Cork Area Commuter Rail Programme

Introductory commentary on the February 2023 "Phase 2 Option Selection Report"

Please note that certain sections of the report have been updated at a later stage of the design process. The Project Report (18/06/2025) summarises the most updated status of the CACR programme.

Cork Area Commuter Rail (CACR) Programme

Phase 2 Option Selection Report

February 2023

Quality information

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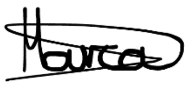			
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	16/09/2022	Draft	Derval Cummins	DC	Director
2	20/09/2022	Draft	Derval Cummins	DC	Director
3	18/10/2022	Draft	Derval Cummins	DC	Director
4	23/02/2023	Final	Damien Lambert	DL	Associate Director

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Definitions and Terms

Term	Definition
AACE	Association for the Advancement of Cost Engineering
BEMU	Battery Electric Multiple Unit
CACR	Cork Area Commuter Rail
CAF	Common Appraisal Framework
CI	Capital Investments
CMA	Cork Metropolitan Area
CMATS	Cork Metropolitan Area Transport Study
CSO POWSCAR	Census of Anonymised Records
DART	Dublin Area Rapid Transit
DoT	Department of Transport
DPER	Department of Public Expenditure and Reform’s
ENEVAL	Environmental Evaluation Model
EMU	Electric Multiple Unit
IÉ	Iarnród Éireann
LRT	Light Rail Transit
LT	Lunchtime
MCA	Multi-Criteria Analysis
NDFM	National Demand Forecasting Model
NDP	National Development Plan
NIFTI	National Investment Framework for Transport in Ireland
NPF	National Planning Framework
NPV	Net Present Value
NTA	National Transport Authority
OB	Overbridge
O&D	Origin & Destination
OLE	Overhead Line Equipment
PSC	Public Spending Code
PT	Public Transport
SWRM	South-West Regional Model
SAC	Special Area of Conservation
SAR	Strategic Assessment Report
SDZ	Strategic Development Zone
SET	Signalling, Electrical and Telecommunications
SPA	Special Protection Area
SPR	Strategic Park and Ride
SR	School Run
TII	Transport Infrastructure Ireland
TPSS	Traction Power Substation
TSS	Train Service Specification
TUBA	Transport User Benefit Appraisal
UBC	Underbridge

Executive Summary

Introduction

The Cork Area Commuter Rail Programme (CACR) represents a transformational investment in the rail network in Cork. It will improve the attractiveness of rail, to encourage modal shift from car-based travel and reduce congestion and emissions. Improvements to the commuter rail network in Cork were initially identified through the Cork Metropolitan Area Transport Strategy (CMATS) and include:

- Integration of the three existing rail corridors in the Cork area, which penetrate the city at Kent Station, providing a high frequency north-east connection through the city
- Full electrification, or alternative fuelling, of the suburban rail network
- Other infrastructure improvements (track enhancements, additional platforms, increasing signalling capacity, safety related upgrades such as level crossings closures etc.) required to accommodate a transformative "turn up and go" 10-minute frequency (from current 30-minute frequency) for the suburban rail network in Cork
- Additional rolling stock to be introduced to meet the potential of the existing and future demand
- Multi-modal integrated transport hub for the city provided at Kent Station to promote model shift from the private car and enhance attractiveness of the city docklands regeneration and development
- New stations at prime regeneration sites, Park & Ride interchange points and new development areas.

Figure A illustrates the extent of the CACR Programme within the Cork Region, based on existing rail corridor and stations.

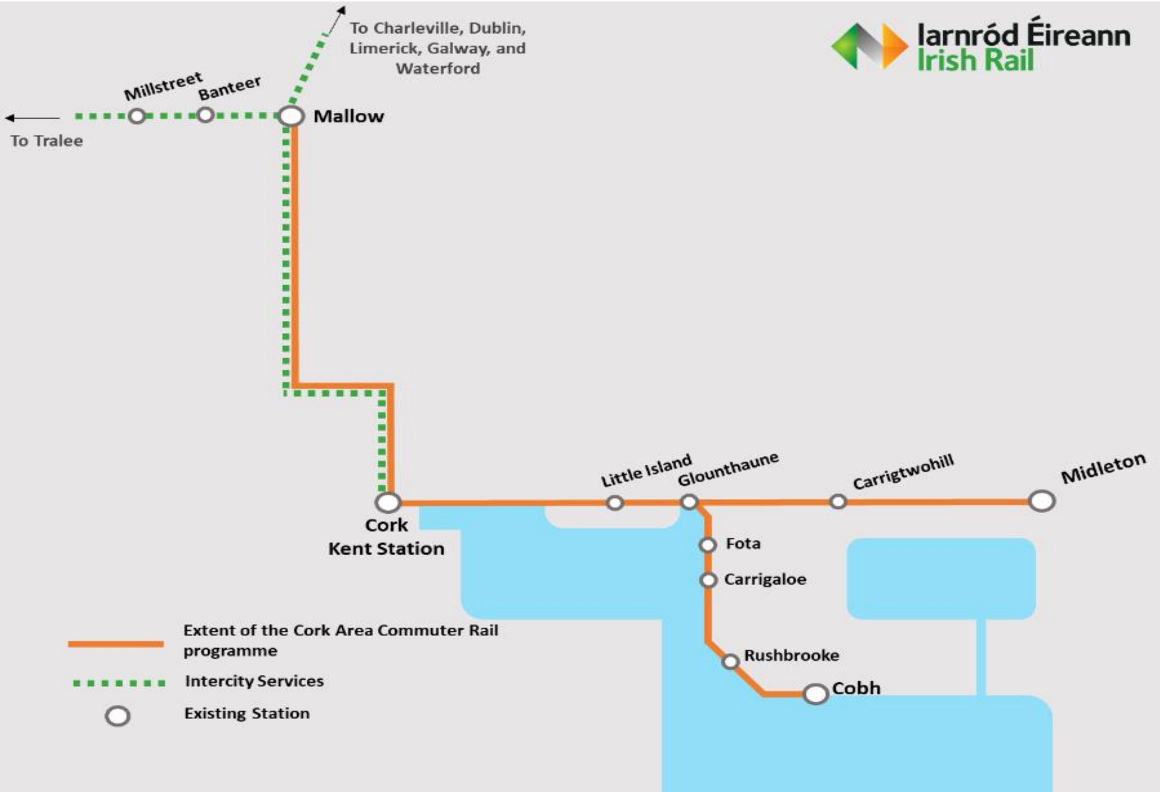

Figure A: Extent of CACR within the Cork Region

The primary objective of the CACR Programme is to 'Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services. CMATS envisaged this rail service as operating at regular 10-

minute services interval on each line, with through running at Kent Station, and a 5-minute service between Glounthaune and Kent.

Purpose of the Option Selection Report

The Option Selection Report is a Phase 2 deliverable that follows the Scheme Feasibility Report. Its purpose is to examine the proposed options emerging from the Scheme Feasibility Report for delivery of the CACR Programme through a robust and systematic selection approach to determine a preferred option which will fulfil the business needs and project objectives. This report assesses the options against a baseline Do Minimum situation to select a preferred option. With relevant approvals, the Preferred Option emerging from this report will form the basis for the further development of the project and will be progressed for assessment within the Project Appraisal Report.

Options Identification and Selection Approach

With the core objectives and strategic context for the CACR Programme established, options for several critical programme elements were developed prior to agreeing options to bring forward for assessment. Each of these elements is presented in Figure B. Options for each element were developed in close collaboration with internal stakeholders within IÉ as well as external stakeholders including the NTA, the Cork City and County Councils.

The programme aim for development of all options was to upgrade the Cork rail system to reduce transport emissions and to achieve a 10-minute headway on each section of the network and a 5-minute service between Kent Station and Glounthaune, as set out in CMATS and the Phase 1 SAR.

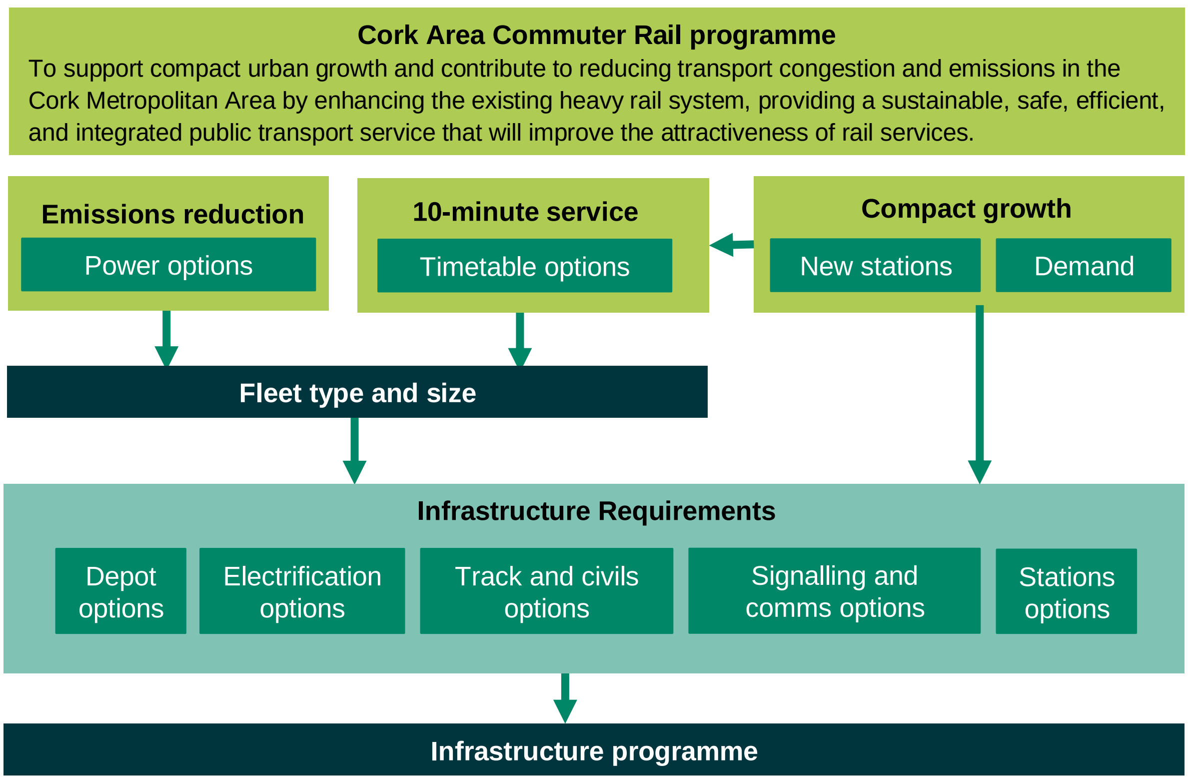

Figure B: Key Elements informing the options identification process

Power and Fleet Options

A new fleet for the CACR Programme will be required to replace the diesel fleet currently operating in Cork and to cater for the increases in demand forecast. The type of traction deployed will have a significant impact on the number of train services that can be delivered and the benefits the network will generate.

