to SEAI emitted 137,000 Tonnes of CO_2 in 2013. A proportion of this reduction is offset by an increase in the km travelled by trains with DART+ in place however as energy generation continues to move towards renewables and we achieve 70% renewables by 2050 the difference between the positives and negatives will widen. Overall DART+ will provide the below emissions impacts over the 60-year appraisal period.

Table 7.3 – Tonnes of CO_2 saved (60 years)

Impact	Tonnes CO_2
Shift to lower emission modes	45,000
Shift to lower emission rail fleet	608,000

7.8 Impacts on other transport users

DART+ has the potential to encourage and enable mode shift away from private cars, especially for users whose regular trip origin destinations will have an improved rail service available to them.

This will have the impact of reducing congestion experienced by remaining road traffic. This will benefit buses, goods vehicles, cyclists, pedestrians and remaining private cars.

The existing level crossings impact other non-rail travellers and cause delays to bus passengers, pedestrians, cyclists, goods vehicles and private vehicles. The impact can be severe: at some locations the level crossings can be closed for 83% of the time during peak hours. The DART+ level crossing interventions are presented below and in Appendix A.

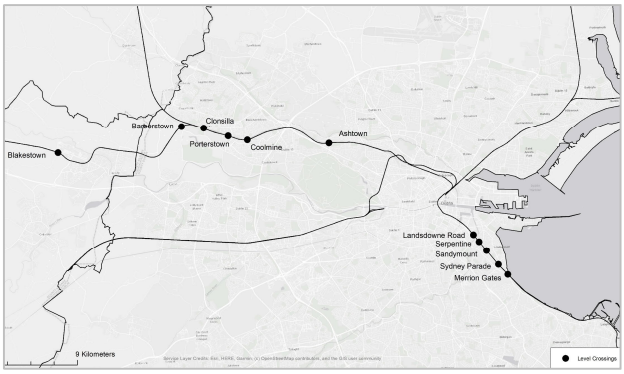


Figure 7.15 – DART+ Proposed Level Crossing Closures

The level crossing interventions associated with DART+, which in most cases include the provision of pedestrian and cycle alternative crossing points, will improve average journey times using active modes given the removal of delays caused by frequent level crossing closures.

The closure of level crossings on the DART+ Coastal line between Lansdowne Road and Merrion Gates with replacement vehicular infrastructure at Merrion Gates will complicate Sandymount vehicular access to Ballsbridge and Merrion Road, increasing vehicle journey times in the area. A full assessment on the impacts of the level crossing closures on the DART+ Coastal lines will be undertaken by the DART+ Coastal MDC.

The closure of level crossings, in addition to encouraging the transition to public transport and active modes will increase safety for the entire transportation network. Automobile accident risk will decrease as level crossings are closed and more users choose public transport, and the replacement cycle and pedestrian infrastructure at these crossings reduces the risk of accidents between trains and pedestrians/cyclists as well.

The design process is ongoing for DART+ West and may identify the need for alternative vehicular crossings in some locations. New vehicular crossings at Ashtown and Barberstown would result in marginal improvements in journey times for road users who previously used those level crossings, without overloading other areas of the network. This indicates that DART+ West will

improve use of transit and active modes without sacrificing journey times for other users of the transport network.

7.9 Impacts on active mode users

In addition to the impacts on existing walkers and cyclists identified above, the introduction of improved rail services will improve the attractiveness of heavy rail which has the potential to generate additional walking and cycling trips.

This will lead to increased active travel (walking and cycling) usage by passengers switch from the private car to rail who will choose to either walk or cycle at either end of their journey to access the train station or their final destination.

7.10 Other Impacts

7.10.1 Health

As a secondary impact, DART+ will improve citizens' health due to increased physical activity by encouraging public transport usage which is often accompanied by increases in walking and cycling to access stations.

The increase in use of active modes subsequently has a positive effect on productivity through improved health.

7.10.2 Benefits for visitors

Dublin is a key destination for domestic and international visitors, attracting 7.6 million visitors in 2017[43]. Fáilte Ireland launched the Dublin Visitor Orientation Strategy in 2017, with a primary goal being to encourage more visitors to experience an extended city and county tourist offering, rather than staying confined to the city centre. For most visitors, public transport and taxis are the most common mode of transport to get around Dublin[44]. As well as increasing access to more destinations around Dublin, the DART+ Programme will contribute to delivering an enhanced rail network, more services and an easy-to-understand network that will make it easier for visitors to access and use public transport.

7.10.3 Integration with rail policy

Rail Freight Strategy 2040

IÉ are currently developing a 2040 Rail Freight Strategy to grow the existing business and provide a greater number of rail freight services. One of the considerations of this strategy is how an expanded freight network would impact on existing and current passenger services and how an expanded rail freight business would operate amongst future passenger service schedules. IÉ is cognisant of the expanded services schedules included in the DART+ programme and the interaction with future freight service schedule. IÉ must aim to mitigate constraints and conflicts between passenger service and freight trains. This could be managed by the appropriate scheduling of freight links where service levels and network capacity limitations dictate.

Iarnród Éireann Strategy 2027

IÉ have developed a Strategy for the remaining duration of the National Development Plan 2021-2027 sets out how our services will be transformed over the life of the National Development Plan 2018-2027. It was created in response to changing customer needs including the key role Ireland's railway will play in helping to power the nation's economic and social development towards a sustainable, inclusive and prosperous future. The implementation of DART+ is one of the core components of this Strategy. DART+ compliments other aims of the Strategy, firstly; improvements to Intercity service frequencies and journey times as accommodated by the increased paths created by DART+, in particular on DART+ South West where 4-tracking is being introduced in Heuston station from Park West and Cherry Orchard station. Secondly; development of commercial freight opportunities that have a natural fit with the rail mode, which as discussed can be managed by the appropriate scheduling of freight links.

DART+ will ease some of the pressure on the existing network in the medium to long term however, it does not preclude further improvements in the national rail network.

7.11 DART+ – The impact in numbers

Figure 7.16 presents the forecast change in modal shares as a result of the DART+ programme. The modelling forecasts a shift towards public transport usage across the Eastern Region by 2028 which is maintained up to 2043 and beyond.

[44] *Fáilte Ireland 2017 Research Overview Presentation – 2017 Dublin Figures.*

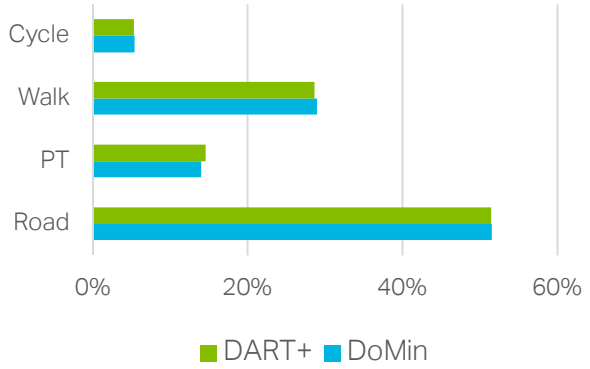
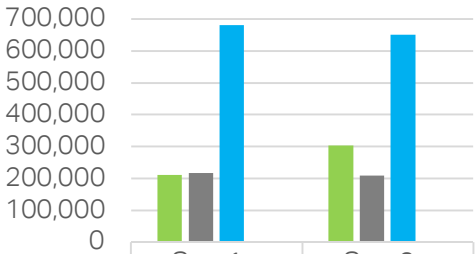


Figure 7.16 – Projected Mode Share - 2043
Source: NTA ERM

The mode shift to public transport is delivered through a significant increase in rail passengers which is offset by a slight reduction in bus and Luas passengers. Introduction of DART+ will result in an increase in public transport patronage of around 15 million passengers per annum by 2043 with a reduction in road (private vehicle) demand.

The shares for each public transport mode are presented in Figure 7.17 which shows a significant shift towards heavy rail with an increase in the region of 100,000-150,000 passenger boardings per day or 25-30 million per annum. Inclusion of BusConnects and Metrolink may erode some of this increase however it is likely that the model underestimates the shift to public transport so the impact of erosion may not be significant in reality.



	Sce 1 - ADE_DM	Sce 2 - ADF_DS1
DART+Irish Rail	209,470	303,418
Luas	215,755	207,535
Urban+Other Bus	680,642	648,670
TOTAL	1,105,867	1,159,623

DART+Irish Rail
Luas
Urban+Other Bus

Figure 7.17 – Daily Boardings - 2043

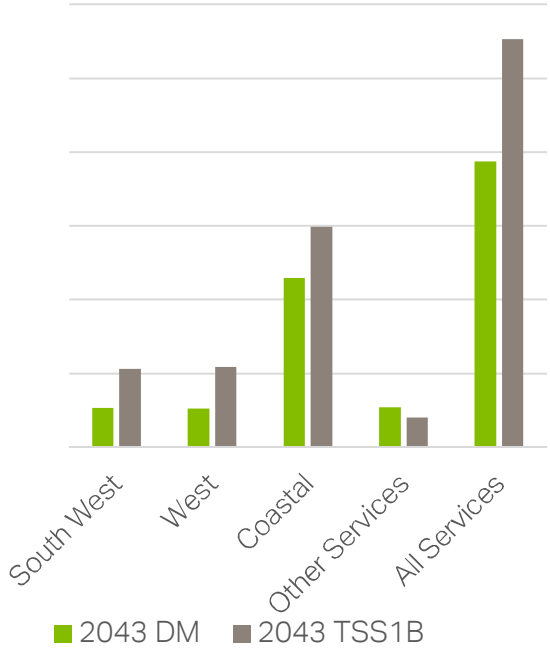


Figure 7.18 – Comparative Daily Boardings by rail line - 2043

FINANCIAL APPRAISAL

08

8. Financial Appraisal

8.1 Introduction

The primary focus of the financial appraisal is on affordability and financial impact of DART+. A financial analysis or appraisal is an important building block in the overall appraisal process and acts as a first step before carrying out the economic appraisal. A financial analysis only considers financial cash flows whereas an economic analysis examines all costs and benefits for society and not just the direct financial flows arising from the project.

The core objectives of the financial appraisal are:

- Identifying and estimating the financial cashflows
- Assessing financial sustainability
- Determining the extent to which investment cost and ongoing maintenance and operational cost will not be recouped by net revenue
- Calculating performance including the NPV and Internal Rate of Return (IRR)
- Assessing the funding sources (public, private, EU) for the project and examining the return on capital for different sources of funds.

In line with PSC and CAF, the appraisal should clearly identify and examine a benchmark or counterfactual for comparative purposes.

The counterfactual or Do Minimum involves an assumption about the future state of the world in the absence of the project or programme.

The financial appraisal is therefore based upon examining the incremental costs and revenues of the Do Something over the Do Minimum.

8.2 Assumptions

The financial appraisal has been conducted in line with PSC requirements. The core assumptions are outlined below.

- All values are based upon 2019 prices discounted to 2019 using real discount rated where Present Value figures are quoted.
- For present value calculations, a **real discount rate of 2.31% was used for the full 60-year period as advised by the NDFA.**
- VAT is excluded.
- Costs incurred and revenues received are incremental above the Do Minimum.
- The Capex and Opex costs of infrastructure enhancements between Bray and Greystones have been included however benefits and potential revenue increases, associated with improved services have not yet been included.

8.2.1 Appraisal Period

In the appraisal of capital projects, the DoT CAF states that a 30-year appraisal period should only be used where the life of an asset is at least 30 years. With regard to DART+ there are a number of elements within the capital cost envelope which will have an asset life of greater than 30 years. These include bridges, structures and the new depot facilities.

To address this, in terms of appraisal period, a residual value period of 30 years is applied based on the guidance.

To account for residual value of the programme, renewal, operations and maintenance costs for years 31-60 after opening are also quantified and included in the appraisal. This includes costs associated with the renewal of rolling stock which has an asset life of around 35 years and provisions for OHLE renewals which has an asset life of around 40 years.

This approach has been adopted in both the financial and economic appraisal.

8.2.2 Price Indexation

For the purposes of deflating costs which are provided in nominal values to 2019 prices, the Harmonised Index of Consumer Prices (HICP) has been used as the basis of deflating. This only accounts for general inflation. Escalations above or below general inflation are not removed as they reflect relative changes in the value of goods.

Where prices require adjusting for inflation, actual outturn data up to 2019 has been used with 2020 onwards based upon the medium to long-term HICP rate of 2%.

Train operating and maintenance costs forecasts are assumed to remain constant in real terms. This is aligned with PSC which requires that unless empirical evidence is available, real price which assume constant price levels should be used.

8.3 Capital Costs

As identified in Chapter 6 the total capital cost forecast for DART+ is €2.960 billion inclusive of inflation and VAT.

The Present Value of Costs allows for residual values and for renewal of assets which have asset lives less than 60 years. For OHLE, a lifecycle costing approach has been used which includes an allowance for renewals. For rolling stock, these costs were captured as one-off costs incurred once the fleet has reached 35 years which is captured in the residual value/renewals element.

Table 8.1 – Capital Cost Summary and Present Values (2019 Real Prices)

Capital Costs	60 Year Present Value - €m
Construction Costs	€2,113.4
Renewals and Residual Value	€167.6

8.4 Revenue Forecasting

Although the ERM contains a fares model which can be used to estimate revenue changes, these are applied at a generic passenger-km level as the ability to breakdown the revenue increments by the corridor is limited and because standard TUBA outputs aggregate public transport modes which limits the ability to split out the revenue impacts of DART+ by mode.

Further detail is required to more robustly quantify the revenue impact on IÉ. The approach adopted for heavy rail is discussed below.

8.4.1 Rail Demand and Revenue Forecasting

For heavy rail demand, the revenue forecasts have been based upon a bespoke rail demand forecasting model to add additional robustness to the revenue forecasting and to provide a more accurate representation. The use of a bespoke revenue modelling approach also enables 2019 fare data to be used as part of the financial forecasting. For abstraction from bus, Luas and highway tolls, these have been based upon outputs from the ERM.

Rail fare and revenue data for the study area was obtained from IÉ at an origin destination level. This covered all ticket sales channels contributing to fare revenue.

The origin and destination data was processed into 21 designated flow groups aligned with the corridors which will have enhanced services through DART+. This enabled a seamless linkage with the ERM, which was the source of the modelled future demand uplifts through the Baseline Scenario TSS and linkages to abstraction from bus and Luas.

In terms of future fares assumptions, it is necessary to consider potential fare changes due to NTA's revised fare structure and the Next Generation Ticketing (NGT) project. This is a project to renew the ticketing equipment and methods of payment for customers impacted by DART+. Changes implemented as part of this project include contactless payments, cashless operation and QR tickets, which would impact on fare structures in the future.

As a result of these changes, NTA have released some modelling guidance which reflects expected outcomes of this on the fare structures.

Furthermore, an allowance for ancillary revenue is also included in the rail revenue forecasts. This covers revenue associated with car parking, adverting and retail which are assumed linked to footfall and demand.

Table 8.2 shows the incremental change in fare revenues across all public transport modes. Annual figures are shown for the two ERM modelled years alongside present values.

Table 8.2 – Revenue Summary and Present Values (2019 Real Prices)

Option	2028	2043	60 Year PV €m
Heavy Rail New Revenue	€52.7	€68.6	€1,989.6
Abstraction from Bus	-€16.1	-€24.3	-€615.7
Abstraction from Luas	-€2.0	-€3.3	-€91.8
Abstraction from Highway Tolls	-€2.1	-€3.1	-€77.6
Net Revenue Impact	**€32.4**	**€38**	**€1,204.6***

**it should be noted that the use of the NDFA discount rate is the financial appraisal does not reflect the revenue figures used in the economic appraisal which is based on CAF discount rates.*

Although the DART+ enhancements deliver a 60-year present value of €1.2bn to Heavy Rail this is offset by a reduction of €616m for bus and €92m for Luas due to passengers switching public

transport. In addition, modal shift from highway to rail also reduced toll road income by a further €78m.

8.5 Train Service O & M

This captures the financial impact of the incremental costs associated with operating the additional train services as described in Chapter 6. This covers costs associated with the maintenance of the additional rolling stock and changes in traction energy and drivers as a result of the DART+ TSS and electrification.

Table 8.3 shows the annual incremental cost forecasts as derived in Chapter 6 and the associated Present Value over the appraisal period.

Table 8.3 – Train Service O&M Summary and Present Values (2019 Real Prices)

Train O&M Costs	Annual Cost (€m 2019 Prices)	60 Year PV €m
Incremental Cost	€41.1	€698.9

8.6 Infrastructure O & M

This captures the financial impact of the incremental costs associated with the maintenance of the additional infrastructure described in Chapter 6. This captures primarily the costs associated with the maintaining the additional OHLE and the extra maintenance costs associated with track due to the additional services delivered as part of DART+. Table 8.4 shows the annual incremental cost forecasts as outlined in Chapter 6 and the associated Present Value over the appraisal period.

Table 8.4 – Infrastructure O&M Summary and Present Values (2019 Real Prices)

Service O&M Costs	Annual Cost (€m 2019 Prices)	60 Year PV €m
Incremental Cost	€31.3	€842.2

8.7 Key Financial Metrics

8.7.1 Full Exchequer Impact

Table 8.5 shows the Exchequer Impact. This covers all elements which will impact on the Exchequer in addition to costs and revenue solely associated with the construction and operation of DART+. Indirect taxation is also included as the loss of tax revenue through modal share to public transport which is zero rated for tax results in a loss to the Exchequer of tax revenue.

Table 8.5 – Exchequer Impacts (2019 Real Prices Discounted to 2019)

Exchequer Impacts	60 Year PV €m
Capital Costs	€2,280.9
Train Service O&M	€1,106.8
Infrastructure O&M	€842.2
Indirect Taxation loss	€223.1
less Net Revenue generated	-€1,204.6
NPV Costs	**€3,248.5**

This shows an overall cost to the Exchequer discounted over 60 years of €3.2 bn.

8.7.2 Full Exchequer Impact @ CAF Discount Rates

The Exchequer Impact using the CAF discount rates is set out below as a sensitivity test.

Table 8.6 – Exchequer Impacts (2019 Real Prices Discounted to 2019)

Exchequer Impacts	60 Year PV €m
Capital Costs	€1,999.6
Train Service O&M	€698.9
Infrastructure O&M	€531.8
Indirect Taxation loss	€134.3
less Net Revenue generated	-€694.5
NPV Costs	**€2,669.9**

8.7.3 Public Transport Only Impact

This shows financial impact to the public transport network covering solely the net revenue attributable to rail, bus and LUAS and the associated costs with running the additional rail services. Figure 8.1 shows the fare revenue over the appraisal period by mode.

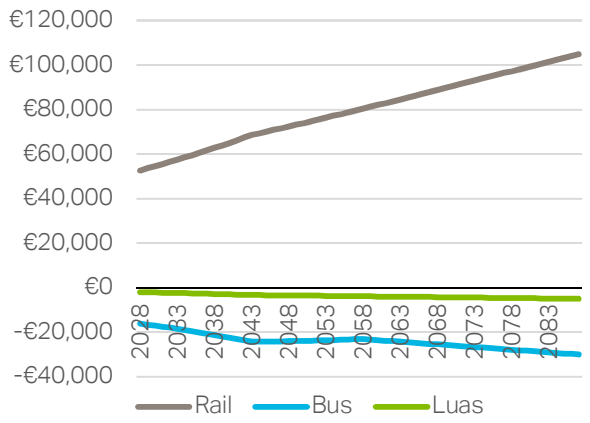


Figure 8.1 – Revenue Change by Mode (€, 000's)

Figure 8.2 shows the annual impact of the revenue combined with the O&M to show the PT only subsidy impact and provides a summary including the 60 year present value.

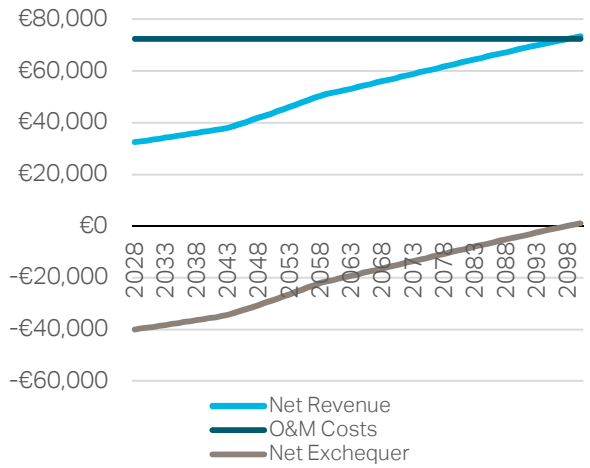


Figure 8.2 – Exchequer Impact (€, 000's)

Table 8.7 – Revenue Summary and Present Values (2019 Real Prices)

Option	2028	2043	60 Year PV €m
O&M Costs (Train Services and Infrastructure)	-€72.5	-€72.5	-€1,949.0
Net Revenue	€32.4	€38.0	€1,204.6
Total	-€40.0	-€34.5	-€744.5

It can be seen that the DART+ will have a negative impact on the Exchequer to the value of €744m when considering the annual costs and revenues associated with public transport. This figure excludes capital costs, revenue losses due to modal shift on highway tolls and indirect tax.

8.8 Affordability and Funding

8.8.1 NDP Funding

Project Ireland 2040: National Development Plan allocates €2 billion in funding for DART+ between 2018 and 2027. Expenditure to 2027 is being planned within this funding allocation, however the total cost of DART+ will exceed the allocation to 2027. Independent of exceeding the funding allocation, some elements of DART+ will be delivered post-2027.

The delivery mechanism chosen for DART+ ensures that it can be delivered sequentially. The delivery mechanism will provide some flexibility for elements of the programme, as whilst each DART+ Project will deliver benefits in its own right the sequential delivery will ensure the benefits of the programme as a whole will be greater than the sum of its individual elements.

This approach to delivery minimises financial risks. It provides the opportunity for funding to be accessed incrementally prior to the commencement of works.

8.8.2 Operating Subsidy

Outside of the upfront capital costs funded through the NDP, there will be additional ongoing costs associated with operating the additional train services and the infrastructure maintenance.

It is envisaged that the incremental costs associated with the train operations net of the revenue increase would need to be captured through an increase in the PSO funding.

The PSO subsidy is Exchequer funded, paid through the DoT to the NTA, who negotiate and manage the contracts with IÉ's Railway Undertaking. Based upon the IÉ 2018 annual report, the total PSO payment to IÉ was €89m in 2018 which covers all rail services in Ireland.

The PSO costs do not include the costs associated with the infrastructure maintenance. IÉ's management of infrastructure is funded under EU regulation by a 5-year IMMAC direct from the DoT, and track and station access charges from passenger and freight rail services. Total income through the IMMAC across the whole IÉ network was €125m in 2018 based upon the IÉ 2018 annual report.

Costs associated with the Infrastructure O&M would therefore be required to be covered through the IMMAC and access charges.

Table 8.8 shows the forecast change in PSO. This is based upon the costs associated with the additional train service O&M plus the access charges between the Railway Undertaking (RU) and IM, less the incremental revenue generated by DART+.

Table 8.8 – Net Change in PSO (2019 Real Prices)

Incremental PSO Payment Change	2028 Annual	2043 Annual	60 Year PV €m
Train Service O&M Cost	€41.1	€41.1	€1,106.8
Access Charges Cost	€16.9	€16.9	€453.7
less Revenue	*-€52.7*	*-€68.6*	-€1,989.6
Change In PSO	**€5.3**	**-€10.6**	**-€429.1**

This shows an overall reduction in the PSO with the driver being the additional revenue for heavy rail. Although incremental costs exceed incremental revenue in 2028, the growth of revenue post 2028 as shown in the 2043 figure, results in revenue exceeding the O&M costs of operating the additional train services and the associated access charges through the increase in vehicle kilometres.

Table 8.9 shows the forecast change in the IMMAC. This is based upon the costs associated with the additional maintenance costs associated with DART+ with the access charge component netted off which gets transferred to the RU.

Table 8.9 – Net Change in IMMAC (2019 Real Prices)

Incremental IMMAC Change	Annual Cost	60 Year PV €m
Infrastructure Maintenance Costs	€31.3	€842.2
less Costs Covered by Access Charges	-€16.9	-€453.7
Total Change In IMMAC	**€14.4**	**€388.5**

The IMMAC is forecast to increase by €14.4m per annum and €389m PV over the 60-year appraisal period. This is driven by the maintenance costs of the new assets and costs associated with the additional gross tonnage on the existing network.

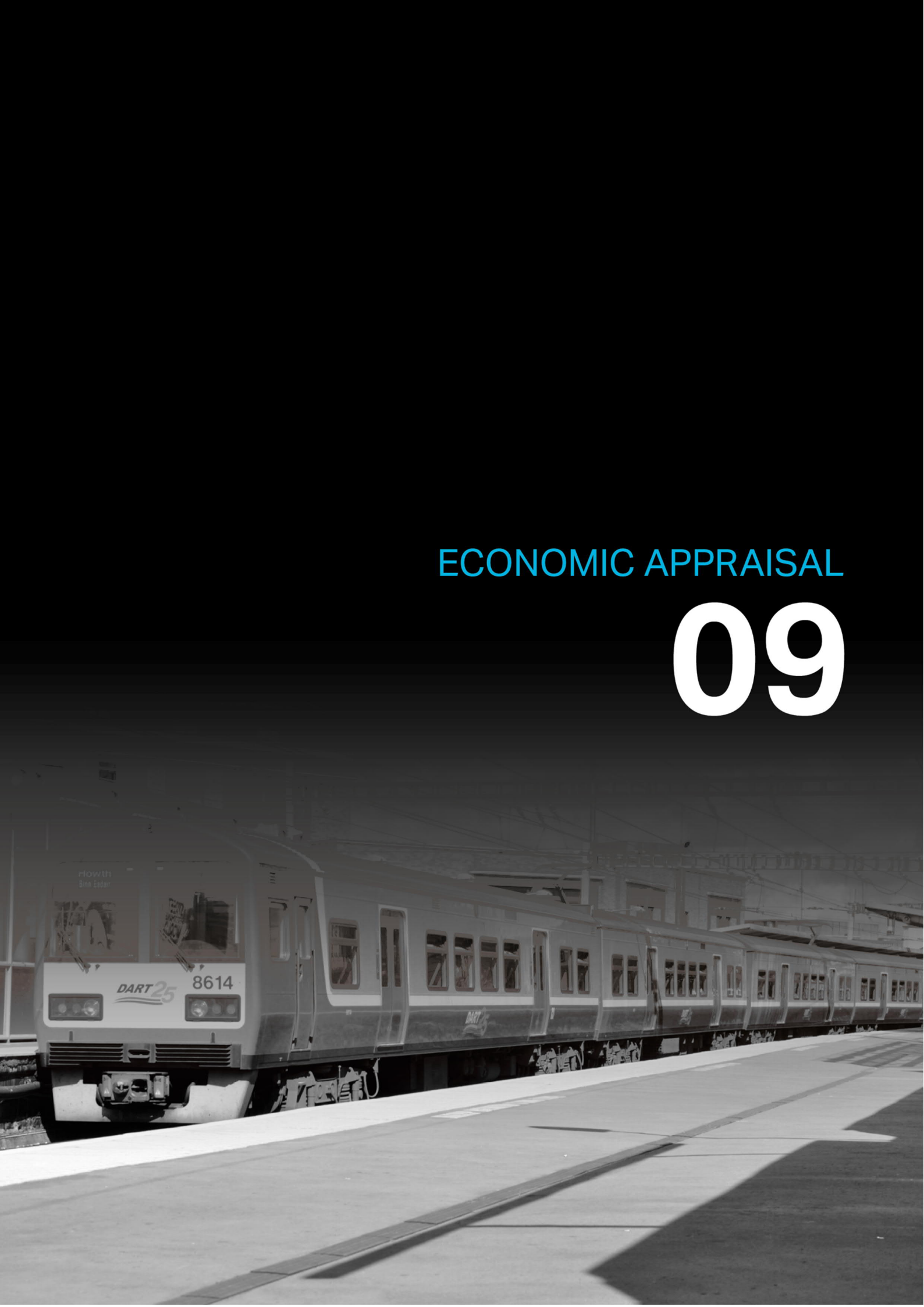
8.9 Financial Summary

A summary of the key figures is outlined below.

- A total cost forecast to the Exchequer discounted over 60 years of €3.25bn. This consists of a total cost of €4.45bn offset by a net revenue increase of €1.2bn.
- In terms of the impact to Iarnród Eireann which considers solely the impact on the rail network, the PSO discounted over 60 years is forecast to reduce by €429m with a corresponding increase in the IMMAC of €389m.

ECONOMIC APPRAISAL

09



9. Economic Appraisal

9.1 Introduction

This section provides an overview of the transport user benefits, the present value of costs and the range of Benefit to Cost Ratios (BCR) arising from the DART+ Cost Benefit Analysis (CBA).

The appraisal is informed by the requirements of DPER's Public Spending Code and the DoT's CAF for Transport Projects and Programmes.

9.2 Appraisal Framework and Assumptions

The outputs from the transport modelling and cost forecasting have provided the core inputs to the CBA process. The transport model has provided outputs for 2028, 2043 and 2058 for this purpose. The CBA assesses the impact of each scheme on users and operators under the following headings:

- Net transport user benefits
- Journey time (in-vehicle time, transfer time, walk and wait time etc.)
- Charges (fares/tolls etc.) – See Section 8
- Vehicle operating costs – See Section 8
- Net transport operator benefits – See Section 8
- Impacts on Greenhouse Gas emissions
- Investment costs
- Operating and maintenance costs – See Section 8
- Revenue including both revenues generated by DART+ services and abstraction from other modes – See Section 8

Additional benefits have been calculated outside of the ERM model for the following.

- Greenhouse gas emissions associated with change in fleet from diesel to electric which are not included in TUBA.
- Reliability as changes in reliability are not explicitly modelled within the ERM. These have been calculated separately and included as sensitivity test.

The Cost-Benefit Analysis has been undertaken using TUBA software in line with the Public Spending Code. Individual economic parameters will be based on industry-standard variables extracted from the TII Project Appraisal Guidelines and DoT guidance. This includes Values of Time, Carbon and vehicle operating cost assumptions.

Core assumptions used in the appraisal are:

- A price base year and present value year of 2011 as defined in the DoT CAF
- A standard appraisal period of 30 years with a residual value period of a further 30 years
- Discount rate of 4% for 30 years from current year and 3.5% for years 31-60
- Shadow price of public funds of 130%
- Shadow price of labour of 100%
- Scheme opening year of 2028 in line capital cost profile

As outlined in Chapter 7, the values used in the appraisal are incremental benefits, costs and revenue of the Do Something scheme over the Do Minimum. The Transport Modelling Report outlines the detail of the specific assumptions used for both the DM and DS.

9.3 Results

9.3.1 Economic Benefits

This covers primarily the user benefits associated with improved services to existing users and the subsequent impact on other passengers through modal shift.

This also covers revenue both for public transport and highway tolls which is categorised in TUBA as a private sector impacts and thus fall under business benefits.

These benefits are shown in Table 9.1.

Table 9.1 – User Benefits (€ Millions - 2011 Values and Prices)

60 Year PV €m	Highway	Public Transport
Travel Time	-€185.2	€6,351.9
Vehicle Operating Costs	-€4.0	€0.0
User Charges	€34.4	€37.5
Present Value of Benefits	**-€154.8**	**€6,389.4**

9.3.2 Greenhouse Gases

The greenhouse gas benefits are driven by two separate impacts.

- Changes due to modal shift and changes in congestion on the road network.
- Changes in the Eastern region rolling stock fleet ratio from mainly diesel to electric.

The highway impacts have been estimated using TUBA[45] whilst the rolling stock impact has been calculated based upon changes in vehicle kilometres between diesel and electric and associated fuel use. Emissions factors for diesel and electric (including BEMU) and associated monetised CO_2 costs for traded and non-traded have been based upon assumptions and sources in the 'Public Spending Code Supplementary Guidance - Measuring & Valuing Changes in Greenhouse Gas Emissions in Economic Appraisal'.

These benefits are shown in Table 9.2.

Table 9.2 – Greenhouse Gases (2011 Values and Prices)

Greenhouse Gases		60 Year PV €m
Highway		€0.2
Rail	Mode Shift	€0.229
	Fleet Change	€32.7
Total		**€33.1**

9.3.3 Indirect Taxation

The impacts on indirect tax revenue are included as part of the Present Value of Benefits (PVB), rather than the Present Value of Costs in line with CAF. These impacts are driven by changes in tax payment to the Exchequer through changes in fuel duty and shift to public transport which is exempt from VAT.

Table 9.3 – Indirect Taxation (2011 Values and Prices)

Indirect Tax (PV)	60 Year PV €m
Highway	€0.8
Rail	-€98.1
Total	**-€97.3**

9.3.4 Revenue

The impacts on revenue as outlined below.

Table 9.4 – Revenue (2011 Values and Prices)

Revenue (€millions)	60 Year PV €m
Rail (Farebox and Ancillary)	€1,099.9
Abstraction from bus and Luas	-€394.5
Abstraction from Toll Roads	-€58.3
Net Revenue	**€647**

9.3.5 Benefits summary

A summary of the benefits is provided below.

Table 9.5 – Benefits (€ millions - 2011 values and prices)

60 Year Present Value - €m		Road user	Public Transport
Travel Time		-185.2	6351.9
Vehicle Operating Costs		-€4	-
User Charges		34.4	37.5
Greenhouse Gases	Mode Shift	€0.2	-
		-	€0.229
	Fleet Change	-	€32.7
Indirect Tax		€0.8	-
		-	-€98.1
Revenue	Rail (Farebox and Ancillary)	-	€1,100
	Abstraction from bus and Luas	-	-€395
	Abstraction from Toll Roads	-€58	-
Sub-Total by mode		-211.8	7029
Present Value of Benefits		**€6,817**	

9.3.6 Costs

This captures the costs associated with the construction, operation and maintenance based upon the assumptions outlined in Chapter 6.

[45] *Transport users benefit appraisal (TUBA) software undertakes the economic appraisal of transport schemes in accordance with the DoT's cost benefit analysis guidance*

Table 9.6 – Costs (2011 Values and Prices)

Indirect Tax (PV)	60 Year PV €m
Capital Costs	€1,742.5
Capital Cost - Renewals and Residual Value	€84.6
Train Service Operating Costs	€638.6
Infrastructure Maintenance Costs	€485.9
Present Value of Costs	**€2,951.7**

9.3.7 CBA Results Summary

A summary of the economic benefits associated with the DART+ Programme is shown in Table 9.7.

Table 9.7 – CBA Summary (2011 Values and Prices)

	60 Year PV €m
User Benefits	€6,234.6
Greenhouse Gases	€33.1
Revenue	€647.0
Indirect Tax	-€97.3
Present Value Benefits	**€6,817**
Present Value Costs	**€2,952**
NPV	**€3,865**
BCR	**2.3**

The above shows that DART+ represents very good value for money with a strong return on investment.

9.4 Sensitivity Tests

Sensitivity tests in relation to modelling assumptions, economic variables and costs have been undertaken. The results of these sensitivity tests are presented in the following sections.

9.4.1 Cost Contingency sensitivity

Notwithstanding the inclusion of risk and optimism bias in the base case scenarios involving both an increase and decrease in contingency levels have been assessed as part of a sensitivity test to account for uncertainties in cost estimation, given that some elements of the programme are at an early stage in planning and design. The corresponding CBA results are outlined in Table 9.8. DART+ would generate a BCR of 2.2 if capex contingency was increase to 55% (and inflation increased by 1%) from 35% and a BCR of 2.6:1 if contingency was reduced to 20% (and inflation decreased by 1%) from 35% both of which still represent a positive economic return on investment.

Table 9.8 – Cost Sensitivity - CBA Summary (2011 Values and Prices)

	Upper @ 55% & +1% inflation	Lower @ 20% & -1% inflation
	60 Year PV €m	
Present Value Benefits	€ 6,817	€ 6,817
Present Value Costs	€ 3,129	€ 2,632
NPV	€ 3,688	€ 4,185
BCR	2.2	2.6

9.4.2 Wider Economic Impacts - Agglomeration

The process for quantifying the agglomeration effect of the DART+ is set out in Section 7.5. DART+ is forecast to lead to agglomeration benefits of some €431million over the 60-year period which is included in the below.

Table 9.9 – Agglomeration Test - CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€7,248
Present Value Costs	€2,952
NPV	€4,296
BCR	2.5

9.4.3 Journey Time Reliability

DART+ will deliver improved efficiencies in the operation of the DART services, reduced dwell time and variation in dwell time at stations and reduce likelihood of delays. This will reduce the variability in rail journey times by ~ 40%. Reliability benefits are separate from journey time savings. They capture the perceived benefit associated with reduced uncertainty that users experience when the variation in their rail journey times is reduced. Figure 9.1 presents a situation where improvements in the variability of a rail service do not necessarily result in journey time savings. It is therefore appropriate that the appraisal of the DART+ Programme aims to capture both the journey time savings (due to reduced headways, improved rail speeds and more direct journeys) and reliability savings (through improved rail

infrastructure and operations reducing the likelihood of delays).

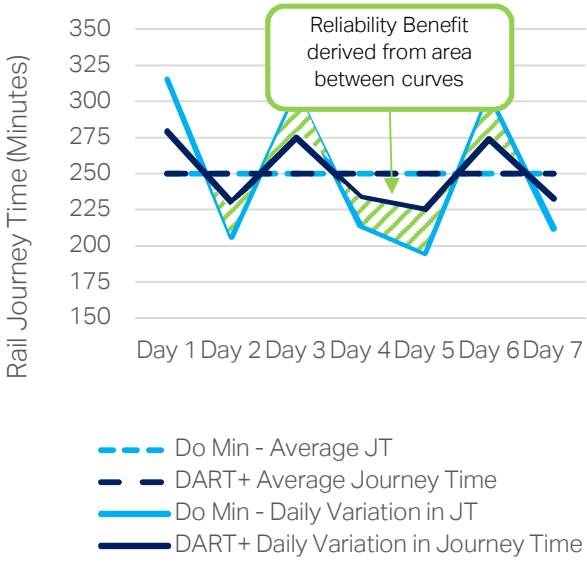


Figure 9.1 - Sample Journey Time – Average and Daily Variation

For the Preliminary Business Case, reliability benefits have only been included as a sensitivity test to the appraisal as a conservative approach has been taken to ensure the appraisal is robust to all eventualities as the Programme progresses.

Future discussions with DoT may result in reliability benefits being included in the Base Case as part of the future iterations of the Preliminary Business Case and/or the Final Business Case. The inclusion of journey time reliability benefits further strengthens the economic case for the programme as set out below. Results summarised in Table 9.10 indicate that the DART+ benefits will increase by ~€105m and the corresponding CBA results are outlined below.

Table 9.10 – Reliability Test - CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€ 6,922
Present Value Costs	€2,952
NPV	€ 3,970
BCR	2.3

9.4.4 Alternative Plausible Future

The future is uncertain. In transport planning and in particular the development of major transport investment projects it is necessary to project demand for travel up to 30 years into the future. On-going changes in technology, social norms and public policy mean that projecting travel demand is difficult.

In general, the impact of changes in technology, social norms and or public policy can take a long time to materialise. At a regional or national level year on year change in travel demand associated with new infrastructure or a new policy can be almost imperceptible but over the medium or long term, the aggregate impact is clearer.

One way to accommodate uncertainty and reflect potential changes in demand for travel is to use scenario planning. This involves making evidence-informed projections about changes to key variables such as:

- Employment composition and location
- Population composition and location
- Trip rates and frequencies
- Travel preferences
- Mode choice

Rather than considering these changes in isolation, scenario planning varies them together to assess how changes in different variables interact and to develop an alternative future scenario for travel demand.

In addition, scenario planning provides a framework to consider "shock waves" that occur from time to time. These "shock waves" can lead to an acceleration in the natural rate of change in society. The COVID-19 pandemic is an example of such shockwaves and was discussed in Section 3.7.

An alternative scenario for future travel demand has been developed by the NTA which considers the medium to long-term impacts associated with an accelerated transition to remote working, remote education and associated changes for a proportion of the population. The scenario assumes that the economy rebounds quickly and grows back with economic trends and factors, such as unemployment remaining unchanged.

The trip rates assigned with the NTA National Demand Forecasting Model have been adjusted to reflect the impact of greater working from home on different cohorts of the population considering employment type and trip type.

Overall the alternative scenario results in a significant reduction in the total number of trips on the transport network, approximately 8% lower

than base projections. In the case of DART+ these changes in demand reduces the overall benefits by 16% however DART+ still returns a robust BCR.

Table 9.11 – Alternative Future Test - CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€5,753
Present Value Costs	€2,952
NPV	€2,801
BCR	2.0

9.4.5 Metrolink / BusConnects Sensitivity

The NTA Transport Strategy for the Greater Dublin Area 2016 – 2035 is modally balanced and designed to cater to the future needs of the Greater Dublin Area. It integrates short, medium and long-term plans for light and heavy rail, bus, cycling, walking and roads. The Strategy recognises that need for a balanced network across all public transport systems and that the achievement of the Strategies aims requires all systems in place. In this regard the various public transport systems, i.e. heavy rail, metro, bus and light rail, are complementary to each other and in the long term each is likely to positively impact the other as the shift to public transport accelerates. The impacts on revenue as outlined below.