An initial long list of six options was identified which included alternatives for the development of a conventional electrified system which utilises EMU (electric multiple unit) vehicles and OLE (overhead line equipment), BEMU (battery electric multiple units) based systems reliant on the static charging of vehicles, hybrid systems which attempt to charge BEMU vehicles dynamically during service operations and finally, a system which is based on hydrogen powered rolling stock.

This long list was rationalised during the Sift 1 stage based on an assessment of option viability and technical feasibility. The resultant short list of options, presented in Table A, was then subjected to MCA, presented in Table B to identify the best performing option for the CACR programme.

Table A: Power and Fleet Sift 1 Summary

Options	Short List / MCA
Option 1: 1500V DC EMU with OLE	✓
Option 2: 25kV AC EMU with OLE	✓
Option 3: BEMU 1500V DC	✓
Option 4: BEMU 25kV AC	✗
Option 5: Dynamic BEMU with limited OLE	✓
Option 6: Hydrogen	✗

Table B: Summary of Power and Fleet MCA Scoring

Options	Capital Cost	Operating Cost	Safety	Planning & Environment	Integration	Overall Rating
Option 1: 1500V DC EMU with OLE						
Option 2: 25kV AC EMU with OLE						
Option 3: 1500V DC BEMU						
Option 5: Dynamic						

A 1500V DC BEMU (battery electric multiple units) based systems reliant on the static charging of vehicles, was found to be the best performing fleet and power option due to lower overall capital costs, lower operating costs, reduced planning and environmental risk and increased network flexibility. It includes the development of a service network based on BEMUs supported by a network of battery chargers at Mallow, Blarney, Kent and Midleton stations and the depot.

Infrastructure Requirements

The significant increase in service frequency and capacity (longer trains), combined with the move from a diesel to BEMU fleet and the development of eight new stations, requires significant changes to the railway infrastructure, illustrated in Figure C. These changes are the same for all options with one exception: TSS2 requires an additional turnback with charging facilities at Mallow Station. Infrastructure costs would be slightly higher for TSS2 as a result, though offset by smaller fleet requirements. A key implication is that the TSS2 infrastructure could accommodate TSS1, but not vice versa.

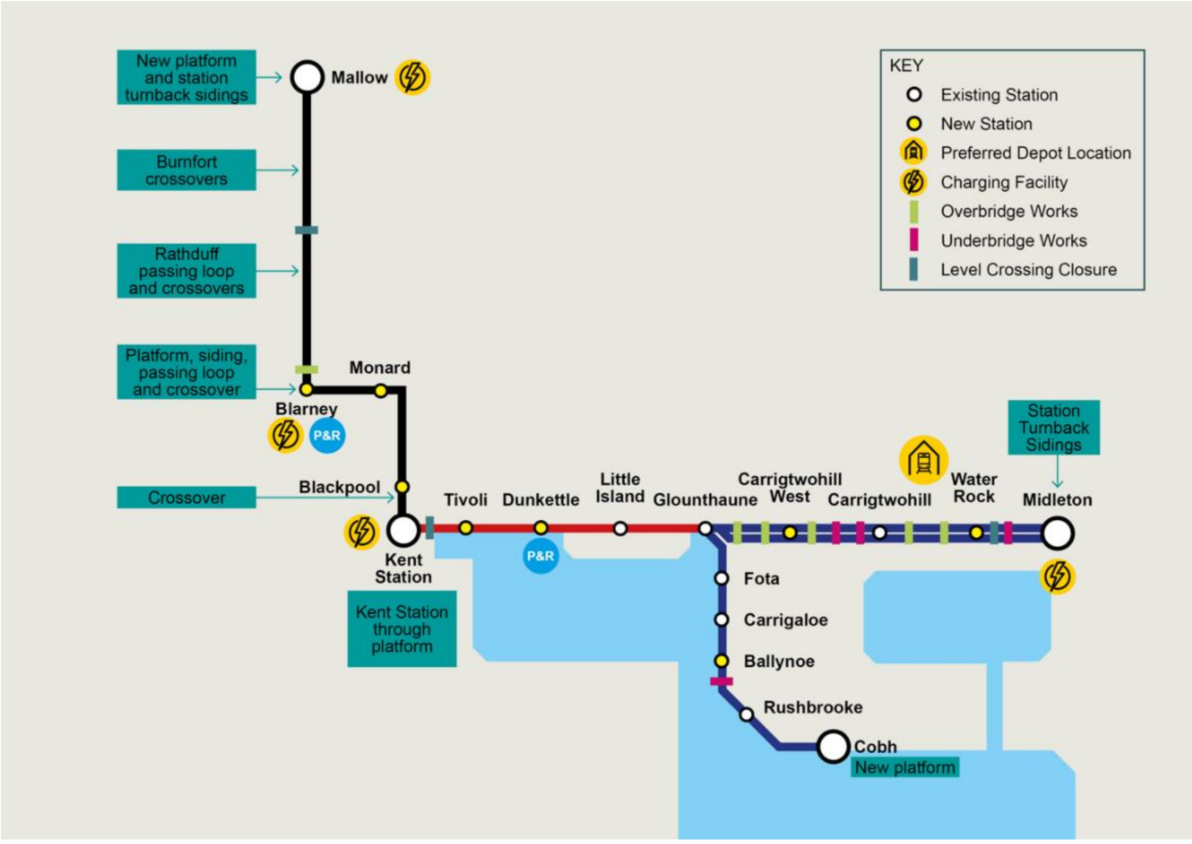

Figure C: CACR Programme Infrastructure Interventions

Service Improvement Options

Train Service Specification (TSS) options developed to provide the 10-minute service included several elements: timetables, turnaround and charging strategy, operational flexibility requirements, fleet size, infrastructure requirements.

After a long-listing process, two issues were the focus for subsequent optioneering:

1. Prioritisation of Midleton, or both Cobh and Midleton, for through service beyond Kent - It is not possible for all services to be through running as the Cobh and Midleton branches cannot both feed directly into the Blarney/Mallow branch.

2. Optimal suburban service provision at Mallow which is relatively distant from Kent, and even from Blarney, and may not warrant a full 10-minute service frequency.

Three short listed options were assessed (TSS1, TSS2, and TSS2a) illustrated in Figure D, each with implications for the fleet requirement, infrastructure requirements and the associated costs and benefits. The infrastructure interventions required to deliver each TSS were developed in parallel. Table C summarizes the key positive and negative features of the shortlisted TSS options.

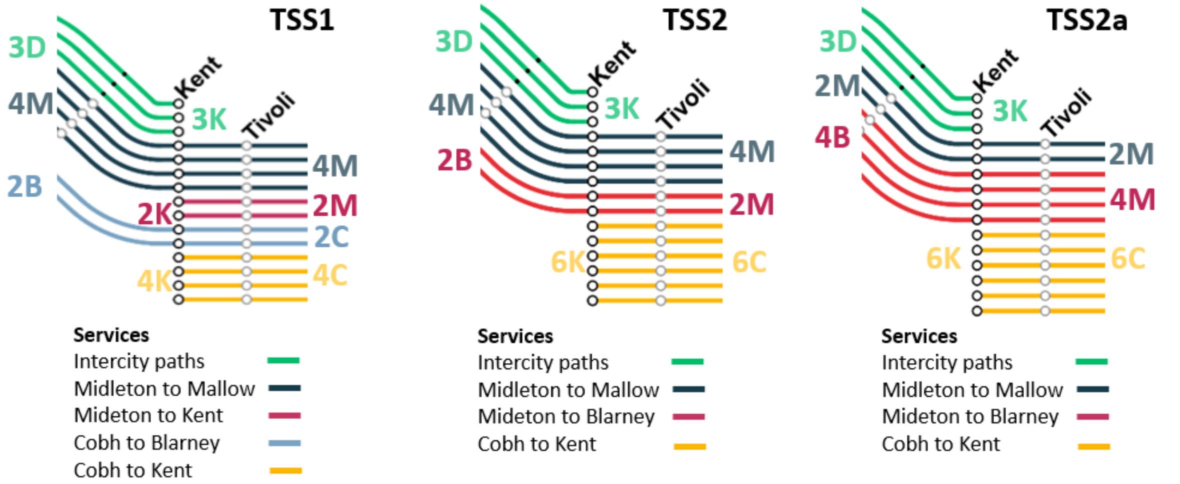

Figure D: TSS Shortlisted Options Summary

Table C: TSS Shortlisted Options Summary

<table>
<tr><th>Option</th><th>TSS1</th><th>TSS2</th><th>TSS2a</th></tr>
<tr><td rowspan="2">Positive features</td><td rowspan="2">Consistent with CMATS principles (six tph; cross city from Cobh)</td><td colspan="2">Significant improvements in services for passengers from Cobh, in comparison to Do-Minimum, while through services are operating on the corridor with the greatest potential for economic and population growth (Mallow-Midleton)</td></tr>
<tr><td>Consistent O&D patterns for CACR services</td><td>Realistic alignment with demand north of Blarney
Infrastructure allows for scale up of commuter services to Mallow if required</td></tr>
<tr><td rowspan="2">Negative features</td><td rowspan="2">Irregular interval between Kent and Blarney or a wait at Kent</td><td colspan="2">Interchange necessary from Cobh branch to west of Kent</td></tr>
<tr><td>Third turnback facility and charger in Mallow</td><td>Reduced service to Mallow</td></tr>
</table>

Option TSS1, the CMATS Proposal, is closely based on the CMATS operating principle. It offers through services from both Midleton and Cobh, although some services on both lines would terminate at Kent. The disadvantage is that services between Kent and Blarney would either operate on an irregular service interval, rather than the regular 10-minute interval required, or be held at Kent for up to five minutes to regularise the intervals. Neither alternative offers the truly attractive customer proposition intended.

Option TSS2, the Regular 10-minute Interval, offers a simpler customer proposition with regular 10-minute service intervals on each branch. All Cobh services would terminate at Kent, so passengers for Blarney and beyond would change train. All Midleton services would continue to either Blarney or Mallow. Prioritising the Midleton branch is justified by its larger catchment, greater growth potential and greater number of new and existing stations. The demand forecasts support this approach. It requires 24 trainsets compared with 25 for TSS1.

Options TSS2a, the Reduced Mallow Commuter Service, is a variation on TSS2 where the number of services to Mallow are reduced from four to two services per hour. It requires only 21 trainsets for operation and has lower operating costs. On the other hand, it has lower demand and offers fewer benefits than TSS1 and TSS2.

Table 7-10 compares the key metrics for each option: fleet size, cost, demand and related indicators, and economic performance.

Table D: Comparison of Key Metrics

Analysis Elements		Base Year	Do Minimum		TSS1		TSS2		TSS2a	
			2030	2050	2030	2050	2030	2050	2030	2050
Fleet Size	Trainsets (2050)				25		24		21	
Demand forecast	Public Transport Daily Trips	142,094	251,860	338,663	261,759	360,599	261,652	357,745	261,504	357,660
	Public Transport Daily Mode Share	7.8%	11.5%	12.5%	11.9%	13.3%	11.9%	13.2%	11.9%	13.2%
	Irish Rail Boardings	14,853	14,151	19,193	20,418	28,576	20,265	28,809	19,484	27,830
Costs	Capital cost (2021 prices, undiscounted)	N/A	N/A	N/A	€1,207 million		€1,196 million		€1,161 million	
	Additional operational cost per annum (2021 prices, undiscounted)	N/A	N/A	N/A	€32 million		€31.9 million		€31.1 million	

A Multi-Criteria Analysis (MCA) of the TSS options was undertaken in line with the approach set out in Department of Transport Common Appraisal Framework (CAF), appraising the following criteria: Environment, Economy, Accessibility and Social Inclusion, Integration, Safety and Security, Physical Activity. An appreciation of constraints and opportunities within the study area, as well as the defined project objectives led to the establishment of sub-criteria for the MCA, tailored to have commonality with the CAF and specificity for the CACR Programme. For example, Economy was divided into three sub-criteria: User Benefits, Reliability and Transport Interchange and Integration.

Given the similarities between the TSS options, the criteria and sub-criteria had similar results for each. The main difference identified was in the 'Transport Interchange and Integration' sub-criterion. Overall, the demand analysis shows that TSS2 leads to more interchange in the network and better complementarity, or integration, with the rest of the CMATS systems, leading to better overall public transport demand and mode share.

Table E presents the summary MCA scoring of the three shortlisted TSS options, compared to the Do Minimum alternative, based on the six CAF criteria.

Table E: CACR Programme TSS Options Summary Scoring of Six CAF Criteria

Scoring System for Service Option and Depot Comparisons
Significant comparative advantage over other options
Some comparative advantage over other options
Comparable to other options
Some comparable disadvantages over other options
Significant comparative disadvantage over other options

MCA Criteria	Do Minimum	TSS1	TSS2	TSS2a
Environment				
Economy				
Access and Social Inclusion				
Integration				
Safety and Security				
Physical Activity				

In summary, TSS2 is recommended as the preferred option. It offers a regular, easy to understand, service pattern. It has the highest forecast rail passenger boardings and public transport user benefits because it meets customer demand better, although demand forecasts are quite similar for all options.

As there is not a lot to choose between the TSS options, a flexible approach may be practical. The infrastructure for TSS2 meets the requirements to operate TSS1, giving the flexibility to introduce through services from Cobh to Blarney if the market requires. TSS2a is a variation of TSS2 which could be implemented on an interim basis while demand grows but is less favourable than TSS2 in the long term.

Alignment with NIFTI

THE CACR Programme, as developed through options presented in this report, is significantly aligned with NIFTI Modal and Intervention hierarchies compared to the Do-Minimum option, as illustrated in Table F.

Table F: CACR Programme Alignment with NIFTI Hierarchies

NIFTI Hierarchies		Do-Minimum	CACR Programme
Modal Hierarchy	Active Travel		
	Public Transport		
	Private Vehicles		
Intervention Hierarchy	Maintain		
	Optimise		
	Improve		
	New		

1. Introduction

1.1 Purpose

AECOM was appointed by Iarnród Éireann (IÉ) to undertake the Phase 1 Strategic Assessment Report (SAR), and the Phase 2 Concept, Feasibility and Options Study, for the Cork Area Commuter Rail (CACR) Programme. The Phase 2 Option Selection Report is the part of the Phase 2. The purpose of the report is to examine the proposed options through a robust and systematic selection approach to determine a preferred solution which will fulfil the project objectives. A comparative analysis was developed based on quantitative and qualitative factors for evaluating the proposed options and identifying the preferred option.

1.2 Background

The CACR Programme represents a transformational investment in the rail network in Cork. It will improve the attractiveness of rail, to encourage modal shift from car-based travel and reduce congestion and emissions. Improvements to the commuter rail network in Cork were initially identified through the Cork Metropolitan Area Transport Strategy (CMATS) and include:

- Integration of the three existing rail corridors in the Cork area, which penetrate the city at Kent Station, providing a high frequency north-east connection through the city
- Full electrification, or alternative fuelling, of the suburban rail network
- Other infrastructure improvements (track enhancements, additional platforms, increasing signalling capacity, safety related upgrades such as level crossings closures etc.) required to accommodate a transformative “turn up and go” 10-minute frequency (from current 30-minute frequency) for the suburban rail network in Cork
- Additional rolling stock to be introduced to meet the potential of the existing and future demand
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- New stations at prime regeneration sites, Park & Ride interchange points and new development areas.

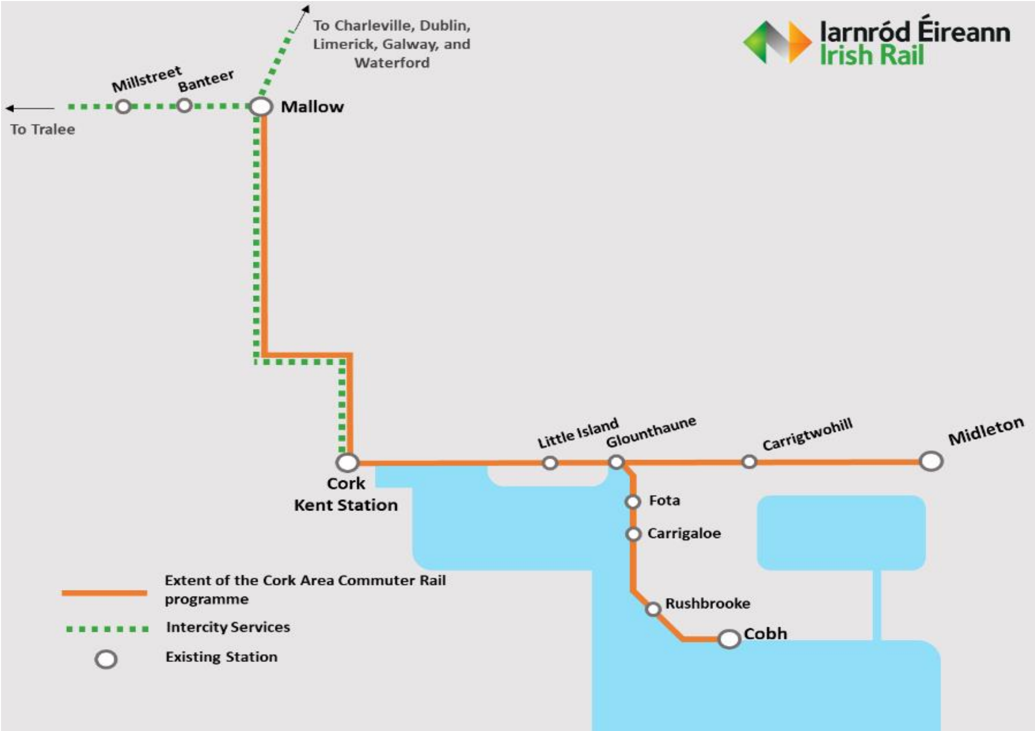

Figure 1-1: Extent of CACR within the Cork Region

This vision for the CACR network has been developed further by Iarnród Éireann (IÉ) through Phases 1 and 2 of the IÉ Project Management Procedure Standard (Version 3).

1.3 Key Appraisal Report Chronology

1.3.1 Strategic Assessment Report

The Strategic Assessment Report (SAR) is a Phase 1 deliverable, and the first deliverable to be delivered in the Department of Public Expenditure and Reform's (DPER) Public Spending Code (PSC) lifecycle and decision gate process. The purpose of the Strategic Assessment stage is to critically examine the rationale for the programme proposed and ensure the strategic fit of it with Government policy, particularly the Project Ireland National Development Plan (NDP) and National Planning Framework (NPF). The SAR describes the scale of the intervention required and allows for early scrutiny of the objectives of the programme, along with the early introduction of potential performance indicators. The SAR also identifies a long-list of potential options for delivering the proposed scheme.

1.3.2 Scheme Feasibility Report

The Scheme Feasibility Report follows on from the Strategic Assessment Report and is a Phase 2 deliverable. It describes in detail the requirements, constraints and feasible solutions for delivery of the CACR Programme, providing the rationale upon which the options can be assessed, allowing for the subsequent Options Selection Report. It sets out the process to identify and consider the requirements for the proposed interventions, and the feasible engineering and delivery solutions for each intervention.

1.3.3 Option Selection Report

In accordance with Project Approval Guidelines, the Option Selection Report is a Phase 2 deliverable that follows the Scheme Feasibility Report. Its purpose is to examine the proposed options emerging from the Scheme Feasibility Report for delivery of the CACR Programme through a robust and systematic selection approach to determine a preferred option which will fulfil the business needs and project objectives. This report will assess the options against the baseline to select a preferred option. With relevant approvals, the Preferred Option emerging from this report will form the basis for the further development of the project and will be progressed for assessment within the Project Appraisal Report.

1.3.4 Project Appraisal Report

The Project Appraisal Report is a Phase 2 deliverable required under the NTA Project Approval Guidelines (2020), developed in accordance with the DPER Guidelines and the DOT Common Appraisal Framework. This is the second deliverable in the lifecycle appraisal process (following the Option Selection Report) and builds upon the preferred option assessed and identified within the Option Selection Report. The project base case and option selection, definition, comparative evaluation and initial appraisal of the preferred option are critical activities underpinning the Preliminary Business Case to be developed in Phase 3 for the preferred option. Consequently, the objective of the Project Appraisal Report is to document those activities and demonstrate that there continues to be merit in the project.

1.4 Phase 1 and Phase 2 Methodology

Figure 1-2, from the IÉ Project Management Procedures Standards provides a high-level overview of the project Phases, deliverables, for the development, management, and delivery of projects in the Capital Investments (CI) Division.

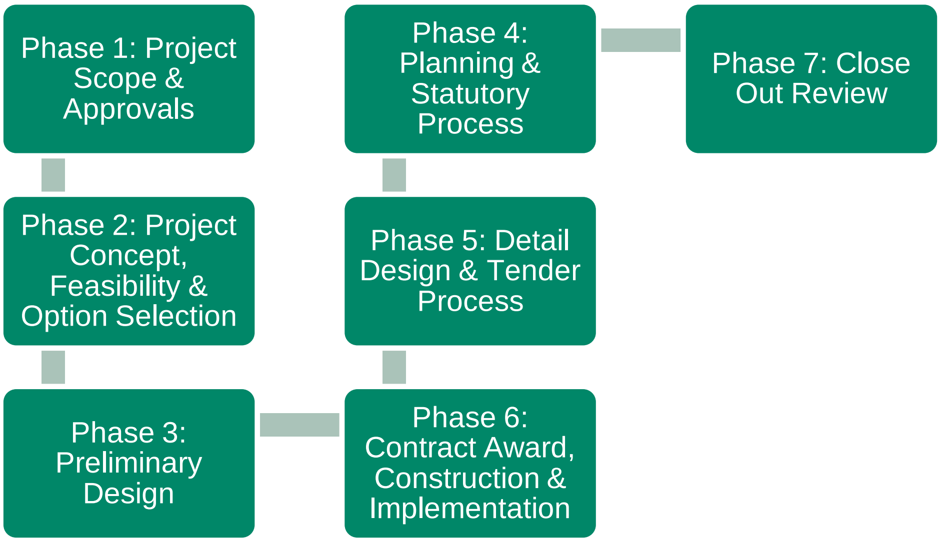

Figure 1-2: IÉ Project Management Procedures

1.4.1 Phase 1 SAR

The Phase 1 Strategic Assessment Report (SAR) was approved by the IÉ Board in August 2021 and has been circulated among both internal and external stakeholders for feedback. The SAR developed the rationale for the CACR Programme and undertook a critical examination of the strategic fit with Government policy, particularly the Project Ireland 2040 National Development Plan (NDP) and National Planning Framework (NPF).