Table 9.12 – Revenue (2011 Values and Prices)

Revenue (€millions)	60 Year PV €m
Rail (Farebox and Ancillary)	€1,099.9
Bus	-€299.5
LUAS	-€25.8
Metrolink	€14.8
Toll Roads	-€14.5
Net Revenue	€658.6

The economic performance of this sensitivity test is presented below.

Table 9.13 – Wider Network Impact Test - CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€6,463
Present Value Costs	€2,952
NPV	€3,511
BCR	2.2

9.4.6 Reduced growth rate

A sensitivity where growth expected by 2040 is slowed and is not reached until 2050 was also assessed.

Table 9.14 – Reduced Growth Test - CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€ 6,337
Present Value Costs	€2,952
NPV	€ 3,385
BCR	2.2

9.4.7 Reduced benefits & higher cost sensitivity

As sensitivity test was undertaken which examined the effect of a reduction in programme benefits occurring as well as an increase in costs through increased contingency, to account for potential changes in benefits and uncertainties in cost estimation. The corresponding CBA results are outlined in Table 9.15. DART+ would generate a BCR of 2.0 if capital cost contingency increased to 55% and benefits were as per the reduced growth sensitivity in Section 9.4.6 which still presents a positive economic return on investment.

Table 9.15 – CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€ 6,337
Present Value Costs	€ 3,175
NPV	€ 3,162
BCR	2.0

9.5 Detailed analysis of appraisal results

This section of the economic appraisal provides further insight into the economic impacts of the DART+ Programme. Specifically, it sets out the impacts across trip purpose and time period.

Impact by trip purpose and period

The DART+ Programme will lead to significant improvements in the rail network and wider public transport system throughout the day. An overview of the impacts by time period for each mode and trip purpose is provided below.

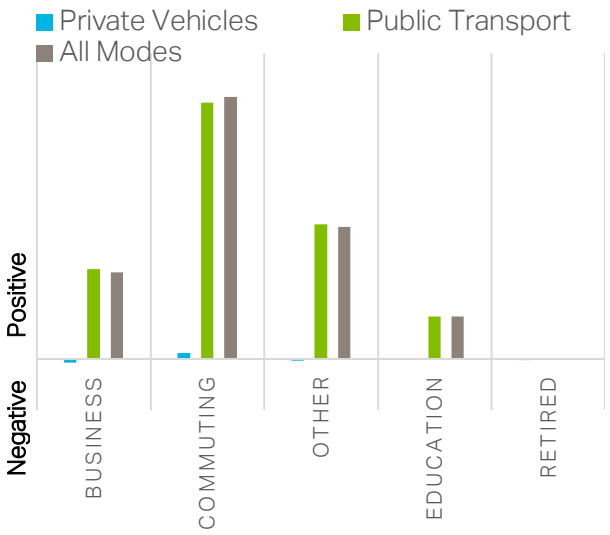


Figure 9.2- Impacts by Trip Purpose and Mode

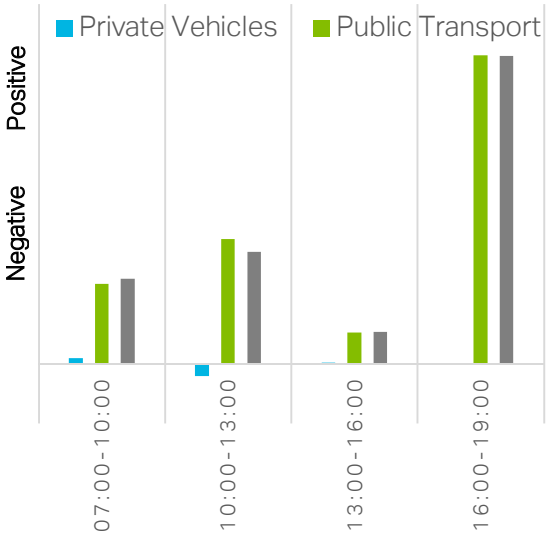


Figure 9.3– Impacts by Time Period and Mode

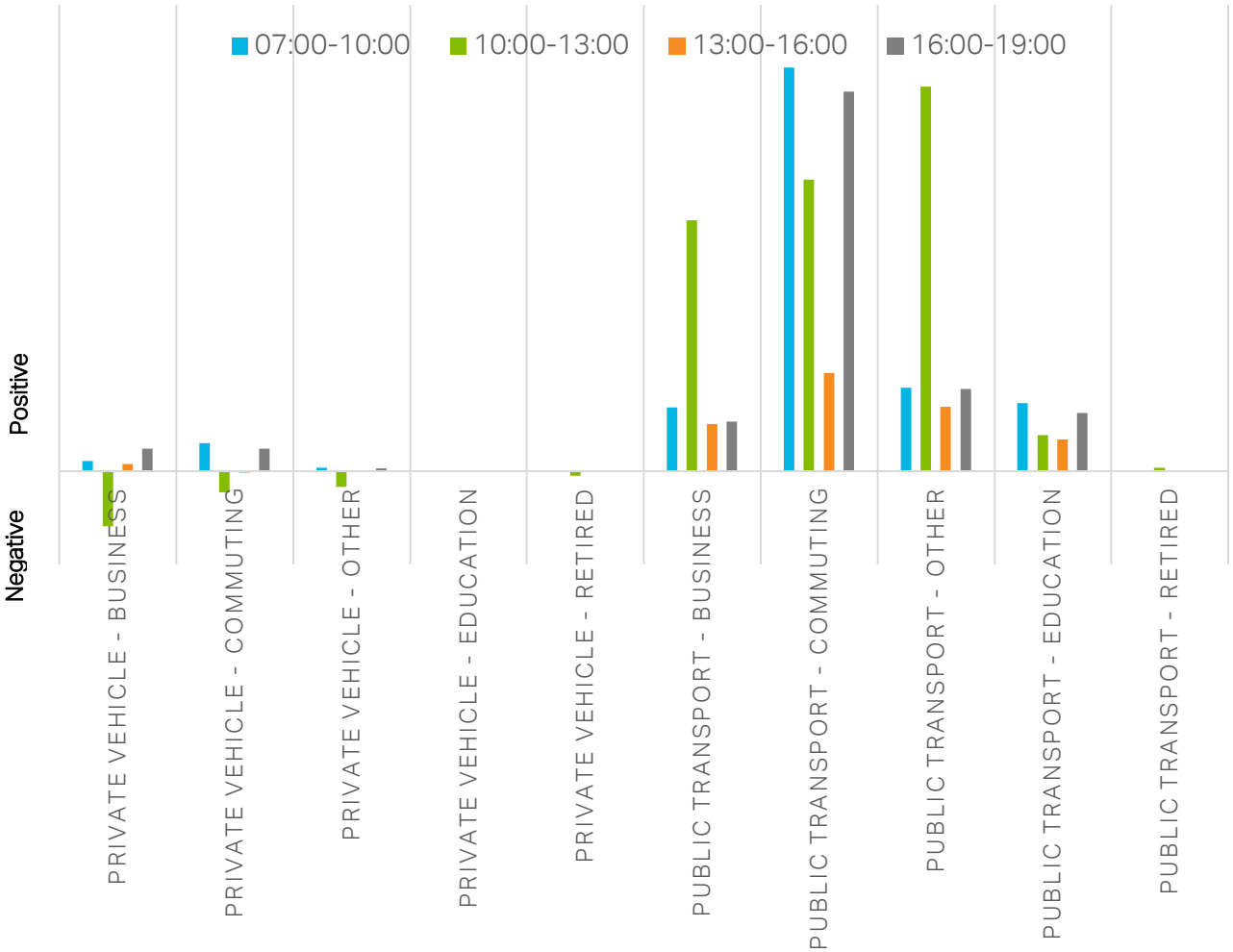


Figure 9.4 – Impacts by Time Period, Mode and Purpose

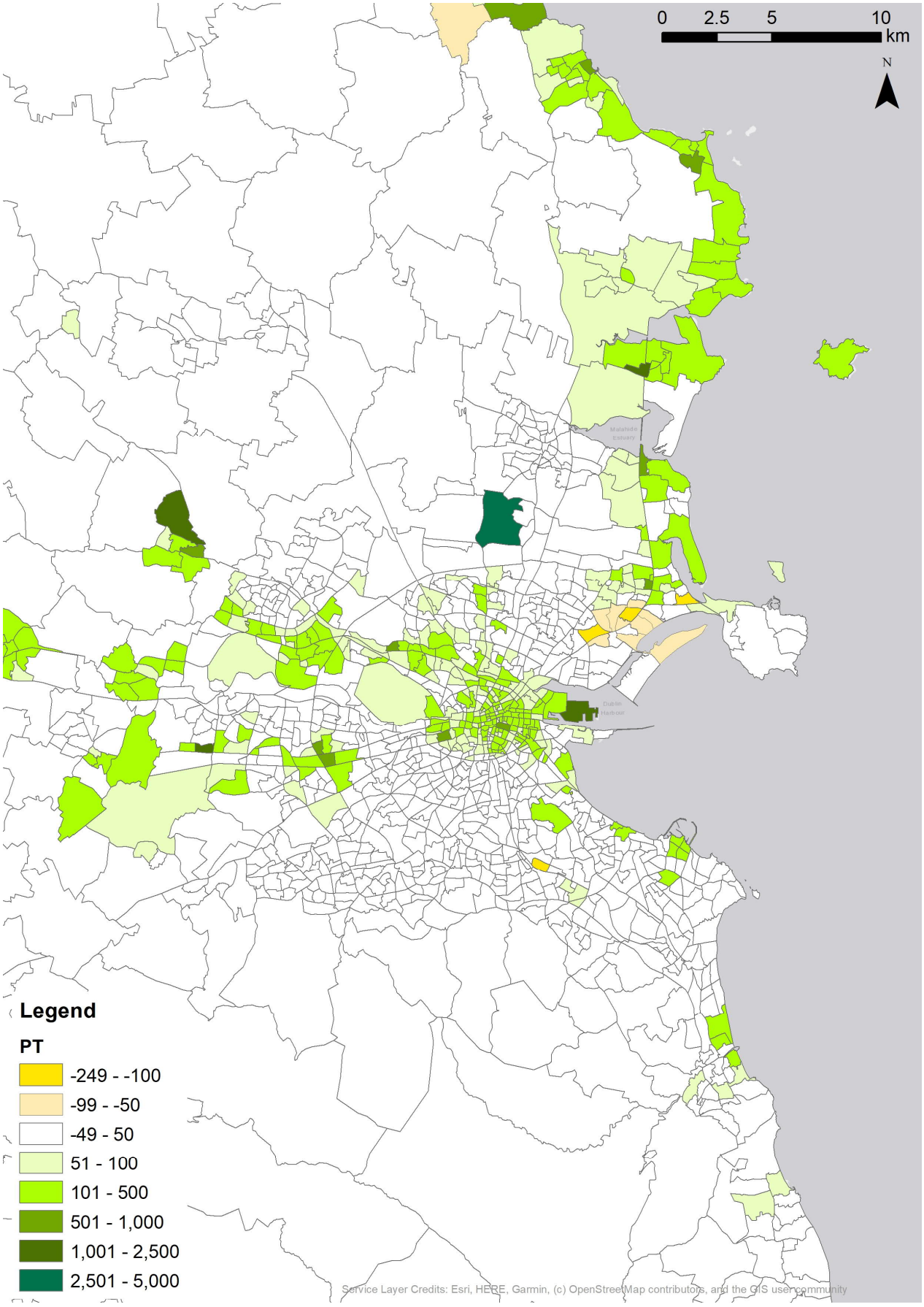


*Figure 9.5 – Geographic Spread of **Public Transport** Impacts – 2043 – Dublin Area*

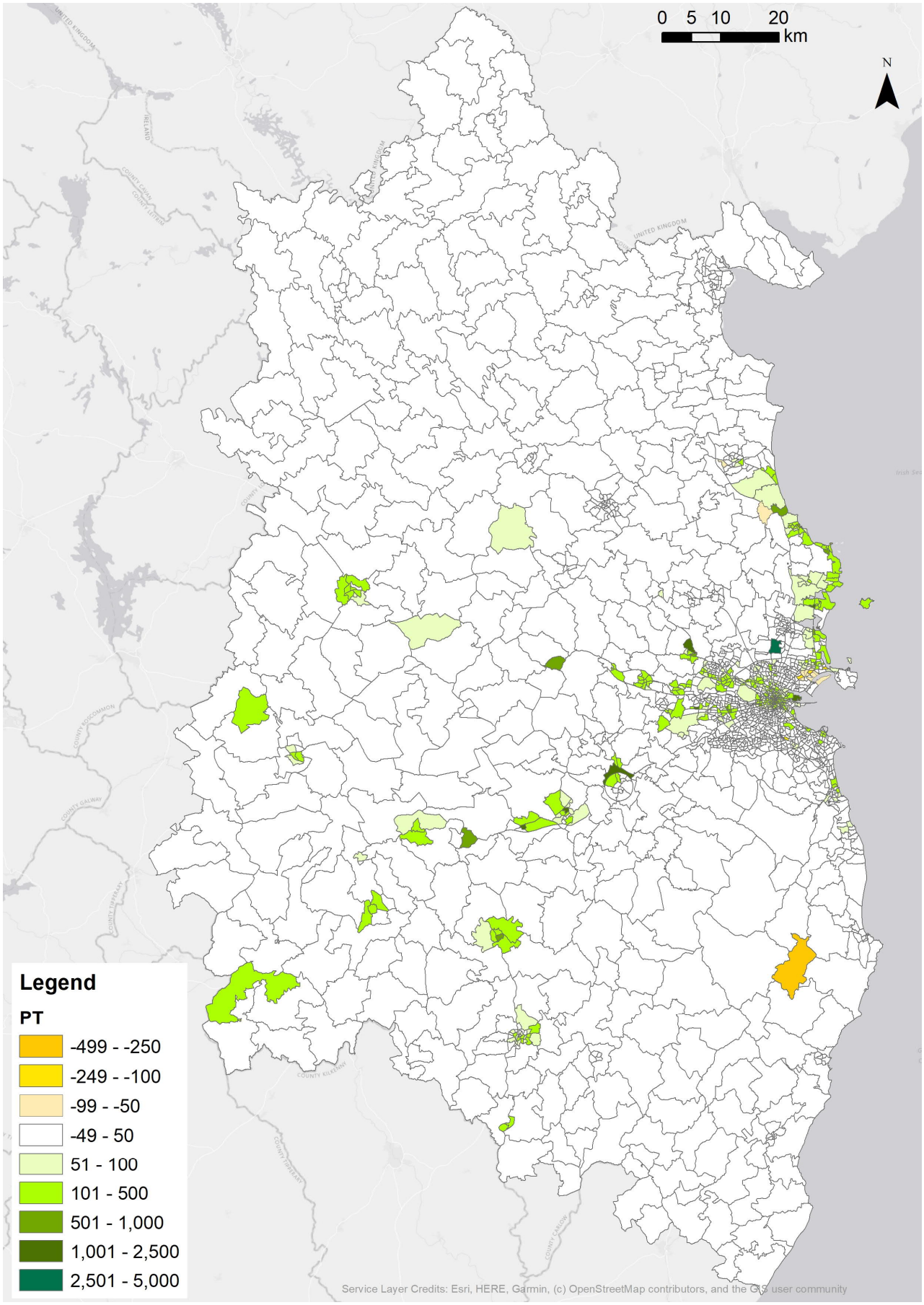


*Figure 9.6 – Geographic Spread of **Public Transport** Impacts – 2043 – Eastern Region*

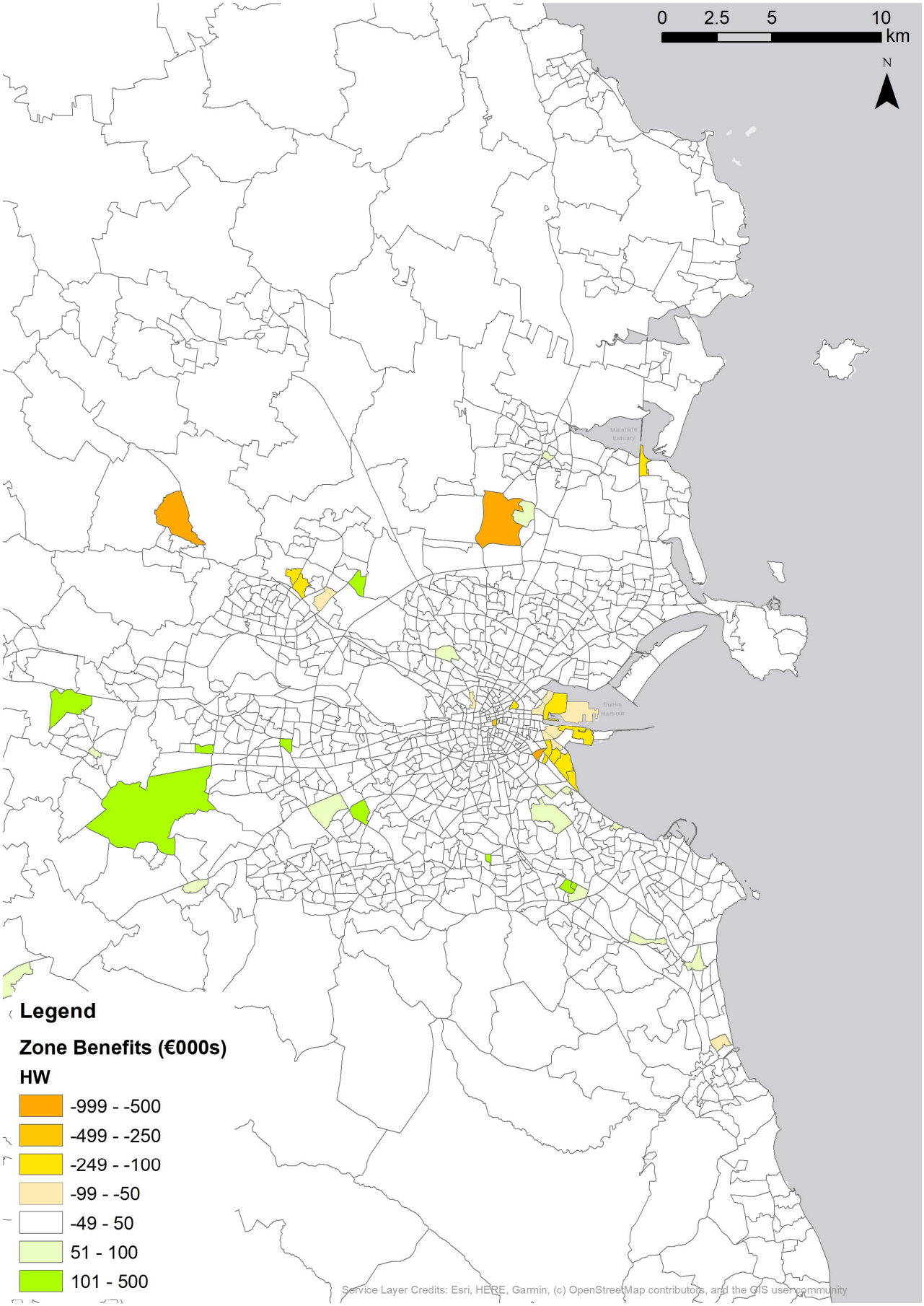
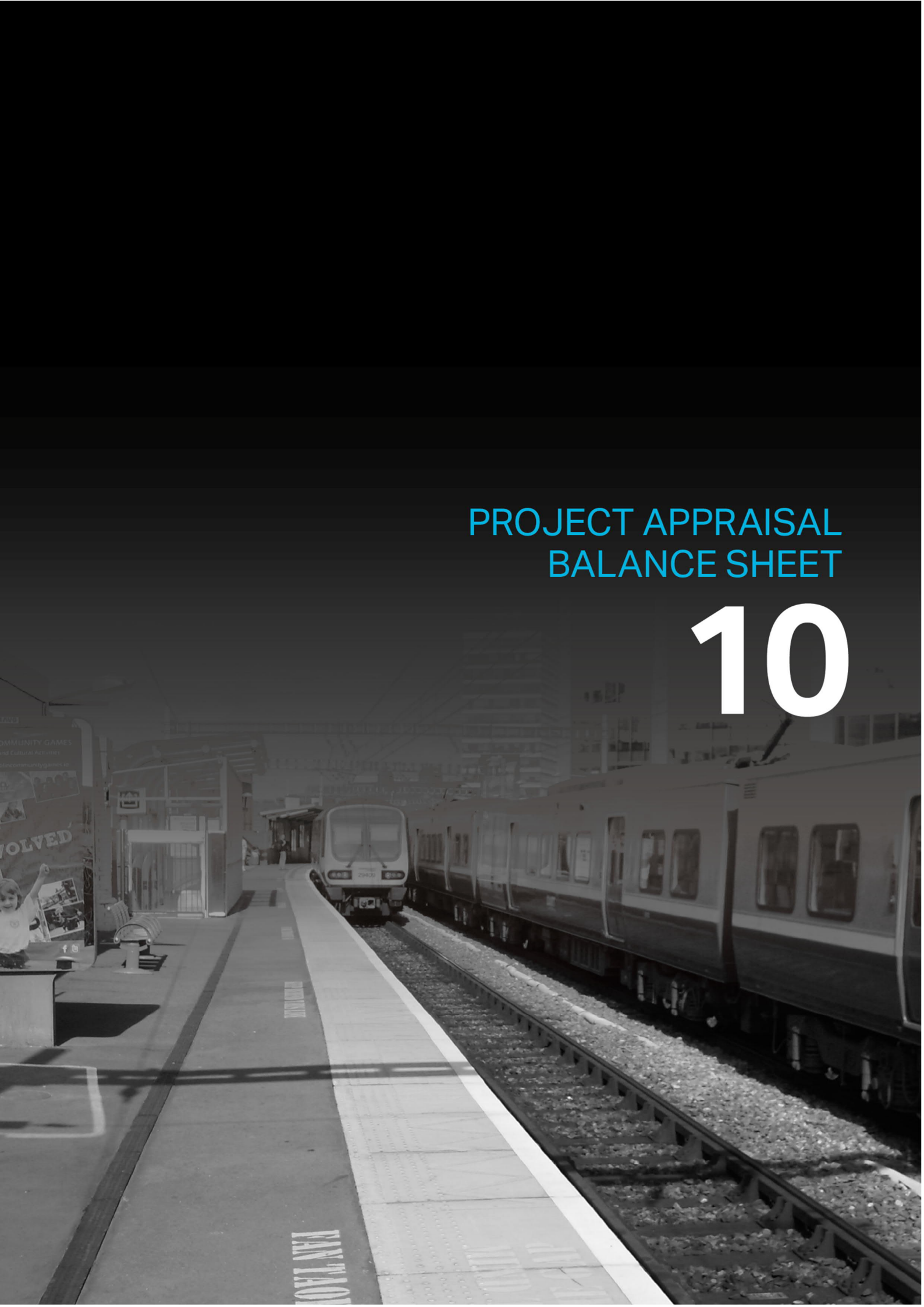


*Figure 9.7 – Geographic Spread of **Private Vehicle** Impacts – 2043 – Dublin Area*

PROJECT APPRAISAL BALANCE SHEET

10



10. Project Appraisal Balance Sheet

A summary of the results of the project appraisal for the preferred option are captured using a Project Appraisal Balance Sheet (PABS). This draws together the above outputs into a centrally focused summary.

The PABS reports the scoring of the Project against the six criteria of Economy, Safety, Environment, Accessibility and Social Inclusion, Integration and Physical Activity. A multi-point scaling system is used, ranging from significantly negative to significantly positive.

The appraisal addresses the operational phase of the programme. Other impacts will occur during the construction phase, for example construction-related noise and traffic impacts. Assessment of these, and other local impacts, fall under the remit of the project Environmental Impact Assessment process and will be documented in the EIAR (Environmental Impact Assessment Report) for each infrastructure project. The EIAR is one of the key documents for the Railway Order application.

Project Appraisal Balance Sheet								
PABS Summary Table								
Project Title:			**Reference Number**	n/a	**Project Description**		**Programme Cost (€m)**	**Date**
DART+ Programme			**Modelling Base Year**	2016			€2,952	6th Sept 2021
			Opening Year	2028				
Criteria		**Quantitative Statement**	**Summary of Keys Impacts (Qualitative Assessment)**			**Quantitative Assessment**	**Monetised (€m over 30 yrs. plus 30 yr. residual)**	
Environment	**Air Quality and Climate**	Positive	In quantitative terms the DART+ programme will have a positive impact upon air quality removing some 650,000 Tonnes of greenhouse gases from the atmosphere over the 60-year appraisal period. This reduction is as a result of a shift to more sustainable transport modes and improved efficiency in rail services. In addition, DART+ will replace the existing diesel fleet with electric fleet further improving air quality.			A reduction of 650,000 Tonnes of greenhouse gases will have a positive impact tin terms of Ireland's obligations under the EU 2020 Target (EU, 2017). Subject to further environmental assessment and appraisal as part of the Design Stage and EIAR process.	Value of Change in Emissions **Value of Change (€m)** +€33.0	
	Noise and vibration	Assessed at the next phase of design	The programme will result in an increase in public transport use and lead to a reduction in car use which would reduce traffic and relatively reduce noise and vibration.					
	Waste		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Landscape & Visual Amenity (incl. Light)		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Biodiversity, Flora & Fauna		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Agriculture		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Non-Agricultural Properties		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Architectural Heritage		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Archaeological and Cultural Heritage		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Soils & Geology		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Hydrology		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					
	Hydrogeology		N/A – Subject to environmental appraisal as part of Design Stage and EIAR process					

Safety	Collision Reduction		Transport investments can have a significant effect in improving safety and reducing incidents. In particular, the movement of transport users from private vehicles to public transport can greatly reduce the number of incidents. This combined with the removal of the majority of the existing level crossings will lead to a slight positive impact in terms of safety.		
	Security				
Physical Activity	Journey Quality	Slightly Positive	DART+ will not directly impact upon journey quality however improved rail services will encourage more cycle and ride trips.	Outputs from the ERM suggest that an additional 35million walking/cycling trips representing a 51% increase will be made as part of a multi modal trip using public transport with DART+ in place.	
	Absenteeism	Slightly Positive	The programme has a positive effect on citizens' health thanks to increased physical activity both in the form of cycling and walking, which subsequently has a positive effect on reducing absenteeism.		
	Reduced Health Risk	Slightly Positive	DART+ will not directly impact upon people's health however improved rail services will encourage more cycle and ride trips		
Economy	Transport Efficiency and Effectiveness	Highly Positive		The economic appraisal of the Base Case presents a strong economic case for the DART+ Programme. Overall, the programme has a Base Case BCR of 2.3:1 and provides an NPV of €3.9 billion over a 30-year appraisal period (including the 30-year Residual Value period). Sensitivity analysis assessed the impact of including reliability impacts, varying demand levels and increased costs on the economic viability of the programme. The sensitivity tests presented a lowest BCR of 2.0 for a scenario with the upper cost scenario and slow growth benefits combined. In all sensitivity tests, the programme presents a strong BCR and NPV suggesting that the programme is worth progressing to the next stage of planning and design. The results of the CBA assessment demonstrate that the proposed programme is projected to provide a strong return on investment and is economically viable under all scenarios that were assessed.	**Value of Change (€m)** +€6,784.0
	Wider Economic Impact	Highly Positive		DART+ will bring people and business closer together, open up new direct services and lead to significant agglomeration impacts which are valued at some €431m. This has been allowed for in a sensitivity test.	**Value of Change (€m)** +€431
	Funding	Neutral		The funding mechanism for the scheme is yet to be decided. At this point it is assumed the Programme will be exchequer funded through existing taxation arrangements.	

Accessibility and Social Inclusion	Deprived Geographic Areas	Highly Positive	The DART+ Programme has a far-reaching impact in the city centre and across the Eastern region. The programme provides a step change in public transport capacity and ensures future economic growth can be supported. The contribution of the DART+ Programme to developing a fully integrated public transport network in the region and particularly in the city centre will lead to a significant increase in accessibility and social inclusion. The DART+ Programme will improve journey times and journey time reliability, thereby improving access to employment, education, healthcare for all users including vulnerable groups. In addition, the programme will improve the quality of service provided to vulnerable users through improved fleet, ease of payment and improved stop infrastructure.	Impact on Deprived Areas The number of people located within 1km of a high frequency rail service would increase by 134%, from approximately 258,000 today to over 600,000. DART+ will reach an additional ~85,000 people living in areas defined as below average or worse by Pobal.	
	Vulnerable Groups	Moderately Positive			
Integration	Transport Integration	Highly Positive	DART+ will improve the interchange opportunities with other public transport modes, encouraging and enabling model shift from the private car. This will lead to increased patronage on other public transport modes besides heavy rail as the levels of interchange increase. The programme will be complementary to other schemes outlined in the Project Ireland 2040: National Development Plan such as the proposed Metrolink BusConnects Programme both of which are currently in planning. The programme will improve rail based public transport at both a local, regional and national level, by improving rail frequencies, journey time and reliability throughout the Eastern region. The programme will achieve the objectives of the Project Ireland 2040: National Planning Framework, the GDA Transport Strategy 2016 – 2035 and the City and County Development Plans to generally improve quality of life and improve accessibility to work, education and other activities.	Overall, DART+ will lead to a 43% increase in the number of people interchanging between different public transport services. Interchange between rail services will increase by 10,000 interchange trips a day whilst Rail to Luas and Rail to Bus interchange trips will increase by 4,500 and 13,000 trips a day respectively.	
	Land-Use Integration	Moderately Positive			
	Geographical Integration	Highly Positive			
	Integration with Other Government Policies	Highly Positive			

Overall Scale of Impact	Environmental	Moderately Positive	Economy	Highly Positive	Summary of Benefits (€ millions)			
	Safety	Moderately Positive	Accessibility & Social Inclusion	Highly Positive	PVB	€6,817	NPV	€3,865
	Physical Activity	Slightly Positive	Integration	Highly Positive	Present Value of Cost (PVC)	€2,952	BCR	2.3:1

GOVERNANCE PLAN

11

11. Governance Plan

In 2020, Iarnród Éireann began the process of developing the DART+ Governance and Assurance Framework[46] which was launched in January 2021. The Framework recognises the scale and complexity of the programme and aligns with the PSC requirements as well as the Iarnród Éireann's corporate governance framework.

Statutory stakeholders

Iarnród Éireann is the Sponsoring Agency for DART+, with responsibility for proposing and implementing the programme. It has primary responsibility for evaluating, planning and managing DART+ and engaging at the Decision Gates with the Approving Authority for Approval in Principle and/or Approval to Proceed to the next stage of the project lifecycle

NTA is the Approving Authority with ultimate responsibility for the project or programme. It is responsible for granting approval for DART+ to proceed under the management and oversight of another body. It assesses the proposal at the key decision gates in the project lifecycle. It is responsible for funding and ensuring the project or programme is delivered as approved. The NTA is responsible for evaluating the business case and development for conformity with strategic transport and value for money objectives and ensuring that the organisation of DART+ is appropriate to its scale, complexity and the challenges it faces. In line with the Public Spending Code, the NTA approves the submission of documentation to the Department of Transport for review at the relevant Decision Gates prior to the Department seeking Government approval to proceed.

The NTA is also the Transport Authority responsible for procuring public transport services, developing an integrated, accessible public transport network and providing services such as integrated ticketing and information. In the Dublin area it is the NTA's role to undertake strategic planning of transport and to secure the provision of public transport infrastructure.

The DoT is responsible for ensuring that procedures are in place to ensure compliance with the PSC within the bodies under its aegis. In addition, and as stated in the Public Spending Code, Government approval is required for proposals with an estimated cost over €100million. As the estimated cost of DART+ is over €100million, Government approval will be required at PSC Decision Gates 1, 2 and 3. The PSC states that it is the responsibility of the parent Department, in this case the DoT, to facilitate seeking that Government approval. The DPER is responsible for technical review of the programme at key stages. The reviews focus on the business case and whether the overall appraisal is robust, and the analysis supports the conclusions drawn. Unlike the NTA review, the DPER review is policy neutral and intended to support consistent application of the PSC across sectors.

The DART+ Programme governance framework ensures that the roles and responsibilities of the stakeholders are clearly defined and understood, and that the structures are in place so each can perform their function effectively.

11.1 Governance principles

The Governance framework is based on a set of best practice principles and recommendations from professional bodies, lessons learned reviews and practical examples from successful projects:

- Clarity of the decision-making authority across the DART+ Programme
- Integration of the project lifecycle with the governance and assurance framework
- Integration of decision making relating to all relevant factors e.g. scope, schedule, delivery risk and cost, at common points to enable robust baseline setting and change management
- A structured hierarchy of decision making and escalation with delegation of decision making to the most appropriate levels
- Clear roles and responsibilities for everyone across the programme
- Defined tolerances for escalation and informing corrective actions and a determined process for controlling change

[46] *DART+ Governance and Assurance Handbook, January 2021*

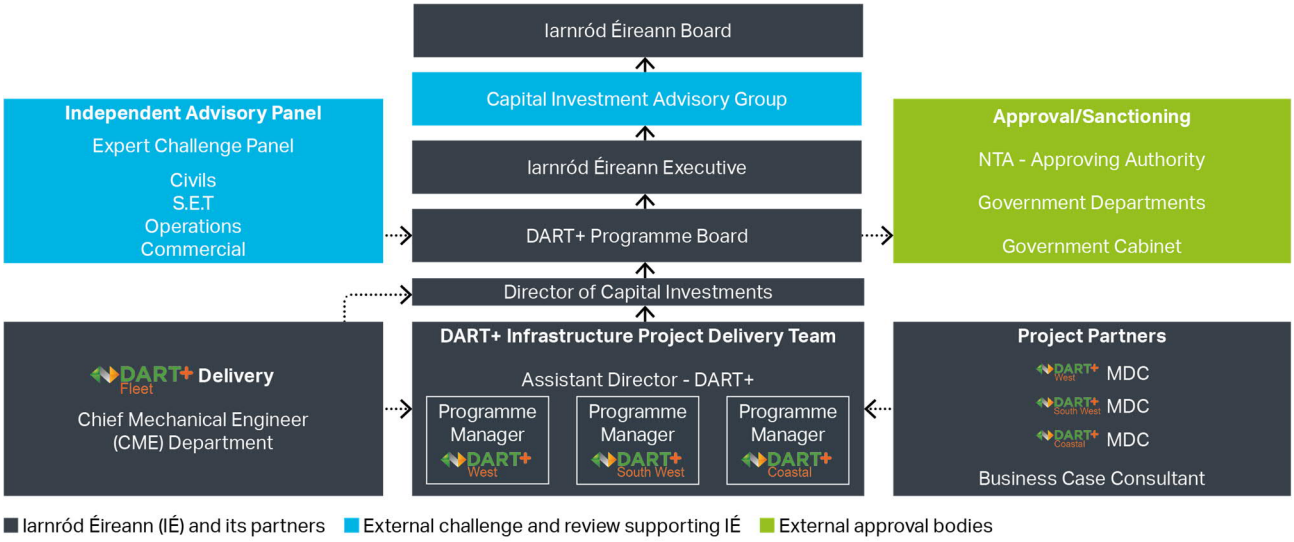
- A determined process for reporting and other communicating between the Programme Team and senior boards
- Underpinning of the governance approach by risk-based assurance.

The principles are derived from good practice recommendations from the Organisation for Economic Co-operation and Development (OECD), Institute of Directors, UK's Independent Commission on Good Governance in Public Services, Project Management Institute, the UK Government's "Improving Infrastructure Delivery: Project Initiation Routemap Governance Module. They are in line with the *Capital Works Management Framework* guidance and the NTA *Project Management Guidelines*.

11.2 Governance structure

Application of the principles led to a programme governance structure which is shown in Figure 11.1

Figure 11.1 – DART+ governance structure



11.1 Governance bodies

The roles and responsibilities for each of the bodies shown in Figure 11.1 are outlined below.

The **Iarnród Éireann Board** tests alignment of the DART+ programmes with IÉ corporate objectives. It authorises the release of key submissions to third parties. It provides ultimate oversight of the DART+ Programme, delegating down its authority from the NTA to the IÉ Executive, except for matters specifically reserved for the board set out in the corporate governance.

The **Capital Investment Advisory Group** -provides independent advisory challenge and advice to the IÉ Board on all key aspects of the construction, design and delivery of DART+. The group holds no formal decision-making delegations.

The **Iarnród Éireann Executive** provides strategic overview and challenge of the DART+ Programme status including benefits realisation and key risks/issues. Holds no formal decision-making delegations.

The **DART+ Programme Board** will provide oversight of all areas of the project, providing the overall strategic direction, and end user requirements are met, resolving key issues that arise. The board will act as the formal steering group required and provide advice to the Programme Team. The DART+ Programme Board approves all project documentation before submission to the Iarnród Éireann Executive and ultimately, the Iarnród Éireann Board.

The Programme Board is collectively responsible to act as the main decision making body for all matters not reserved for Senior IÉ Bodies, the NTA and other high level third parties; to take on the responsibilities of the formal Steering Group, providing advice to the programme team, approving documents and managing change to the agreed level of delegation that has been provided by the IÉ Executive Team.

DART+ Programme Sponsor - sponsorship of the programme is led by the Director of Railway Undertaking and the Director for Infrastructure Management who both have a role on the DART+ Programme Board. The sponsor is accountable for ensuring that all work is governed effectively and that the programme delivers the objectives and benefits of the DART+ programme. Holds no decision-making powers or delegation. Ensures that the business case remains valid and challenges the AD DART+ to deliver the programme requirements.

The **Director of Capital Investments** leads and directs the activities of the Capital Investments Directorate which includes the delivery of DART+ and all capital funded projects within IÉ.

The **Assistant Director (AD) DART+** is responsible for the programme's delivery, making the day-to-day management decisions for the DART+ Programme. The AD DART+ has been given the necessary delegated authority to carry out their role by the Programme Board.

The **Expert Challenge Panel** carries out a high-level independent evaluation of proposals in order to assess the technical and commercial validity of proposals, reporting to the DART+ Programme Board. The role is advisory only and the panel has no formal IÉ decision making authority. It is a panel of external Rail, Financial, and Major Programme Experts and chaired by an external candidate.

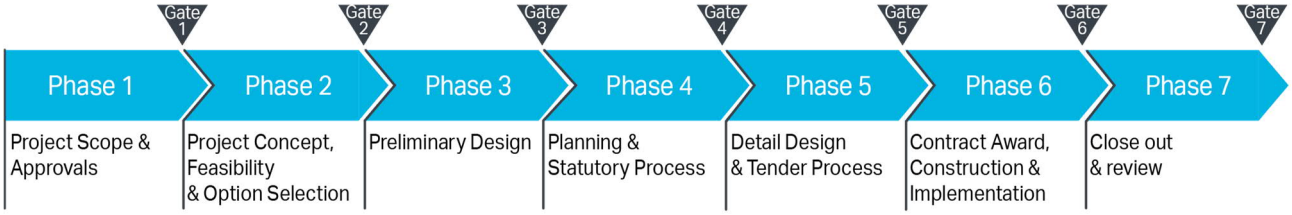
The **Programme Managers** (DART+ Project managers) are responsible for the individual Projects' delivery, making the day-to-day management decisions for their project. The Programme Managers are responsible for the management and delivery of their Project and have the necessary delegated authority to carry out their role by the DART+ Programme Board.

The **Project Partners** are responsible for their respective areas of expertise in relation to the programme and their respective projects. The Project Partners liaise directly with their individual DART+ Programme Project Team on a day-to-day basis and have no decision-making authority in respect of the DART+ Programme.

11.2 Programme controls

The IÉ Project Management Procedures (PMP) include a phased project lifecycle as shown in Figure 11.2[47].

Figure 11.2 – IÉ PMP - Project life cycle and gate reviews



[47] *The defined requirements for each phase are found in the IÉ Project Management Guidelines – PMP-001 – Project Management Procedures Standard*

Project Control Points occur at the end of each phase when Project Gateway Reviews are carried to ensure the project has met defined requirements. Additional reviews occur at major decision points or milestones within a phase.

Gateway reviews are initiated, by the DART+ Programme team, at the end of each Phase of the DART+ Programme Lifecycle and reviewed by the Expert Challenge Panel. They test that the programme is becoming more certain (reduced risk) in terms of scope, cost, schedule, value and benefit.

Progression from one phase to the next is dependent on passing the gateway review, as shown in Figure 11.3.

Figure 11.3 – Gateway review

Gateway reviews are carried out at the individual project level. This allows for the more advanced projects to continue to meet their planned milestones.

The gateway review allows the IÉ Board to decide if;

- The programme has met the necessary requirements for that phase and that there is evidence to support this;
- The programme remains value for money, deliverable within the baseline schedule and within the cost constraints;
- The programme remains a strategic priority;
- The programme is set up, prepared and ready to proceed into the next phase, with evidence to support this.

Due to the requirement to maintain programme and contract efficiencies some next Phase activities may commence in parallel with a current phase, if IÉ Board approval is given, and only after consideration of risk.

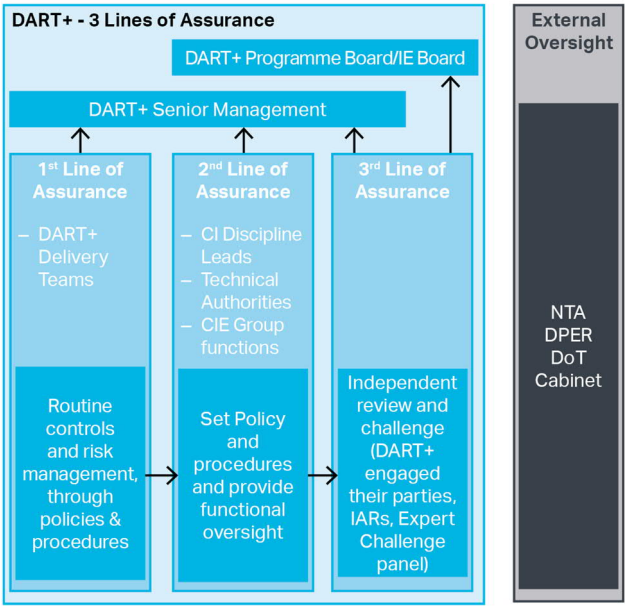
Key project decision points are Project Control Points that do not occur at the end of a lifecycle phase yet require approval from an IÉ governance body. They include:

- Approval of the Railway Order documents prior to submission to An Bord Pleanála
- Approval to accept the terms and conditions of the granted Railway Order
- Approval of the contract and selection award criteria
- Approval to continue with project funding
- Authorisation to issue major tender documents
- Authorisation to commence testing and commissioning
- Approval of handover to commence service.

11.3 Assurance framework

The project control points and Gateway Review process works together with a programme assurance process to form a risk-based approach to the key decisions. The assurance framework which has been developed by IÉ for DART+ is shown in Figure 11.4 and provides for independent oversight of the programme's progress and the data being used to inform the levels within the governance structure.

Figure 11.4 – DART+ assurance framework



As required by the PSC, the assurance approach will be risk-based. It will deploy the Three Lines of Defence Model with the level of defence applied to each item determined by its risk profile (based on issues such as criticality and complexity).

- **First Line:** the management and internal controls of the DART+ Programme Team and their delivery partners will be responsible for implementing the First Line programme processes and procedures.

- **Second Line:** management and technical assurance will be provided by CIÉ teams outside of the DART+ Programme Team.
- **Third Line:** independent assurance will be provided by third parties, and through Integrated Assurance Reviews by the Expert Challenge Panel.

Integrated Assurance Reviews (IARs) will be introduced to provide additional third line assurance of the whole programme. These will be conducted by the Expert Challenge Panel near the end of a project phase, at an agreed interim review point or they could be triggered by a specific incident e.g. forecast programme slippage or budget overruns.

Each IAR will use a set of constructive challenges (or Lines of Enquiry) that are appropriate for the lifecycle phase of the programme. The output will be an independent assessment of the DART+ Programme as an integrated entity.

11.4 Financial authority

Table 1.11 summarises the financial delegations that are to be applied to all projects until the end of Phase 4. These will be reviewed during Phase 4 and any agreed changes will from part of the Phase 4 Gateway Review.

Table 11.1 Financial delegations

Authority	Approving Change	External Approval Required
IÉ Board	IÉ Board approval required to authorise any change/ claim in excess of €500k or that will lead to the NTA approved overall capital cost being exceeded. Approval also required to seek NTA approach for extra funding if NTA approved capital cost	All changes in excess of €50k will require NTA approval in addition to IÉ approvals.
IÉ Executive	IÉ Exec have no authority to approve change.	
DART+ Programme Board	Programme Board authorised to approve any change/claim between gateways requested by AD DART+ for all changes in excess €500k	
AD DART+	AD DART+ authorised to internally approve and to directly request the required external approval any change/claim between gateways requested by Programme Managers up to a maximum value of €250k.	
Programme Managers	Programme Managers authorised to approve any change/claim between gateways up to a maximum value of €50k.	N/A

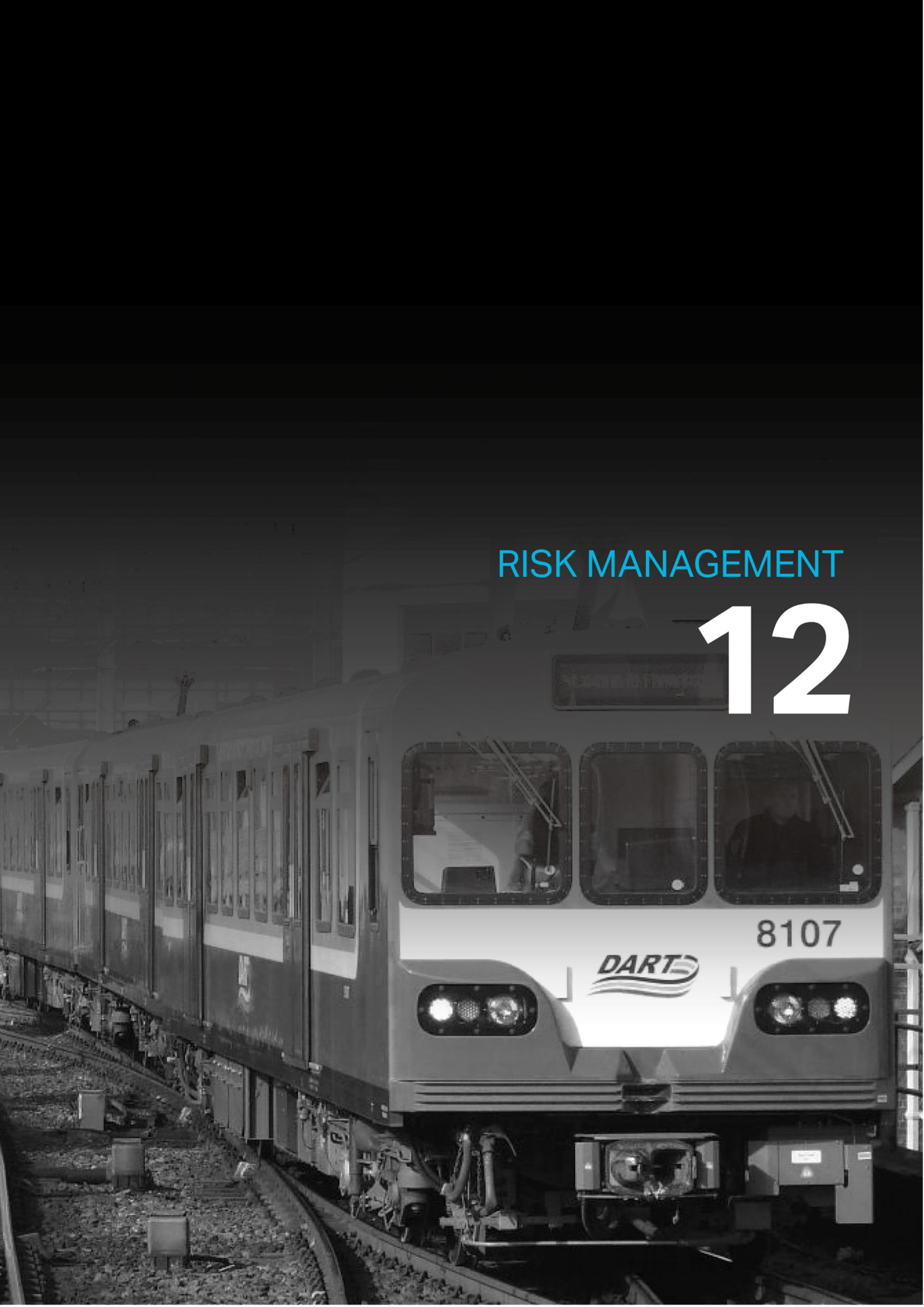
11.5 Conclusion

Robust corporate governance and assurance arrangements have been established for the DART+ Programme.

They are documented in the DART+ Programme Governance and Assurance Handbook. The arrangements will be monitored and updated if required as the programme develops.

RISK MANAGEMENT

12



12. Risk Management

The management of risks relating to the DART+ Programme will help determine the success of the programme. Failure to manage these risks will negatively impact the scope, cost, schedule or quality of the final product.

This section relates exclusively to programme risks with safety assurances and health & safety risks being managed elsewhere under each project.

The risk management process is central to the formal project management process employed for the delivery of DART+.

Risk management processes have been developed in line with Iarnród Eireann's *'PMP-002, Risk and Contingency Management Procedure'* and established to manage and mitigate risk at a DART+ programme level and at an individual project level (DART+ West, DART+ South West, DART+ Coastal – North and South).

Risk management processes have been designed to consider strategic, programme, project and operational risks.

The risk analysis also informs the economic and financial appraisal of the Programme, through the quantification of the probability and severity of each risk, to determine the risk-adjusted programme costs and benefits. Based on this analysis, appropriate mitigation measures will be identified.

The Detailed Project Brief and Procurement Strategy documentation which is required for PSC Gate 2 (approval to go to tender) will include more detail on the programme and project level risk management arrangements. Some of the key risks have been expanded upon in Appendix E.

12.1 Programme level risk management

The project team has undertaken significant work to assess risks at a programme through a series of workshops to:

- Identify constraints
- Identify and categorise risks
- Assessment criteria review
- Qualitatively assess risks
- Mitigation review for all risks.

At a programme level the strategic level risks which could impact the delivery of the overall programme have been identified and catalogued within the programme risk register. The risk register has also identified risk owners and mitigation actions for each of these risks.

Some of the critical risk categories identified to date are set out below.

- Budget shortfall where there is a difference between funding and cost estimates, where NTA cash flow profile does not match the Programmes cash flow requirements and the impact of macro-economic conditions or changes in policy in the availability of funding.
- Rolling stock procurement delay or cost variability.
- Infrastructure programme delays due to issues identified through detailed design, planning delays and third-party delays.
- Risk of scope change concerning station upgrades, fleet requirements, train service specification and network upgrades.
- Risk to fleet strategy should approval of electrification/infrastructure projects be delayed.
- Uncertainty of cost estimates
- Existing overhead line equipment capacity and issues regarding energy requirements
- Timely introduction of new technologies such as the new TPS and the NTCC and the impact of delays.
- Timely system and programme integration.
- Timely approving of the scheme by various stakeholders involved in DART+. Conflicts could produce delays at various stages of the Programme.

12.2 Project level risk management

At an individual project level, the assessment of risk is an integral part of the delivery approach as the projects move through the project lifecycle. The risk management approach is a key tool used by the delivery team to manage the outcomes of the project risks throughout the project lifecycle and incorporate lessons learnt from throughout project lifecycle.

This process has been established for DART+ West with similar structures to be put in place for the other elements of the programme in due course.

As part of this approach a core risk management team has been established to manage the

process, as well as risk champions to manage identified risks.

The risk management process has identified the risks for all the phases of the project lifecycle, however specific emphasis has been placed on the management of the risks up to the end of Phase 3 (submission of the Railway Order). Risks are recorded in the project risk register where lessons learnt from other previous projects have been considered to inform the risk identification process. The Project Risk Register has been developed using the NTA Band 3&4 Quantitative Risk Assessment (QRA), which includes a matrix for accessing the impact and probability of each of the individual risks.

The risk management strategy includes processes for the allocation of risks into a range of assigned categories including operational, programme, cost, funding, integration and fleet to enable the project team focus and report on the risk on a categorised basis. Risks mitigation actions are then defined which *hold, evade, lower* of *share* the risk identified.

- Hold-the risk is held by IÉ
- Evade-the risk is evaded through risk mitigations
- Lower-the risk impact and probability are lowered through mitigation processes
- Share-the risk is shared between IE and other contracted party through mitigation.

The impact and probability ranking for each of the risks is then updated on an ongoing basis as part of a risk review where each risk is rescored as required based on the risk profile at time of the review. In addition, risks are reviewed on a regular basis and at project gateways in due course and communicated to the wider project team.

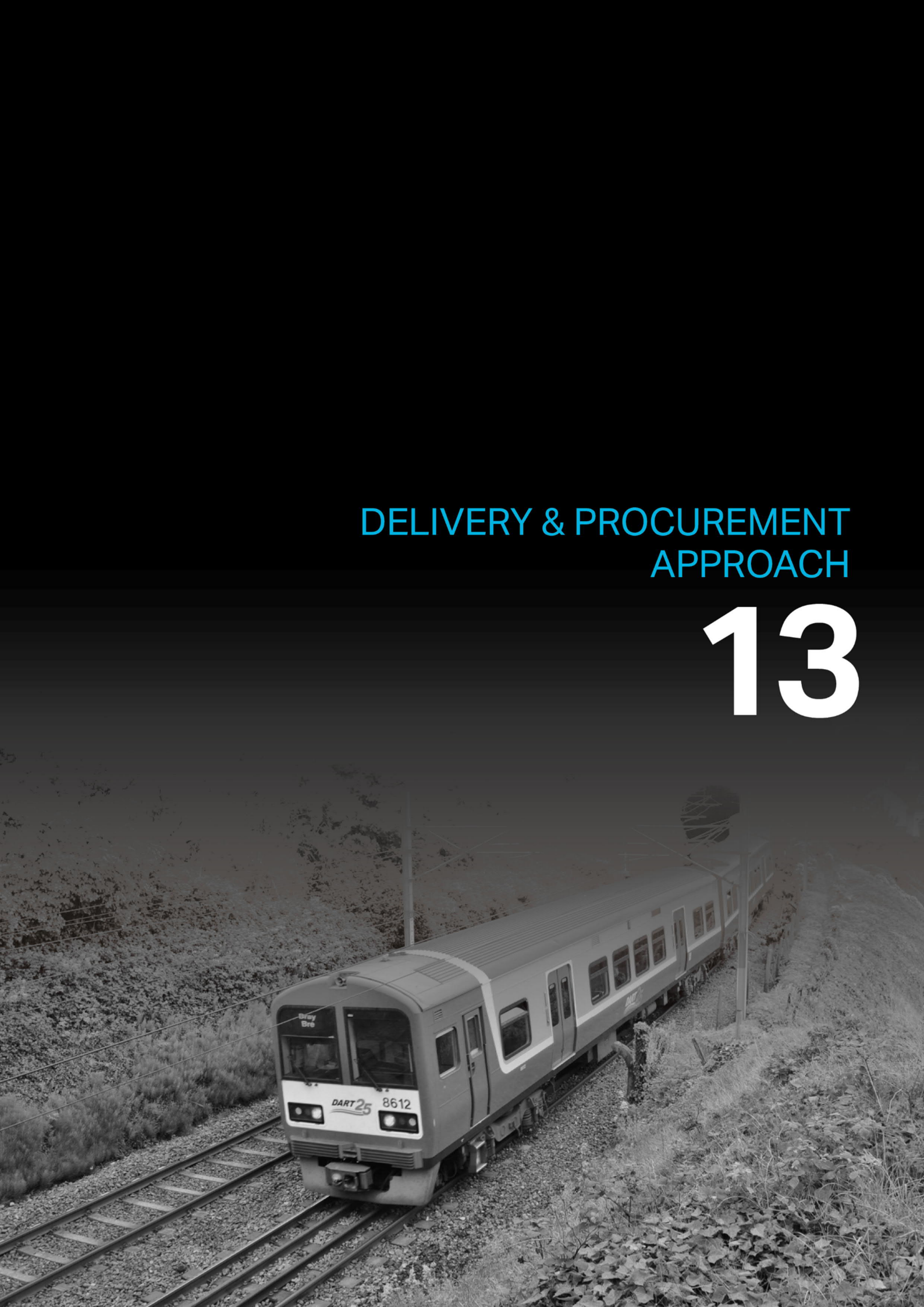
To date these risk management procedures have identified a variety of risks to the project which have been included in the project risk registers. Risk relate to infrastructure and rolling stock and include issues such as:

- Tender prices exceed the available budget
- The new depot is not available in time for new units and existing depot cannot maintain new rolling stock
- Inflation/escalation on project exceeds budget provisions
- Covid -19 impacts on possessions leading to delays.
- Electrification is not completed in time for EMU delivery
- Compatibility with existing units leads to issues in service
- Maintenance issues resulting from a lack of familiarity with new vehicles
- Late handover of civil/building works impact on Utility works - Electricity Supply Board (ESB)

The risk registers (available separately) identify the risk category and owner of the project risks and document the details of the mitigation and action plans agreed to address these risks.

DELIVERY & PROCUREMENT APPROACH

13



13. Delivery & Procurement Approach

Procurement of DART+ is carried out in accordance with the NTA and CIÉ Group Procurement Policies and Procedures, Department of Finance's Capital Works Management Framework and all National and European Union procurement requirements.

All tender and contracting processes are carried out in accordance with NTA and/or Iarnród Éireann approved procedures and will follow existing procurement practices in the selection of suppliers. All external suppliers are procured through a competitive tendering process.

IÉ's capacity to deliver DART+ is shown by previous projects, notably the Kildare Route Project which was similar to the planned infrastructure projects and previous signalling and rolling stock projects. IÉ's capacity is further demonstrated through the delivery and procurement approach outlined below and supported by the governance and rick management procedures described in previous sections.

13.1 Corporate procurement approach

CIÉ Group Procurement Policies and Procedures (2018) sets out the corporate level principles which govern all IÉ procurement processes including that of DART+. The core values which govern all procurement are:

- Achieving best value for money in terms of overall lifecycle costs;
- Ensuring compliance with Government Guidelines, applicable EU procurement legislation (EU Procurement Directives) and all other applicable laws;
- Properly managing commercial and safety risk; and
- Service delivery to internal clients.

13.1.1 Procurement principles

Value for money will be attained by:

- Ensuring the market is researched prior to tender;
- Encouraging competition and innovation in the marketplace (e.g. by considering splitting large contracts into lots);
- Maximising the use of performance specifications (i.e. specify the outputs required, not the technical inputs);
- Obtaining competitive prices, founded on fair and open competition;
- Ensuring the required quality of works, supplies and/or services procured
- Ensuring the service requirements are met in terms of delivery, technical support, and lifetime support.

Transparency will be ensured by advertising the contract in advance on the Government website, in specialist journals or the Official Journal of the European Union (OJEU) as appropriate and in compliance with EU Procurement Directives.

Equality of treatment (non-discrimination): All potential contractors should know the rules in advance and the rules should be applied to every contractor in the same way.

Proportionality: Any measure chosen should be both necessary and appropriate in light of the objectives. Administrative requirements should not be excessive and should be kept to a level appropriate to the size and complexity of the purchase, in order to ensure minority suppliers and small and medium enterprises (SMEs) are not discouraged from participating in tenders.

Mutual recognition: Products and services supplied by contractors in different EU Member States should be accepted if the products and services meet the legitimate objectives. Tenders should specify a common technical specification implementing an EU standard or EU technical approval where possible.

13.1.2 Sustainable Procurement Policy

IÉ seeks to mitigate its impact on the environment by promoting the sustainability of its operating processes and procedures. Therefore, IÉ is committed to implementing a sustainable procurement approach in the acquisition of materials, services and works, in particular where this delivers tangible benefits and value to the organisation. To fulfil this commitment, IÉ will where practicable, encourage suppliers in this regard and reward those with an economic sustainable approach to service delivery. Areas of impact can include:

- Adopting award criteria, where practicable, to include an element that is responsive to

companies and products that have a reduced impact on the environment;
- Using a life-cycle costing approach in assessing tenders with criteria that can include energy efficiency, operational, maintenance, disposal and final removal costs;
- Considering sustainability in the design of buildings, vehicles, and plant & equipment;
- Inclusion of sustainability considerations in the development of requirement specifications;
- Selecting suppliers who comply with applicable environmental and social legislation.

13.2 Procurement governance and management

IÉ Central Procurement is responsible for all procurement. and assigns a procurement executive to each DART+ Project. This executive runs the procurement in accordance with EC procurement rules and reports to IÉ's Chief Procurement Officer, who reports to the IÉ Board through the Chief Financial Officer. The procurement executive prepares the contracts award papers which the Chief Procurement Officer puts to the IÉ Board for approval. This separation of the procurement function from the DART+ teams and Programme Board ensure independent, best practice, procurement.

13.3 Rationale for traditional Government procurement rather than Public Private Partnership (PPP)

The PSC requires the PBC to explain why DART+ is following a traditional Exchequer-funded procurement route rather than a PPP route. In 2007, the potential for PPP procurement of the original DART Underground programme was examined at the request of Government. This analysis concluded that the programme was not suited to a PPP process because it consists of line works that require continuous interface with network operations, interface with IÉ technical specialities and substantial input by IÉ into design, planning and delivery. In other words, it could not be constructed and managed separately which is a requisite for PPP. The exception was the tunnel element, which could be separated apart from the tie-in as either end; however, this element is not part of the current DART+ Programme.

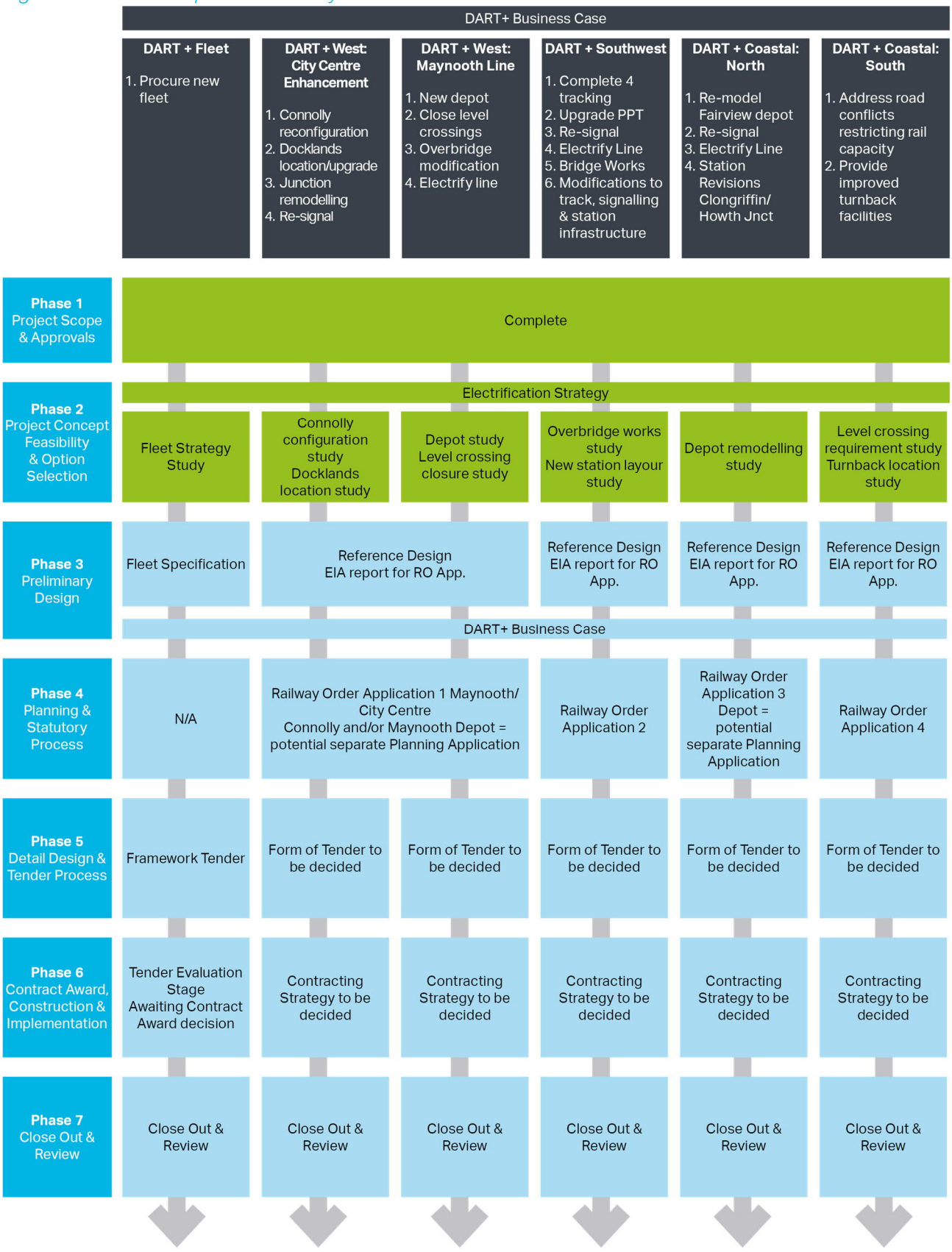
The passage of time has not changed the rationale for pursuing a traditional Exchequer funded procurement route. Instead, the rationale has been strengthened because public funding is readily available to the Exchequer at low cost. By comparison PPP is a relatively expensive and complex funding model that is generally adopted when public funding is not available.

For the fleet procurement, operating lease models as followed by the UK ROSCOs or other entities were considered by IÉ and NTA and rejected because they would cost more overall due to VAT and the funders rate of return requirements. Also, the track gauge in Ireland differs from other jurisdictions, so rolling stock would not be easily transferable. This does not fit with the leasing model.

13.4 Programme delivery framework

A phased delivery framework applies to DART+, as shown in Figure 13.1. DART+ Fleet is the first project owing to the long lead-in times for rolling stock delivery and because additional capacity is needed in the short term. DART+ West combines the City Centre Enhancement, which serves the entire Connolly/Docklands environs, and the Maynooth Line works, which includes the depot for the expanded fleet. This is the main reason why DART+ West is to be the first infrastructure project to be implemented.

Figure 13.1 – DART+ phased delivery framework



13.5 Rolling stock procurement

Following the options assessment process discussed in Chapter 5, the fleet requirements were specified, and procurement initiated for a framework supplier.

13.5.1 Procurement approach

A single supplier rather than multi-supplier approach is typical for rolling stock procurement, largely for reasons of economies of scale and interoperability. Rolling stock is not purchased 'off the shelf', the process takes around five years and includes a comprehensive design review process carried out between IÉ and the supplier. Management of this process would not be feasible with multiple suppliers. Once the design and manufacturing process is established, it delivers economies of scale.

Interoperability and compatibility are critical, and although technologies from different suppliers can be made to work together, a multi supplier arrangement could result in numerous suppliers of 'similar but different' components and interoperability issues e.g. braking systems, traction packages bringing with it secondary difficulties with training (maintenance and driver) and the ordering of replacement parts.

The Framework agreement has no minimum order quantity over its 10-year duration. With the exception of the first order which will be placed at the same time as contract award, orders will only be placed following Railway Order approvals. The first order can enter service without any of the upgrades associated with the infrastructure projects.

13.5.2 Rolling stock framework contract

The framework contract will provide for the manufacture and delivery of both EMU and Battery Electrical Multiple Units (BEMU) where required.

The trains will be compatible with the existing DART network 1500v DC overhead power supply (in terms of the current draw, traction profile under acceleration and re-generation) and also with the power supply for the proposed extension sections which will also be 1500v DC. The trains will meet the current and proposed timetable performance targets.

The framework will allow for the procurement of up to 600 vehicles over the life of the agreement. However, within the time frame of the NDP, 260 vehicles will be required to be procured to support additional services and deliver targeted capacity enhancements as a result of DART+.

In addition, a Technical Services and Spares Supply Agreement (TSSSA) of up to 15 years from delivery of last unit will form part of the overall contract award.

13.5.3 Rolling stock supplier selection

A two-stage procurement process consisting of a pre-qualification and tender stage has been applied to the procurement of rolling stock. Suppliers were firstly short-listed based on their experience in the manufacture of EMUs and BEMUs, as well as standard IÉ procurement criteria

Short-listed suppliers were then invited to tender with the contract to be awarded to the most economically advantageous tender.

The rolling stock procurement is at PSC Gate 3, the point of approval to award the contract. The deliverables for Gate 3 approval for the DART+ Fleet project have been prepared separately to this overall programme Preliminary Business Case.

13.6 Implications of the Railway Order process

The procurement strategy for the infrastructure works was determined by the approach to the Railway Order application. The option of a single Railway Order application for the entire DART+ programme was considered and compared with the option to make several applications. In assessing the options, IÉ considered:

- Planning regulations
- Timing of land acquisition
- Commonality of design or project teams delivering the Railway Order
- Commonality of public and other stakeholders considering the geographical spread of the programme
- Potential for a local issue on one element to delay or otherwise affect the whole programme.

The comparative analysis determined that the best approach to the Railway Order (RO) process is to make four applications, one for each line. This approach avoids several planning process related risks, yet suits a staged delivery of the programme, while also accounting for the different risks associated with the different bundles. It means that funding for the total programme would not have to

be found and committed at one time. It allows for each application to be independently delivered resulting in operational benefits to IÉ albeit at a sub-optimal level until the overall DART+ Programme is delivered.

By comparison, a single RO application would have the following disadvantages:

- There would be a large and costly property acquisition to be underwritten within 18 months of the RO
- Very large geographical extent meaning that:
  - The whole DART+ geographical area would be included in the RO application, potentially including line sections where no physical work is proposed
  - Public consultation and stakeholder engagement would need to be co-ordinated over the whole area which would make the process very long and distract focus away from the areas that most need consultation
- Risk that one local issue would delay the whole programme.
- Potential for legal challenges on basis of non-completion of overall program within the 10-year life of the RO.

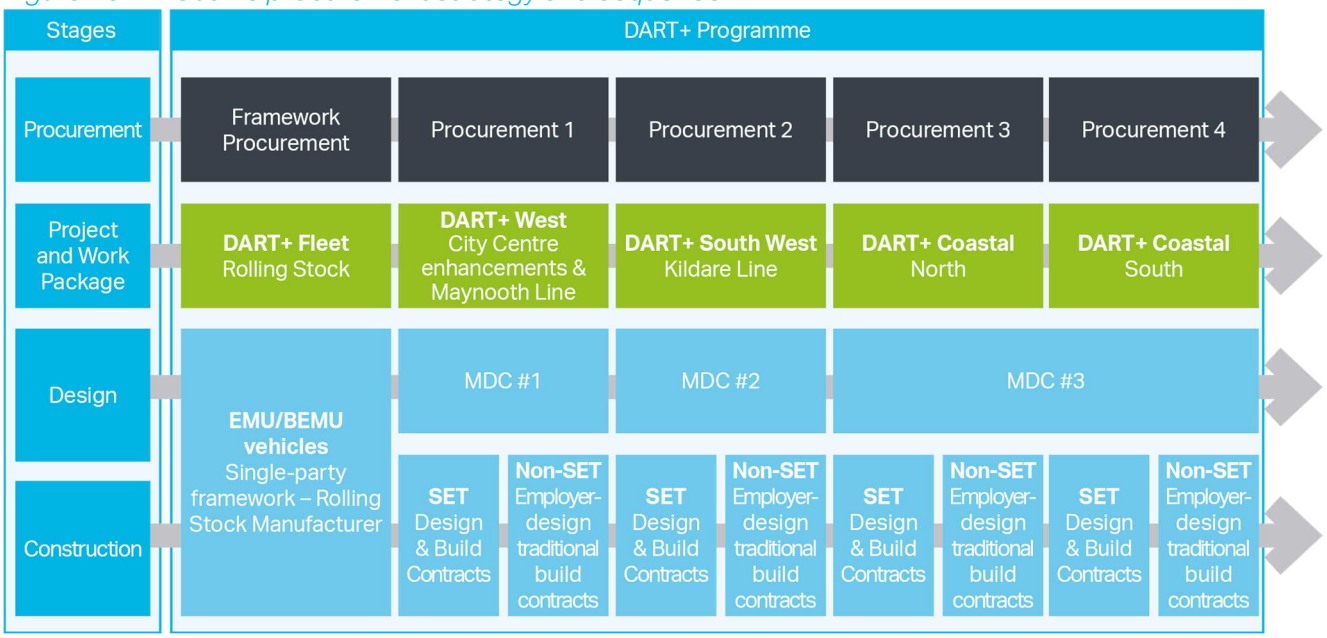
13.7 Procurement of infrastructure works

The DART+ Programme Team has separated the Project's infrastructure works into four procurements for the following reasons:

- Were the three infrastructure procurements to be combined as one Railway Order, this elevates the risk of the entire Project being delayed due to a challenge which may only relate to one area or line of the network
- Combining all the DART+ infrastructure projects would result in too large a contract reducing the pool of eligible consultants and reducing competition.
- Further to the above point, were a single MDC to be appointed for the entire Programme, the MDC might require a significant amount of sub-contracted parties resulting in a more fragmented approach to the Programme with concerns around quality control and coordination of tasks.
- In the event of a termination or contractual difficulties, the entire Programme would be at risk of delay rather than just one of the infrastructure procurements.
- As the Projects are at different stages of development segregating the procurements is more prudent in the interest of timely delivery of services.

Figure 13.2 shows the order of the Project procurements and outlines the procurement strategies. An MDC has been procured, for each of the four infrastructure procurements, to assist the Project Team with the preparation of the designs and the Railway Order submission.

Figure 13.2 – Outline procurement strategy and sequence



The MDCs are tasked with developing the procurement and contracting strategy for tender and construction of their respective parts of DART+. A Detailed Project Brief and Procurement Strategy will be prepared as each project approaches PSC Gate 2.

13.8 Contractor procurement strategy

13.8.1 Procurement strategy process

The MDCs are developing an Initial Procurement Strategy aligned with the latest delivery strategy and current IÉ and NTA aspirations. Following agreement on the initial strategy, IÉ will engage in a preliminary Market Consultation to establish the contractors' level of interest in the project and the available capabilities and skills. The procurement strategy will be updated in the light of market feedback, the developing delivery strategy and the design basis for DART+ Programme. Once the updated Procurement Strategy is confirmed, the MDCs will develop and approve procurement plans for each major contract package. The procurement plans will inform a 'key information for candidates document' that will need to be published with each Contract Notice.

The contractor procurement strategy for DART+ West will form the blueprint for the procurement strategy for the other lines, subject to modification for line-specific requirements and lessons learned on DART+ procurement.

13.8.2 Procurement objectives and principles

The main procurement objectives are:

- To deliver value for money, over the whole life of the infrastructure
- To ensure rail services can be provided efficiently
- To fully meet all procurement requirements and regulations.

13.8.3 Package Strategy

The Contracts Works Package strategy which is being developed breaks down the scope for each DART+ Project into clearly defined elements and sections of work. It will group them into packages that can be effectively designed, procured, and constructed.

The package strategy will consider the capacity of the construction sector to design, construct, test and commission the project, and a range of other issues including:

- Enabling works packages to advance the site services prior to the delivery of the main works.
- Plant, equipment, and construction works to be provided by IE.
- Materials to be provided to contractors on a free-issue basis under existing Framework agreements to ensure standardisation of key equipment.

A range of packaging options will be explored. Works of a similar nature from different locations may be grouped together to increase the value of the contracts, reduce the risks associated with managing multiple contracts and potential impact of delays and make the contracts more attractive in terms of economies of scale.

It is proposed to define the works package options using a scored ranking process of defined procurement objectives and key success criteria. These will be developed as part of the development of the overall procurement strategy and are likely to include items such as

- System Integration and interface management of contracts
- Contractor capability
- Contractor Interest
- Managing interface with Iarnród Eireann (IE) executed works e.g. Permanent way
- MDC & Client resource commitments in managing complex projects
- Economies of scale
- Risk sharing
- Contractor performance or non-performance measures
- Value for Money
- Programme.

The Procurement Strategy will inform the development of detailed procurement plans for the different packages, and the procurement processes, systems and overall workforce planning. This will be the next level of detail and planning and will include;

- detailed consideration of the package scope, delivery schedule and budget
- detailed consideration of the contracting strategy including key terms and conditions
- consideration of levels of liability and insurance strategy
- consideration of the procurement route, i.e., the selection, short-listing and tendering processes to comply with the Regulations
- consideration of key criteria and tests, for example, award criteria and the financial and economic standing tests at the pre-qualification stage
- consultation with the companies that responded to the preliminary market
- consultation on key points of detail within the procurement plan
- acceptable contract liability levels and insurance, etc.

13.8.4 Contract strategy

The contract strategy determines the level of integration of design and construction for a given project. It supports the main project objectives relation to risk allocation, delivery, costs, scope and schedule.

IÉ's initial strategy, which formed the basis of the MDC contract, is based on the Signalling, Electrification and Telecoms (SET) works being carried out on Design and Build contracts and the remainder of the works on Traditional Client Design Contracts. This is shown in Figure 13.2. There are several different contract strategies; the types being dealt with in the development of the procurement strategy generally relate to traditional design and build routes. Consideration is being given to framework contracts and Early Contractor Involvement.

As DART+ is funded by the Exchequer, the use of the Capital Works Management Framework (CWMF) is mandated for the delivery of projects. Consequently, IÉ will endeavour in the first instance to utilise the Forms of Contract provided in the CWMF. Alternative forms of contract may have to be considered following the market consultation process based on the market's willingness to accept the CWMF contracts.

The NEC suite of contracts may be a suitable alternative which is extensively used in the UK and other European Countries. The NEC contract form is currently being used by IÉ on the National Train Control Centre contract and is extensively used by Irish Water, Dublin Airport Authority, and other clients in Ireland.

13.8.5 Market Consultation

A market consultation process is planned for early 2021 for the purpose of engaging with suppliers and contractors and to establish the appetite for the DART+ infrastructure contracts. This will give further clarity on the level of interest and the range of contractors' resources and capabilities. It will help inform and finalise the package and contract strategies.

IÉ's current market knowledge suggests that the Irish construction sector has the skills and capabilities to deliver the building and civils elements of the works, however the SET elements

will require input from specialist International Contractors.

13.8.6 Lessons learned from other projects

The procurement strategy is being developed with the insights gained from other projects. The *Lessons Learnt Review* and *Risk Management Report* from the Kildare Route Project, which is similar in nature, and completed by IÉ in 2009, have been useful reference documents.

The Trafikverket Rapport titled *Procurement of Railway Projects (2016)* reports on a benchmarking study of European projects across six countries. This aimed to increase understanding of procurement strategies used in different countries. It identified five separate disciplines which are inherently different and require diverse competency and resources.

- Civil engineering work e.g. tunnels and bridges
- Signalling equipment
- Electricity supply
- Telecommunications systems
- Track works or "permanent way".

These five types of work are often performed by different suppliers and contractors. They may require quite different procurement strategies.

In addition, it was found that procurement strategies may be affected by domestic characteristics of the railway sectors in different countries, e.g. extent and timing of deregulation, supply market development and competition and level of client and supplier/contractor competencies.

The benchmarking found that the procurement strategies in the six countries vary significantly. They are often influenced by the level of involvement that the railway operating company has in the overall design and delivery of the project. A common key factor is the use of design and build contracts which increase supplier responsibilities. The benchmarking showed that the railways commonly get involved in supporting the contractors in the design work, to give themselves sufficient direction of the project and customisation of its output.

The benchmarking indicated that grouping the overall scope of work into a single contract or a range of different contracts is generally determined by the overall size of the project, the available skills an interest of the supplies and the client's level of expertise to be able to manage the suppliers and contractors.

The DART+ procurement strategy is being developed in the knowledge of this research.

13.9 Delivery schedule

Figure 13.3 shows the delivery schedule for the planning stages for each DART+ Project.

As described in Section 13.4, the primary reason for the sequence is the immediate requirement for additional fleet. DART+ West is the first infrastructure project as it includes the depot which is required to operate all lines.

Management of overlapping procurements will be addressed in the procurement strategy being developed. Arrangements will be detailed in the Detailed Project Brief and Procurement Strategy documentation required for PSC Gate 2.

The DART+ Fleet project is in the final stages of procurement and is subject to separate documentation for PSC Gate 3 approval.