The aim of the CACR Programme is to provide a 10-minute service on each of the three lines of the network, with a 5-minute service between Glounthaune and Kent Station, as envisaged by CMATS.

The SAR develops the programme objectives along with the potential performance indicators. It identifies alternative timetable and service options, and risks.

1.4.2 Phase 2 Methodology

The train service pattern options identified through the SAR were developed further during Phase 2, as follows:

- Demand modelling was undertaken to establish the future demand for each service option
- Power and fleet options were developed to support the identified services
- Concept designs for the identified infrastructure requirements for each service option were developed
- The environmental impact of the infrastructure requirements was determined
- The capital and operational costs for all options was developed
- An objectives achievement assessment, and a Multi-Criteria Analysis (MCA) were undertaken to determine the preferred option, including economic and financial appraisal.

The options development and appraisal process are summarised in Figure 1-3. For further detail on the Phase 2 methodology, refer to the Phase 2 Appraisal Plan, ref: CACR-XX-XX-REP-ACM-PM-0002 dated XXX 2021.

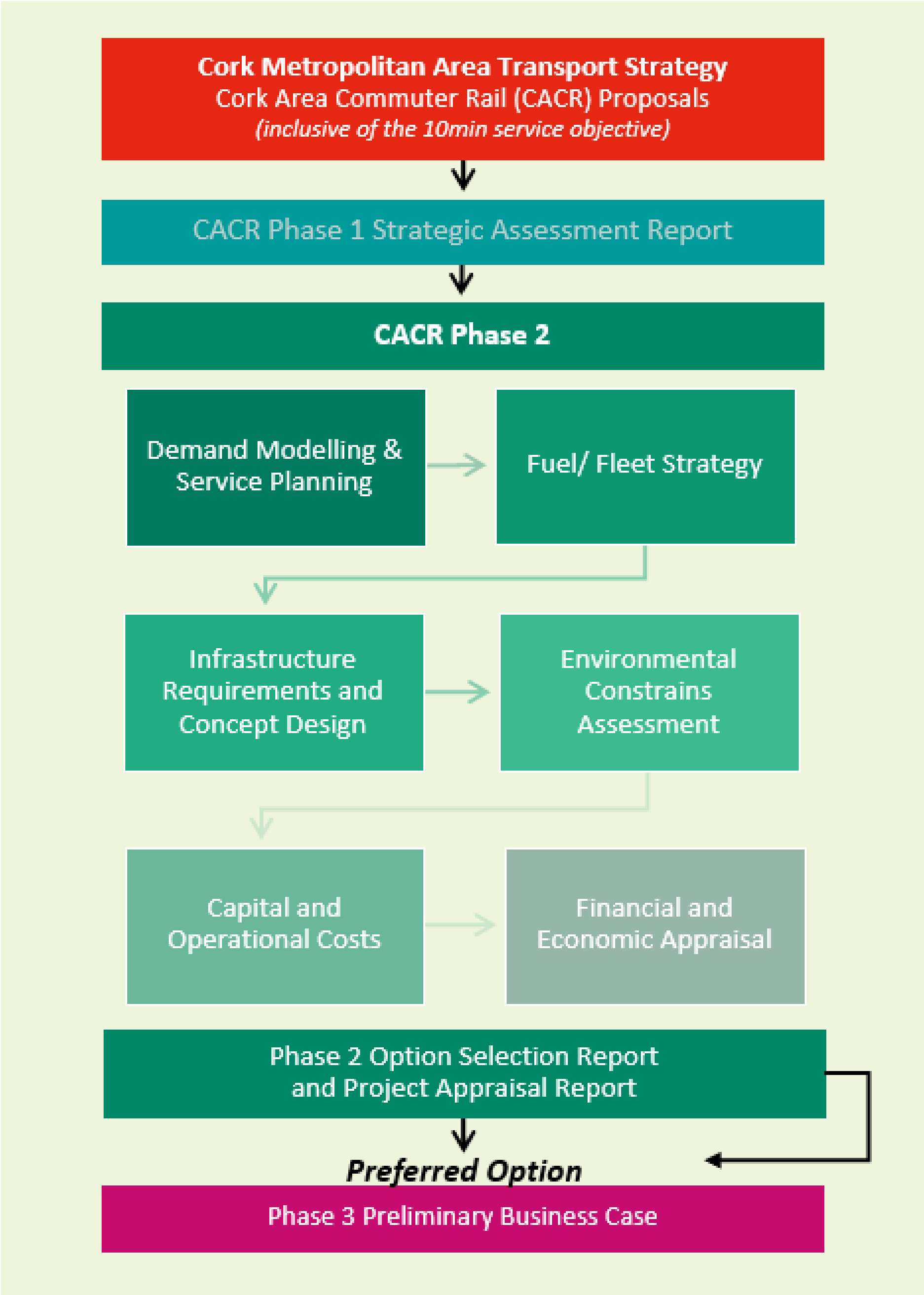

Figure 1-3: Summary of Options Development and Appraisal Process

The assessment was undertaken in accordance with guidelines set out in the Public Spending Code (PSC), published by the Department of Public Expenditure and Reform (DPER) (December 2019) and the Common Appraisal Framework (CAF) for Transport Projects and Programmes (2021 update), published by the Department of Transport, (DoT).

The option assessment has been undertaken at programme level to capture the full holistic benefit of the programme, with the aid of the National Transport Authority's (NTA) Southwestern Regional Model (SWRM). The model allows all impacts across the Cork Region to be assessed as a whole. Outputs from the NTA SWRM have been used to capture the user benefits and revenues through TUBA and the Environmental Evaluation Model (ENEVAL) has also been used. All capital, operating and whole life costs were estimated and included in the assessment.

1.5 Content of the Options Selections Report

Section 2: CACR Programme Context	• A summary of the existing context, the objectives for the programme and a summary of the alternatives assessment
Section 3: Options Identification and Selection Approach	• An overview of how the options were identified and brought forward to the assessment stage is presented
Section 4: Do Minimum Option	• The methodology and inputs which have been used to complete the options assessment
Section 5: Power and Fleet Options	• Methodology used to complete the options assessment • Comparative assessment of the Do Something Power Fleet options • Multi-Criteria analysis of each option
Sections 6: Infrastructure Common to Do Something Options	• A description of the infrastructure and interventions necessary to facilitate the Do Something CACR Programme
Section 7: Service Improvement Options	• Methodology and inputs which have been used to complete the options assessment • Comparative assessment of the Do Something TSS options • Multi-Criteria analysis of each option in line with the Common Appraisal Framework guidelines
Section 8: Summary and Conclusion	• Conclusion to the report outlining the summary of approach and outcomes of the report, including the preferred options

Figure 1-4: Summary of the Options Selection Report Structure

2. CACR Programme Context

2.1 Existing Context

The concept of CACR has been in existence for nearly 20 years, this concept was further refined in 2003/04 as part of a Feasibility Study on a Cork Suburban Rail project and the 2003 Strategic Rail Review. The alignment of CACR with policy has been assessed through the SAR. There is a strong strategic policy fit between CACR and national, regional and local policy objectives, particularly in relation to sustainable mobility, emissions reductions, compact land use development, and consolidation of population and employment growth along high-frequency transport corridors.
At a national level, the key drivers for CACR include:

- Project Ireland 2040, where CACR is aligned with multiple National Strategic Objectives (NSOs) for compact growth, enhanced regional accessibility, a strong economy and a transition to a low carbon and climate resilient society.
- The National Investment Framework for Transport in Ireland (NIFTI) (2021) enables delivery of Project Ireland 2040 by guiding the appropriate investment in transport infrastructure. It addresses the importance of decarbonisation in the decades ahead to meet Ireland's climate change goals. It prioritises maintaining, optimising and improving existing assets over the building of new infrastructure in addition to prioritising active travel and public transport modes over private vehicles. CACR is aligned in seeking to optimise and improve the existing suburban rail system for Cork.
- The Climate Action and Low Carbon Development Act 2021 provides statutory recognition of the national climate objective and a requirement for sector-relevant carbon budgets. The subsequent Climate Action Plan 2021, places further emphasis on the need to decarbonise the transport sector. CACR is aligned in seeking to deliver a new fleet of non-carbon-based fuel trains for the network.

At a regional level, CACR aligns with:

- The Southern Regional Assembly's Regional Spatial and Economic Strategy (RSES) outlines 11 core 'Statements of the Strategy' to build a strong, resilient and sustainable region. CACR aligns with six of these; compact growth; enhanced regional accessibility; sustainable mobility; a strong economy; a low carbon, climate resilient and sustainable society; and sustainable, planned and infrastructure-led development
- Locally, CACR is aligned with the Cork Metropolitan Area Transport Strategy (CMATS) as it will deliver the suburban rail elements of the Strategy. CMATS examined strategic transport options for the Cork Metropolitan Area (CMA), and extending to Mallow, an area hereafter referred to as the 'Cork Region,' on a corridor-by-corridor basis. It concluded that heavy rail is the optimum public transport mode to cater for demand in the catchment of the existing rail line between Mallow, Midleton and Cobh, serving Kent Station.
- Both the Cork City and Cork County Development Plans recognise and aim to enable the proposals in CMATS
- Finally, the Local Area Plans (LAPs) developed for several of the Cork Municipal Districts (MDs) outline proposals and zoning objectives for significant population and employment growth at existing and planned railway stations in the CMA

There is therefore a robust policy context at all levels which support the improvement of the rail system to enable the Cork Metropolitan Area to develop in a sustainable manner, while reducing emissions from transport.

Improved public transport requires integrated system-wide transportation across a rail, light rail, bus, cycling and walking network that allows each mode to play to its strengths. The benefit of rail is that it can carry higher volumes of people, more reliably, than any other mode. The existing network in Cork represents a very significant prior investment that can be fully leveraged and built upon. Rather than a network, it comprises three radial routes that all terminate in the city centre, there are significant gaps between some existing stations and a lack of off-peak services currently. The network needs to be upgraded to modern standards, the timetable and frequency of service needs to continue to improve, and the diesel-fuelled trains that currently operate are increasingly unacceptable from a societal and policy perspective.

In summary, there is an imperative to upgrade the public transport system in the Cork 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 address the drivers for change set out in Table 2-1.