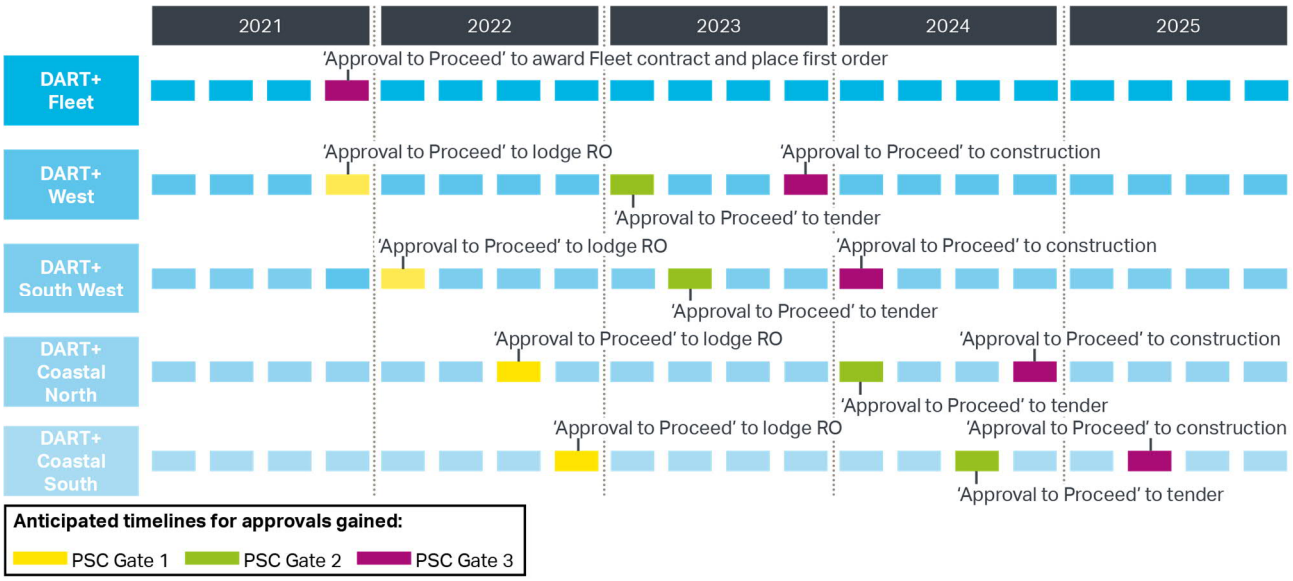


Figure 13.3 – Planning and Approvals schedule for DART+

13.10 Contract interface management

IÉ will develop an Interface Management Plan (IMP) in parallel with the procurement and contracts strategy. IMP will ensure the interfaces between the various works packages are appropriately addressed to mitigate the potential physical and contractual interface risks. It will indicate how the end to end integration of all rail systems and work elements will be achieved and how all designers and contractors should interact with our systems integrator.

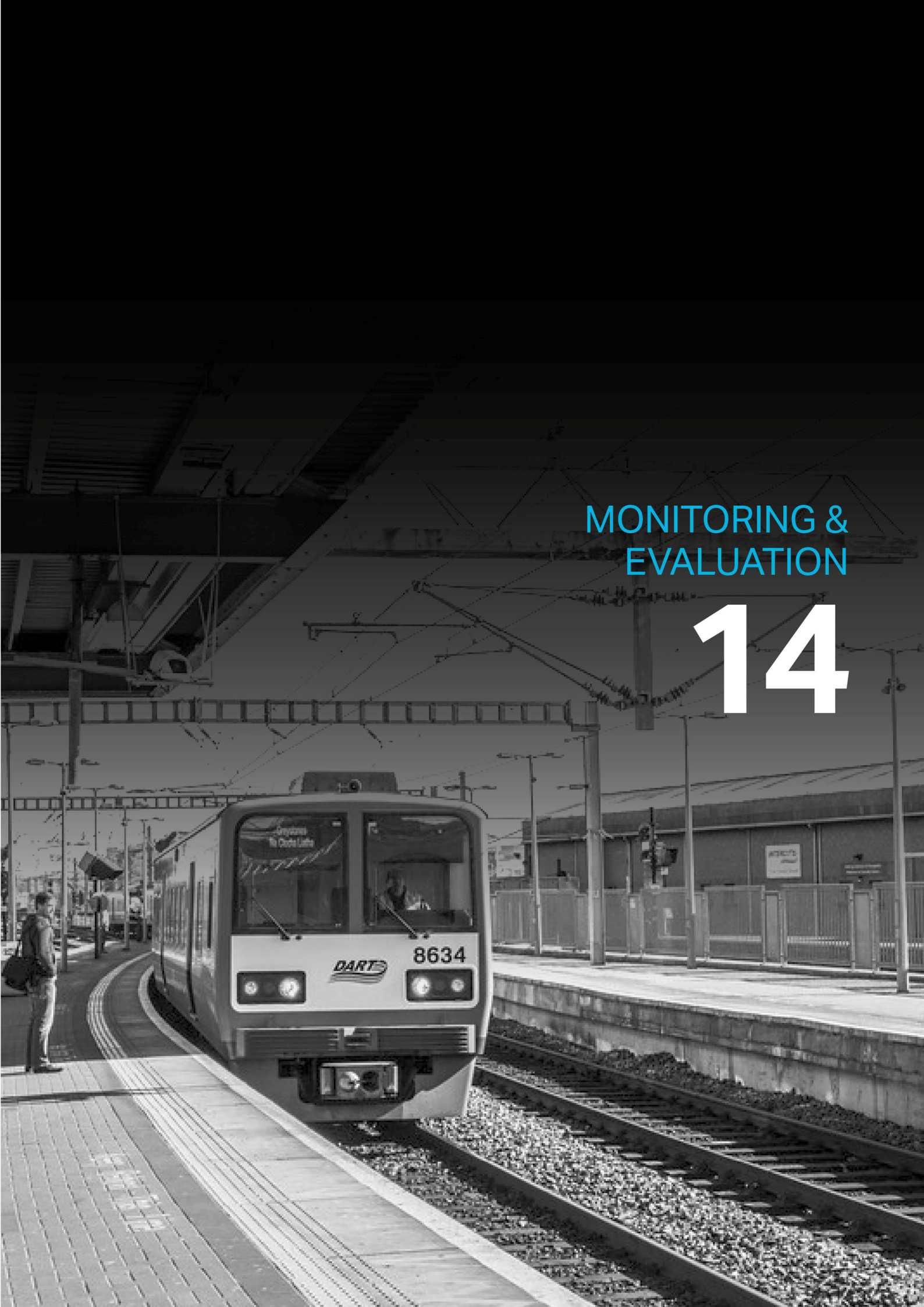
It will be critical to ensure there is clarity of scope and the interfaces between the packages of work, the new and existing systems and that these are clear in each tender/contract. This is often a problematic area when there are many different specialists working, particularly with the SET package interfaces.

The procurement strategy will identify the interface management risks and assess the forms of contract that allow for the most appropriate risk transfer (which party to the contract is most suited to retain and control the risk). Alternative packaging opportunities will be explored to optimise the number of interfaces to meet the requirements, minimise risk at the best value, minimise disruption to rail services and the general public and generate the appetite for the maximum level of competition from the market.

Success here will depend on ensuring that all interfaces with different disciplines and trades are managed through a collaborative approach and that a clear scope and contractual boundaries are defined. IÉ will take lessons learned from previous projects to ensure the tender documents include works that are suitably described together with clear demarcation on tender information.

MONITORING & EVALUATION

14



14. Monitoring & Evaluation

14.1 Monitoring and Evaluation Requirements

The 2019 Public Spending Code's six-stage project lifecycle includes stage 5 'review' and stage 6 'evaluation'. Both stages are designed to enhance the level of scrutiny applied to transformative public infrastructure programmes such as DART+. The stage 5 review, undertaken immediately following programme completion, will consider whether:

- The basis on which the programme was undertaken proved correct;
- The business case and management procedures were satisfactory;
- The operational performance and initial benefits have been realised; and
- The conclusions that can be drawn which are applicable to other programmes, to the ongoing use of the asset, or to associated investment.

The stage 6 evaluation, undertaken up to five years post programme completion, will consider whether:

- The expected benefits and outcomes materialised including operational performance;
- The planned outcomes were the appropriate responses to actual public needs; and again
- The conclusions that can be drawn which are applicable to other programmes, to the ongoing use of the asset, or to associated investment.

This section sets out an overview of the monitoring and evaluation objectives for the DART+ programme, the Logic Path Model, an outline for the detailed evaluation approach, a summary of the key governance requirements and a statement on the need for benefits management.

14.2 Monitoring and Evaluation Objectives

In designing robust and proportionate Monitoring and Evaluation (M+E) activities it is imperative to clearly state the purpose for, and objectives of, M+E. The first and primary purpose will be to ensure accountability, with the evaluation objectives to:

- Determine the extent to which a programme is on track to achieve its stated objectives;
- Determine the extent to which the ex-ante appraisal assumptions and forecasts were accurate; and
- Review how results/impacts have materialised through time, leading to the full ex-post assessment of the programme's outturn value for money.

Accountability-based M+E will form the core part of the review and evaluation stages to understand whether the programme delivered the results expected (*effectiveness*[48]), and if not, why not. Fundamental to this will be assessing the core elements of the Benefit Cost Ratio, the outturn values relative to forecasts and changes in contextual factors, and whether the programme objectives have been achieved (*rationale, impact*).

It is also planned to embed a second M+E purpose, that of enhancing knowledge and learning lessons through the programme implementation and operation. A capital programme such as DART+, with multiple Projects and phasing, supports ongoing benefit review, management and realisation. This will be supported by ongoing M+E activities to ensure that lessons are first identified, and secondly that they inform ongoing programme implementation i.e. that initial investment is used to inform the design, deliver and operation of later programme elements.

This second M+E area will also include the consideration of wider benefits, beyond the core Benefit Cost Ratio elements, including where possible the quantification and monetisation of such benefits. The extent of knowledge-focused M+E will be defined in the detailed M+E plan and supported by the ongoing Benefits Realisation programme, but will have the objectives to:

- Understand which benefits have/not been delivered and why;
- Understand which programme elements were most/least effective and why;
- Identify unintended results and their causes; and

[48] *The Public Spending Code's Value for Money Review includes the assessment of rationale, efficiency, effectiveness, impacts and continued relevance.*

- Understand which programme elements influenced travel behaviour and traveller perceptions/satisfaction and why.

14.3 Programme Intervention Logic Path Model

The Public Spending Code and Common Appraisal Framework include the requirement for a Logic Path Model (LPM) to be developed as part of the Preliminary Business Case. It is good practice to set out the intervention logic for any programme or scheme that is to be evaluated as this demonstrates the assumed links between:

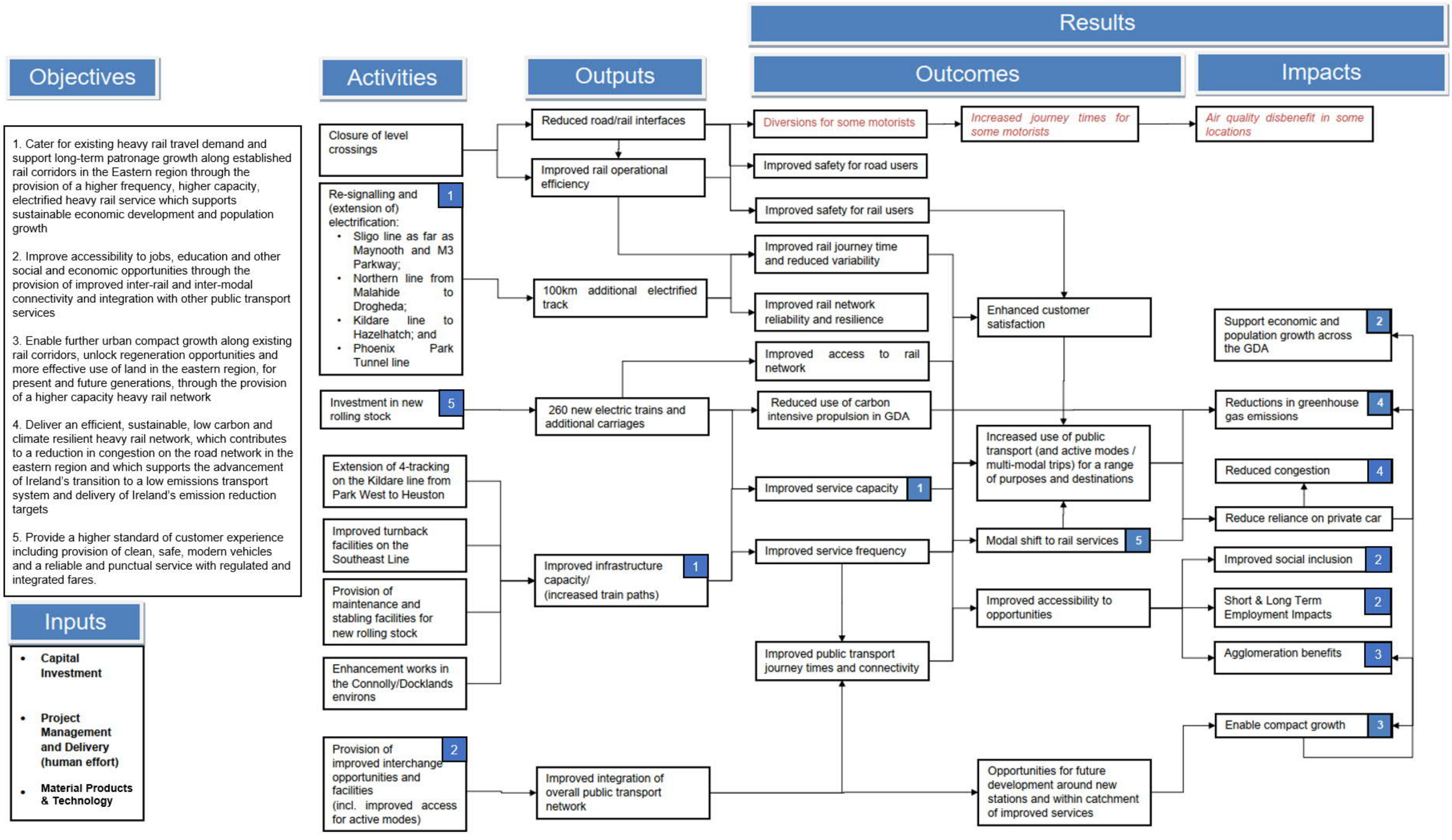
- Objectives – the overarching programme-level objectives;
- Inputs – what is being invested in terms of resources;
- Activities – the actions to turn inputs into outputs;
- Outputs – the implemented programme elements;
- Results – short- and medium-term outcomes e.g. changes in traffic flow levels and modal shift; and
- Impacts – long term results e.g. economic growth, improved health, environmental benefits.

LPMs are particularly useful in helping to identify:

- The key causal pathways from outputs to results, thereby identifying the key interim steps required to realise benefits;
- Any potentially negative or unintended results;
- The complexity of an intervention or programme;
- Where and when defined objectives are assumed to be realised;
- The results anticipated and thereby the monitoring indicators required; and thereby
- The data sources required to monitor and/or evaluate the intervention.

A programme-level LPM has been prepared for DART+ and is shown in Figure 14.1. Within this figure, the blue numbered boxed demonstrate where the broad programme objectives are anticipated to be realised.

Figure 14.1 - DART+ Logic Path Model



14.4 Programmatic Approach to Monitoring and Evaluation

The proposed DART+ Programme is, by its design and geographical coverage, very complex and extensive. The implementation schedule, and other known investment programmes in the region's transport network, will make monitoring and evaluation challenging. However, establishing a robust yet proportional approach to assessing programme delivery and performance is essential. An evaluation framework will therefore be fully developed in an M+E plan and an initial overview is provided here, covering:

- Performance Indicators;
- Baseline data;
- Piloting;
- Implementation monitoring;
- Stage 5 Review; and
- Stage 6 Ex-post Evaluation.

14.4.1 Performance Indicators

An initial set of Performance Indicators has been defined, aligned to the business case indicators and determined by the programme objectives and results (outcomes and impacts) set out at a high level in the LPM and in detail in Chapter 4. These indicators represent a method for measuring the success of the DART+ Programme post implementation and allow us to assess actual performance against projected performance.

Establishing these indicators ensure that robust baseline data is collected/collated and suitable resources allocated to ongoing monitoring throughout the programme implementation period. The core indicators for programme outputs are in Table 14.1 for results (transport outcomes) are in Table 14.2 and results (economic impacts) are in Table 14.3. The latter wider indicators should be monitored as they provide important context to the more detailed evaluation. However, it should be noted that the ability to attribute any observed changes in data to the DART+ programme would be very difficult.

Table 14.1 – Performance Indicators for Programme Outputs

Programme Output	Performance Indicator
Reduction in road/rail interfaces	Number of level crossings removed
Improved rail operational efficiency	40% improvement in train service reliability
Kilometres of track electrified	Number of KMs and % of network in the Eastern region
Additional rolling stock	Number of fleet units (trains and carriages)
Improved infrastructure capacity	Increased number of paths and 100% increase in capacity
Kilometres of 4-track delivered	Delivery of ~5km of 4-tracking on the Kildare Line.
Number of improved stations/interchanges	Number of new/improved stations including Heuston West, Glasnevin and relocated station at Spencer Dock.
Depot	New depot west of Maynooth

Table 14.2 – Performance Indicators for Results (Transport Outcomes)

Programme Result (Outcome)	Performance Indicator
Number of additional daily train services	Trains per hour (peaks and inter-peak)
Improved accessibility to rail network	130%+ increase in percentage of existing households within 10 minutes of frequent DART service
Improved accessibility to urban centres	Percentage of existing households within 45 minutes of urban centres by public transport

Programme Result (Outcome)	Performance Indicator
Rail journey time	Average journey time for services in peaks and inter-peak periods
Rail journey time variability	40% improvement in average journey time variability for services in peaks and inter-peak periods
Rail patronage	Annual boarding/alighting by station
Public transport integration	40%+ increase in the number of public transport passengers interchanging at rail stations
Rail mode share	Number and percentage of rail passengers shifting from car-based trips – Additional 25million+ rail passenger trips by 2043
	Rail mode share at key cordons
Higher passenger satisfaction	Percentage change of passengers satisfied or very satisfied
Reduction in transport emissions	Change in traffic flows and number of passengers shifting from car-based to rail
Improved safety for road and rail users	Number of accidents at level crossings

Table 14.3 – Performance Indicators for Programme Results (Economic Impacts)

Programme Result (Outcome)	Performance Indicator
Economic growth	Productivity measured by Gross Value Added
	Percentage of working age population in employment
Population growth	Business growth within 800m and 1.5km of DART+ stations
	Number of residents in Eastern region

The nature of the programme also means that an array of wider, unquantifiable benefits could be anticipated, and which could form part of the evaluation. Consideration will be given to defining such benefits during the preparation of the detailed M+E plan and establishing appropriate mechanisms to determine change where appropriate. Enhancing and expanding the details relating to the key indicators will be a core activity during M+E planning.

14.4.2 Baseline Data

Prior to implementation, the programme's anticipated results (outcomes and impacts) will need to be robustly baselined. Based on the Performance Indicators defined above, this is likely to be a combination of existing dataset collation and the collection of new data. The precise data requirements and associated costs will be defined within an M+E plan to establish the process and financial commitment required throughout the evaluation period

Consideration will also be given to the need to collect/collate comparative area data, for a similar route/area that has not been subject to the DART+ programme i.e. a counterfactual. The use of comparator(s) would allow the evaluation to calculate the additional benefits generated from the programme and whether the results are in line with the targets and objectives. Initial consideration of the appropriateness of using comparators is provided in Section 14.4.6.

14.4.3 Piloting

The PSC and the CAF include the need, for current expenditure programmes to consider the implementation and monitoring of pilot investment prior to the implementation of a full programme. Piloting is not a requirement for capital projects, but due to the anticipated phased nature of DART+ Project delivery, a within-programme piloting/review approach will be adopted for DART+ to embed learning and knowledge development as the programme progresses through the phases. This will see the outputs (and their efficiency) and initial results (effectiveness) formally assessed as part of the implementation evaluation. Further consideration will be given during the detailed M+E planning to the implications of undertaking this approach.

14.4.4 Implementation Monitoring

The PSC established the need for capital programmes to have a formal and systematic approach to monitoring delivery and programme management. This will include the ongoing review of Projects and programme delivery and will sit alongside the active management, review and realisation of performance indicators. The implementation monitoring will include regular reviews on topics such as:

- Schedule Management: including identifying changes in planned programme delivery schedules and reasons for observed change;
- Cost Management: including causes for variance in planned costs;
- Risk Management: including the *effectiveness* of planned mitigation and the application of Quantified Risk Management procedures; and
- Stakeholder Engagement: including engagement methods, frequency and lessons learnt.

Reviews will include a desk-based assessment of key management data, supplemented by depth interviews with key delivery team members during implementation. Obtaining the views of stakeholders will be central to this process. The precise scope of the during-implementation evaluation will be developed within the context of the overall programme and DART+ Project governance and reflected within the M+E plan.

14.4.5 Post Completion Review

As set out in Section 14.1, Stage 5 of the project lifecycle will be the formal review of implementation, undertaken immediately following programme completion. The requirement for a full and detailed review following the delivery phase, to complement the ongoing reviews during implementation, is because:

- Regular monitoring of performance indicators should be supplemented with a more in-depth study to assess efficiency and/or effectiveness;
- An independent review of efficiency, effectiveness and continued relevance is needed to be implemented by the Sponsoring Authority;
- The outputs/outcomes of the programme may not occur for some time; and
- The scale of the investment/intervention justifies an in-depth evaluation.

The review will assess and report on the delivery management procedures, the key lessons learnt identified during the implementation reviews, the operational performance of key outputs, including the roles of stakeholders and the extent to which initial results have been realised.

14.4.6 Ex-Post Evaluation

The final stage of the project lifecycle is evaluation, focused on assessing the *effectiveness* and *impact* of the programme. Based on international best practice[49], two ex-post evaluation activities will be undertaken:

- An initial assessment of results (outcomes) one year after the completion of the programme and the operation of enhanced rail services; and

[49] This includes the Department for Transport (UK) framework for Local Major Scheme Evaluations 2012 which was used on the Midland Metro Birmingham City Centre Extension ex-post evaluation.

- A follow-up assessment between 3 and 5 years post completion, to consider the ongoing realisation of outcomes and the emergence of change within impact performance indicators e.g. economic growth.

This methodology will include a combination of:

- Revisiting the financial and economic appraisal in the Final Business Case to see if the assumptions were correct and if the anticipated benefits and costs materialised over time;
- Use of Value for Money Review (VfMR) and Focused Policy Assessment (FPA) methodologies to look at the efficiency, effectiveness and/or impact of the programme; and
- Interviews with key stakeholders to obtain their views on results, including any unanticipated outcomes.

Within the remit of the VfMR consideration will also be given to the precise evaluation design to be adopted. Defining the design within the M+E plan will demonstrate how it is proposed to identify the results/impacts of the programme, and accounting for the influence of other factors e.g. context changes or other large-scale investment such as BusConnects and MetroLink. It is also important at that stage to clearly set out the resource requirements/commitments for a robust ex-post evaluation.

Considering alternative explanations for observed changes in performance indicators will be central to determining the actual contribution of the programme. There are three main types of evaluation design that are commonly adopted for large transportation interventions and which will be considered in the detailed M+E planning:

- Outcomes based design: which focuses on analysing changes in key datasets between the before and after situation, and assumes that little has changed in the wider context
- Quasi-experimental design: which uses comparator areas or corridors to consider what would have happened in the absence of the intervention i.e. the comparators are similar to the treatment corridors but will not have DART+ investment
- Theory-based designs: which uses all available qualitative and quantitative evidence to assess the assumed causal pathways between outputs and results, testing their validity and drawing conclusions on the contribution of specific interventions to observed change.

An outcome-based design is the most basic available as it focuses on a simplistic before and after comparison of key result indicators. The main risk in adopting this approach is that it may not fully reflect changes in the wider context to the programme, and thereby spurious or inaccurate conclusions could be drawn regarding the programme's true impact. This risk is exacerbated by long delivery periods. However, monitoring the core result/impact indicators is an important foundation for the DART+ monitoring and evaluation approach, even if it will not permit robust attribution of impacts.

A central challenge will be how to enhance these core monitoring activities. The adoption of a quasi-experimental design, through the use of comparison corridors/areas, is challenging for large transportation programmes because:

- A myriad of factors will influence travel behaviour, and these may vary between location
- Identifying corridors within the Dublin area that are similar to each of the DART+ corridors in their characteristics (e.g. length and social demographics) but which will not be influenced by other non-DART+ investment may not be possible given the BusConnects and MetroLink programmes

The costs and benefits of adopting such an approach will be explored in full during the preparation of the detailed M+E plan.

Given the complexity of the DART+ Programme it will also be appropriate and advisable to adopt a Theory of Change design. This will embed the detailed analysis of individual causal pathways, as set out in the LPM, to test the assumed results generated by DART+ investment. Reflecting the challenges of

attributing results and impacts to the programme, the option of employing a **contribution analysis** approach will also be considered to help structure the Theory of Change evaluation. A strength of the contribution analysis approach, and the use of multiple datasets, would be the ability to identify and assess unintended outcomes. This could, for example, include an increase in travel time for particular modes/routes or a different interchange pattern than forecast. The use of stakeholder consultation and DART+ user surveys will assist in evaluating such outcomes. Two other considerations that will need to be accommodated within the final M+E plan are:

- How to consider the impacts of the programme from the user's perspective i.e. analysing journey times and reliability for the most heavily patronised routes/stages rather than at the whole corridor level; and
- How the various datasets will be analysed at the corridor and programme levels will need to be determined.

The approach to evaluating the impacts of the DART+ Programme on the wider economy and regeneration of the Eastern region will also be considered further in the M+E plan. Whilst it is possible to review secondary datasets on issues such as employment and productivity, attributing any observed changes to transport investment is full of complexities and risks. A more robust and proportionate approach could be to extend the Theory of Change methodology to consider the potential contribution of the programme i.e. demonstrating changes in accessibility to employment and training as a proxy for actual observed change in economic metrics. The geographical scale at which many economic datasets are available at also restricts undertaking a more detailed analytical exercise.

Within the remit of the VfMR consideration will also be given to the precise evaluation design to be adopted. Defining the design within the M+E plan will demonstrate how it is proposed to identify the results/impacts of the programme, and accounting for the influence of other factors e.g. context changes or other large-scale investment such as BusConnects and MetroLink. It is also important at that stage to clearly set out the resource requirements/commitments for a robust ex-post evaluation. Monitoring and Evaluation Governance

14.5 Monitoring and Evaluation Governance

14.5.1 Monitoring and Evaluation Responsibilities

The implementation, review and evaluation activities associated with the DART+ programme is likely to occur over a significant time period, from baseline through to final ex-post assessment. This means that active management of the programme's M+E will be required throughout, alongside benefits realisation, to ensure the results are achieved and value for money secured. As set out in the PSC, it is the Sponsoring Agency's responsibility to ensure that:

- Monitoring and managing the **Implementation Stage** of the project in line with approval given including regular reporting to the Approving Authority and robust management of the contract. If developments occur that impact on the viability of the project, the Sponsoring Agency is responsible for notifying the Approving Authority immediately;
- Planning and conducting a **Review** of the project, incorporating lessons learned into processes and guidance, and submitting a Project Completion Report to the Approving Authority as the project concludes; and
- Planning and conducting an ex-post **Evaluation** of the project, incorporating lessons learned into processes and guidance, and submitting an Ex-post Evaluation Report to the Approving Authority.

14.5.2 Monitoring and Evaluation Schedule

As set out herein, the DART+ programme will need to undertake regular monitoring of programme implementation, alongside more detailed milestone-based evaluations at the end of implementation review and ex-post periods. The programme will need to be baselined as close to the point of implementation as possible, to ensure the most robust data is recorded i.e. the risks are minimised of

other factors influencing travel behaviour between the baseline and start of programme implementation.

The programme baseline will need to be confirmed during the preparation of the detailed M+E Plan. This will need to reflect the actual proposed start of programme implementation.

Collecting/collating data at the key points set out in Table 14.4 will be key in establishing whether the objectives and results identified at the outset have been achieved and to what extent.

Table 14.4 – Evaluation Schedule

DART+	Evaluation Milestone	Year
Implementation Period	Baseline	~2020-2021
	Implementation monitoring	~2022
	End of implementation Review	~2028
	Ex-post Evaluations	2030-2035

14.5.3 Benefits Realisation Management

A Benefits Realisation Plan (BRP) will be required to ensure that the necessary arrangements are in place to monitor the achievement of benefits (output, outcomes and impacts) during and after programme implementation. The BRP, and embedding a culture of benefit management, will support the realisation of all anticipated outcomes and impacts. It is recommended that discussions are held with stakeholders around the approach to, and level of, benefits management.

CONCLUSION

15

15. Conclusion

The DART+ Programme represents the largest heavy rail investment scheme in the history of the State, providing a transformational change in capacity and frequency between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones. The DART+ Programme, or simply DART+, is a cornerstone transport commitment in Project Ireland 2040.

DART+ will upgrade the heavy rail system throughout the Eastern region. It will provide a network of low emission, high frequency, high capacity rail services giving a growing population better access to opportunities and services across the region. The rail system will be able to achieve its full potential, offering more people a real alternative to the private car. It will support the national policies of compact urban growth and carbon emissions reduction, and contribute to Dublin's continued development as an attractive, thriving city and the engine of economic growth for Ireland.

DART+ is a central pillar in a future integrated sustainable transport system in Dublin City Centre and the broader Eastern Region[50]. In the context of the State's climate action plans, DART+ will be essential to the reduction in transport emissions; firstly, through the procurement of a low emissions fleet, and secondly; through reducing emissions from road congestion by encouraging and enabling modal shift.

DART+ will have a dynamic impact on land use and spatial planning for the Eastern Region, as both transport and land-use have the ability to impact on the other. Transport infrastructure has a significant influence on the patterns in which cities grow, making DART+ vital to sustainable land-use patterns in the future.

The key outcomes of DART+ are;

- DART+ will deliver a 'turn up and go' service to over 600,000 people living within a 1-kilometre catchment of its stations.
- DART+ will double passenger capacity across the heavy rail network into Dublin, creating a high frequency standard of service to Drogheda, Maynooth, Dunboyne, Celbridge and Greystones.
- Compared with now, there will be up to three times as many services on parts of the network.
- Upon opening, DART+ will deliver initial year-on-year passenger growth of 46 per cent.
- The number of people using public transport is forecast to grow by 56 per cent between 2028 and 2043 with DART+ in place.
- Increased frequency will lead to a more dynamic public transport system resulting in a 43 per cent increase in people interchanging between services.
- Heavy rail services will become more reliable reducing the variability in end to end journey times by up to 40 per cent.
- DART+ will reduce greenhouse gas emissions by moving from diesel to electric trains and by transferring travel away from private vehicles, leading to a reduction of some 650,000 Tonnes of CO_2 over 60 years.
- The number of residents located within 1km of a high frequency DART service would increase by 134 per cent, from approximately 250,000 today to over 600,000.
- DART+ will bring the DART service to an additional 85,000 people living in areas to the west and the north defined as 'below average or worse' by Pobal's index of social deprivation.

[50] *The Eastern Region refers to the area encompassed by Dublin, Louth, Meath, Kildare and Wicklow.*

- DART+ will be a good use of public money. The value of the socio-economic benefits it brings is over double the costs, resulting in a Benefit to Cost Ratio of 2.3 to 1. This accounts for the impact across all modes.
- DART+ is an incremental programme over ten years. Benefits will start to be realised as soon as each element is complete.
- Capital expenditure on DART+ will create a total of €1 billion in Gross Value Added (GVA) between 2019 and 2030.
- DART+ will generate 14,200 annual Full-Time Equivalent (FTE) jobs during construction[51].

This Preliminary Business Case has shown that DART+ will meet the aims and objectives set for the programme and that it will provide a strong return on investment. The benefits of DART+ for society, the economy and the environment greatly exceed the cost of its construction, operations, maintenance and renewals. Investment in DART+ represents a good use of public funds.

[51] *These are annual jobs. For example, someone employed by the programme for three years would count as three FTE.*

DART+ PROGRAMME

AECOM

PROGRAMME AIM:

Support urban compact growth and contribute to reducing transport congestion and emissions in the Eastern region by enhancing the heavy rail network between Dublin City Centre and the areas of Drogheda, Maynooth, Dunboyne, Celbridge and Greystones, providing a sustainable, safe, efficient, integrated and accessible public transport service along these corridors.

PROGRAMME IMPACTS:

46%
rail patronage increase one year after implementation (including existing background growth trends)

650,000
tonne reduction in greenhouse gas emissions due to modal shift and increased electrification of the rail fleet

2.3 : 1
Benefit Cost Ratio

134%
increase in residents located within **1km** of a high frequency DART service

1km

100%
increase in the capacity of the rail network in the Eastern region by 2028

2028 **56%** 2043
forecast increase in public transport patronage with DART+ in place between 2028 and 2043

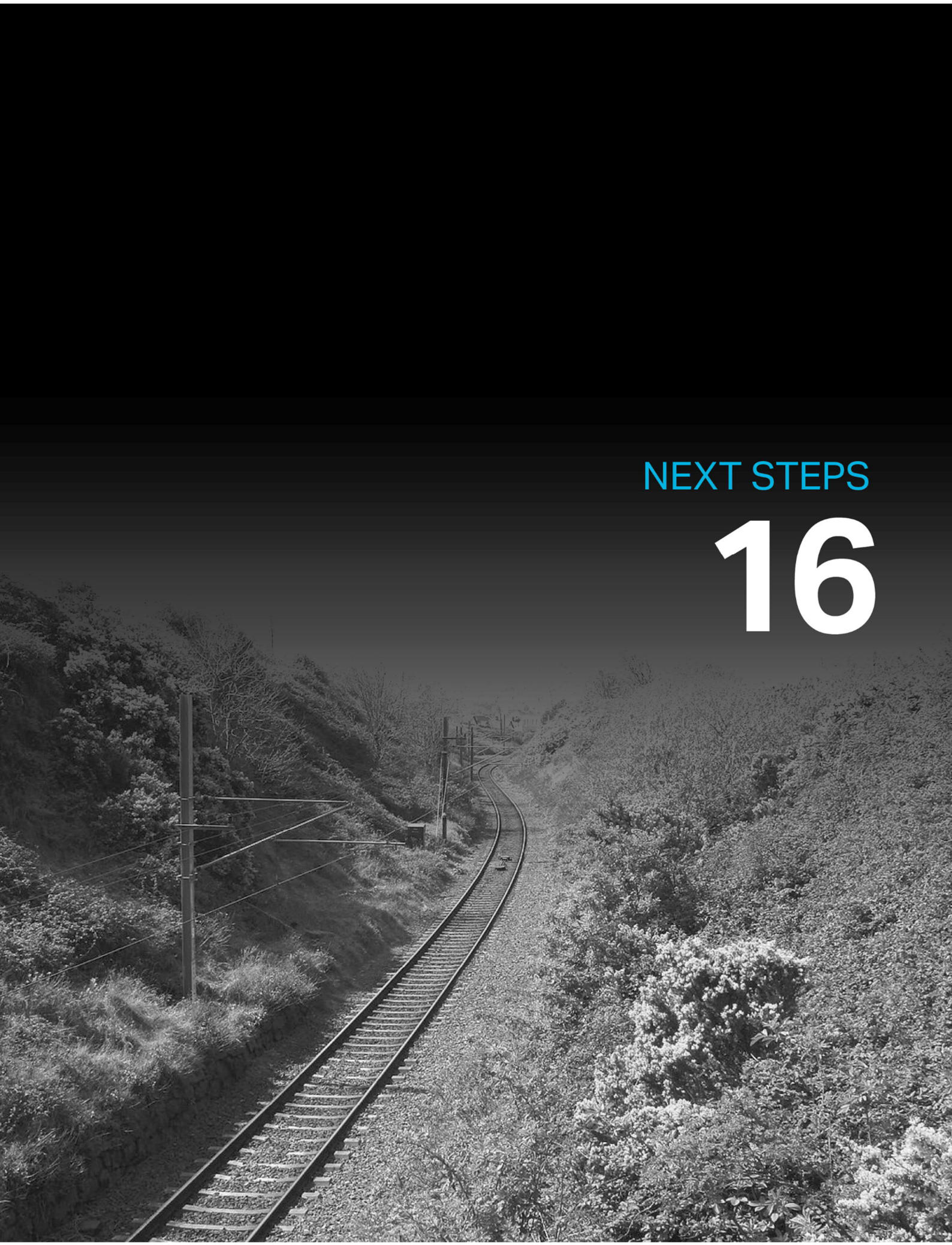
40%
40% improvement in the arrival time reliability of train services operating on the DART+ network

€3bn
CAPITAL INVESTMENT COSTS
2019 Values

43%
Increase in the number of people interchanging between different public transport services, and travelling by foot or by bicycle for part of their trip

Inclusivity in public transport

Improvement in access to services and opportunities for the **45,000** people living in socially deprived areas within the extended DART catchment



NEXT STEPS

16

16. Next Steps

The next step in the business case and PSC approvals is to submit the PBC to the Approving Authority seeking:

- Gate 3 approval for DART+ Fleet (WP1) which will allow contract award and the first fleet order to be placed within the fleet cost envelope set out in this PBC. Supplementary documentation in relation to DART+ Fleet will be provided separate to the programme level PBC in accordance with the requirements for Gate 3 approval
- Gate 1 approval for DART+ West to progress to Gate 2, allowing for progression towards submission of its Railway Order application

Following Gate 1 approval for each DART+ infrastructure project, the Detailed Project Brief and Procurement Strategy will be prepared for each in advance of reaching Gate 2 which grants approval to go to tender. The business case will only be updated at that point if there is a material difference to the project as a result of the Railway Order outcome.

A Final Business Case will be prepared based on tendered costs to allow each project to proceed through Gate 3 which allows contract award.

Figure 16.1 shows how the programme will progress through the PSC approvals process. The DART+ Fleet project is in the final stages of procurement. Approval is not being sought to move all Projects within the DART+ Programme through the next PSC. Approvals being sought by this iteration of the PBC are set out above.