Table 2-1: Key Drivers for Change (source: CACR SAR)

Driver for change	Indicators
Contribute to emission reduction targets	1. Help in the achievement of decarbonisation targets 2. Need to reduce emissions from private cars 3. Requirement to create a high-efficiency low-emissions mass transit system
Facilitate the anticipated growth in passenger demand	4. Existing heavy rail network forecast to operate at near capacity in short term 5. Year on year growth in passengers 6. Need to provide a high frequency rail network to meet projected growth in demand
Support economic and population growth	7. Need to support land use policy including high-density development within the Cork Region 8. High-quality efficient transport required to reduce congestion 9. Supporting the movement of the workforce
Enable compact growth within the Cork Region	10. Need to support the ambition for long-term concentrated development along largely established population centres, as well as Strategic Development Zone (SDZ) areas 11. Need to ensure the dynamic impact of transport and land-use planning is maximised
Encourage and Enable Modal Shift	12. Create an attractive integrated transport system 13. Provide a real alternative to the private car 14. Increase frequency and reliability 15. Investment to allow heavy rail to reach its mode share potential 16. Improve customer experience and ease of use

2.2 Existing Transport Network

The transport context is one of increasing demand, expected to continue into the future, The dominance of the car will remain the case without significant investment in more sustainable modes. Improvement and investment in public transport infrastructure and services is required to enable modal shift to more sustainable modes.

The NPF envisages that Cork (city and suburbs) will become the fastest-growing region in Ireland with a projected 50% to 60% increase of its population by 2040. Population increases have been planned in areas within the commuter rail catchment, such as Monard, Blarney/Stoneview, Carrigtwohill and

Ballyvolane. Similar significant increases in employment are projected for Midleton, Monard and Ballyvolane.

At present, the overall 24-hour travel demand within the CMA is approximately 830,000 trips with 200,000 occurring during the AM period. This existing demand is catered for almost exclusively by road-based modes. With a 69% mode share, the private car is the current dominant mode of travel and has remained relatively steady from 2011 to 2016, as presented in Figure 2-1. The combined public transport mode share is less than 10%. Bus is the dominant public transport mode at present, with extensive coverage across the city and inner suburban areas. BusConnects Cork will reinforce the role of the bus as the primary mode of public transport within the city.

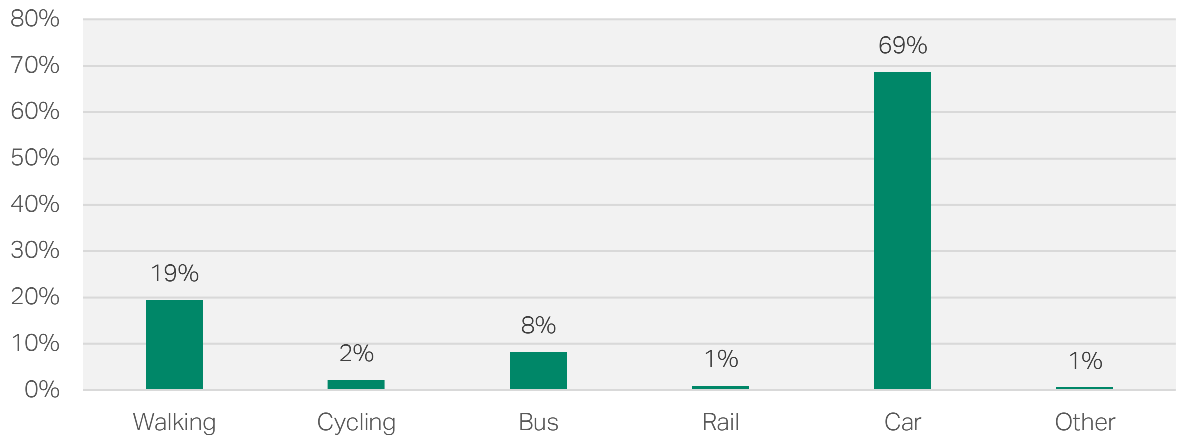

Figure 2-1: 2016 Mode Share for Trips to Work and Education - Overall CMA[1]

Despite a general trend of growth in passenger numbers on existing commuter rail services, the rail mode share in the overall CMA has remained static at 1% since 2011. However, the existing commuter rail network within the CMA is well positioned to cater for journeys to some outer suburbs and wider commuter towns. Due to a limited number of stations on the network and an infrequent service of one train every 30 minutes, there is an unrealised potential for rail to cater for a greater proportion of travel demand. The introduction of additional rail stations on the Cork region rail network will increase the population catchment by 75% and the employment catchment by 37%. The population within a one-kilometre radius from the existing and new stations and the number of jobs is presented in Table 2-2.

Table 2-2: Population and Working Population within a one-kilometre radius

	Population within 1km catchment[1]	Number of workers within 1km catchment[1]
Existing stations	36,000	28,000
New and existing stations	48,000	36,000

2.3 Rationale for Investment

The investment rationale establishes why a public policy intervention is necessary. It considers the public policy objectives of a project or programme and the reasons for public sector provision or involvement.

A summary of the rationale for investment in the CACR is as follows:

- To support policies to improve spatial planning and densification with commercial and residential development opportunities adjacent to rail stations with higher frequency services

[1] Census small areas that intersect with a one-kilometre radius of the existing and proposed stations on the commuter rail network was used as a proxy to determine the potential catchment of the network

- To make a step change in moving towards a decarbonised commuter rail transport system
- To increase rail mode share, leading to a reduction in car-based travel and associated reduction in overall transport-related emissions
- To improve heavy rail capacity, both infrastructure capacity (i.e., trains per hour) and passenger carrying capacity (i.e., trains x passengers per vehicle) with more stations providing greater catchment and additional rolling stock facilitating higher frequencies
- To develop a more attractive service by moving from the current 30-minute service interval to a "turn up and go" 10-minute service.
- To increase customer satisfaction through higher frequencies, improved journey time reliability and punctuality, in addition to additional fleet, additional stations and an integrated fare structure across public transport modes

For further detail on the Rational for Investment, refer to the Phase 1 Strategic Assessment Report (SAR) dated November 2021.

2.4 Objectives

The CACR Programme objectives were set through a collaborative approach, involving NTA as well as relevant departments of IÉ. This provided a wide business and policy perspective and rooted the objectives in the issues to be addressed, the rationale for change and how to implement it.

The objectives are, where possible, specific, measurable, achievable, relevant and time-bound (SMART). They are also strategically aligned with the four NIFTI Investment Priorities – Decarbonisation, Mobility of People and Goods in Urban Areas, Protection and Renewal and Enhanced Regional and Rural Connectivity, as illustrated in Table 2-3.

Appendix A contains a mapping of the sub-objectives, performance criteria and their alignment to CAF criteria.

Table 2-3: CACR Programme Objective and Sub-objectives Alignment to NIFTI Investment Priorities

CACR Programme Objectives / NIFTI Investment Priorities		Decarbonisation	Mobility of People and Goods in Urban Areas	Protection and Renewal	Enhanced Regional and Rural Connectivity
Primary Objective	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services	✓	✓	✓	✓
Sub-Objectives	Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth.	✓	✓	✓	✓
Sub-Objectives	Develop an integrated suburban rail system improving accessibility to jobs, education and other social and economic opportunities, inter-modal connectivity, and integration with other public transport services.		✓	✓	✓
Sub-Objectives	Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.		✓	✓	✓
Sub-Objectives	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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	✓			

2.5 CMATS

2.5.1 Options for Strategic Rail Corridor

The development of CMATS involved an integrated review of transport demand and supply across the Cork Region. The multi-modal strategy identified key corridors for demand across the Cork Region and how future transport networks could respond. Various options to respond to the identified demand were developed including BusConnects, light rail and active modes with enhancement of public transport networks prioritised.

CMATS carried out an MCA, guided by CAF, to determine the appropriate public transport option to support the forecast demand on the CMATS Strategic Rail Corridor. This demand was forecast at a maximum one-way demand of around 3,600 passengers/hour/direction east of Kent Station and around 2,350 pax/hr/direction north of Kent Station. The two-way cross city demand was identified as around 1,000 pax/hr. The following options were considered:

- Option 1: Improvements to existing rail line and increase in services
- Option 2: Convert rail line to pedestrian and cycle path
- Option 3: Cater for demand growth by car and increased road provision
- Option 4: Cater for demand growth by increased bus service provision

- Option 5: Convert rail line and services to Light Rail Transit (LRT).

Following the MCA, **Option 1: Improvements to existing rail line and increase in services** was chosen as the preferred option, as it provided the most benefits overall (Safety, Integration, Accessibility and Social Inclusion) while maximising the economic benefits by building on previous investments made by the state. CMATS set out the high-level service improvements, new stations and new infrastructure required to meet the aims for the strategic rail corridor in CMATS. The CACR programme represents this package of measures.

2.5.2 CMATS Plan for the Commuter Rail Network

The demand analysis undertaken for CMATS concluded that the projected level of demand along the existing rail line between Mallow, Midleton and Cobh serving Kent Station, combined with previous proposals for upgrade of the Cork commuter rail network, gave an impetus for exploring options to significantly increase rail network capacity. Investment in the existing rail corridor to respond to the strategic demand was an obvious opportunity, negating the requirement for investment in alternative public transport modes which would be geographically extensive, potentially more complex to deliver and ultimately less attractive to the passenger.

Aiming to meet the anticipated demand in the rail corridor, and to make the service more attractive, CMATS proposed to increase the service intervals across the Cork commuter rail network. The service intervals, shown in Table 2-4, result in a 10-minute "turn up and go" service from Kent to Midleton, Cobh and Mallow. This would provide a 5-minute service interval from Glounthaune to Kent.

Table 2-4: CMATS Proposed Service Frequencies

Station pairs*	Existing service intervals	Proposed service intervals
Kent – Midleton	30 mins	10 mins
Kent – Cobh	30 mins	10 mins
Kent – Mallow	30 mins	10 mins
Kent – Glounthaune**	15 mins	5 mins

**to provide through running services between Mallow and both Midleton and Cobh to cater for the identified cross city demand. ** Combination of peak frequency in the core section*

3. Options Identification and Selection Approach

With the core objectives and strategic context for the CACR Programme established, options for several critical programme elements were developed prior to agreeing options to bring forward for assessment. Each of these elements is presented in Figure 3-1. Options for each element were developed in close collaboration with internal stakeholders within IÉ as well as external stakeholders including the NTA, the Cork City and County Councils.

The programme aim for development of all options was to upgrade the Cork rail system to reduce transport emissions and to achieve a 10-minute headway on each section of the network and a 5-minute service between Kent Station and Glounthaune, as set out in CMATS and the Phase 1 SAR.

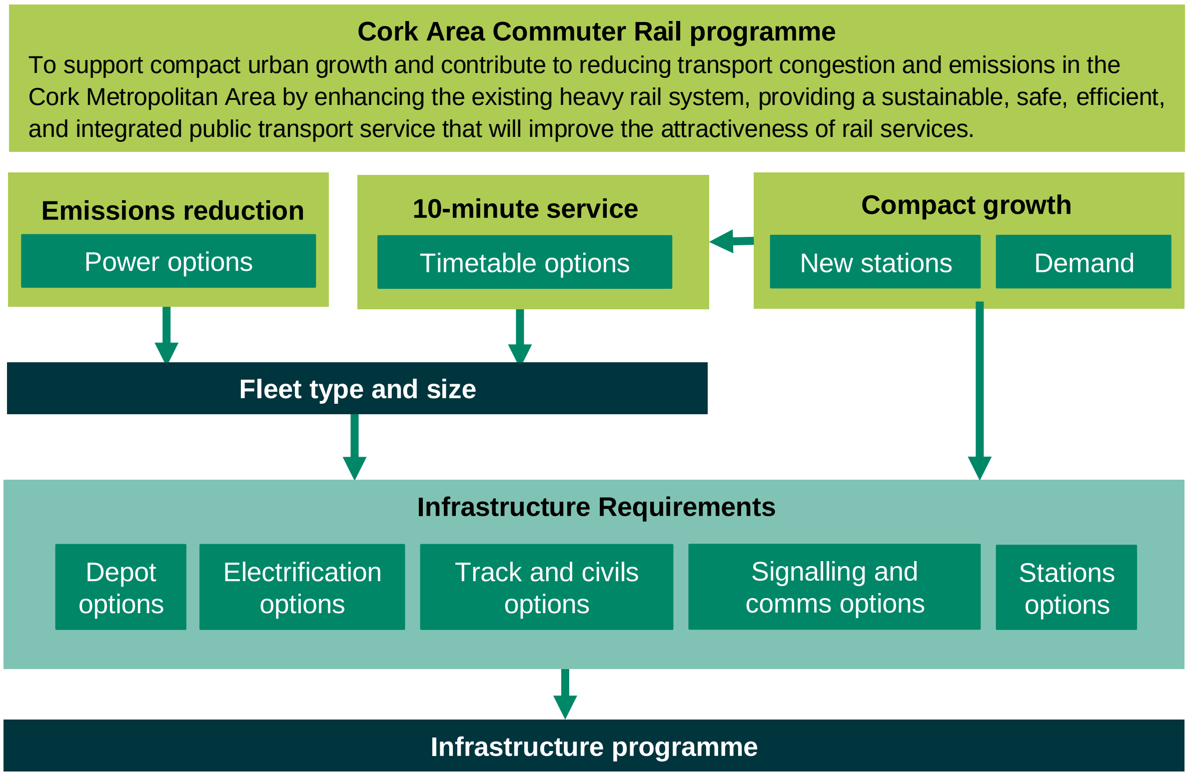

Figure 3-1: Key Elements informing the options identification process

Options were compared to a Do Minimum option, detailed in Section 4.

The alternative power and fleet options, detailed in Section 5, were focused on moving away from diesel through introduction of new fleet, supplemented by fleet expansion required to operate the 10-minute service interval across the network. Each of the different power options considered had unique infrastructure requirements.

In addition to the required infrastructure for the preferred power and fleet option, the CACR programme required additional infrastructure investments, common to all Do Something TSS options, detailed in Section 6. These include new stations, upgrades at existing stations, track alignment, bridges, signalling, car parking facilities.

In parallel, different approaches for providing a 10-minute service were investigated through improvement options, detailed in Section 7.

The CACR Programme as a whole was considered in terms of NIFTI modal and Investment priorities, in comparison to the Do-Minimum option, as summarised in the conclusion.

4. Do Minimum Option

4.1 Overview

The Do Minimum Option is the basis from which to compare the future Do Something options. It includes assumptions about how transport and land use will change in the period up to 2030 and 2050 without the CACR Programme proceeding.

AECOM consulted IÉ and the NTA to agree a realistic list of assumptions for the Do Minimum Option. A full list of the assumptions made for this option is presented in Table 4-1. The key assumptions are:

- No investment in new heavy rail infrastructure, including platforms, tracks, stations, power and fleet
- Services are increased to the limit of existing infrastructure capacity
- CMATS proposals for BusConnects, active modes and some road network improvements all delivered by 2030
- No light rail proposals delivered by 2030
- Supporting measures such as a 20% reduction in public transport fares and a 50% reduction in on-street city centre parking also delivered
- City Centre Movement Strategy delivered
- Land use assumptions based on the most recent version of SWRM

Table 4-1: Summary of Do-Minimum Assumptions

Source		Potential Measure	Include in 2030 Do Min / (Interim - 2040)	2030 Dynamic Do Min / (Interim - 2040)
Irish Rail Assumptions		Mallow Line - 7 TPHPD - 6 commuters, 1 Intercity	Y / Y	Y / Y
CMATS / CACR Programme		- Kent Through Running Platform - Glounthaune-Midleton Double Tracking - Cork Area Re-signalling	N/N N/N N/N	N/N N/N N/N
CMATS BusConnects - infrastructure	Do Strategy	- 9 high frequency radial routes - 3 high frequency orbital routes	N/N	N/Y
CMATS BusConnects - services			Y/Y (modelling dependent on bus service plans)	Y/Y
CMATS Light Rail	Do Strategy	- 25 stations, 5 min head way etc.	N/N	N/Y(TBC) modelling focus on service levels rather than mode
CMATS Walking	Do Strategy	Cork Walking Strategy 2013-2018 Improvements	Y/Y	Y/Y
		Walk links along new road links	Y/Y	Y/Y
		Internal walk links within identified development areas	Y/Y	Y/Y
CMATS Cycling	Do Strategy	Primary, Secondary, Feeder and Greenway network	Y/Y	Y/Y
Land Use		From most recent version of the SWRM	Ensure developments associated with new stations i.e., Docklands, Water-Rock etc are included	
CMATS Supporting Measures		20% fare reductions	Yes (90min fare)	Yes (90min fare)
		NGT/Integrated Ticketing	N/N	Y/Y (limited impact on SWRM coding etc)
		Transfer Penalty reductions – Integrated Ticketing	N/N	Y/Y (for consistency with CMATS)
		50% reduction in on-street parking (related to bus priority)	Y/Y	Y/Y
		N40 Demand Management - MTFO	Y/Y	Y/Y
		N40 Demand Management - Fiscal	N/N	N/Y (subject to fiscal scheme detail availability)

Source		Potential Measure	Include in 2030 Do Min / (Interim - 2040)	2030 Dynamic Do Min / (Interim - 2040)
Source		Potential Measure	Include in 2030 Do Min / (Interim - 2040)	2030 Dynamic Do Min / (Interim - 2040)
Local transportation / improvement schemes		From County Development plans and/or LAPs that are not included in CMATS	None outside those listed in this list	None outside those listed in this list
Land Use		From most recent version of the SWRM	Ensure developments associated with new stations i.e. Docklands, WaterRock etc are included	
CMATS Road Network Improvements	DM	- M28 Cork to Ringaskiddy - Dunkettle Interchange Upgrade	Y/Y Y/Y	Y/Y Y/Y
	DS National	- N22 Baile Bhuirne to Macroom improvements - http://www.n22bbm.ie/ - N25 improvements Carrigtwohill to Midleton(new junctions) - N27 improvements - N71 improvements - N40 South Ring Road - N/M20	Y/Y Y/Y N/N - BusConnects (if appropriate) N/N - BusConnects (if appropriate) N/N N/N	Y/Y Y/Y N/N - BusConnects (if appropriate) N/N - BusConnects (if appropriate) N/N N/Y
	DS Local	Cork Northern Distributor Road;	N/N	N/N
		Northern Ring Road	N/N	N/N
		Southern Distributor Road;	N/N	N/N
		Local Road improvements to support the Cork County Urban Expansion Areas;	Y/Y	Y/Y
		City Centre Movement Strategy;	Y/Y	Y/Y
		Docklands internal roads to support development;	Y/Y	Y/Y
		South Docklands Eastern Gateway Bridge;	Y/Y	Y/Y
		Water Street Bridge;	Y/Y	Y/Y

Source		Potential Measure	Include in 2030 Do Min / (Interim - 2040)	2030 Dynamic Do Min / (Interim - 2040)
		Mill Road Bridge; and	Y/Y	Y/Y
		Potential eastern access to Tivoli	Y/Y	Y/Y
CMATS Park & Ride		At Blarney and Dunkettle stations	N/N (unless bus P&R prior to CACR Programme)	N/N (unless bus P&R prior to CACR Programme)
		On LRT line at Ballincollig	N/N	N/Y
		On road network at Bandon Road, Cork Airport and Carr's Hill	N/N	N/N

4.2 Commuter Rail

4.2.1 Infrastructure, Power and Fleet

The Do-Minimum infrastructure for the Cork Region commuter rail assumes no new infrastructure resulting from CMATS, in the absence of the CACR Programme i.e. no new through running platform at Kent station, double tracking of Glounthaune-Midleton, or re-signalling.

Similar assumptions are true for power and fleet, so there would be no decarbonisation of the services through alternative power supply or introduction of additional trainsets.

4.2.2 Service Plan

The Do-Minimum rail service plan[2] (including train stock type) and run time assumptions have been provided by IÉ and are shown in Table 4-2 and Table 4-3.

Table 4-2: Do Minimum Rail Service Plan

Corridor	Stock Type	AM Peak			Lunch Time (LT)	School Run (SR)	PM Peak		
		7am-8am	8am-9am	9am-10am	10am-1pm	1pm-4pm	4pm-5pm	5pm-6pm	6pm-7pm
EASTBOUND/SOUTHBOUND									
Mallow – Kent	2X2600	1	1	-	-	-	-	1	-
Mallow – Kent	4 ICR	-	1	-	-	-	-	-	-
Kent – Midleton	2X2600	2	2	1	3	3	1	2	1
Kent – Cobh	2X2600	1	1	1	3	3	1	1	1
Kent – Cobh	4X2600	1	1	-	-	-	1	1	1
Dublin – Kent (Intercity)	7 ICR	-	-	1	3	3	1	1	1
Mallow – Kent (Intercity)	7 ICR	-	1	-	-	-	-	-	-
WESTBOUND/NORTHBOUND									
Kent – Mallow	2X2600	-	-	-	-	-	1	-	2
Kent – Mallow	4 ICR	-	1	-	-	-	-	-	-
Midleton – Kent	2X2600	2	2	2	3	3	1	1	2
Cobh – Kent	2X2600	1	1	1	3	3	1	1	1
Cobh – Kent	4X2600	1	1	1	-	-	-	1	1
Kent – Dublin (Intercity)	7 ICR	1	-	1	3	3	1	1	1
Kent – Tralee (Intercity)	7 ICR	-	1	-	-	-	-	-	-

Table 4-3: Do Minimum Rail Run Times

Station A to B	Run time (mins)	Dwell time (mins)
Mallow to Kent	18.88	-
Kent to Little Island	6.1	1
Little Island to Glounthaune	2.1	0.5
Glounthaune to Carrigtwohill	3.82	1
Carrigtwohill to Midleton	5.25	0.5

[2] Based on a point in time **before** the schedule change in the summer of 2022 that brought in 30 mins off peak as well as during peak

Station A to B	Run time (mins)	Dwell time (mins)
Glounthaune to Fota	3.75	1
Fota to Carrigaloe	2.94	0.5
Carrigaloe to Rushbrooke	2.31	0.5
Rushbrooke to Cobh	1.73	0.5