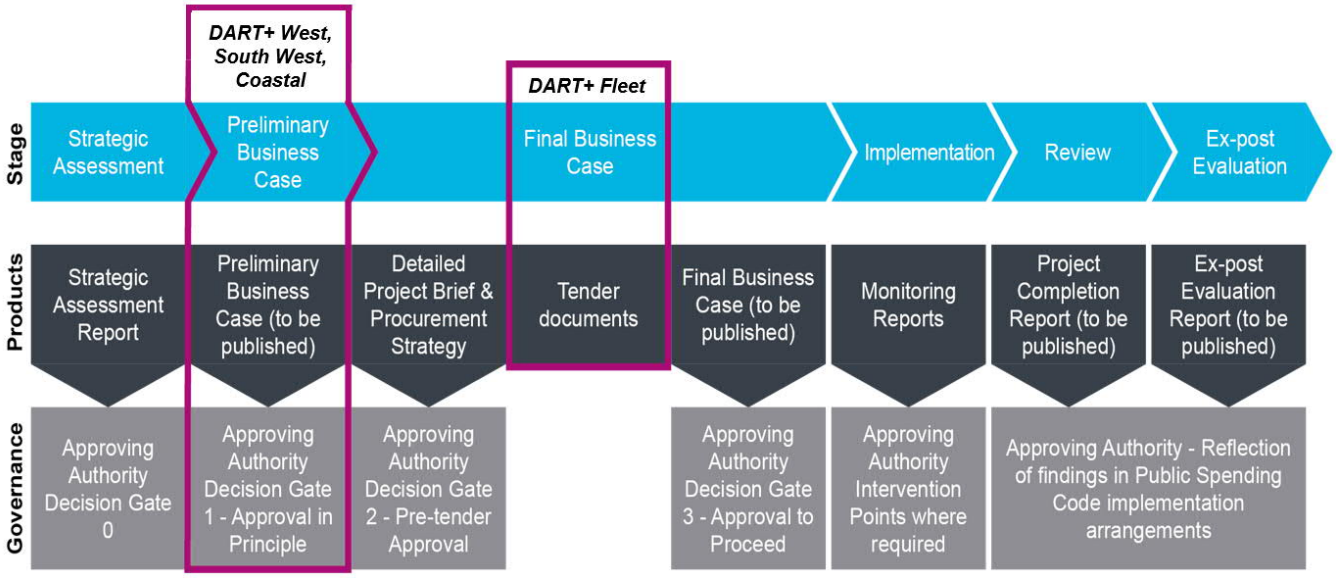
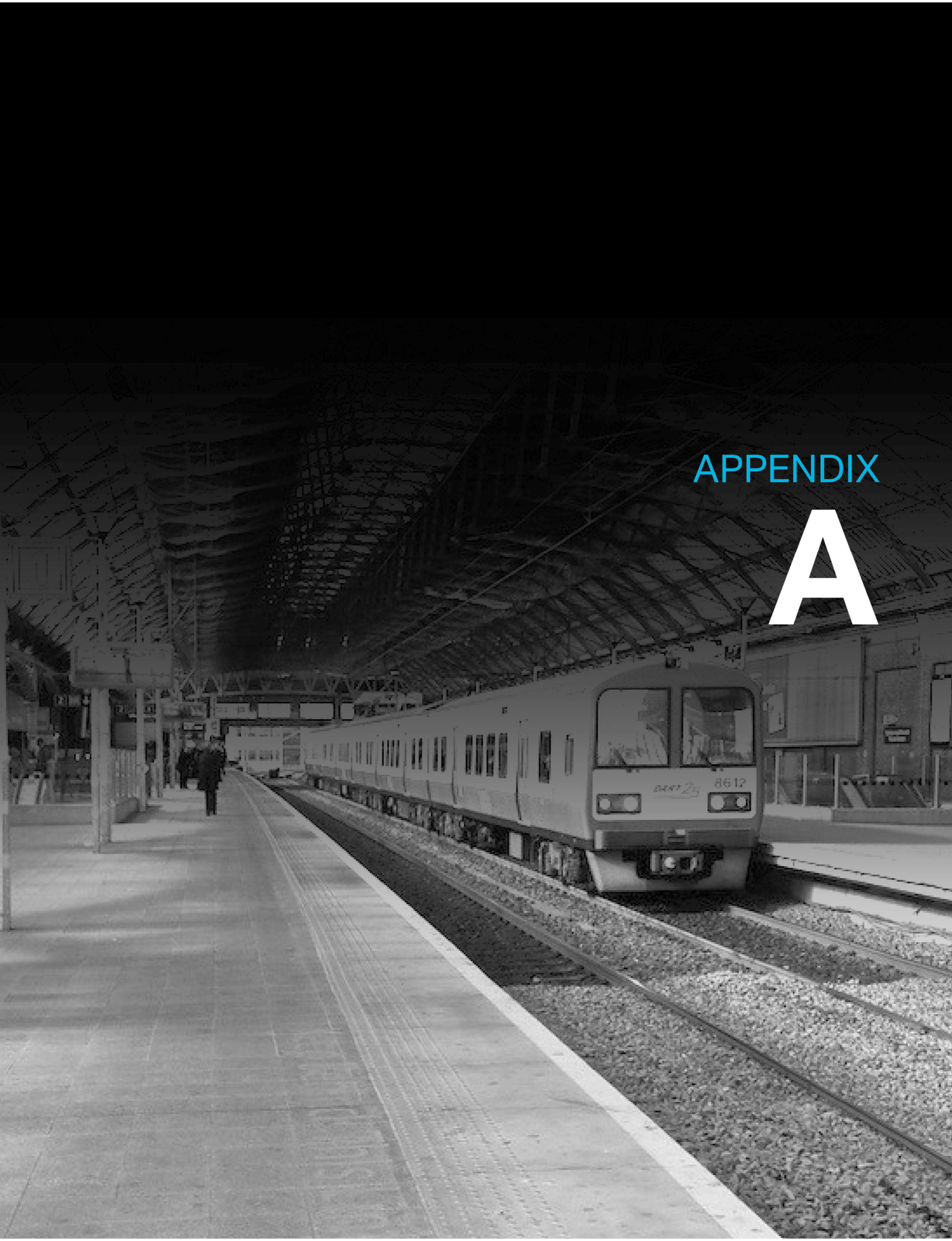


Figure 16.1 – Public Spending Code Progress



APPENDIX A

Project	Deliverables
DART+ Fleet	• Procurement of 260 vehicles • Provision of train simulators to support driver training • Provision of an Automated Visual Inspection System for Fleet Monitoring and Maintenance • Provision of a Technical Support and Spares Supply agreement for the first 15 years of the unit's life
DART+ West	• Electrification between Maynooth/M3 Parkway and Connolly/Docklands • Re-signalling between Maynooth and Connolly • Upgrades at Connolly and Docklands • Relocation of Docklands station to a new site at Spencer Dock • Removal of level crossings • Construction of new depot west of Maynooth with twin track installed and resignalling from Maynooth Station to the depot • Construction responsibility for a new DART station and alignment work at Glasnevin[52].
DART+ South West	• Extension of 4-tracking on the Kildare line from east of Park West station to Heuston station • Re-signalling and electrification from Hazelhatch & Celbridge station to Heuston station and re-signalling and electrification on the Phoenix Park Tunnel (PPT) line (Islandbridge Junction to Glasnevin Junction) • Upgrade of 6 bridges along the line for clearances. Studies required for others on PPT line • New station at Heuston West
DART+ Coastal North	• Electrification from Malahide to Drogheda • Track reconfiguration at Clongriffin and Howth Junction & Donaghmede stations • Bridge reconstructions and civil works to support the electrification and capacity increase. • Re-configuration and upgrading of the existing depot at Fairview
DART+ Coastal South	• Turnback facility at either Dun Laoghaire or Bray • Removal of level crossings • Bray-Greystones enhancements

[52] *Glasnevin interchange design and Railway Order with TII*

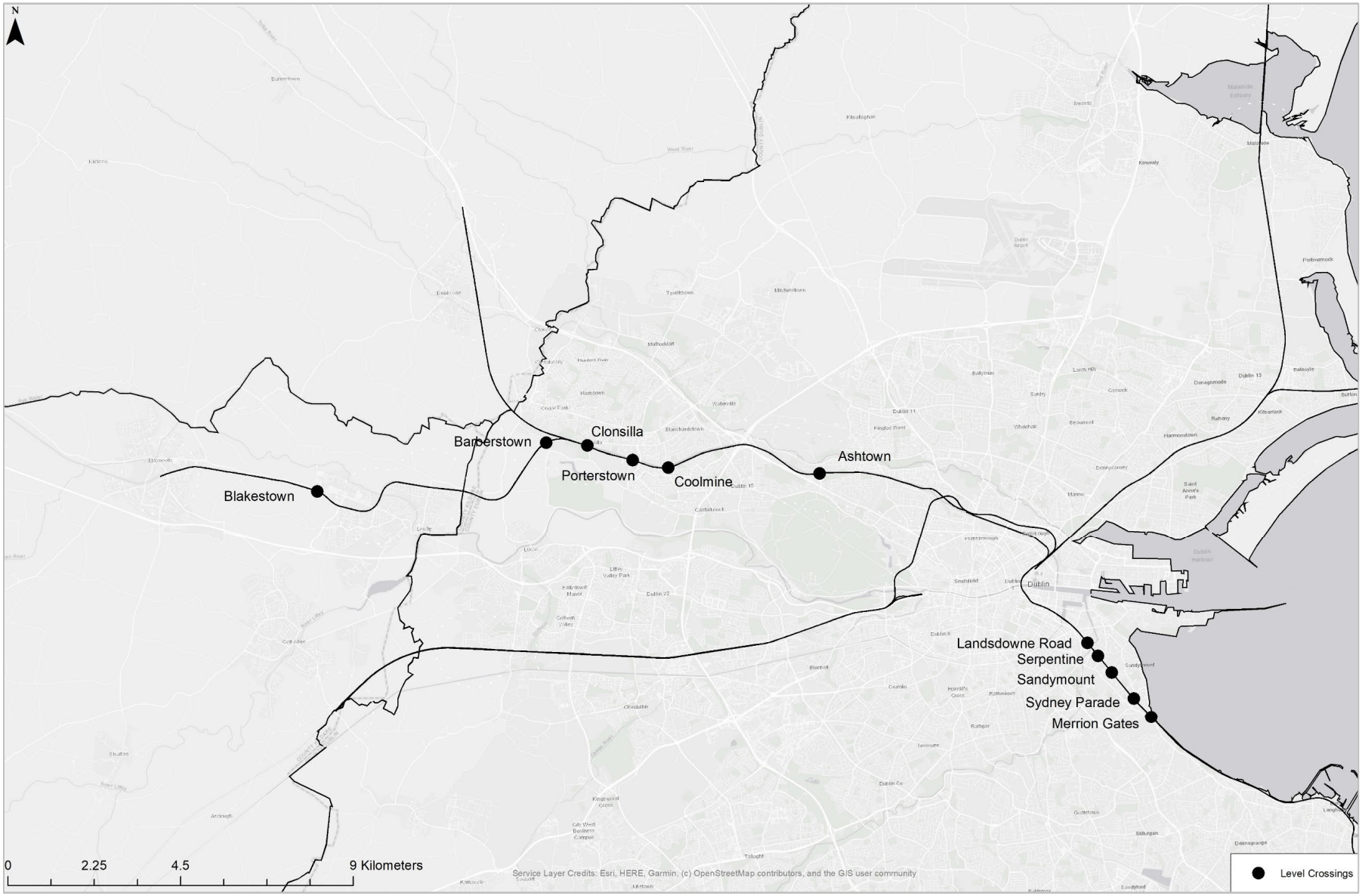
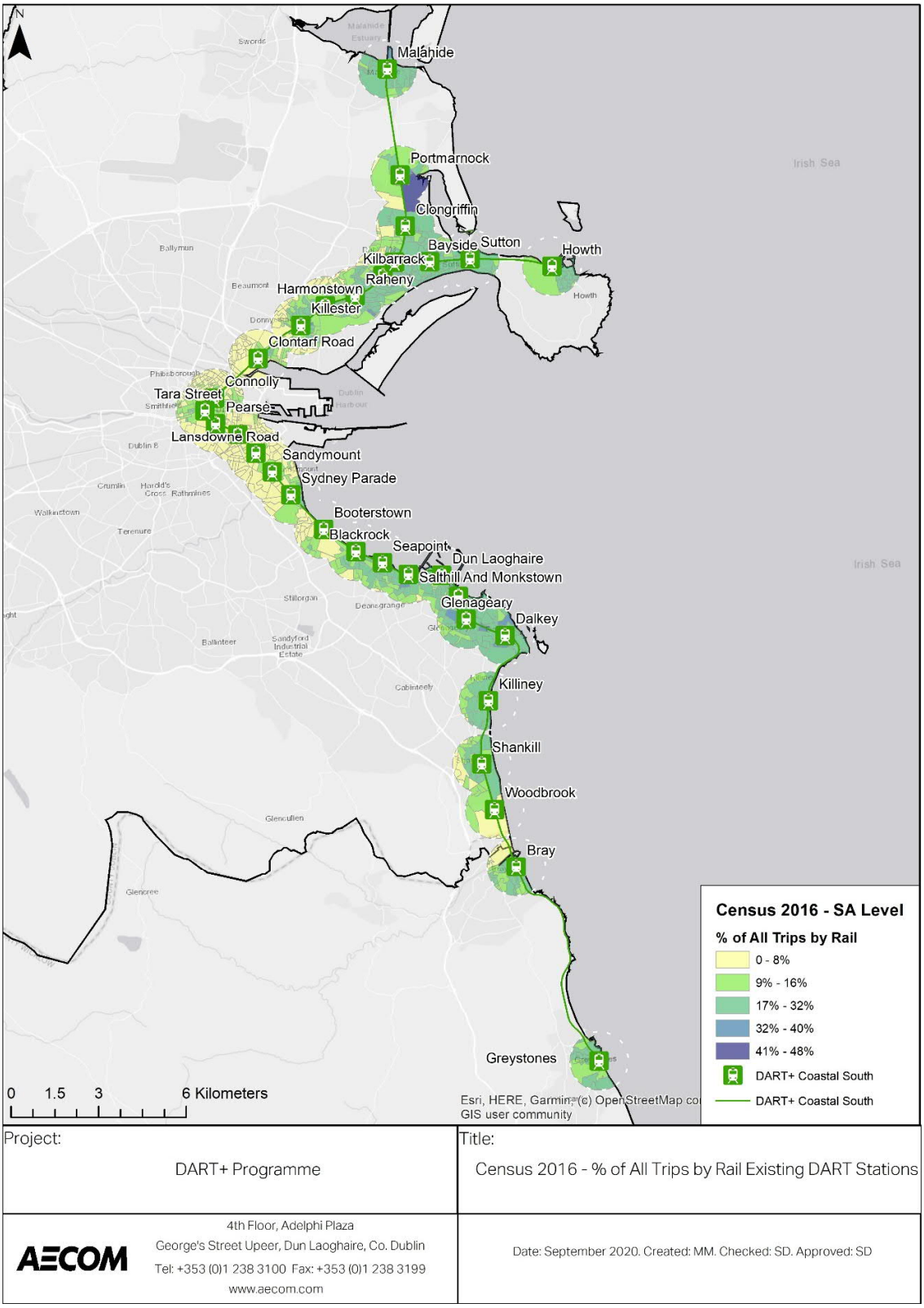


Figure A.1 – DART+ Proposed Level Crossing Closures

APPENDIX B



Project:	Title:
DART+ Programme	Census 2016 - % of All Trips by Rail Existing DART Stations
AECOM 4th Floor, Adelphi Plaza George's Street Upeer, Dun Laoghaire, Co. Dublin Tel: +353 (0)1 238 3100 Fax: +353 (0)1 238 3199 www.aecom.com	Date: September 2020. Created: MM. Checked: SD. Approved: SD

Figure B.1 - Existing DART Network – Rail Mode Share for areas within 1km of stations – Source: 2016 CSO Census

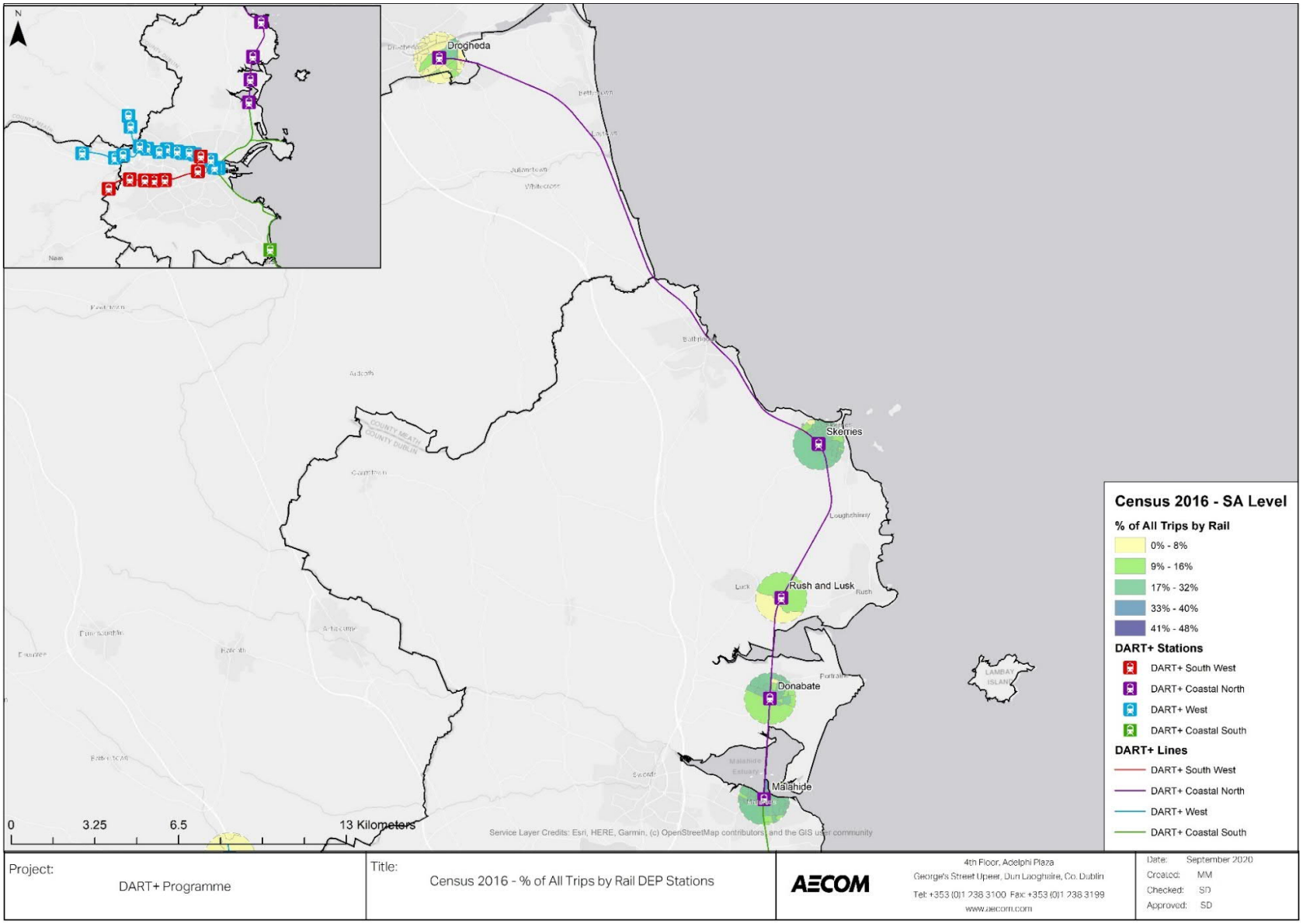


Figure B.2 – Proposed extension of DART Network to North – Rail Mode Share for areas within 1km of stations – Source: 2016 CSO Census

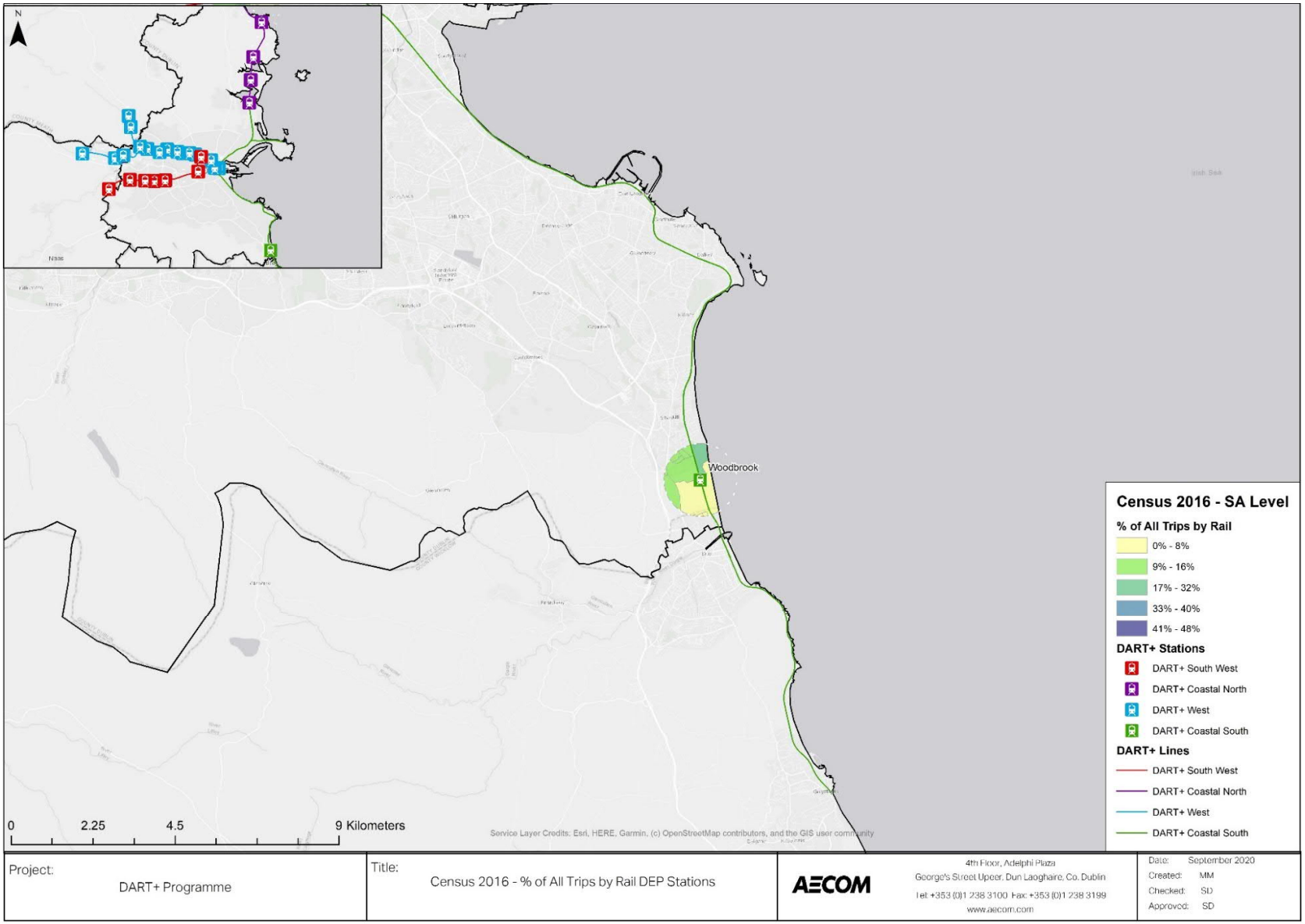


Figure B.3 – Proposed extension of DART Network to South – Rail Mode Share for areas within 1km of stations – Source: 2016 CSO Census

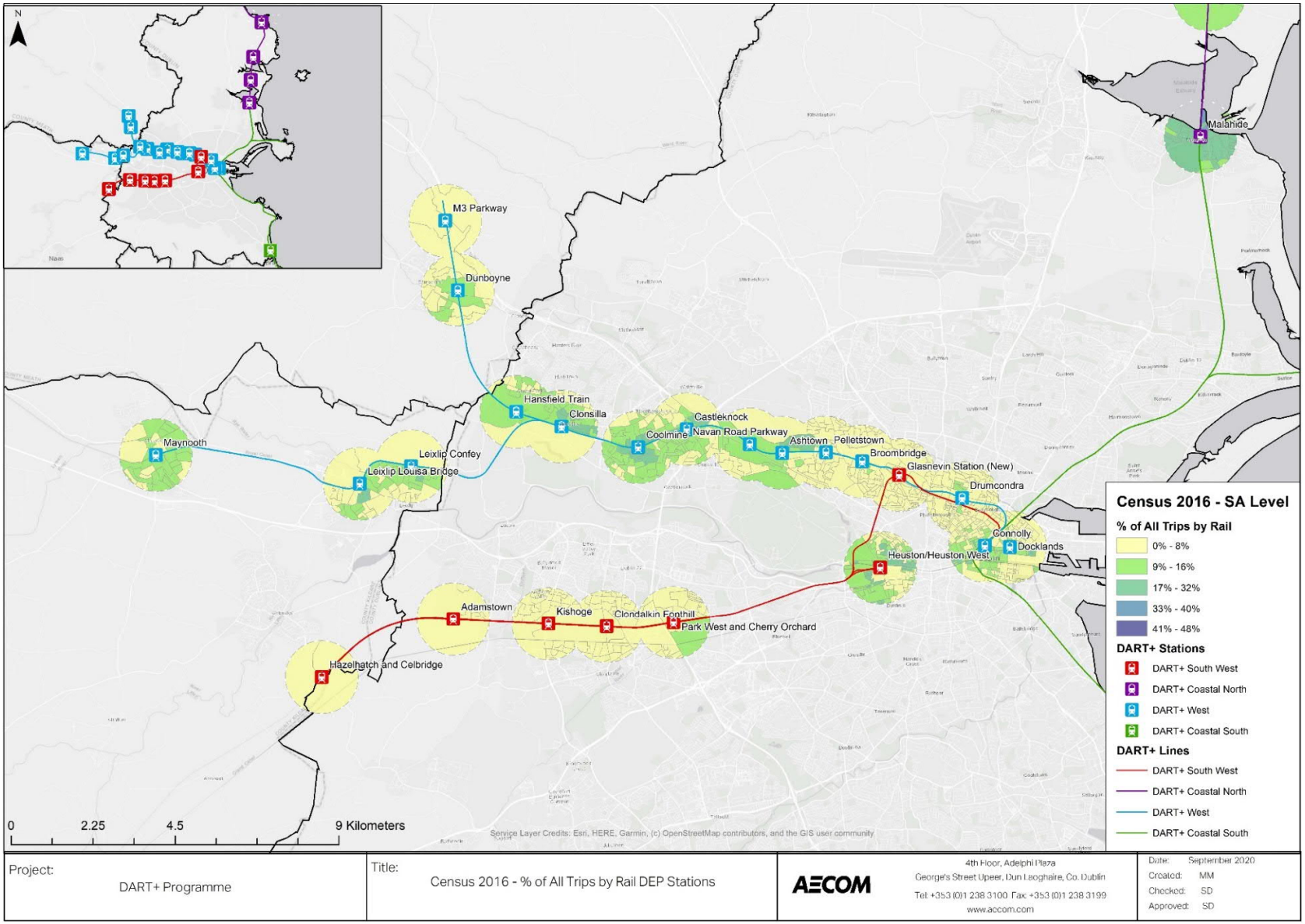


Figure B.4 – Proposed extension of DART Network to West – Rail Mode Share for areas within 1km of stations – Source: 2016 CSO Census

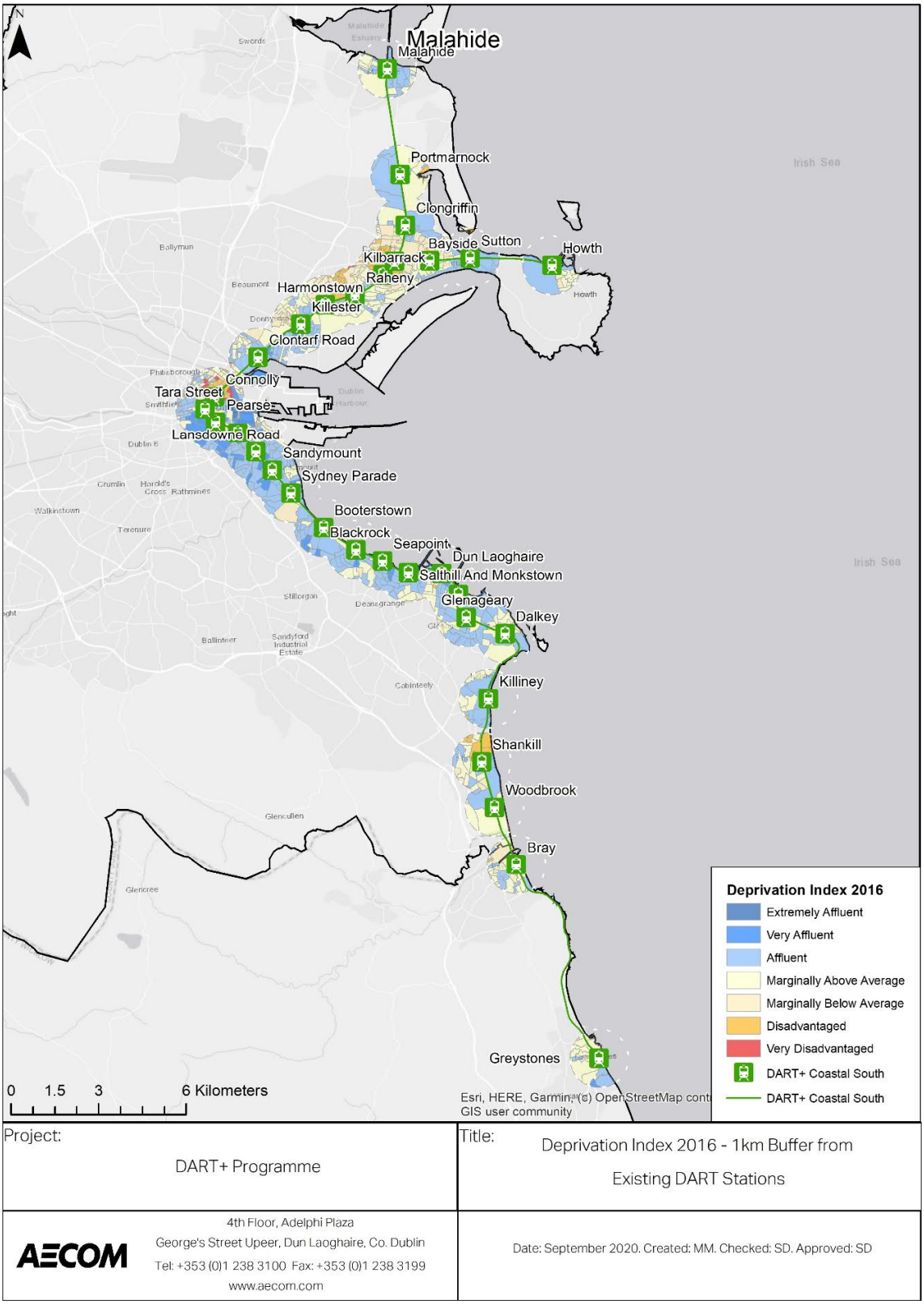


Figure B.5 – Existing DART Network – An Pobal Deprivation Index for areas within 1km of stations
Source: Pobal

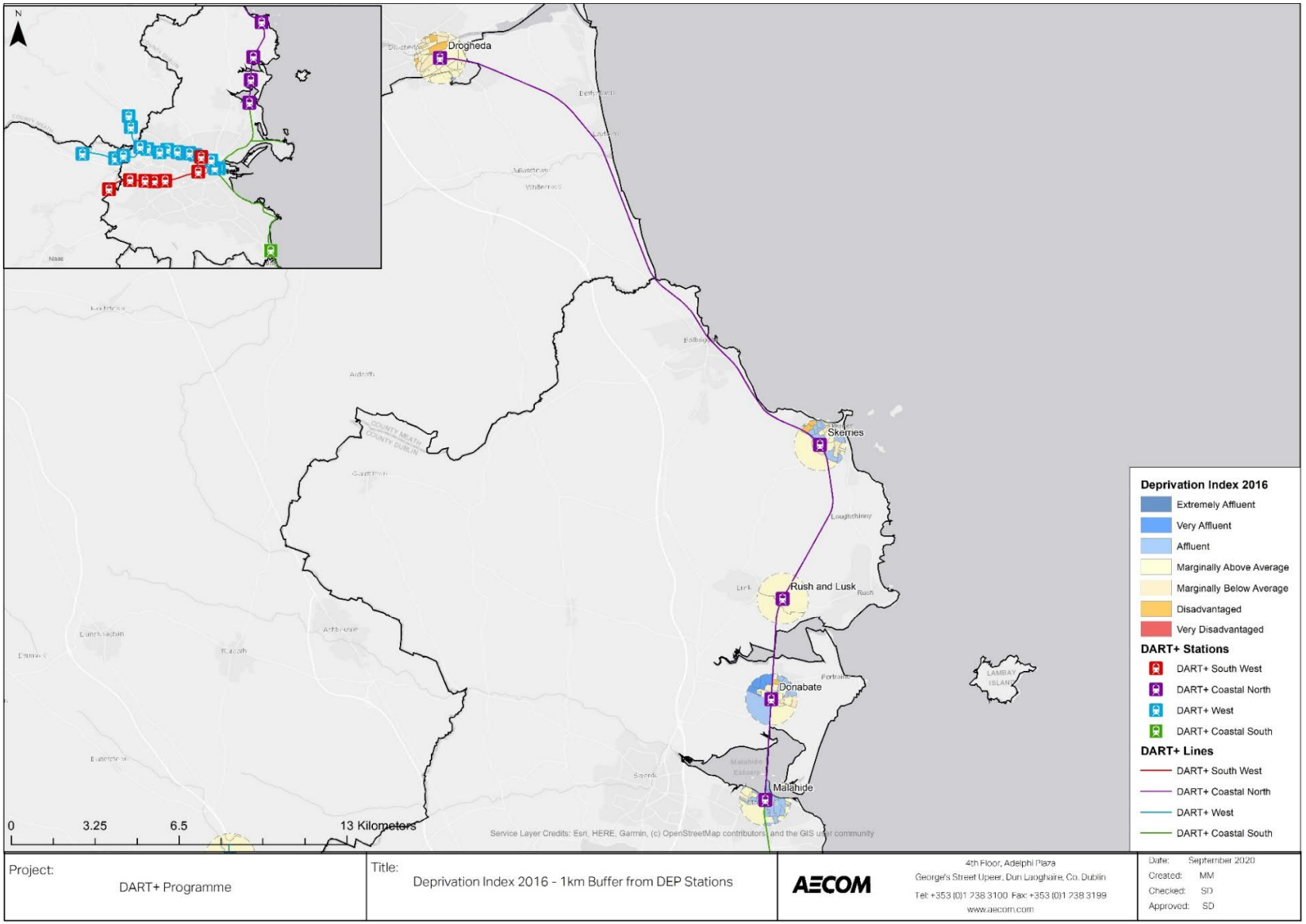


Figure B.6 – Proposed extension of DART Network to North – An Pobal Deprivation Index for areas within 1km of station
Source: Pobal

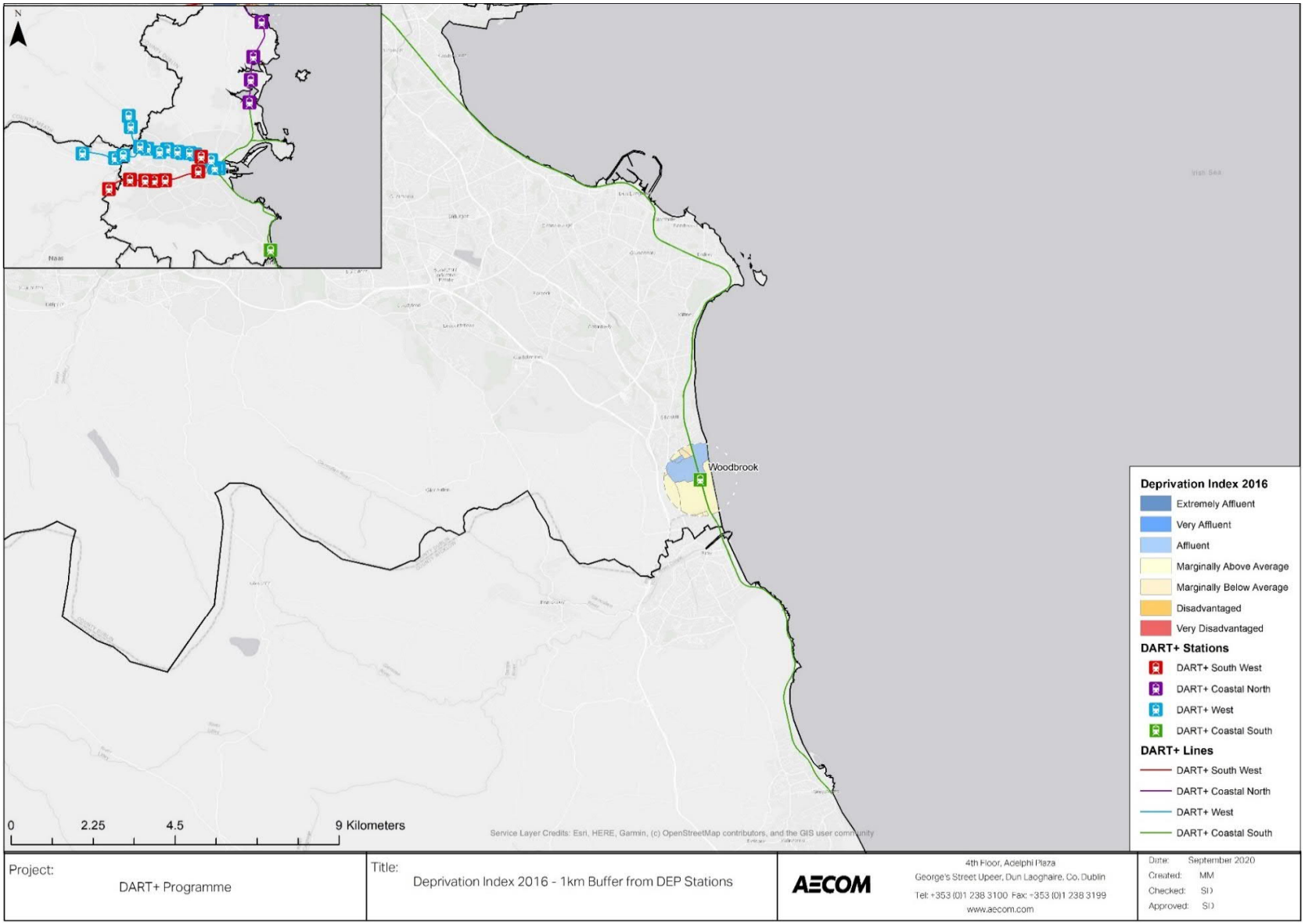


Figure B.7 – Proposed extension of DART Network to South – An Pobal Deprivation Index for areas within 1km of station
Source: Pobal

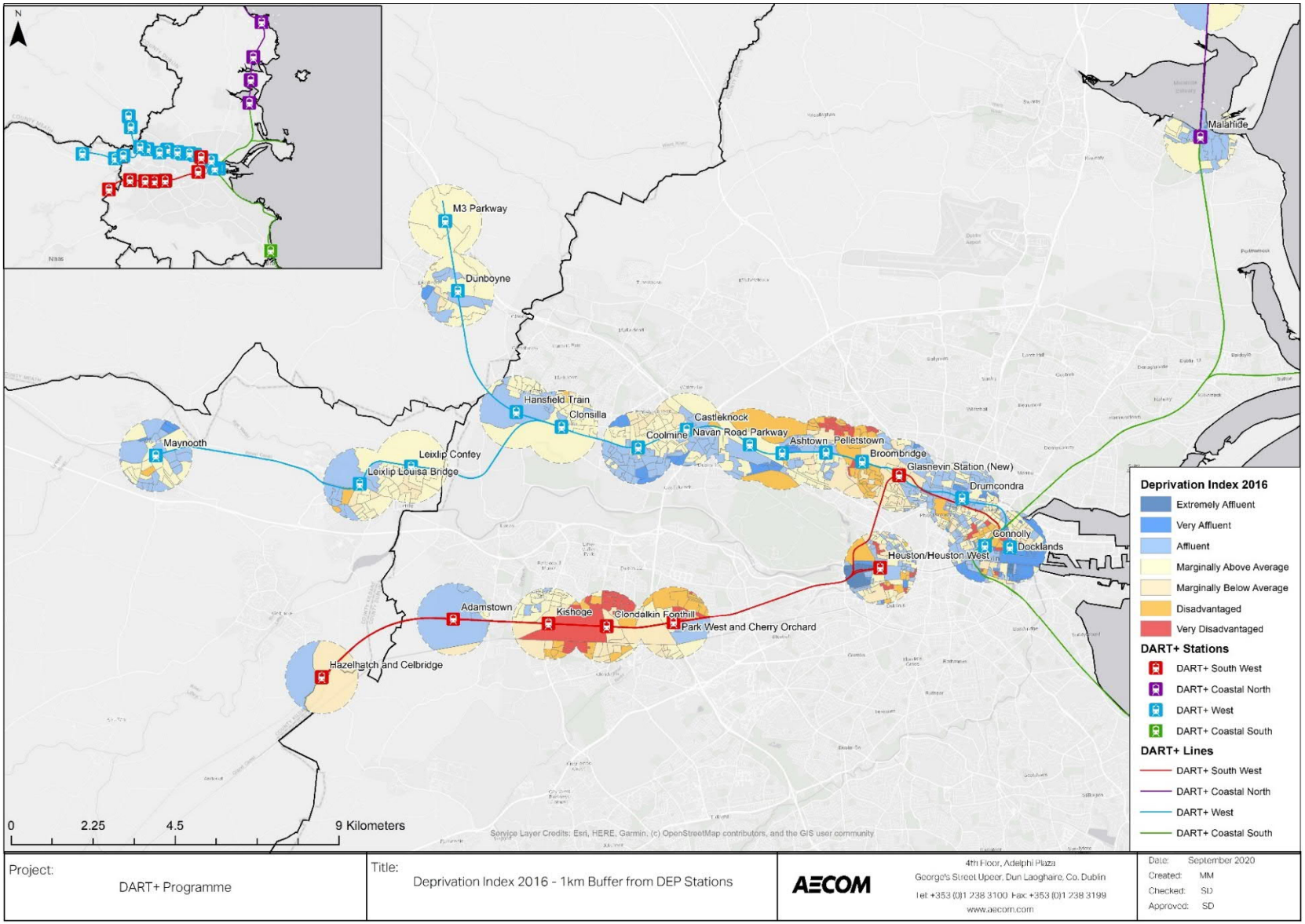


Figure B.8 – Proposed extension of DART Network to West – An Pobal Deprivation Index for areas within 1km of stations
Source: Pobal