4.3 BusConnects

The BusConnects programme will be included forming the network shown in Figure 4-1 and comprising the following service coverage improvements:

- A Core Radial Bus Network with nine routes on which most routes operate at a minimum 15-minute frequency
- An Orbital Bus Network comprising four services
- Supporting radial bus services

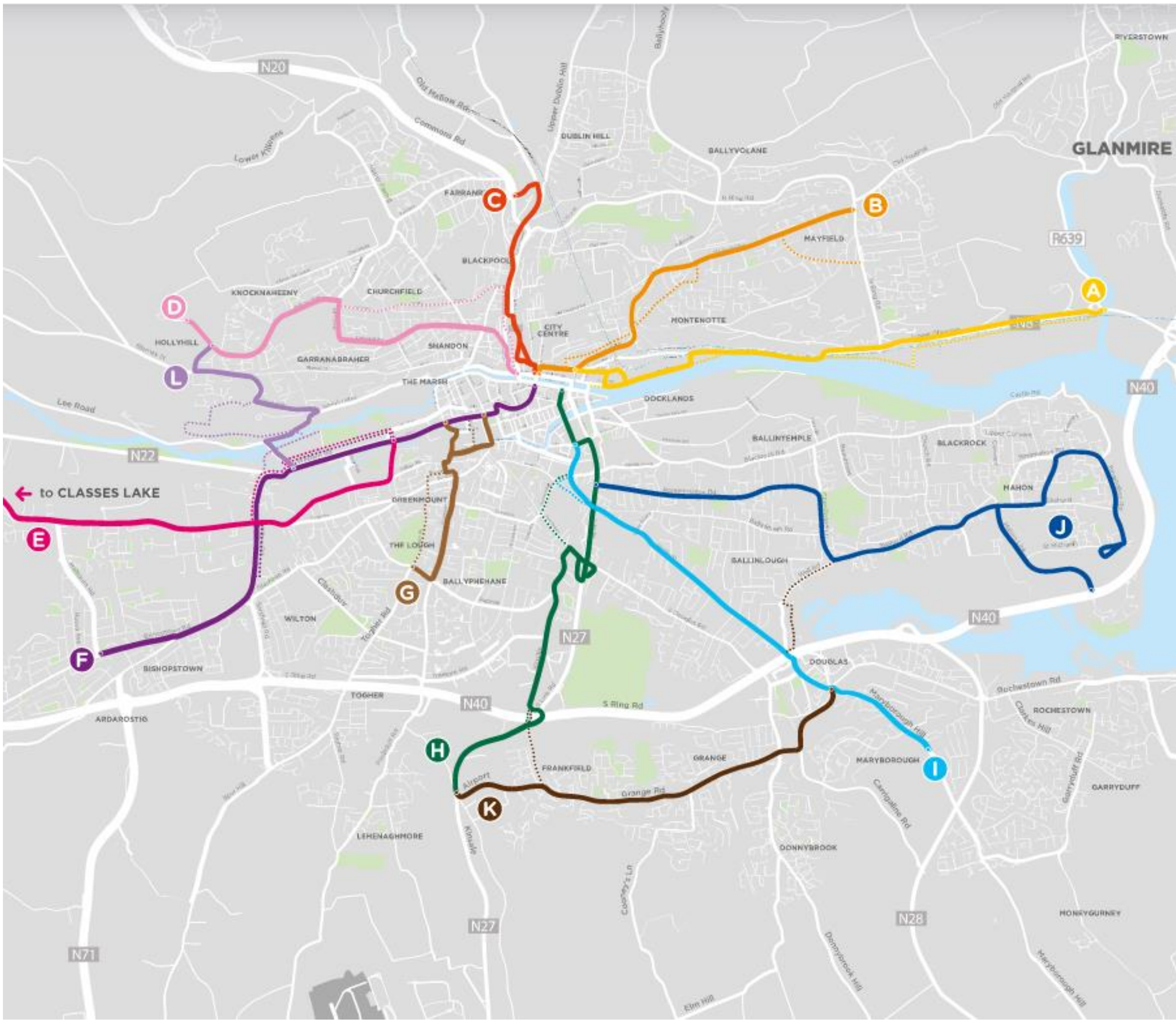

Figure 4-1: 12 Sustainable Transport Corridors
(Source: BusConnects Cork – Sustainable Transport Corridors Report, April 2022)

4.4 Light Rail

The CMATS proposed east-west light rail service is shown in Figure 4-2. The scheme includes an estimated journey time of 47 minutes with a headway of five minutes and an hourly capacity of 4,600 passengers per hour per direction. It was not included in the Do Minimum for 2030 but was included in the Dynamic scenario modelling for 2050.

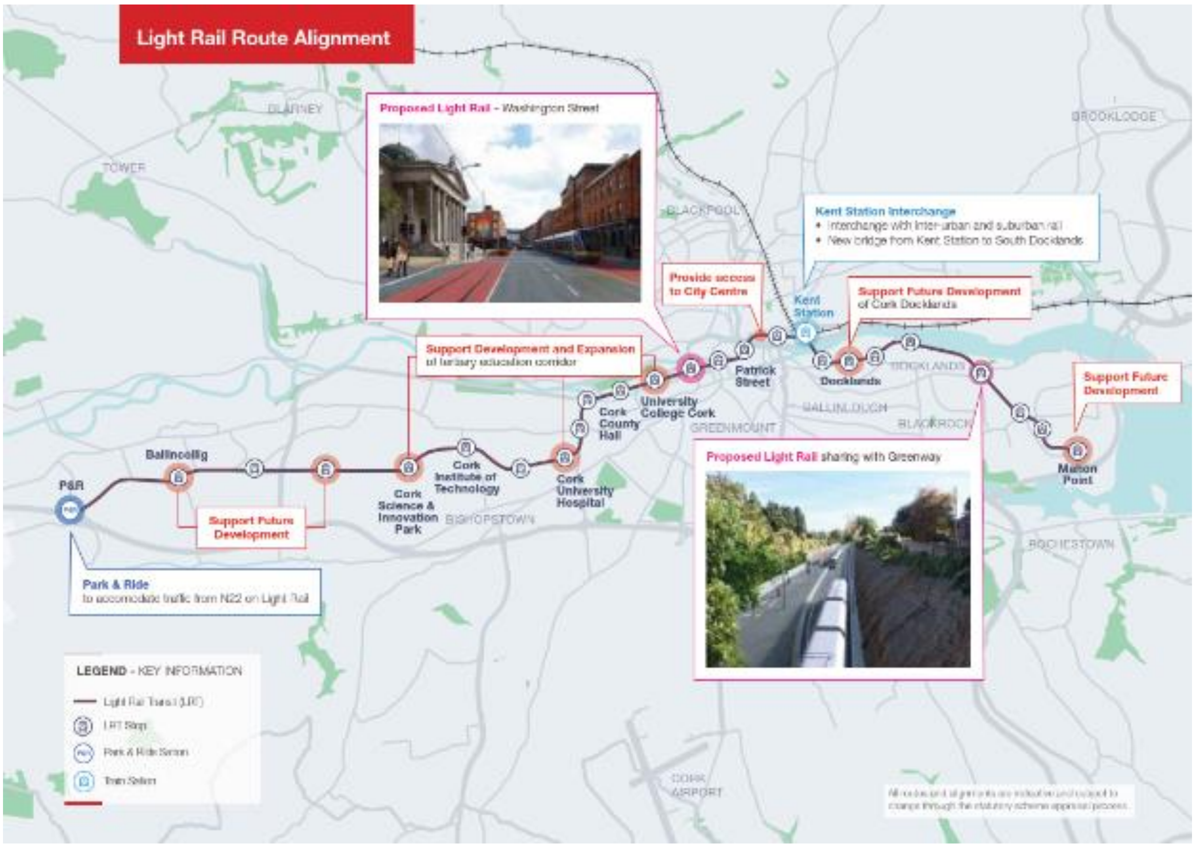

Figure 4-2: Light Rail Route Alignment *(Source: Cork Metropolitan Area Transport Strategy)*

5. Power and Fleet Options

5.1 Approach

A new fleet for the CACR Programme will be required to replace the 2600 diesel multiple unit (DMU) fleet currently operating in Cork and to cater for the increases in demand forecast. The type of traction deployed will have a significant impact on the number of train services that can be delivered and the benefits the network will generate.

The assessment of power and fleet options for the CACR Programme employed a two-stage sifting process (as shown in Figure 5-1) to determine the performance of the options considered. A matrix of options was identified that included combinations of different network power and rolling stock types.

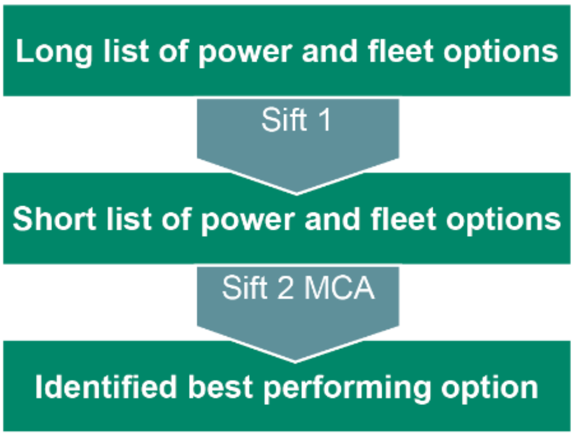

Figure 5-1: Power and Fleet Options Assessment Process

5.2 Power and Fleet Options

An initial long list of six options was identified which included alternatives for the development of a conventional electrified system which utilises EMU (electric multiple unit) vehicles and OLE (overhead line equipment), BEMU (battery electric multiple units) based systems reliant on the static charging of vehicles, hybrid systems which attempt to charge BEMU vehicles dynamically during service operations and finally, a system which is based on hydrogen powered rolling stock.

- Option 1-1500V DC EMU with OLE: Conventional Electric Multiple Units (EMU's) operating within a fully electrified 1500V DC network.
- Option 2-25kV AC EMU with OLE: Conventional Electric Multiple Units (EMU's) operating within a fully electrified 25kV AC network.
- Option 3-BEMU 1500V DC: Option 3 includes the development of a network where services are solely provided by BEMUs. In this option, vehicle charging is provided at Mallow, Blarney, Kent and Midleton, as well as within the depot.
- Option 4-BEMU 25kV AC: In this option 25kV AC battery charging is considered at the same locations as identified in Option 3.
- Option 5-Dynamic BEMU with limited OLE: Option 5 use BEMU vehicles however, unlike Option 2, charging takes place while the vehicles are in motion via a limited section of OLE.
- Option 6-Hydrogen: In this option electricity is produced by a hydrogen fuel cell onboard the vehicle.

This long list was rationalised during the Sift 1 stage based on an assessment of option viability and technical feasibility. The resultant short list of options, presented in Table 5-1, was then subjected to MCA to identify the best performing option for the CACR programme.