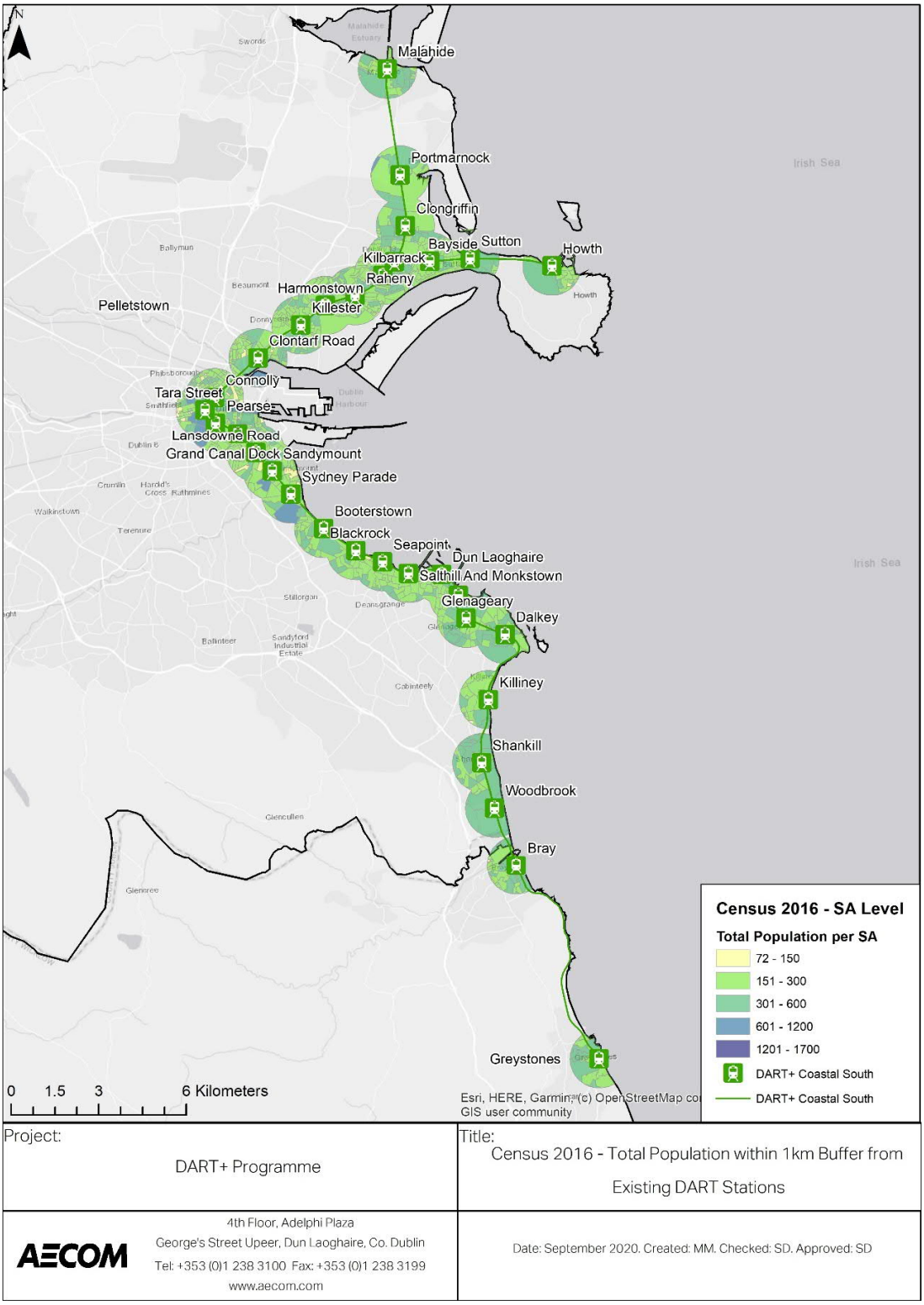


Figure B.9 – Existing DART Network – 2016 population for areas within 1km of stations

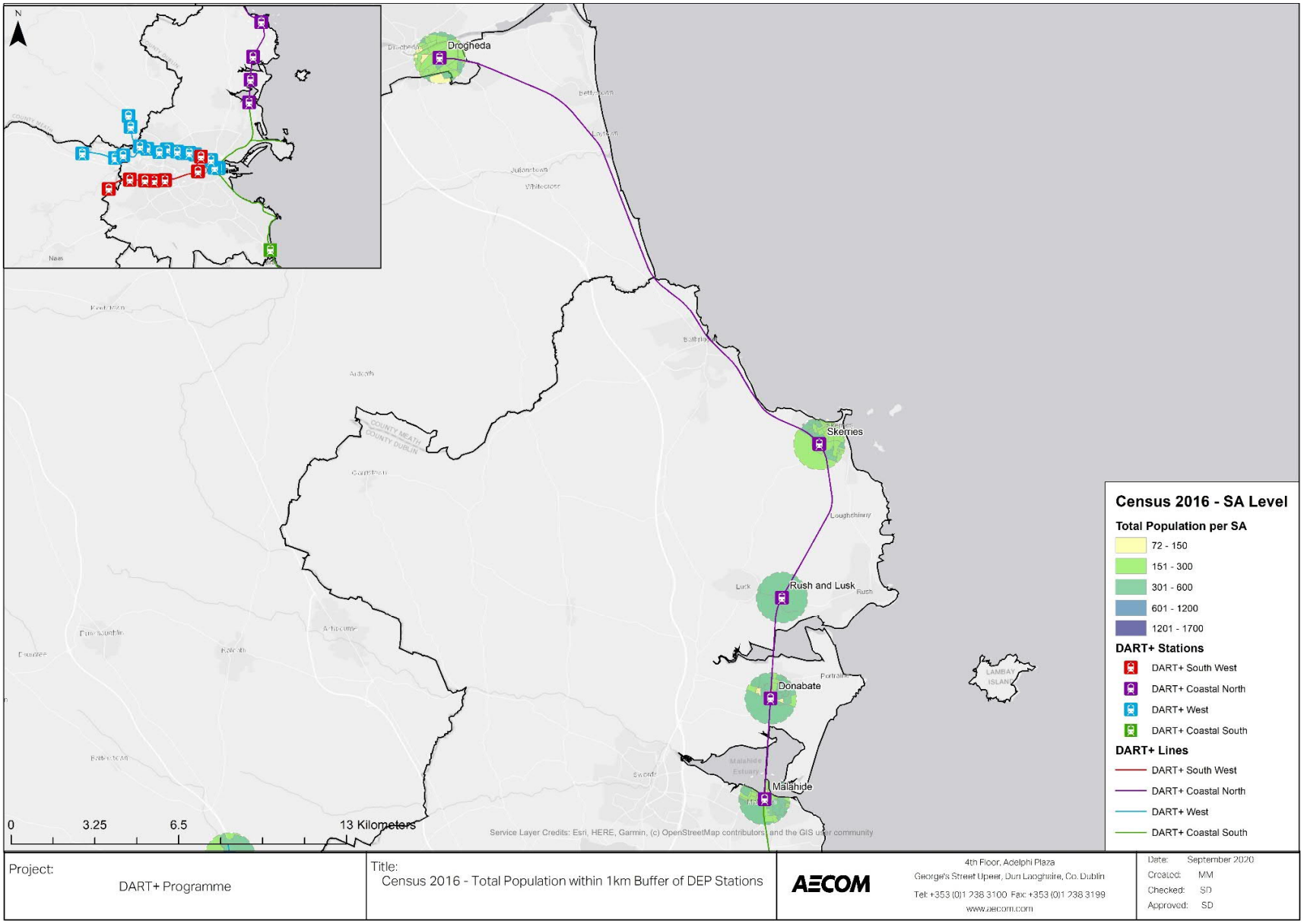


Figure B.10 – Proposed extension of DART Network to North – 2016 population for areas within 1km of stations

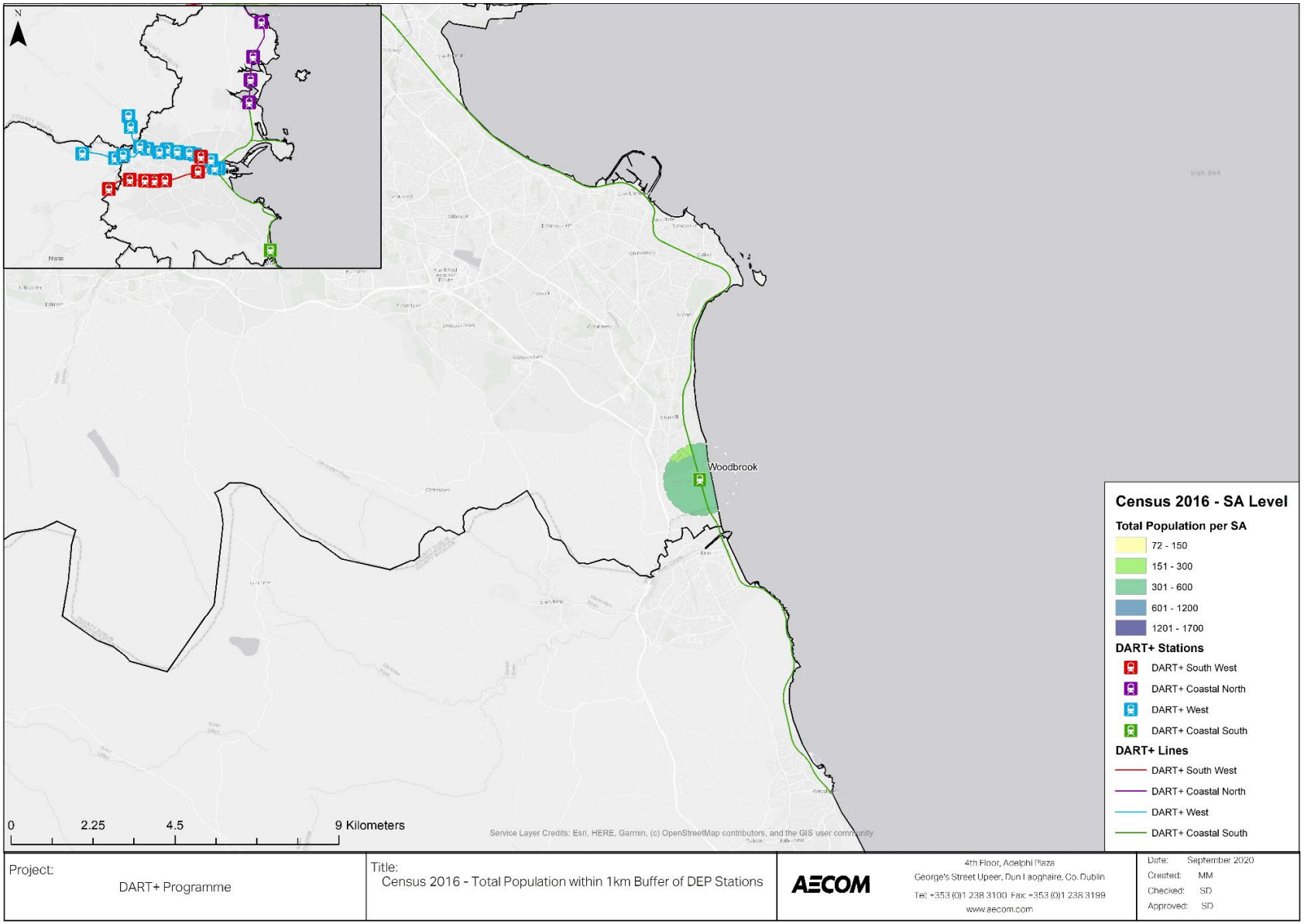


Figure B.11 – Proposed extension of DART Network to South – 2016 population for areas within 1km of stations

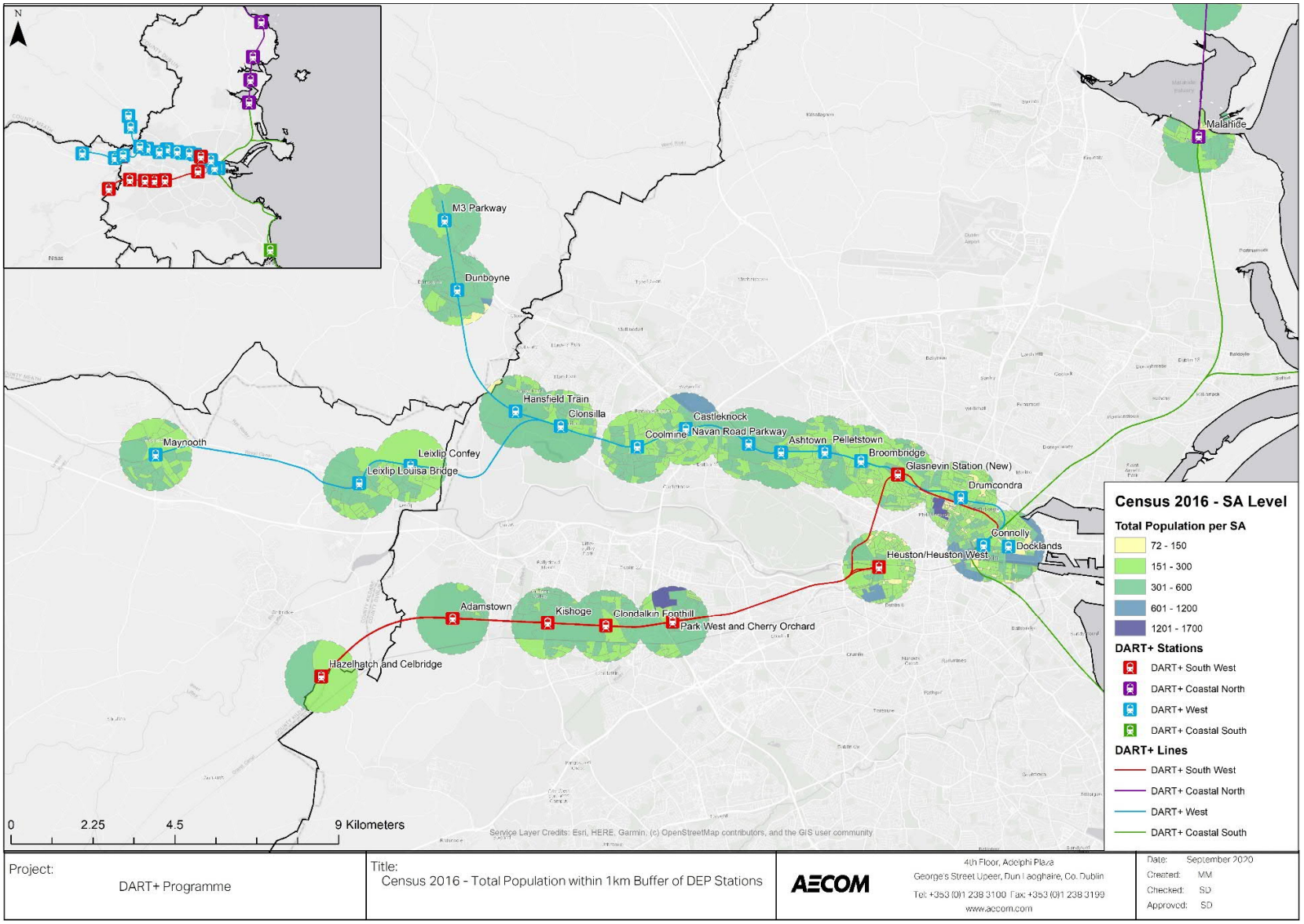


Figure B.12 – Proposed extension of DART Network to West – 2016 population for areas within 1km of stations

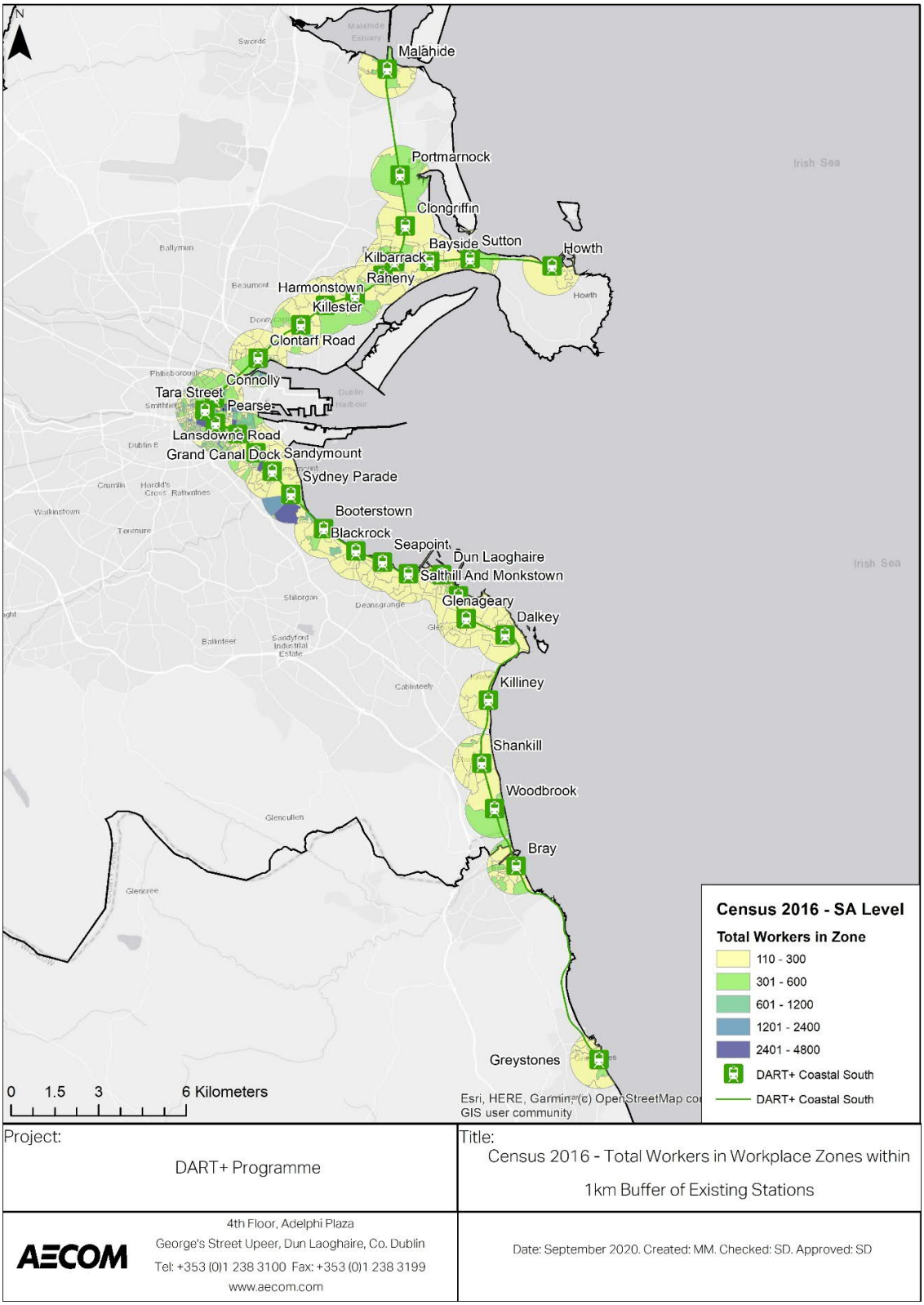


Figure B.13 – Existing DART Network - 2016 jobs for areas within 1km of stations

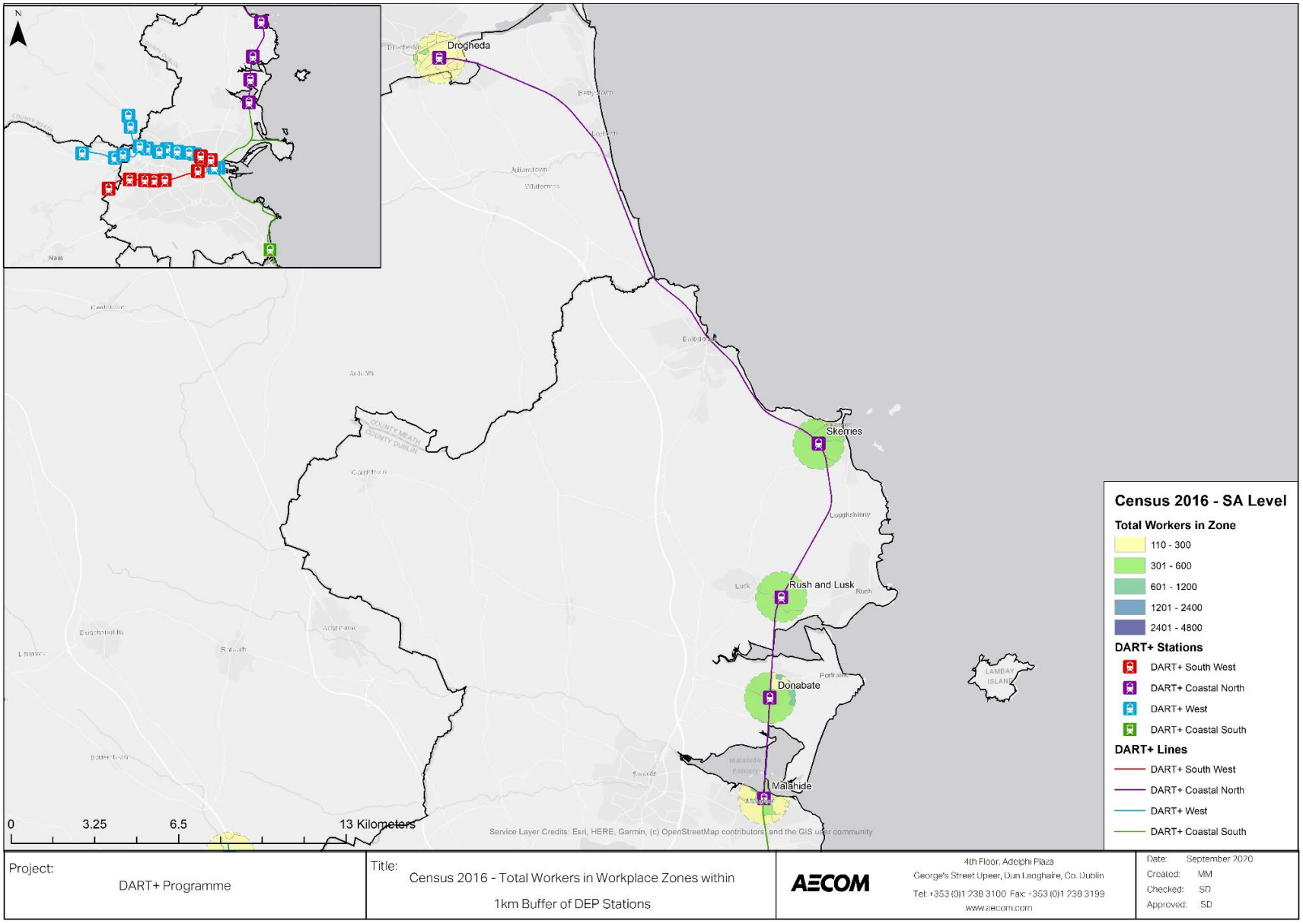


Figure B.14 – Proposed extension of DART Network to North – 2016 jobs for areas within 1km of stations

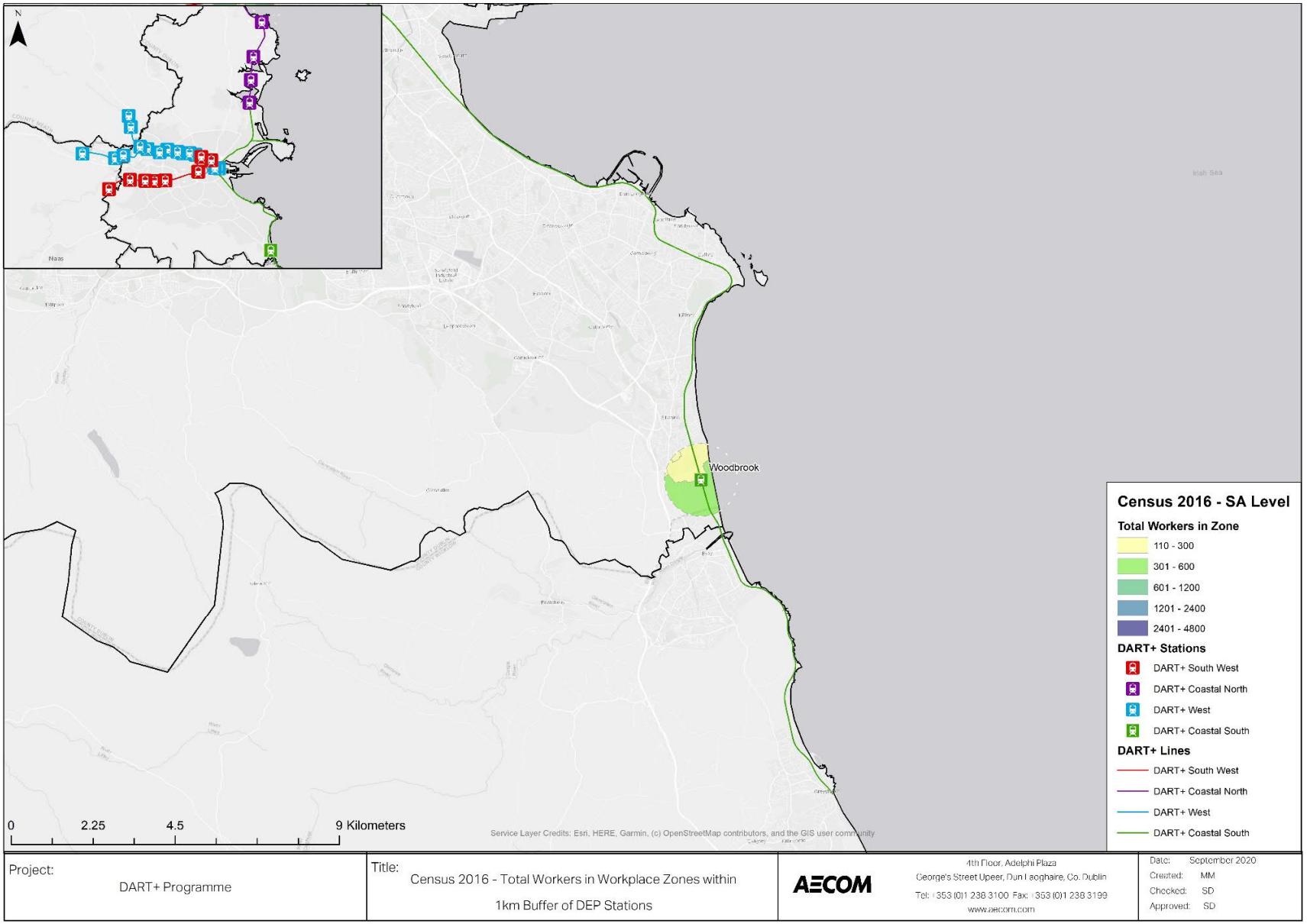


Figure B.15 – Proposed extension of DART Network to South – 2016 jobs for areas within 1km of stations

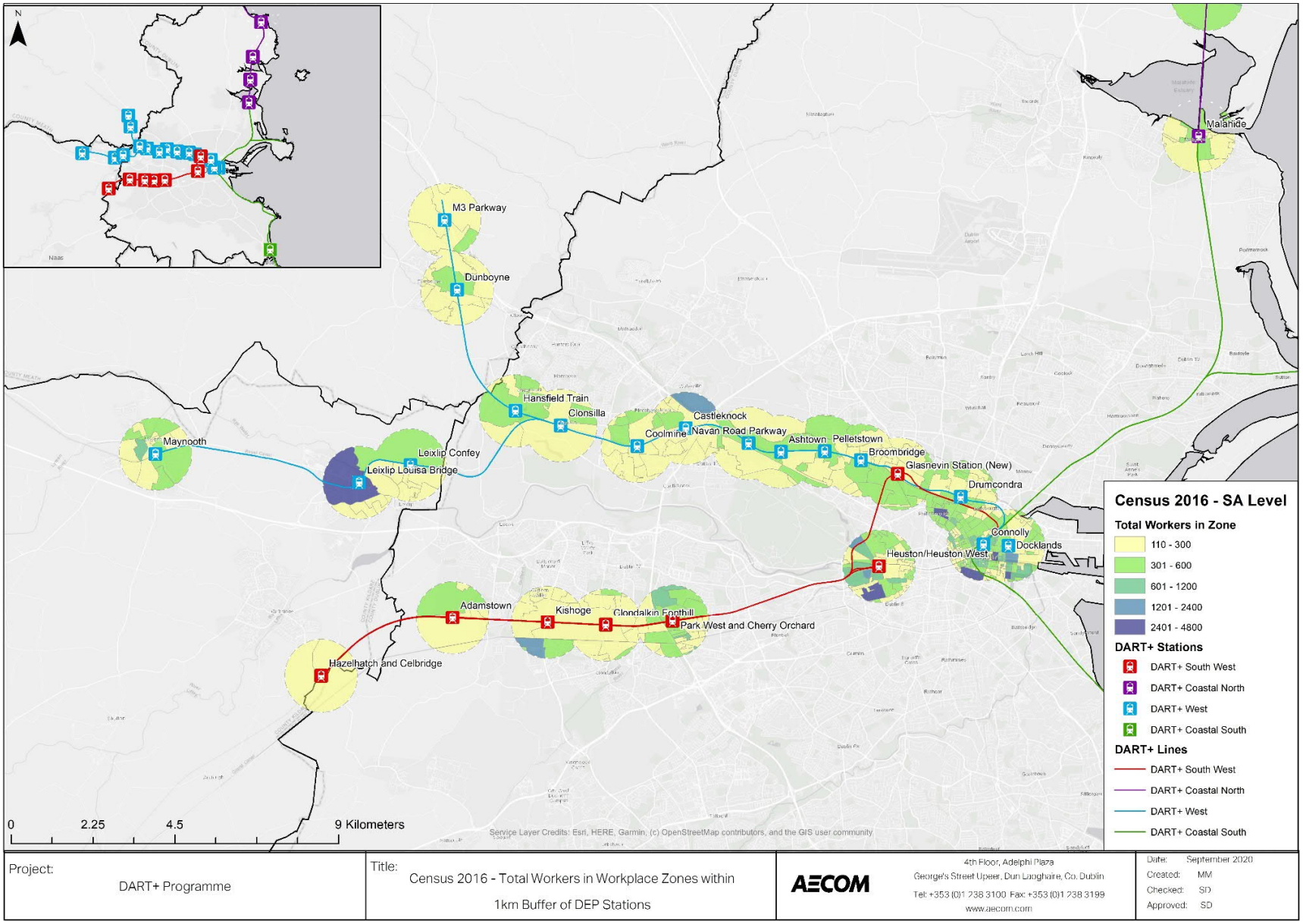
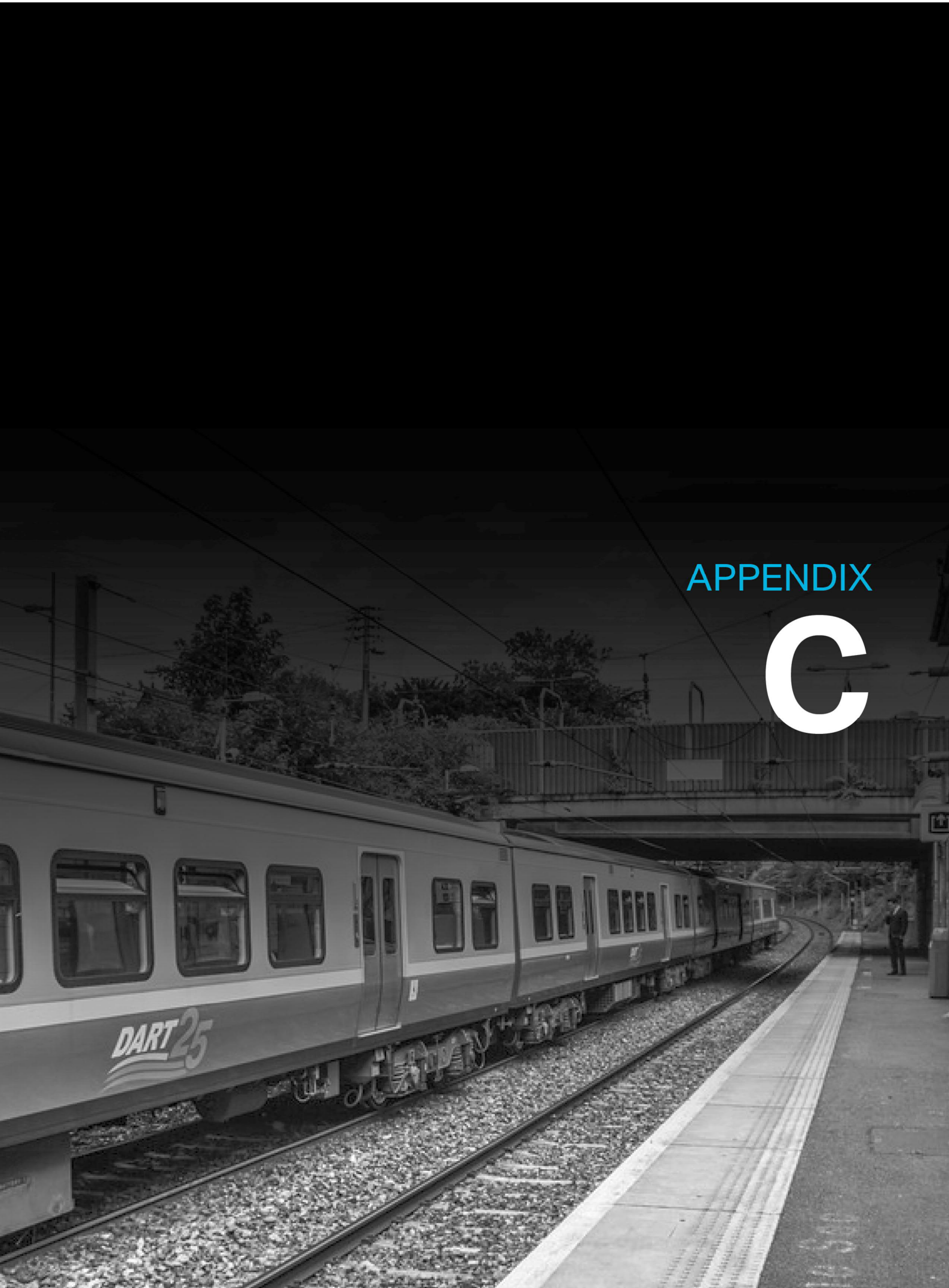


Figure B.16 – Proposed extension of DART Network to West – 2016 jobs for areas within 1km of stations



APPENDIX C

Figure C.1 – Option 1

Option 1 is an access from Kilcock interchange by the existing road network where a ring one direction could be provided because of the narrow width of these roads and so no new infrastructure is necessary, but a rearrangement of the direction of traffic.

Figure C.2 – Option 2

Option 2 is an access from Kilcock interchange through a residential area where the final stretch up to the depot is a new road 670 m long (dotted line).

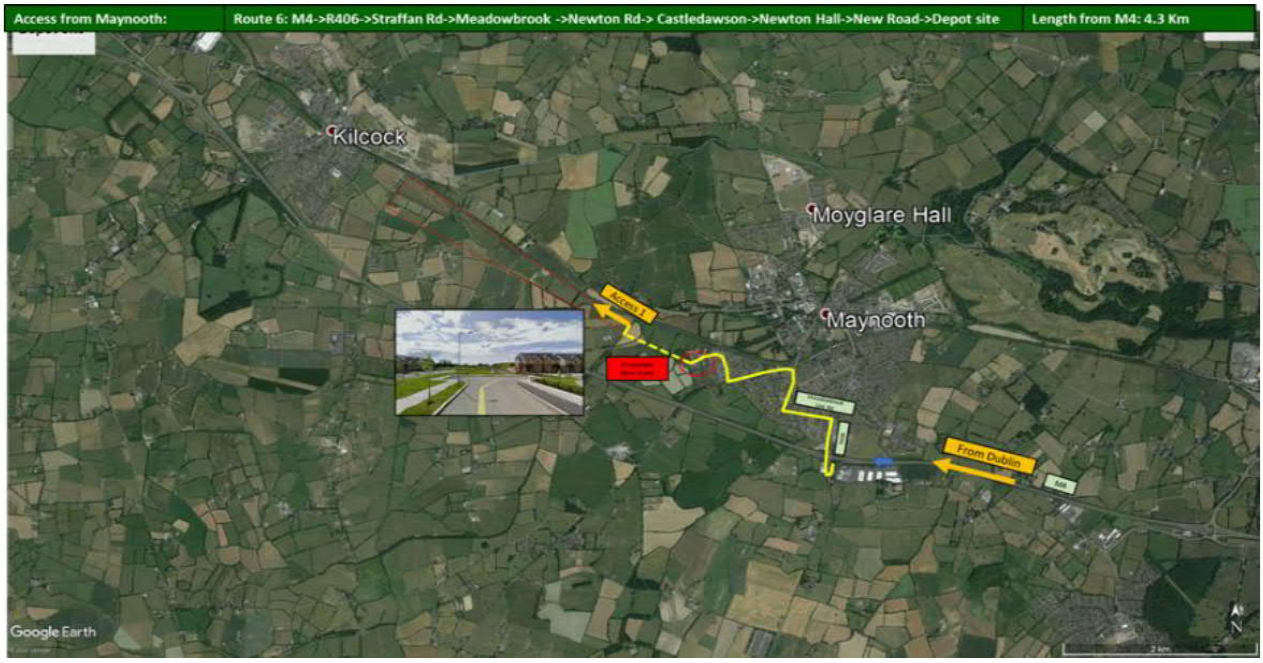


Figure C.3 – Option 3

Option 3 is a road access from Maynooth interchange, this route goes through a large residential area with narrow meandering roads and the final stretch up to the depot is a new road 850 m long (dotted line).

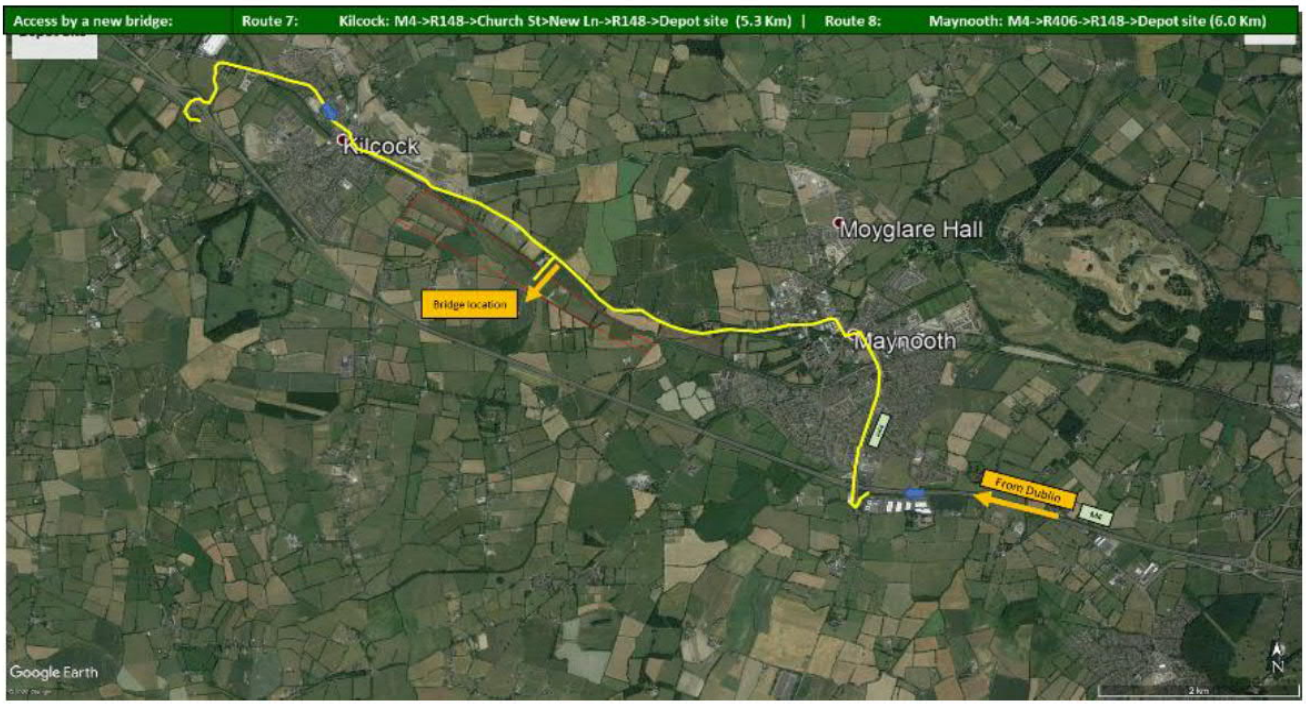


Figure C.4 – Option 4

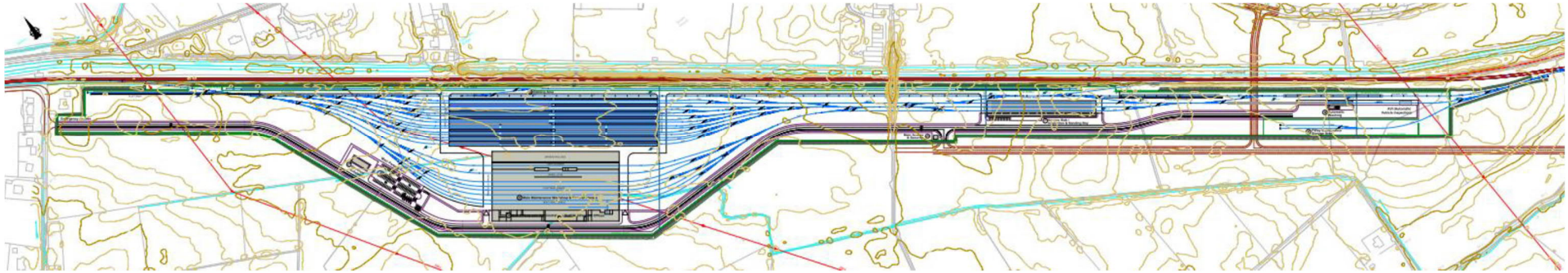


Figure C.5 – Alternative 3 Depot layout

APPENDIX D

CENTRE OF EXCELLENCE

DART Expansion

Maintenance Depot

Site Location Assessment

Issue Date: 11/07/2019
Rev: Insert 01
Filename: Depot Location Assessment 01 (20190711_Issue)

7 Assessment Criteria

7.1 Pre-Appraisal Criteria

Each of the strategic locations was subject to a preliminary pre-appraisal using the minimum functional site thresholds and satisfying a number of high level principles, as follows:

A. Site area equal to or greater than 20 hectares;

B. Linear site length off / parallel to operational land of equal to or greater than 1.8km. This threshold is based on the following depot process flow:

- 250m from operational line to end of reception road;
- 350m from reception road to end of Automatic Vehicle Inspection (AVI) / train wash road;
- 200m depot handover point;
- 200m service slab;
- 200m cleaning slab/stabling
- 200m maintenance roads;
- 400m end of depot stabling /backend shunting.

C. Is it practical to develop a Maintenance Depot at the exact strategic node?

D. Is it practical to develop a Maintenance Depot lineside in the wider environs of the strategic node?

E. Are there fundamental issues with the specific strategic node that deem it unfeasible to continue in the assessment?

7.2 Assessment Criteria

Following the pre-appraisal, a consistent set of assessment criteria was used in the formal appraisal.

While this study is focussed specifically on location assessment the criteria in the main align with applicable topics that should be considered under a qualitative appraisal as identified in the Common Appraisal Framework for Transport Projects and Programmes (DTT&S, 2016).

In this regard the following criteria was considered:

- Economy
    - Capital Cost: The indicative scheme infrastructure requirements for the maintenance depot has been considered. There are additions/deductions from the scheme requirements based on the depots site specific location. Land acquisition costs have not been taken into account at this early stage. Therefore, as there are no differentiating capital cost factors between sites, it is not considered as an assessment criteria in choosing a preferred depot location.
    - Operating Cost: The position of the maintenance depot on the network does have an impact on on-going operating costs, in terms of empty running of trains at start and end of service. The depot position also impacts on track access maintenance time, which also impacts on on-going operating costs.
- Demand

The position of the maintenance depot will not impact on train service capacity and/or passenger demand. The Working Timetable will take account of start of service/end of service passenger requirements and will appropriately manage and regulate the logistics of getting the rolling stock into position. Therefore, it is not considered as an assessment criteria in choosing a preferred depot location.

- Integration
    - Land-Use Integration: The position depot must be adjacent to the existing network. National, regional and local policy and objectives are to ensure higher density development is concentrated at appropriate locations along the rail network to promote public transport in factor of private car journeys. Therefore, the depot study does consider land-use integration as an assessment criteria. The depot study seeks to ensure each location is assessed to ensure a potential site does not adversely impact a future land-use development aspiration. The siting of the depot will not, in itself, impact on land-use integration.
    - Public Transport Integration: The position of the maintenance depot will not impact on public transport integration. The Working Timetable, together with integration with other public transport operators, will take passenger requirements and public transport integration. Therefore, it is not considered as an assessment criteria in choosing a preferred depot location.
    - Walking/Cycling/Private Car Journey Integration: The position of the maintenance depot will not impact on walking/cycling/private car journey integration. Therefore, it is not considered as an assessment criteria in choosing a preferred depot location.
    - Impact on the Road Network: The position of the maintenance depot relative to the public road network is a factor in the assessment. Material imports/exports during construction and operation are a factor in delivering a functioning depot. Therefore, road access in considered as an assessment criteria in choosing the preferred depot location.
- Environment: The availability of suitable land and the effects on the neighbouring environment are factors to be considered in the assessment of the depot and are differentiators between potential sites. Therefore, these are considered as assessment criteria in choosing the preferred depot location.

- Accessibility and Social Inclusion: The broad meaning of "Accessibility and Social Inclusion" in the Common Appraisal Framework Guidance is to maximise access to jobs for deprived geographic areas. The position of the rail depot will not impact on the rail services offered by Iarnród Éireann and therefore, on taking the broad meaning, the depot will not affect passenger options for access jobs. On a localised level and regardless of site specific location, the maintenance depot will be design to ensure it is un-assisted accessible for mobility and sensory impaired persons. Therefore, accessibility and social inclusion is not considered as an assessment criteria in choosing the preferred depot location.

- Safety: The position on the rail depot will not impact on rail safety or depot safety. All necessary safety measures and risk minimisation measures will be incorporated into the depot design, irrespective of location. Therefore, safety is not considered as an assessment criteria in choosing the preferred depot location.

- Physical Activity: The position on the rail depot will not impact on physical activity and this criteria is not a differentiator between potential depot sites. Therefore, physical activity is not considered as an assessment criteria in choosing the preferred depot location.

The criteria used is detailed below and is the outcome of a workshop held with key internal stakeholders. They are not listed in any order of priority.

Each of the selected sites is assessed under the following criteria:

1. Minimised empty running for daily service commencement / ending of service (cost implication);

2. Maximise track access time for maintenance (rail safety / public service obligation);

3. Complexity of access and egress to / from depot (public service obligation / train planning logistics);

4. Availability of suitable lands (construction deliverability);

5. Consideration of neighbouring environment (construction deliverability);
6. Road vehicle routing for access to site (construction deliverability);
7. Compliance with transportation and land-use policy (Compliance with policy); and
8. Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding).

The options were compared against how well they delivered on the criteria description, using a five-point scale. This scale ranges from Significant Advantageous to Significant Disadvantageous.

The appraisal system is shown below.

Score	Description
Most preferable	Significant advantages over other options
Preferable	Some advantages over other options
Neutral	Comparable to other options
Not Preferable	Some disadvantages to other options
Least Preferable	Significant disadvantages to other options

For each of the criterion, the options are compared against how well they deliver on the criteria using a five-point scale. The score for each criteria is based on a qualitative justification. These justifications are determined in a collaborative technical assessment across the Project Team. Following the appraisal of each option the overall scores are determined and an Emerging Preferred Option identified.

8.14 Pre-Appraisal Conclusion

Item	Strategic Location	Pre-Appraisal Conclusion
1	Fairview Depot	Discontinued from assessment
2	Connolly Station	Discontinued from assessment
3	Heuston Station	Discontinued from assessment
4	Pearse Station	Discontinued from assessment
5	North Wall Railway Yard	Discontinued from assessment
6	East Wall Railway Yard	Discontinued from assessment
7	Inchicore Railway Works	Discontinued from assessment
8	Drogheda Station/Depot	Taken forward for further assessment
9	Maynooth Station	Taken forward for further assessment
10	M3 Parkway Station	Taken forward for further assessment
11	Hazelhatch Station	Taken forward for further assessment
12	Greystones Station	Discontinued from assessment
13	Bray Station	Discontinued from assessment

9 Location Assessment

9.1 Introduction

Four locations have been shortlisted for consideration in the location appraisal. The shortlisted locations are general geographic zones and not taken to individual site areas.

- Drogheda Environs;
- Maynooth Environs;
- M3 Parkway Environs; and
- Hazelhatch Environs.

The geographic setting of these 4 areas is shown on Figure 9.1.

For the purpose of the location assessment, it is assumed that the capital cost of depot construction is neutral across all sites.

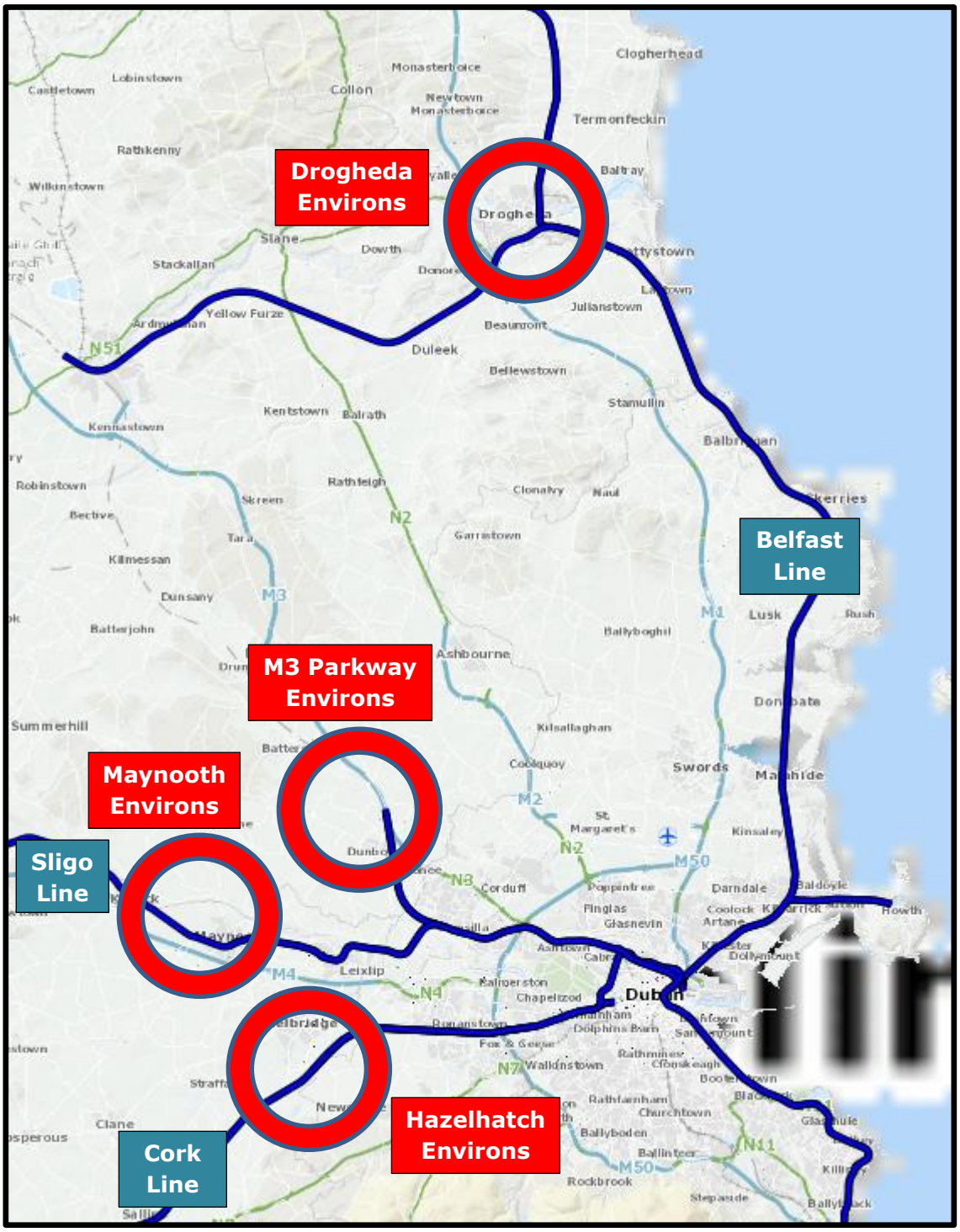


Figure 9.1: Regional Location of Potential Depot Site for Assessment

9.2 Drogheda Environs

The potential for siting a single, centre of excellence maintenance depot in the Drogheda environs is assessed. It has previously been determined that there is no potential for siting the depot in the immediate environs of Drogheda Station. Therefore, a new depot is considered in the context that it will be located either north of south of Drogheda town centre. Given the differences in geographic setting, Drogheda South and Drogheda North are assessed separately.

Drogheda South

The potential sites south of Drogheda are along the operational twin track railway approximately 44-48km north of Connolly. The DART Expansion Drogheda end node is significantly further that the other network end nodes.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Drogheda environs will result in highest empty running cost and has significant disadvantages to other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Drogheda will result in earliest and latest train movements into/out of depot and will have higher magnitude	

	impacts on possession times. This will have some disadvantages to other options by virtue of greater travel distance.	
Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot south of Drogheda will result in a high complexity of train movements as the depot is not at end of the line and is within the high frequency network. This will result in significant disadvantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential site is south of Drogheda town centre and immediately west of Bettystown/Laytown in an agricultural setting. There are 100 year pluvial flood zones adjacent to the railway corridor on the site south of Drogheda. There are no recorded National Monuments or buildings of national importance on any of the potential sites. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. By virtue of the sites proximity to existing Bettystown residential development, this option has some disadvantages to other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicular access to this site will generally be reliant on the M1 motorway. To access the potential sites north of Drogheda, vehicles will leave the M1 at Junction 10 and travel via N51/R132 and then the local Cockle Road towards Termonfeckin. Access to site is not precluded for HGV vehicles, therefore this site has some advantages over other options.	

Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas outside the zoned boundaries of Drogheda	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Northern Line is currently comparatively well served with train services into the city centre, comprising Intercity, Outer Commuter and Inner Commuter (DART) service sharing twin track. At present 11 train services enter the city centre in the morning AM Peak and this is anticipated to grow to 12 services in 2021. The planned service pattern under DART Expansion is 13 train service into the city centre. The 2018 rail census shows train occupancy levels of 87% for inbound trains in the morning Am peak hour, with the vast majority of passenger boarding inbound from Drogheda. The land-use along the eastern rail corridor is well established. The extension of electrification from Malahide to Drogheda will not result in a significant increase in train path capacity. However additional passenger capacity will be provided by increase train lengths. If DART Expansion progressed with the maintenance depot at Drogheda: 1. The passenger demand for services is anticipated to grow annually in a gradual increasing manner as no significant major land holdings remain undeveloped; 2. Extension of electrification will bring no significant increase in train path capacity. However additional	

	passenger capacity will be provided by increase train lengths; 3. The 38km Northern Line electrification is the most expensive electrification section to complete and would only be completed early to provide access to the depot; 4. The Northern line will not be capable of fully absorbing the planned early fleet deliveries and this will require acceleration of the programme for electrification of other radial line and impact the cashflow; 5. Based on the current Working Timetable, electrification of the Northern Line would displace 6 ICR/DMU trains which will be cascaded to other non-electrified lines. This is less than the cascade effect on the Maynooth Line. Therefore, a depot at Drogheda would have significant disadvantages to other options as it would amend the rolling stock delivery schedule and/or adversely impact on the NDP funding profile. Extension of electrification on the Northern Line is not the highest priority for DART Expansion, as the diesel rolling stock, albeit a higher levels of service, will be capable of meeting passenger demand in the short to medium term. If the depot was sited at Drogheda, the extension of northern line electrification would have to be prioritised and this would divert finding from other radial lines where infrastructural improvements would be potentially delayed with resultant impact on capacity increases.	

Drogheda North

The potential sites north of Drogheda are also along the operational twin track railway approximately 53-56km north of Connolly. The DART Expansion Drogheda end node is significantly further that the other network end nodes.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Drogheda environs will result in highest empty running cost and has significant disadvantages to other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Drogheda will result in earliest and latest train movements into/out of depot and will have higher magnitude impacts on possession times. This will have some disadvantages to other options by virtue of greater travel distance.	
Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling.	

	A depot north of Drogheda is at the end of line and will only interface with three trains/hour passenger services. The access/egress from the operational line to the depot is not considered complex. This will result in some advantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential site is north of Drogheda town centre in an agricultural setting. There are a number of watercourses crossing the sites north of Drogheda which are within the 100 year fluvial flood zone. There are also 100 year pluvial flood zones adjacent to the railway corridor on the site. There are no recorded National Monuments or buildings of national importance on any of the potential sites. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. By virtue of the flood risks identified on the site, this option has some disadvantages over other options.	
Vehicle routing for access to site	Vehicles access a Drogheda depot will generally be reliant on the M1 motorway. To access the potential sites north of Drogheda, vehicles will leave the M1 at Junction 7 and travel via R132 and then the local L5615 or L1611 towards potential sites. Access to site is not precluded for HGV vehicles, therefore this site has some advantages over other options.	
Road vehicle routing for access to site (Construction Deliverability)	The potential sites are north and south of Drogheda town centre in agricultural settings. There are 100 year pluvial flood zones adjacent to the railway corridor on the sites south of Drogheda. There are no recorded National Monuments or buildings of national importance on any of the potential sites. Residential development is generally	

	associated with agricultural holdings and has also developed in ribbon fashion along local roads.	
Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas outside the zoned boundaries of Drogheda	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Northern Line is currently comparatively well served with train services into the city centre, comprising Intercity, Outer Commuter and Inner Commuter (DART) service sharing twin track. At present 11 train services enter the city centre in the morning AM Peak and this is anticipated to grow to 12 services in 2021. The planned service pattern under DART Expansion is 13 train service into the city centre. The 2018 rail census shows train occupancy levels of 87% for inbound trains in the morning Am peak hour, with the vast majority of passenger boarding inbound from Drogheda. The land-use along the eastern rail corridor is well established. The extension of electrification from Malahide to Drogheda will not result in a significant increase in train path capacity. However additional passenger capacity will be provided by increase train lengths. If DART Expansion progressed with the maintenance depot at Drogheda:	

	1. The passenger demand for services is anticipated to grow annually in a gradual increasing manner as no significant major land holdings remain undeveloped; 2. Extension of electrification will bring no significant increase in train path capacity. However additional passenger capacity will be provided by increase train lengths; 3. The 38km Northern Line electrification is the most expensive electrification section to complete and would only be completed early to provide access to the depot; 4. The Northern line will not be capable of fully absorbing the planned early fleet deliveries and this will require acceleration of the programme for electrification of other radial line and impact the cashflow; 5. Based on the current Working Timetable, electrification of the Northern Line would displace 6 ICR/DMU trains which will be cascaded to other non-electrified lines. This is less than the cascade effect on the Maynooth Line. Therefore, a depot at Drogheda would have significant disadvantages to other options as it would amend the rolling stock delivery schedule and/or adversely impact on the NDP funding profile. Extension of electrification on the Northern Line is not the highest priority for DART Expansion, as the diesel rolling stock, albeit a higher levels of service, will be capable of meeting passenger demand in the short to medium term. If the depot was sited at Drogheda, the extension of northern line electrification would have to be prioritised and this would divert finding from other radial lines where infrastructural improvements would be potentially delayed with resultant impact on capacity increases.	

9.3 Maynooth Environs

The potential for siting a single, centre of excellence maintenance depot in the Maynooth environs is assessed. It has previously been determined that there is no potential for siting the depot at Maynooth Station. Therefore, a new depot is considered in the context that it will be located either east or west of Maynooth town centre.

Maynooth East

The potential sites east of Maynooth are along the operational twin track railway approximately 20-23km west of Connolly.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Maynooth environs has some advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Maynooth will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	
Complexity of access and egress to / from	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the	

depot (Public Service Obligation / Train Planning Logistics)	depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot east of Maynooth will result in a high complexity of train movements as the depot is not at end of the line and is within the high frequency network. This will result in significant disadvantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	There are no significant watercourses crossing the potential sites east of Maynooth. There are some 100 year pluvial flood zones adjacent to the railway corridor. Donaghmore Church and graveyard (National Monuments) are situated close to the railway corridor and would be potentially impacted by depot development. The Rye Water Valley/Carton Special Area of Conservation borders the potential depot site to the north of the railway corridor. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. The Intel complex and St Catherine's Park are situated east of the potential depot sites. By virtue of the ecological and heritage issues, this option has some disadvantages over other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicles access to a Maynooth East depot will generally be reliant on the M4 motorway. Vehicle will leave the M4 at Junction 6 and travel on the R449 and R148 to access the potential sites. Improved localised assess from the R148 to the potential depot site will need to be provided to facilitate HGV vehicle access. Therefore, this site has some disadvantages in comparison to other options.	

Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas outside the zoned boundaries of Maynooth.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Maynooth /M3 Line is currently comparatively poorly served with train services into the city centre, comprising Intercity and Commuter diesel service sharing twin track. At present 6 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 15 train service into the city centre. The 2018 rail census shows train occupancy levels of 92% for inbound trains in the morning AM peak hour, with the vast majority of passenger boarding inbound from Maynooth. The land-use along Maynooth /M3 rail corridor is moderately well established, with some significant major land holding still not yet developed. If DART Expansion progressed with the maintenance depot at Maynooth or M3 Parkway: 1. The passenger demand for services will grow annually in a significant increasing manner as a latent population demand exists for train services that cannot be accommodated at present due to rail infrastructure constraints. Developing remaining land holdings will add population demand for increased services; 2. Extension of electrification, together with city centre enhancement works and removal of level crossing conflicts will bring a very significant increase in train path capacity;	

	3. The 32km Maynooth Line upgrade is more expensive electrification than the Northern Line upgrade, but the service benefits of Maynooth line upgrade is significantly higher; 4. The Maynooth Line will be capable of fully absorbing the planned early fleet deliveries and this will not affect the overall programme for electrification of other radial lines, nor impact the cashflow; 5. Based on the current Working Timetable, electrification of the Maynooth Line would displace 9 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the highest cascade effect which will provide increase passenger capacity benefits to the other lines. Therefore, a depot at Maynooth / M3 Parkway would have significant advantages to other options as it would locate the depot on the line with a high service capacity increase. Therefore, the DART Expansion delivery programme would be optimised and passenger benefits would accrue in tandem.	

Maynooth West

The potential sites west of Maynooth are along the operational single track railway approximately 25-28km west of Connolly. A depot at this location will require the construction of up to 3-4km of new track to provide twin track directly to the potential depot site.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Maynooth environs has some advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Maynooth will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance. A depot at Maynooth will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	
Complexity of access and egress to / from depot (Public Service	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services	

Obligation / Train Planning Logistics)	operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot west of Maynooth is at the end of line and will only interface with one train/hour passenger service. The access/egress from the operational line to the depot is not considered complex. This will result in significant advantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential site west of Maynooth is set to agricultural use. There are no significant watercourses crossing the potential sites. There are pockets of 100 year pluvial flood zones adjacent to the railway corridor on the sites adjacent to the railway. There is a single National Monuments record within the potential sites (Barrow). There are no buildings of national importance on any of the potential sites. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. The environmental issues identified are not considered significant to preclude development of the site. Therefore, this option has some advantages over other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicles access to a Maynooth West depot will generally be reliant on the M4 motorway. Vehicle will leave the M4 at Junction 7 and travel on R406 through Maynooth and on to R148 and L5041 to access the potential sites. Alternatively the potential sites could be accessed by leaving the M4 at Junction 8 and travelling via R148 through Kilcock and then the L5041. Access to site is not precluded for HGV vehicles, therefore this site has some advantages over other options.	

Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas outside the zoned boundaries of Maynooth and Kilcock.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Maynooth /M3 Line is currently comparatively poorly served with train services into the city centre, comprising Intercity and Commuter diesel service sharing twin track. At present 6 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 15 train service into the city centre. The 2018 rail census shows train occupancy levels of 92% for inbound trains in the morning AM peak hour, with the vast majority of passenger boarding inbound from Maynooth. The land-use along Maynooth /M3 rail corridor is moderately well established, with some significant major land holding still not yet developed. If DART Expansion progressed with the maintenance depot at Maynooth or M3 Parkway: 1. The passenger demand for services will grow annually in a significant increasing manner as a latent population demand exists for train services that cannot be accommodated at present due to rail infrastructure constraints. Developing remaining land holdings will add population demand for increased services; 2. Extension of electrification, together with city centre enhancement works and removal of level crossing conflicts will bring a very significant increase in train path capacity;	

	3. The 32km Maynooth Line upgrade is more expensive electrification than the Northern Line upgrade, but the service benefits of Maynooth line upgrade is significantly higher; 4. The Maynooth Line will be capable of fully absorbing the planned early fleet deliveries and this will not affect the overall programme for electrification of other radial lines, nor impact the cashflow; 5. Based on the current Working Timetable, electrification of the Maynooth Line would displace 9 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the highest cascade effect which will provide increase passenger capacity benefits to the other lines. Therefore, a depot at Maynooth / M3 Parkway would have significant advantages to other options as it would locate the depot on the line with a high service capacity increase. Therefore, the DART Expansion delivery programme would be optimised and passenger benefits would accrue in tandem.	

9.4 M3 Parkway Environs

The potential for siting a single, centre of excellence maintenance depot in the M3 Parkway environs is assessed. It has previously been determined that there is no potential for siting the depot at M3 Parkway Station. Therefore, a new depot is considered in the context that it will be located either north or south of the Station.

M3 Parkway South

The potential sites is south of M3 Parkway between Dunboyne Station and M3 Parkway Station along the operational twin track railway approximately 17-19km west of Connolly.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the M3 Parkway environs has significant advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at M3 Parkway will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	

Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot south of M3 Parkway will result in a high complexity of train movements as the depot is not at end of the line. The potential depot is on a spur to the Maynooth Line and joins at an at-grade junction at Clonsilla. This will result in significant disadvantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The site would have to be outside the lands zone at M3 Parkway for a major town centre. This poses some disadvantages in comparison to other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential sites south of M3 Parkway is set to agricultural use. There are no significant watercourses crossing the potential sites. A significant portion of the site is within the 100 year fluvial flood zones of the River Tolka adjacent to the railway corridor on the sites adjacent to the railway. There are no National Monuments record within the potential sites. There are no buildings of national importance on any of the potential sites. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. By virtue of the regularity of flooding on the River Tolka this option has significant disadvantages to other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicles access to an M3 Parkway depot (south) will generally be reliant on the M3 motorway. Vehicle will leave the M3 at Junction 5 and travel on R157 and then L2228 and old Navan Road through Dunboyne, through built up residential area. Therefore, this site has some disadvantages in comparison to other options.	

Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas but bordered by zoned lands north and south.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Maynooth /M3 Line is currently comparatively poorly served with train services into the city centre, comprising Intercity and Commuter diesel service sharing twin track. At present 6 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 15 train service into the city centre. The 2018 rail census shows train occupancy levels of 92% for inbound trains in the morning AM peak hour, with the vast majority of passenger boarding inbound from Maynooth. The land-use along Maynooth /M3 rail corridor is moderately well established, with some significant major land holding still not yet developed. If DART Expansion progressed with the maintenance depot at Maynooth or M3 Parkway: 1. The passenger demand for services will grow annually in a significant increasing manner as a latent population demand exists for train services that cannot be accommodated at present due to rail infrastructure constraints. Developing remaining land holdings will add population demand for increased services; 2. Extension of electrification, together with city centre enhancement works and removal of level crossing conflicts will bring a very significant increase in train path capacity;	

	3. The 32km Maynooth Line upgrade is more expensive electrification than the Northern Line upgrade, but the service benefits of Maynooth line upgrade is significantly higher; 4. The Maynooth Line will be capable of fully absorbing the planned early fleet deliveries and this will not affect the overall programme for electrification of other radial lines, nor impact the cashflow; 5. Based on the current Working Timetable, electrification of the Maynooth Line would displace 9 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the highest cascade effect which will provide increase passenger capacity benefits to the other lines. Therefore, a depot at Maynooth / M3 Parkway would have significant advantages to other options as it would locate the depot on the line with a high service capacity increase. Therefore, the DART Expansion delivery programme would be optimised and passenger benefits would accrue in tandem.	

M3

Parkway North

The potential sites is north of M3 Parkway, on lands north of M3 Parkway that are currently not along operational railway. M3 Parkway Station is approximately 17-19km west of Connolly. Development will require the construction of approximately 4-5km of twin track railway.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the M3 Parkway environs has significant advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at M3 Parkway will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	
Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot north of M3 Parkway will result in a high complexity of train movements, albeit the depot is at end of the line.	

	The potential depot is on a spur to the Maynooth Line and joins at an at-grade junction at Clonsilla. This will result in significant disadvantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway and outside the lands zone at M3 Parkway for a major town centre. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential sites north of M3 Parkway is set to agricultural use but with significant ribbon residential development along the L2225. Some of the potential depot lands are situated within the 100 year fluvial flood zones of the River Tolka, There are no National Monuments record within the potential sites. There are no buildings of national importance on any of the potential sites. Residential development is generally associated with agricultural holdings and has also developed in ribbon fashion along local roads. By virtue of the position of the site in close proximity to the River Tolka, the site has some disadvantages to other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicles access to an M3 Parkway depot (north) will generally be reliant on the M3 motorway. Vehicle will leave the M3 at Junction 5 and travel northbound on R147 and then via R154 and L2225. Access to site is not precluded for HGV vehicles, therefore this site has some advantages over other options.	
Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas but bordered by zoned lands to the south.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs;	

with Policy / Compliance with Funding)	• Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Maynooth /M3 Line is currently comparatively poorly served with train services into the city centre, comprising Intercity and Commuter diesel service sharing twin track. At present 6 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 15 train service into the city centre. The 2018 rail census shows train occupancy levels of 92% for inbound trains in the morning AM peak hour, with the vast majority of passenger boarding inbound from Maynooth. The land-use along Maynooth /M3 rail corridor is moderately well established, with some significant major land holding still not yet developed. If DART Expansion progressed with the maintenance depot at Maynooth or M3 Parkway: 1. The passenger demand for services will grow annually in a significant increasing manner as a latent population demand exists for train services that cannot be accommodated at present due to rail infrastructure constraints. Developing remaining land holdings will add population demand for increased services; 2. Extension of electrification, together with city centre enhancement works and removal of level crossing conflicts will bring a very significant increase in train path capacity; 3. The 32km Maynooth Line upgrade is more expensive electrification than the Northern Line upgrade, but the service benefits of Maynooth line upgrade is significantly higher; 4. The Maynooth Line will be capable of fully absorbing the planned early fleet deliveries and this will not affect the overall programme for electrification of other radial lines, nor impact the cashflow; 5. Based on the current Working Timetable, electrification of the Maynooth Line would displace 9 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the highest cascade effect which will provide increase passenger capacity benefits to the other lines. Therefore, a depot at Maynooth / M3 Parkway would have significant advantages to other options as it would locate the	

	depot on the line with a high service capacity increase. Therefore, the DART Expansion delivery programme would be optimised and passenger benefits would accrue in tandem.	

9.5 Hazelhatch Environs

The potential for siting a single, centre of excellence maintenance depot in the Hazelhatch environs is assessed. It has previously been determined that there is no potential for siting the depot at Hazelhatch Station. Therefore, a new depot is considered in the context that it will be located either east or west of the Station.

Hazelhatch East

The potential sites are east of Hazelhatch Station, along the 4 track section, approximately 14-16km west of Heuston Station. The short to medium term configuration will operate DART trains on the northernmost tracks. Therefore, the maintenance depot would have to be on the northside of the railway corridor to prevent capacity restrictions. In the longer term with DART Underground in-situ, DART train will operate on the southernmost tracks. At this stage, the maintenance depot will result in network capacity restrictions.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Hazelhatch environs has significant advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night	

	time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Hazelhatch will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance. A depot at M3 Parkway will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	
Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot east of Hazelhatch on a 4 track section does not introduce a high level of complexity, because Intercity/Outer Commuter services are separated from Inner Commuter services. This will result in some advantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The potential site is immediately adjacent to the Adamstown SDZ boundary. This poses some disadvantages in comparison to other options.	
Consideration of neighbouring environment (Construction Deliverability)	The potential site east of Hazelhatch is set to agricultural use, with some residential landholdings. The site is generally free of fluvial or pluvial flood risks. There are no National Monuments record within the potential sites. There are no buildings of national importance on any of the potential sites. The eastern boundary of the potential site abuts the Adamstown SDZ lands. Given the location of the potential site adjacent to Adamstown SDZ, this site has some disadvantages to other options.	
Road vehicle routing for access to site	Vehicles access to Hazelhatch East depot will generally be reliant on the M4 motorway. Vehicle will leave the M4 at	

(Construction Deliverability	Junction 5 and travel southbound on R403 and then via Stackumny Lane to access the potential site. Access to site is not precluded for HGV vehicles, therefore this site has some advantages over other options.	
Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas but bordered by zoned lands to the east. The site straddles Kildare Co and South Dublin Co functional area.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Kildare Line is currently comparatively well served with train services into the city centre, comprising Intercity, Outer Commuter and Inner Commuter diesel service sharing a section of 4 track from Hazelhatch to Park West, with the remainder reducing to twin track. At present 12 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 26 train service into the city centre (12 Intercity/Outer Commuter and 14 DART services). The 2018 rail census shows train occupancy levels of 65% for inbound trains in the morning AM peak hour, with relatively low passenger boarding inbound from Hazelhatch (albeit Hazelhatch to GCD is only newly added to the Working Timetable). The land-use along the Hazelhatch-Heuston rail corridor is not well established, with significant remaining undeveloped land. Development at Adamstown and Clonburris has progressed at a slower pace than originally anticipated.	

	If DART Expansion progressed with the maintenance depot at Hazelhatch: 1. The passenger demand for services could grow annually in a significant increasing manner only if development rate accelerates. The potential level of train service if Kildare Line Upgrade was developed early may be excessive until the lands are fully completed; 2. Extension of electrification, together with completion of 4 tracking from Park West to Heuston and the city centre enhancements will bring a very significant increase in train path capacity; 3. The 20km Kildare Line electrification is the most expensive radial line for early delivery but the service benefits are also high. However, the passenger demand for services may not materialise in the short term if land development is not completed; 4. The Kildare Line will be capable of fully absorbing the planned early fleet deliveries. Early progression of the Kildare Line will impact the cashflow; 5. Based on the current Working Timetable, electrification of the Kildare Line would displace 4 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the lowest cascade effect which will provide the lowest passenger capacity benefits to the other lines. Therefore, a depot at Hazelhatch would have some disadvantages to other options as it would negatively impact on the cashflow and the service levels delivered may not be utilised if future land development is delayed.	

Hazelhatch West

The potential sites are west of Hazelhatch Station, on a twin track section, approximately 16-18km west of Heuston Station. A depot west of Hazelhatch will require the extension of the 4 tracking to the point of entry to the depot, so that the capacity of the Mainline is not compromised. The short to medium term configuration will operate DART trains on the northernmost tracks. Therefore, the maintenance depot would have to be on the northside of the railway corridor to prevent capacity restrictions. In the longer term with DART Underground in-situ, DART train will operate on the southernmost tracks. At this stage, the maintenance depot will result in network capacity restrictions.

Criteria	Discussion	Assessment Conclusion
Minimised empty running for daily service commencement / ending service (Cost Implication)	With a single centre of excellence maintenance depot, a number of trains at commencement and termination of daily passenger timetable will run empty between city centre and depot. By virtue of the distance, a depot in the Hazelhatch environs has significant advantages over other options.	
Maximise track access time for maintenance (Rail Safety / Public Service Obligation)	Maximising the time available for infrastructural maintenance is fundamental to the ongoing operation of the railway. A city centre depot would result in maximising possession times. Greater distances from city centre will result in shorter possession times being granted. Possessions need to be sufficient to allow a reasonable time to complete and handback required works. If possessions are too short it will extend non-disruptive possession time (i.e. normal night time work opportunity) into disruptive possessions (i.e. impacting on timetabled passenger services). A depot at Hazelhatch will result in lower magnitude impact on possession times and will have some advantages to other options by virtue of lower travel distance.	

Complexity of access and egress to / from depot (Public Service Obligation / Train Planning Logistics)	Trains entering and exiting the depot need to travel to timetabled service positions. The movement into/out of the depot will potentially impact with other passenger services operating on the line. The complexity in getting into position is a negative factor to logistics and rolling stock marshalling. A depot west of Hazelhatch is at the end of line and will only interface with one train/hour passenger service. The access/egress from the operational line to the depot is not considered complex. This will result in significant advantages in comparison to other options.	
Availability of suitable lands (Construction Deliverability)	At preliminary desk based appraisal there appears to be agricultural lands adjacent to the operational railway that may be suitable for depot development. The location in a broadly agricultural setting offers some advantages over other options.	
Consideration of neighbouring environment (Construction Deliverability)	Residential density in the environs of Hazelhatch Station is quite low. Agricultural land use predominates to the west of the station. The lands are not within any fluvial flood risk areas. There are small localised pockets of pluvial flood risk across the sites. There are no National Monuments record within the potential sites. There are no buildings of national importance on any of the potential sites. Given the setting of this potential site, some advantages over other options.	
Road vehicle routing for access to site (Construction Deliverability	Vehicles access to Hazelhatch West depot will generally be reliant on the M4 motorway. Vehicle will leave the M4 at Junction 5 and travel southbound on R403 and then via Loughlinstown Road to access Hazelhatch Station and the potential sites to its west. There is an existing road to the west of Hazelhatch Station (The Lords Road) but this is access to residential dwellings. It is not considered suitable for HGVs access. Therefore a new road would be required from Hazelhatch Station to the proposed depot adjacent to the railway corridor. Therefore, this site has some disadvantages in comparison to other options.	

Compliance with Transportation and Land-Use Development Policy (Compliance with Policy)	The potential sites are in rural areas but bordered by zoned lands to the east. The site is within Kildare Co functional area.	
Short term impact on DART Expansion Programme delivery by 2027 (Compliance with Policy / Compliance with Funding)	The key requirements to enable delivery and deployment of new DART rolling stock are: • Commissioning of Maintenance Depot; • Increase City Centre capacity through enhancement works in the Connolly/Docklands environs; • Completion of the electrification on whichever line the depot is located. Until these works are complete, the train path capacities on all lines converging on City Centre are limited to present day levels. The funding limitations within the NDP program are a factor in this short term impact assessment to make best use of the available funding to provide additional capacity as soon as possible. In planning the DART Expansion delivery programme, IE has focused on providing increased passenger capacity in the short term, within the constraints of the path limits, by re-deploying carriages freed through new fleet deliveries to provide longer trains in areas where electrification is not completed. The Kildare Line is currently comparatively well served with train services into the city centre, comprising Intercity, Outer Commuter and Inner Commuter diesel service sharing a section of 4 track from Hazelhatch to Park West, with the remainder reducing to twin track. At present 12 train services enter the city centre in the morning AM Peak. The planned service pattern under DART Expansion is 26 train service into the city centre (12 Intercity/Outer Commuter and 14 DART services). The 2018 rail census shows train occupancy levels of 65% for inbound trains in the morning AM peak hour, with relatively low passenger boarding inbound from Hazelhatch (albeit Hazelhatch to GCD is only newly added to the Working Timetable). The land-use along the Hazelhatch-Heuston rail corridor is not well established, with significant remaining undeveloped land. Development at Adamstown and Clonburris has progressed at a slower pace than originally anticipated. If DART Expansion progressed with the maintenance depot at Hazelhatch: 1. The passenger demand for services could grow annually in a significant increasing manner only if development rate accelerates. The potential level of train	

	service if Kildare Line Upgrade was developed early may be excessive until the lands are fully completed; 2. Extension of electrification, together with completion of 4 tracking from Park West to Heuston and the city centre enhancements will bring a very significant increase in train path capacity; 3. The 20km Kildare Line electrification is the most expensive radial line for early delivery but the service benefits are also high. However, the passenger demand for services may not materialise in the short term if land development is not completed; 4. The Kildare Line will be capable of fully absorbing the planned early fleet deliveries. Early progression of the Kildare Line will impact the cashflow; 5. Based on the current Working Timetable, electrification of the Kildare Line would displace 4 ICR/DMU trains which will be cascaded to other non-electrified lines. This is the lowest cascade effect which will provide the lowest passenger capacity benefits to the other lines. Therefore, a depot at Hazelhatch would have some disadvantages to other options as it would negatively impact on the cashflow and the service levels delivered may not be utilised if future land development is delayed.	

APPENDIX

E

DART+ PBC Programme Risks

Project	Risk	Description	Consequences	Impacts	Likelihood	Mitigations
DART+ Fleet	Greater Demand on the Power Supply	Power demand per unit, increased service frequency and any need for battery charging from overhead line will place an increased demand on the power supply IE advises that no assessment or upgrade of the existing OHL and power supply is in the agreed business case.	• Power supply not adequate for new fleet • delays to the roll-out of new fleet	Very High	Medium	• A study to determine what the power requirements will be carried out
DART+ Programme	Budget Shortfall	Budget shortfall where there is a difference between funding and cost estimates, where NTA cash flow profile does not match the Programmes cash flow requirements and the impact of macro-economic conditions or changes in policy in the availability of funding	• Shortfall of Budget Allocation	Very High	High	• Early engagement with the funding authority. • Accurate cashflow forecasting • Incorporate contract mitigation measures e.g. termination clauses, options to reduce scope
DART+ Fleet	Procurement Delay	Rolling stock procurement delay or cost variability.	• Additional procurement costs and Programme delay	High	High	• Monitor contingency and risk allowance carefully. • Avoid scope creep.
DART+ Programme	Programme Implementation Delays	Infrastructure programme delays due to issues identified through detailed design, planning delays and third-party delays.	• Additional Scope requirements • RO and Planning conditions causing design and Strategy amendments	High	Medium	• Ensure design development aligns with the PC2 recommendations • Ensure Design deliverables are in accordance with current Planning and RO Policy's. • Ensure that potential scope additions are identified within the Project Risk registers to capture more Project Specific requirements. • Early engagement with Planning and RO Stakeholders to identify potential challenges
DART+ Programme and Fleet	Scope Change/Creep	Risk of scope change concerning station upgrades, fleet requirements, train service specification and network upgrades.	• Additional Budget/Funding Requirements • Programme Delays • Additional Stakeholder engagement	High	High	• Capture potential scope changes early in the process through a robust RISK Management process. Identify potential Scope GAPS as the Design Development Progresses.

Project	Risk	Description	Consequences	Impacts	Likelihood	Mitigations
DART+ Fleet	Fleet Strategy	Risk to fleet strategy should approval of electrification/infrastructure projects be delayed.	• Delay in the delivery of the new Fleet • Additional cost for delaying delivery of new Fleet	Medium	Medium	• Align new fleet strategy with the DART+ Programme. • Ensure constant interface and integration between the DART+ Projects. • Set realistic targets and Implementation dates for the D&B contracts and ensure prioritisation of the DEPOT is Paramount to allow for the construction of the DEPOT Test Track.
DART+ Programme	Cost Estimates	Uncertainty of cost estimates	• Cost estimate increase as the design develops • Inflation higher than expected			• Cost estimate continually reviewed but as a minimum at each phase gate. • Monitor inflationary impacts
DART+ Programme	Power Requirements	Existing overhead line equipment capacity and issues regarding energy requirements	• Additional cost to renew existing OHLE • Additional Sub Station requirements leading to addition costs and Programme Delay • Additional Design requirements	Medium	Medium	• Ensure completion of a robust Power study • Asset condition and existing capacity of the operational equipment • Understand and define Future Proof requirements
DART+ Programme	TPS/NTCC Interfaces	Timely introduction of new technologies such as the new train protection system (TPS) and the National Train Control Centre (NTCC) and the impact of delays.	• Delay in the implementation and commissioning of	high	high	• Close Interface with the NTCC and TPS Projects • Align the delivery Schedules to ensure implementation dates are compatible • Create a contingency plan • Initiate the use of a live interface Register between the critical Projects
DART+ Programme	Systems Integration	Timely system and programme integration	• Delay in the implementation and commissioning of • Scope Gap between Programmes	high	High	• Align the delivery Schedules to ensure implementation dates are compatible • Create a contingency plan • Initiate the use of a live interface Register between the critical Projects • Initial workshops to define scope of each Project

Project	Risk	Description	Consequences	Impacts	Likelihood	Mitigations
DART+ Programme	Stakeholder Interface	Timely approving of the scheme by various stakeholders involved in DART+. Conflicts could produce delays at various stages of the Programme.	• Project Delays • Design Approval Delays • Budget increase	high	High	• Ensure a robust Engagement Plan is established • Engage with key Internal and external stakeholder early in the design Process • Map out the timelines for the stakeholders to fully understand the Lifecycle and objectives of the individual Projects and Programme and a whole.

APPENDIX

F

Programmatic Scheme Benefits

It is considered by Iarnród Éireann that only the full DART+ Programme meets the Objectives set out in Chapter 4 of the Preliminary Business Case. The ability to fully realise the scheme benefits for DART+ is significantly curtailed without the implementation of the interventions envisaged in each of the Projects which make up the DART+ Programme; DART+ Fleet, DART+ West, DART+ South West, and DART+ Coastal (North and South). The Projects are at different stages of the Public Spending Code Lifecycle and Decision Gate Process with elements within each Project being assessed as they progress through the various stages. The infrastructure projects and their interrelationship within the Dublin rail network can be seen in Figure F1.

Figure F1: The DART+ Programme Infrastructure Projects

Limitations on a 'Basic' Do-Something Package

In terms of assessing an incremental or 'Basic' Do-Something option to achieve the scheme objectives of the DART+ Programme, Iarnród Éireann believe that such an option will not achieve the primary objective of the scheme and the same level of benefits due to the interdependent nature of the DART+ Projects. This note aims to demonstrate what the delivery and removal of individual Projects within DART+

triggers in terms of cause and effect. Table F1 below highlights the key interrelated elements of the DART+ Programme at a Project level.

Table F1: DART+ Programme - Key Interrelated Project Elements

Programme	Key Interrelated Project Elements
DART+ Fleet	• New Fleet delivery
DART+ West	• City Centre Enhancements (incl. Connolly and Docklands/Spencer Dock Environs) • Maynooth Line / M3 Parkway signalling and infrastructure upgrades (Electrification and re-signalling etc., level crossing closures) • New Depot (providing maintenance for all the new DART+ fleet and additional stabling)
DART+ South West	• 4-Tracking Park West to Heuston Station • Additional stabling
DART+ Coastal North	• Electrification and re-signalling, • New enhanced turnback infrastructure at Clongriffin, Malahide, and Drogheda. • Reconfiguration of Howth Jct. to enable shuttle working on the Howth branch. • Additional stabling.
DART+ Coastal South	• Closure of level crossings, • Re-signalling, new enhanced turnback infrastructure at Bray, • Enhanced capacity between Bray and Greystones • Additional stabling.

Project Scenarios

The scenarios presented below in Table F2 describes the impacts of implementing individual Projects of the DART+ Programme and presents, at a high-level, the limitations on infrastructure and fleet in each option. Also presented is a separate scenario on the City Centre enhancement works, which sits within the DART+ West Project.

Table F2: DART+ Programme – Project Scenarios

Scenario	Implications/Limitations
1. City Centre Enhancements Only	Implementing the Dublin City Centre enhancements of the DART+ West Project only does not create any significant additional benefits due to the isolated additional capacity created within the Connolly and Spencer Dock areas only. Benefits in

Scenario	Implications/Limitations
	terms of City Centre operational capacity and reliability improvements of the infrastructure would be expected from the implementation of this element only. The benefits however are significantly curtailed for passengers, as there would be no additional train paths created to feed that enhanced City Centre capacity without the completion of the DART+ infrastructure Projects on each of the surrounding rail corridors emanating from the City Centre. Therefore, completing these City Centre works without interventions along the surrounding rail corridors does not create as a good a return on investment for the Government or the taxpayer. Infrastructure and fleet enhancements as part of the DART+ Programme need to be brought forward to ensure the scheme objectives can be delivered. Some limited additional train paths exist at peak times, however there is no additional fleet available to facilitate any such modest increase that the current infrastructure permits. Beyond the first DART+ Fleet Project order (6 x HLU EMU + 13 HLU BEMU), no additional fleet can be purchased without the building of a new depot, which is to be completed under DART+ West.
2. DART+ Fleet only delivered	If the DART+ Fleet project is delivered in isolation without any of the DART+ infrastructure projects, then only the first fleet order (6 x Half-Length Unit (HLU) Electric Multiple Units (EMU) + 13 HLU Battery Electric Multiple Units (BEMU)) can be operated largely within the capacity constraints on the existing network, with some minor infrastructure works needed (see second paragraph). This first order represents only 29% of the total fleet requirements in the DART+ Programme Preliminary Business Case. The subsequent orders are reliant on two elements; the construction of the new DART depot, located west of Maynooth under the DART+ West Project; and the delivery of the DART+ infrastructure projects. The scope for the depot, including the stabling capacity, is itself is linked to the scope of the entire DART+ Programme being delivered. In terms of the first fleet order, some upgrade works are needed at Drogheda Depot to accommodate the BEMUs, as well as the installation of charging points within the station environs at Drogheda station. The BEMU fleet will require some additional works to be done to one of the existing Iarnród Éireann depots for their heavy maintenance overhauls and major exams as that capacity/capability for the new BEMU fleet is not at Drogheda Depot, which is a DMU depot. This risk is to be mitigated by the

Scenario	Implications/Limitations
	new DART EMU/BEMU depot being built under the DART+ West Project. See Figure 1 in Section 5.
3. DART+ West only delivered (*note includes the City Centre Enhancements (Scenario 1)*)	If the DART+ West Project is implemented only, then the TSS envisaged for Maynooth/M3 Parkway services can be largely implemented, with only some limitations. Services intended to operate southbound from Maynooth to Bray, will need to terminate at Connolly and Grand Canal Dock due to limited capacity south of Grand Canal Dock without the infrastructure enhancements under DART+ Coastal South being implemented. As the new depot and City Centre enhancements form part of DART+ West, it can provide more benefits that the other projects alone, but its scope and scale is prevalent on the enhancements to other rail corridors in terms of the City Centre works and the construction of the new depot and stabling facilities. In this scenario, additional fleet is limited to the first order of 13 HLU BEMUs on the Northern Line and the 6 HLU EMUs on the existing DART route (Malahide/Howth to Bray/Greystones), along with new EMUs to operate DART+ West services. No other additional fleet can be ordered due to a lack of additional Overhead Line Equipment (OHLE)[53], infrastructure capacity, and stabling capacity. Kildare Line services (to Hazelhatch & Celbridge) will be restricted as no 4-tracking will be completed between Park West and Heuston, limiting the level of suburban services possible through the section due to the conflict with Intercity services for section capacity, combined with a lack of other essential infrastructure enhancements. Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, re-signalling, new enhanced turnback infrastructure etc. South Eastern/Southern Line services will be limited due to the lack infrastructure works required to increase services – electrification, level crossing closures, signalling, new enhanced turnback infrastructure etc. See Figure 2 in Section 5.
4. DART+ South West only delivered	If the DART+ South West Project is implemented only, then the TSS envisaged level of service DART+ South West will be limited as additional paths enabled from the City Centre enhancements and other DART+ West infrastructure works. Electrification of the DART+ South West (Kildare line) route provides a little to no

[53] In terms of DART+ South West and DART+ Coastal North in this scenario

Scenario	Implications/Limitations
	benefit in this scenario as no new EMUs could be ordered to operate the newly electrified route as the depot to accommodate them would not be built as it is part of the DART+ West Project. Therefore, in this scenario additional fleet is limited to the first order of 13 HLU BEMUs on the Northern Line and the 6 HLU EMUs on the existing DART route (Malahide/Howth to Bray/Greystones). All other lines will be not be able to operate with any additional fleet due to a lack of depot, enhanced turnback, and stabling capacity. Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, re-signalling, level crossing closures etc. Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, re-signalling, new enhanced turnback infrastructure etc. South Eastern/Southern Line services will be limited due to the lack infrastructure works required to increase services – level crossing closures, re-signalling, new enhanced turnback infrastructure etc. See Figure 3 in Section 5.
5. DART+ Coastal North only delivered	If the DART+ Coastal North Project is implemented only, then the TSS services envisaged for DART+ Coastal North would be limited by the lack of infrastructure works in the City Centre environs of Connolly[54], the lack infrastructure enhancements required south of Connolly as the DART+ Coastal South infrastructure would not be in place, and, most critically, the significant shortfall in depot and stabling capacity and capability which would be provided under the DART+ West Project. In this scenario, additional fleet is limited to the first order of 13 HLU BEMUs on the Northern Line and the 6 HLU EMUs on the existing DART route (Malahide/Howth to Bray/Greystones). No additional fleet beyond the first order could be ordered due to a lack of depot capacity and capability to handle the new DART+ fleet, and the additional stabling capacity required. Lack of city centre works will affect the capacity of all lines in this scenario. Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, re-signalling, level crossing closures etc. Kildare services will be restricted as no 4-tracking will be completed

[54] Per the baseline train services specification (TSS) for DART+ in the DART+ Programme PBC (see Figure 5.10). Note electrification from East Wall Junction to the new Spencer Dock also unlocks future service pattern possibilities from the Northern Line which would not be possible without delivery of DART+ West.

Scenario	Implications/Limitations
	between Park West and Heuston, limiting the level of suburban services possible through the section due to the conflict with Intercity services for section capacity, combined with a lack of other essential infrastructure enhancements. South Eastern/Southern Line services will be limited due to the lack infrastructure works required to increase services – re-signalling, new enhanced turnback infrastructure etc. and the lack of City Centre works at Connolly. See Figure 4 in Section 5.
6. DART+ Coastal South only delivered	If the DART+ Coastal South Project is implemented only, then the TSS envisaged DART+ Coastal South services to/from the city centre, will be limited due to the lack of infrastructure completed in the Connolly environs and to the north and west due to the infrastructure works to be undertaken under DART+ West and DART+ Coastal North not being completed. Lack of city centre works will again affect the capacity of all lines in this scenario. In this scenario, additional fleet is limited to the first order of 13 HLU BEMUs on the Northern Line and the 6 HLU EMUs on the existing DART route (Malahide/Howth to Bray/Greystones). No additional fleet beyond the first order could be ordered due to a lack of depot capacity and capability to handle the new DART+ fleet, and the additional stabling capacity required. Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, re-signalling, level crossing closures etc. Kildare services will be restricted as no 4-tracking will be completed between Park West and Heuston, limiting the level of suburban services possible through the section due to the conflict with Intercity services for section capacity, combined with a lack of other essential infrastructure enhancements. Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, re-signalling, new enhanced turnback infrastructure etc. See Figure 5 in Section 5.

Conclusion

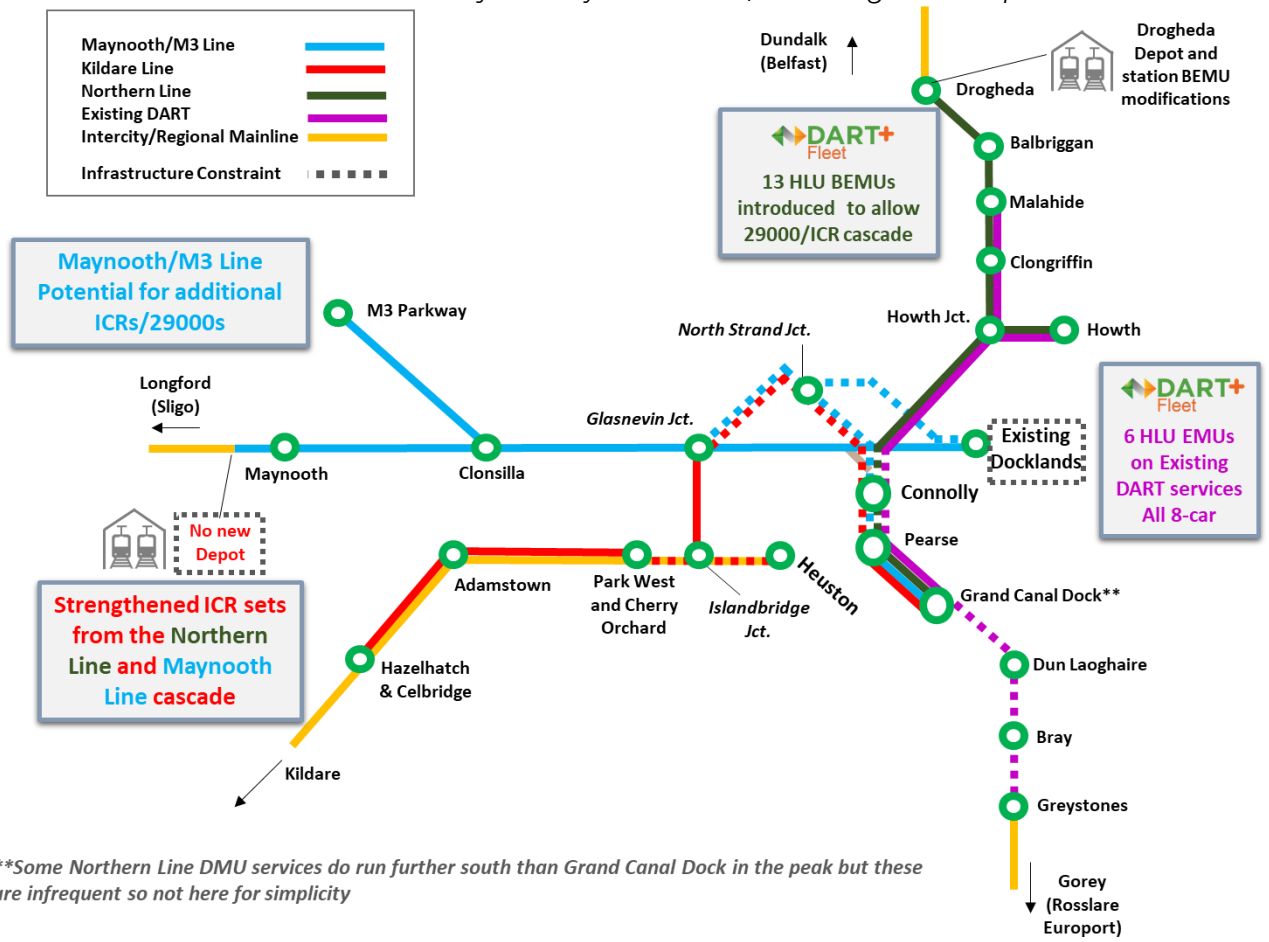
This note aimed to show that the ability to fully realise the scheme benefits for DART+ is significantly curtailed without the implementation of the interventions envisaged in each of the Projects which make up the DART+ Programme; DART+ Fleet, DART+ West, DART+ South West, and DART+ Coastal (North and South). As can be seen from Table F2 above, implementing individual Projects within the DART+ Programme

reduces the overall benefits of the scheme as a whole, with each Project having to be curtailed in its benefits without the full suite of Projects implemented. This shows that the existing the Project packaging strategy is the most appropriate to deliver the scheme objectives and benefits, and that to deliver the Projects as standalone schemes, is not the most appropriate strategy to address the problem DART+ aims to solve and to realise the scheme objectives.

Section 5 provides visuals of the infrastructure constraints at a high-level for scenarios 2 to 6 above, noting that the city centre elements (Scenario 1) are part of the DART+ West Project, and the omission of this element is covered in all scenarios with the exception of DART+ West Project implementation.

Project Scenario Constraints Mapped

Figure F2: First Order of the DART+ Fleet Project only delivered (incl. Drogheda Depot and station works for BEMU operation)[55]



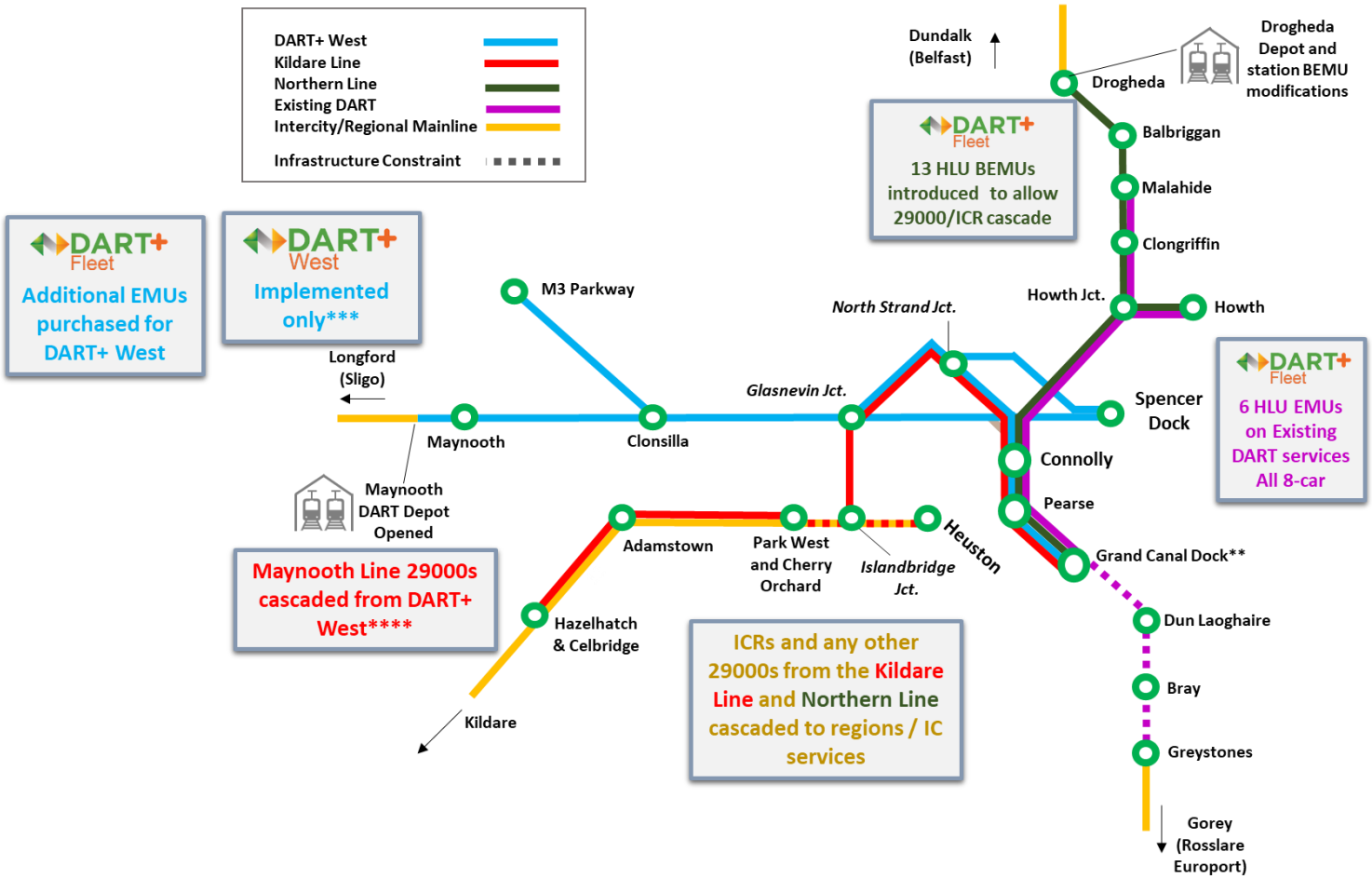
***Some Northern Line DMU services do run further south than Grand Canal Dock in the peak but these are infrequent so not here for simplicity*

Implications:

- **Provides needed additional capacity to the GDA rail system in the short-term prior to the significant infrastructure Projects commencing.**
- Limitation on all lines as no City Centre works are completed
- Limitation on additional fleet due the lack of capacity at existing depots to cope with an increased fleet beyond the size of the first fleet order not possible.
- Lack of depot and stabling for any additional fleet beyond the first order.
- Kildare services will be restricted as no 4-tracking will be completed between Park West and Heuston
- Northern Line services will be limited due to the lack infrastructure works required to increase services – signalling, new enhanced turnback infrastructure etc.
- South East Line services will be limited due to the lack infrastructure works required to increase services – signalling, new enhanced turnback infrastructure etc.
- Scheme benefits are limited to just the additional capacity where new fleet is introduced

[55] *All other scenarios assume these modifications are made at Drogheda to accommodate BEMUs*

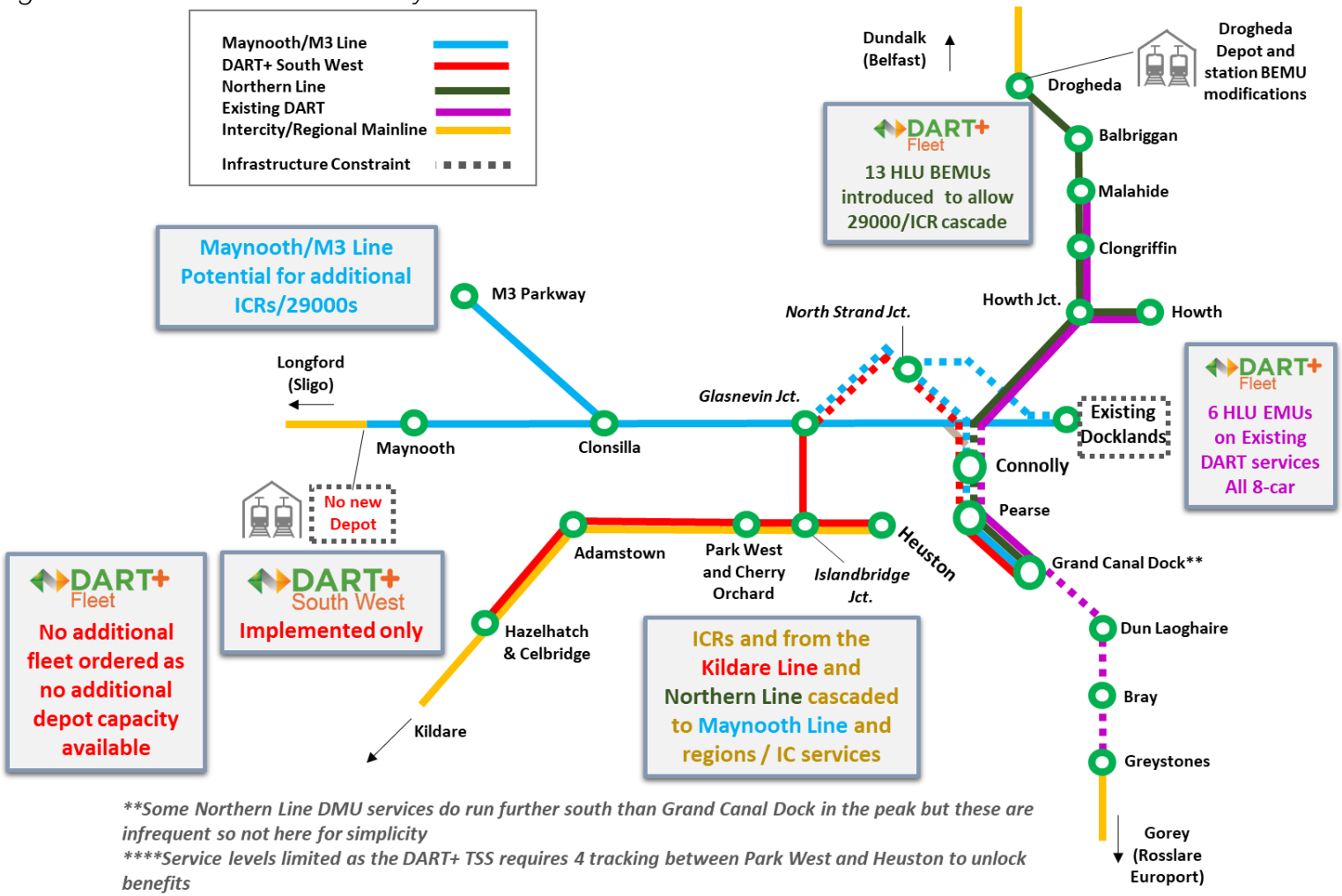
Figure F3: DART+ West only delivered



Implications:

- **DART+ West unlocks operational and depot capacity for it and the other DART+ Projects and is thus the logical first major step to ensuring the programme objectives of the scheme are realised.**
- Limitation on DART+ West services toward Bray due to the infrastructure works to be undertaken under DART+ Coastal South. Trains expected southbound beyond GCD will be required to turnback at Connolly and GCD
- With the exception of the first order on the Northern and existing DART route, along with DART+ West services, all other lines will be not be able to operate with any additional fleet due to a lack of lack of OHLE, infrastructure capacity, depot and stabling capacity.
- Kildare services will be restricted as no 4-tracking will be completed between Park West and Heuston, limiting the level of commuter services possible through the section due to the conflict with Intercity services for section capacity.
- Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, signalling, new enhanced turnback infrastructure etc.
- South East Line services will be limited due to the lack infrastructure works required to increase services – electrification, level crossing closures, signalling, new enhanced turnback infrastructure etc.

Figure F4: DART+ South West only delivered



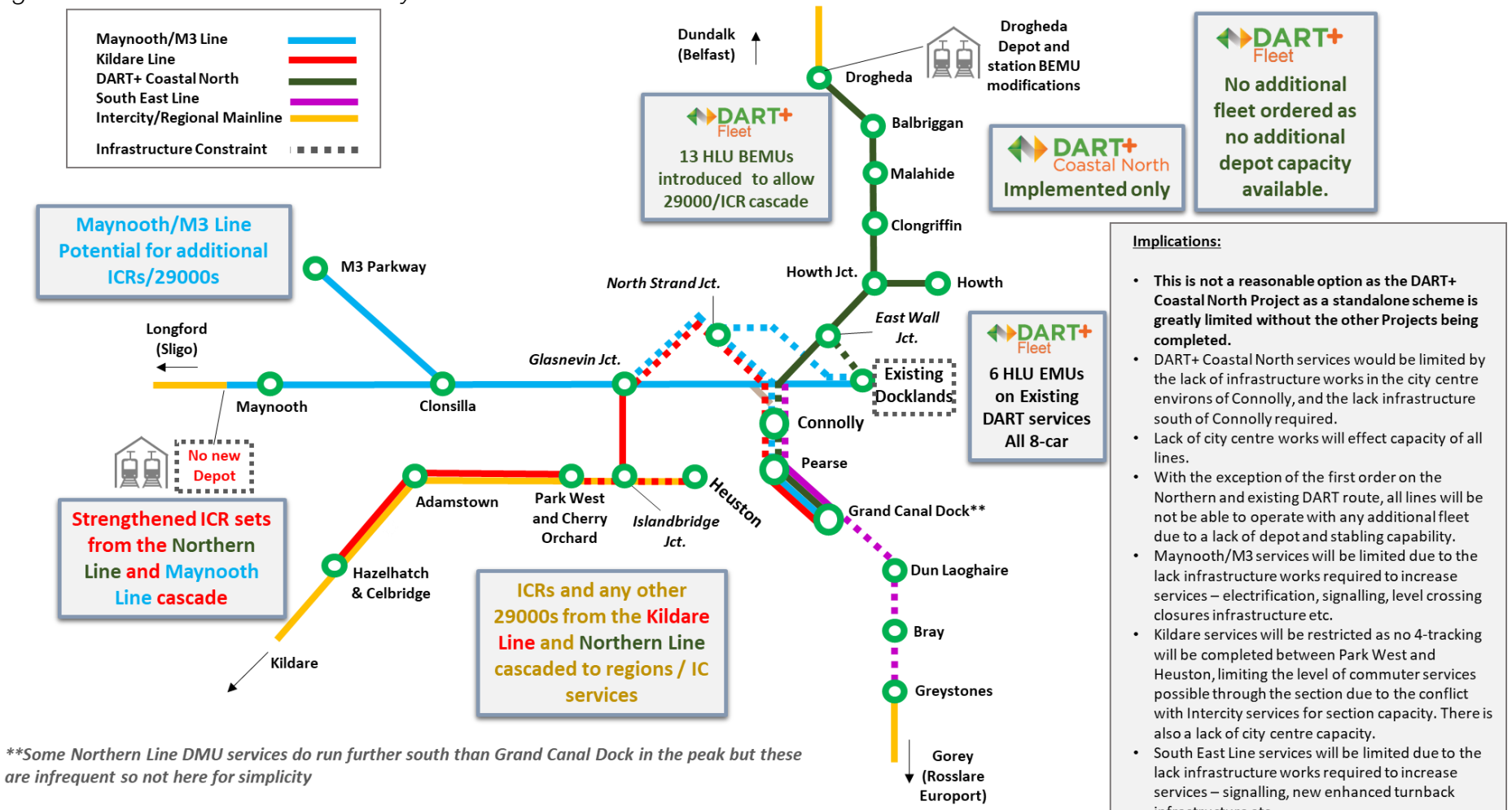
***Some Northern Line DMU services do run further south than Grand Canal Dock in the peak but these are infrequent so not here for simplicity*

*****Service levels limited as the DART+ TSS requires 4 tracking between Park West and Heuston to unlock benefits*

Implications:

- **This is not a reasonable option as the DART+ South West Project as a standalone scheme is greatly limited without the other Projects being completed.**
- DART+ South West services will be limited due to the lack of city centre works in the Connolly/Docklands environs. With the exception of the first order on the Northern and existing DART route, all lines will be not be able to operate with any additional fleet due to a lack of depot and stabling capability.
- Lack of city centre works will effect capacity of all lines.
- Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, signalling, level crossing closures infrastructure etc.
- Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, signalling, new enhanced turnback infrastructure etc.
- South East Line services will be limited due to the lack infrastructure works required to increase services – electrification, level crossing closures, signalling, new enhanced turnback infrastructure etc.

Figure F5: DART+ Coastal North only delivered

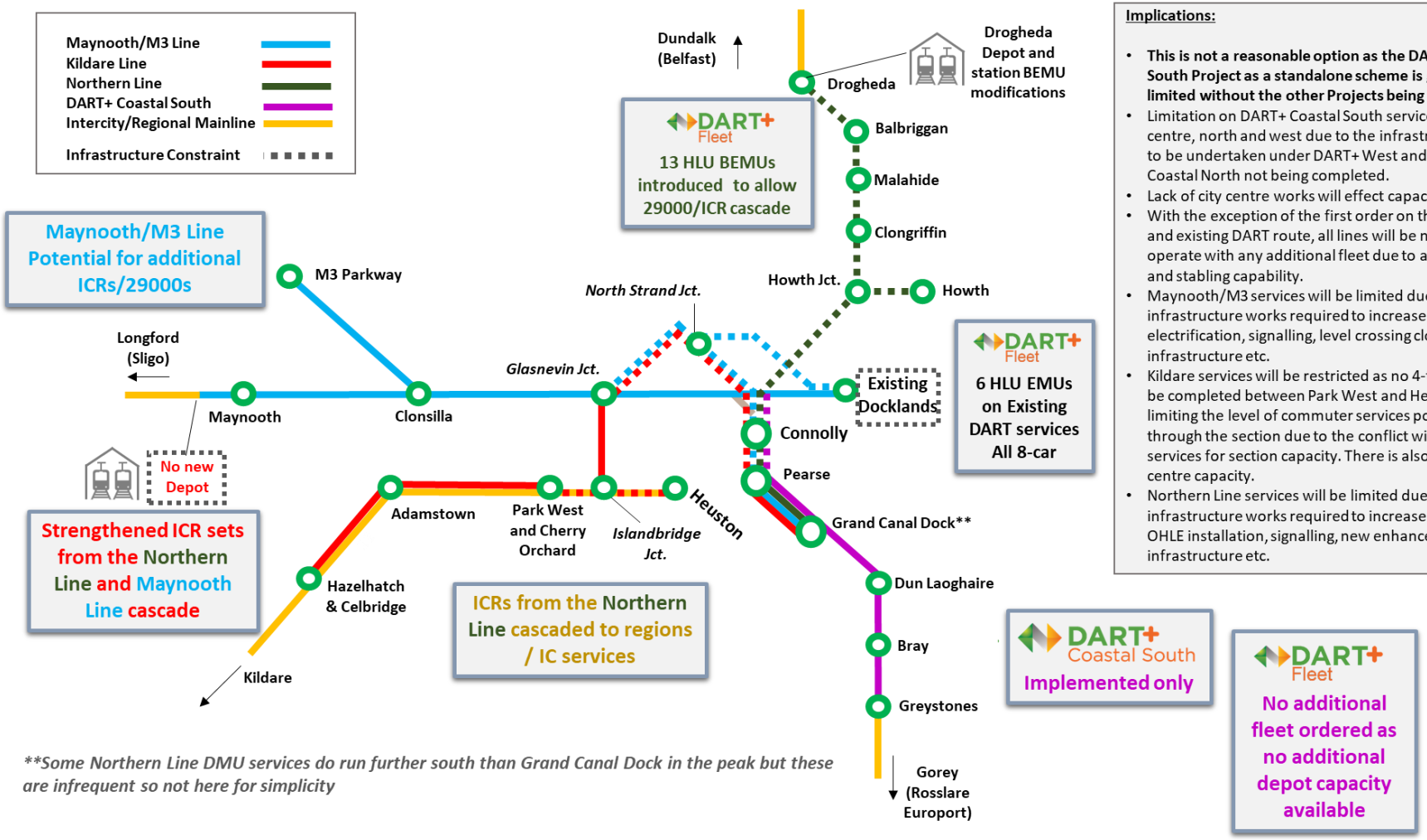


***Some Northern Line DMU services do run further south than Grand Canal Dock in the peak but these are infrequent so not here for simplicity*

Implications:

- **This is not a reasonable option as the DART+ Coastal North Project as a standalone scheme is greatly limited without the other Projects being completed.**
- DART+ Coastal North services would be limited by the lack of infrastructure works in the city centre environs of Connolly, and the lack infrastructure south of Connolly required.
- Lack of city centre works will effect capacity of all lines.
- With the exception of the first order on the Northern and existing DART route, all lines will be not be able to operate with any additional fleet due to a lack of depot and stabling capability.
- Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, signalling, level crossing closures infrastructure etc.
- Kildare services will be restricted as no 4-tracking will be completed between Park West and Heuston, limiting the level of commuter services possible through the section due to the conflict with Intercity services for section capacity. There is also a lack of city centre capacity.
- South East Line services will be limited due to the lack infrastructure works required to increase services – signalling, new enhanced turnback infrastructure etc.

Figure F6: DART+ Coastal South only delivered



***Some Northern Line DMU services do run further south than Grand Canal Dock in the peak but these are infrequent so not here for simplicity*

Implications:

- **This is not a reasonable option as the DART+ Coastal South Project as a standalone scheme is greatly limited without the other Projects being completed.**
- Limitation on DART+ Coastal South services toward city centre, north and west due to the infrastructure works to be undertaken under DART+ West and DART+ Coastal North not being completed.
- Lack of city centre works will effect capacity of all lines.
- With the exception of the first order on the Northern and existing DART route, all lines will be not be able to operate with any additional fleet due to a lack of depot and stabling capability.
- Maynooth/M3 services will be limited due to the lack infrastructure works required to increase services – electrification, signalling, level crossing closures infrastructure etc.
- Kildare services will be restricted as no 4-tracking will be completed between Park West and Heuston, limiting the level of commuter services possible through the section due to the conflict with Intercity services for section capacity. There is also a lack of city centre capacity.
- Northern Line services will be limited due to the lack infrastructure works required to increase services – OHLE installation, signalling, new enhanced turnback infrastructure etc.

Iarnród Éireann
Irish Rail

AECOM

DART+
PROGRAMME

PRELIMINARY BUSINESS CASE

SEPTEMBER 2021

ADDENDUM REPORT

1. Addendum Note

1.1 Introduction

This note sets out an additional economic 'stress test' for the DART+ Programme to understand under what conditions and/or assumptions the project's 'Benefit to Cost Ratio' starts to move towards 1:1. With this in mind a combination of 'downward' assumptions or conditions have been grouped together to represent a 'worst case stress test' scenario. This note should be read in conjunction with the Preliminary Business Case for the DART+ Programme issued in September 2021.

1.2 Economic Appraisal Stress Test

This additional stress test is made up of a combination of the following elements. These have been assessed as a single scenario within the transport modelling and subsequent economic appraisal.

- Dynamic Sensitivity – Metrolink/BusConnects - The NTA Transport Strategy for the Greater Dublin Area 2016 – 2035 is modally balanced and designed to cater to the future needs of the Greater Dublin Area. It integrates short, medium and long-term plans for light and heavy rail, bus, cycling, walking and roads. The Strategy recognises that need for a balanced network across all public transport systems and that the achievement of the Strategy's aims requires all systems in place. In this regard the various public transport systems, i.e. heavy rail, metro, bus and light rail, are complementary to each other and in the long term each is likely to positively impact the other as the shift to public transport accelerates.
- Alternative Plausible Future - An alternative scenario for future travel demand has been developed by the NTA which considers the medium to long-term impacts associated with an accelerated transition to remote working, remote education and associated changes for a proportion of the population. The scenario assumes that the economy rebounds quickly and grows back with economic trends and factors, such as unemployment remaining unchanged. The trip rates assigned with the NTA National Demand Forecasting Model have been adjusted to reflect the impact of greater working from home on different cohorts of the population considering employment type and trip type. Alternative scenario results in a significant reduction in the total number of trips on the transport network, approximately 8% lower than base projections. In the case of DART+ these changes in demand reduces the overall benefits by 16% however DART+ still returns a robust BCR.
- Cost Sensitivity – Upper Scenario - Contingency @ 55% & +1% inflation - Notwithstanding the inclusion of risk and optimism bias in the base case cost scenario an upper bound cost with higher contingency (55%) and inflation has been assessed as part of this stress test to account for uncertainties in cost estimation, given that some elements of the programme are at an early stage in planning and design. For this 'worst case' stress test, which aims to understand under what assumptions and/or conditions the BCR for DART+ would approach 1:1, the upper cost scenario has been assumed.
- Mode Share – Over the past decade investment in transport infrastructure has created an environment which has supported the implementation of transport orientated government policies to encourage a shift to more sustainable modes. These policies have mirrored a global shift in the attitudes to sustainability and a growing awareness of our environmental and climate impacts. Large investment programmes such as DART+ will need to be underpinned by a continuation of strong policy to continue this shift towards sustainable modes into the future. In the period since 2016 usage of public transport has increased by an average of 7% annually in the Dublin region alongside a 4% reduction in car demand across the canal cordon in Dublin on average each year. This is a faster rate of growth than was expected based on previous observed trends prior to 2016[1],

[1] *Canal Cordon Report (2019), p.6: https://www.nationaltransport.ie/wp-content/uploads/2020/12/Canal-Cordon-Report-2019-V3.pdf*

reflecting the way in which mobile technology has made public transport easier to use, also a more positive attitude towards public transport combined with a growing concern for the environment and reluctance towards car ownership and travel in the city.

A conservative approach towards modal shift has been assumed in the modelling process where the presence of Metrolink/ BusConnects in both the DoMin and DoSmth does not lead to a significant change in the modal shift linked to DART+. The potential impact of strong policy support has not been included which would likely lead to an upward change in passenger demand and associated economic benefits.

Overall the 'stress test' scenario results in a significant reduction in the total number of trips on the transport network, approximately 8% lower than base projections. In addition, the demand on DART+ reduces slightly due to some increased competition with other elements of the public transport network which, in this stress test, is not assumed to be offset by a general increase in the usage of public transport. This reduced demand combined with the limited mode shift away from private vehicles, results in less people incurring the benefits of the DART+ Programme in this scenario. To further 'stress test' the project, the upper bound contingency (55%) and higher inflation (+1%) costs were used for the economic appraisal. The results of this test are outlined below.

Table 1.1 –CBA Summary (2011 Values and Prices)

	60 Year PV €m
Present Value Benefits	€3,966
Present Value Costs	€3,129
NPV	€837
BCR	1.3

Even with all these onerous assumptions in place the DART+ Programme still returns a reasonably strong return on investment with a BCR of 1.3:1.