Table 5-1: Power and Fleet Sift 1 Summary

Options	Advantage	Disadvantage	Short List / MCA
Option 1: 1500V DC EMU with OLE	IE have significant experience with 1500V DC systems which would help streamline the introduction and operation of electrified services in Cork.	The development of OLE is expensive and is at risk of challenge during the Railway Order process.	✓
Option 2: 25kV AC EMU with OLE	Should the Dublin to Cork line be electrified at some point in the further, Option 2 would ensure alignment of the OLE systems.	Even more than Option 1, the development of 25kV OLE systems is expensive and increases the risk of challenge during the Railway Order planning process.	✓
Option 3: BEMU 1500V DC	Option 3 eliminates the need for bridge modifications across the Cork commuter network and enables the introduction of electrified services without OLE equipment across the network.	Services are reliant on battery charging at termini station. BEMU vehicles are more expensive than EMU vehicle and require a larger fleet to operate the service.	✓
Option 4: BEMU 25kV AC	Option 4 eliminates the need for bridge modifications across the Cork commuter network and enables the introduction of electrified services without OLE equipment across the network.	Option 4 requires additional intermediary steps and onboard equipment to rectify AC current for battery charging, adding cost and complexity. Where AC battery charging systems have been deployed it has typically been where AC OLE is already available. In the absence of existing AC OLE Option 4 is not an effective solution.	×
Option 5: Dynamic BEMU with limited OLE	This option reduces the number of bridges which require modification to facilitate OLE. This options also allows vehicles to be charged while operating in service.	Option 5 requires the modification of some bridges and the development of a limited section of OLE between Blarney and Glounthaune which increases the risks during planning. It also relies on BEMU rolling stock which are more expensive than EMUs.	✓
Option 6: Hydrogen	A Hydrogen would allow for zero emission vehicles to be deployed without the need to develop OLE equipment.	This technology is not at a point where it is commercially available for large scale passenger services.	×

For further detail refer to the Power and Fleet Options Assessment CACR-REP-ACM-ROL-0001 dated June 2022.

5.3 Multi Criteria Analysis

A multi-criteria analysis (MCA) was carried out on the options described in this section. The MCA provides the framework for the assessment of options and the identification of a best performing option. The MCA brings together all aspects of the assessment to allow for a structured comparative analysis of options.

The criteria referenced within the MCA were developed within the context of the Department of Transport's Common Appraisal Framework. These criteria (see Table 5-2) reflect the key factors which differentiate the performance of each of the options.

Table 5-2: MCA Assessment Criteria aligned to CAF

CAF Criteria	MCA Assessment Criteria
Economy	1. Capital costs 2. Operational expenditure (Opex)
Safety	3. Safety
Physical Activity	NA
Environment	4. Planning and environment
Accessibility and Social Inclusion	NA
Integration	5. Operational Impact *(Incorporating: Impact on future electrification of Dublin-Cork, Operational Flexibility, Network Flexibility)*

The comparative assessment has been undertaken against the five-point scale shown in Table 5-3.

Table 5-3: MCA Scoring System

	Significant comparative advantage over other options
	Some comparative advantage over other options
	Comparable to other options
	Some comparative disadvantage over other options
	Significant comparative disadvantage over other options

Results of the comparative assessment have been applied in accordance with the MCA methodology discussed in Section 7. The scores for individual assessment criteria have been weighted evenly and combined to give an overall MCA rating for each option as shown in Table 5-4.

Table 5-4: Summary of Power and Fleet MCA Scoring

Options	Capital Cost	Operating Cost	Safety	Planning & Environment	Integration	Overall Rating
Option 1: 1500V DC EMU with OLE						
Option 2: 25kV AC EMU with OLE						
Option 3: 1500V DC BEMU						
Option 5: Dynamic						

For further detail refer to the Power and Fleet Options Assessment CACR-REP-ACM-ROL-0001 dated June 2022.

5.4 Power and Fleet Option Selection

5.4.1 Preferred option

Based on the MCA undertaken and summarised in Table 5-4, Option 3 has is the best performing option for the CACR Programme due the reduced risk during the planning and delivery phases and improved safety over the other options considered. Also, while the capital cost of Option 3 is similar to Option 5, it is considerably less expensive than Options 1 and 2 while having comparable operational costs to Options 2 and 5.

Option 3 includes the development of a service network based on BEMUs supported by a network of battery chargers at Mallow, Blarney, Kent and Midleton, as shown in Figure 5-2, and within the depot.

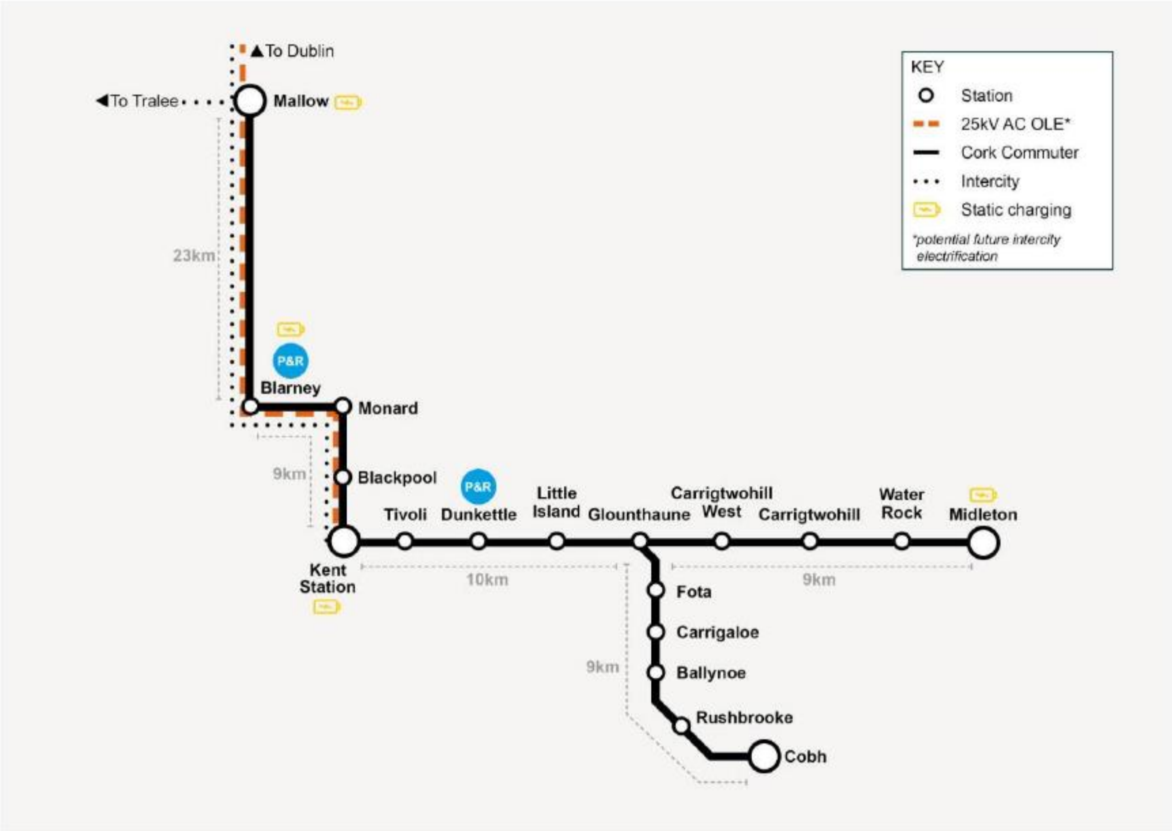

Figure 5-2: Option 3 1500V DC BEMU Network

5.4.2 Cost Considerations

While Option 3 requires the development of BEMU supporting infrastructure and a network of battery chargers, when bridge modification costs and rolling stock are considered the overall cost for Option 3 is lower than the other options. Its overall cost is €32m lower than the next lowest cost option, Option 5, and €241m less than the highest cost option, Option 2.

The infrastructure costs for Option 3 are up to €278m lower than the most expensive infrastructure option, Option 2, due to a reduction in the number of bridges which require modification compared with the options which require OLE. The avoidance of OLE infrastructure also reduces operational costs by up to €176 million over the life of the asset.

Due to the premium associated with BEMU vehicles, Option 3 has the highest fleet cost by up to €57m. The summary of the primary differential capital cost is presented on the following Table 5-5 and in Appendix B.

Table 5-5: Summary of the Primary Differential Capital Cost

	Option 1 1500V DC EMU with OLE	Option 2 25kV AC EMU with OLE	Option 3 1500V DC BEMU	Option 5 Dynamic BEMU
Civil works	79	158	25	32
Electrification costs	162	101	87	101
Planning, Design & EIS	19	21	7	11
Project/Construction Management	22	24	10	12
Additional Land & Property Costs	0.4	0.2	-	0.3
Risk Contingency (40%)	113	122	52	62
Total Infrastructure Costs (ex vat)	396	426	181	218
Total Infrastructure Costs (incl vat)	450	483	205	248
Fleet costs (€m) (incl vat)	211	231	268	258
Total Cost	€ 661m	€ 714m	€ 473m	€ 505m

5.4.3 Environmental Considerations

Option 3 is attractive due to the reduced impact the scheme would have on the communities and environment adjacent to the line during construction and operations as only limited sections of OLE are needed for battery charging compared to the extensive construction of OLE required for Option 1, 2 and 5. The reduced impact reduces the risk of challenge to the Railway Order application. Therefore, it is likely that Option 3 could be delivered more quickly than options which include extensive OLE.

Unlike the other options, Option 3 does not require significant sections of high voltage OLE infrastructure to be developed across the network. The presence of the high voltage power lines would introduce new safety risks to staff and the local community. These would need to be mitigated and managed over the life of the project to avoid safety incidents. As extensive OLE is not required for Option 3, it presents less risk than Options 1, 2 and 5.

5.4.4 Flexibility advantages

Option 3 can be developed to avoid additional technical constraints on future plans for the development of an alternative power source for Intercity services, be this electrification or otherwise. The 1500V DC static charging system, proposed as part of this Option 3, can be designed to be isolated and operated in parallel with the Intercity network This would allow for a 1500V DC BEMU system to operate alongside 25 kV AC Intercity services on the same sections of track.

Additionally, a BEMU network would give IÉ the flexibility to extend services beyond the commuter network in future. For example, services could potentially be extended to Charleville from Mallow without the need for additional charging facilities. While this too may require additional investment and approval as well as consideration of charging time within the operational timetable, the scale of development would be significantly less than the development of an extended OLE solution.

Further information on this options assessment process is contained in the 'Power and Fleet Options Assessment' report, CACR-REP-ACM-ROL-0001, provided separately.

6. Infrastructure Common to Do Something Options

CACR requires infrastructure improvements to allow for new stations, increased service frequency, longer trains, through-running at Kent station and other CACR objectives. Figure 6-1 shows a summary of the infrastructure improvements, which are described in the rest of Section 6. Nearly all the infrastructure improvements required to the network are common to the three timetable options which are described in Section 7. As discussed in the Scheme Feasibility Report[3], all infrastructure defined for CACR has taken consideration of service perturbation and provided infrastructure to mitigate such service disruptions.

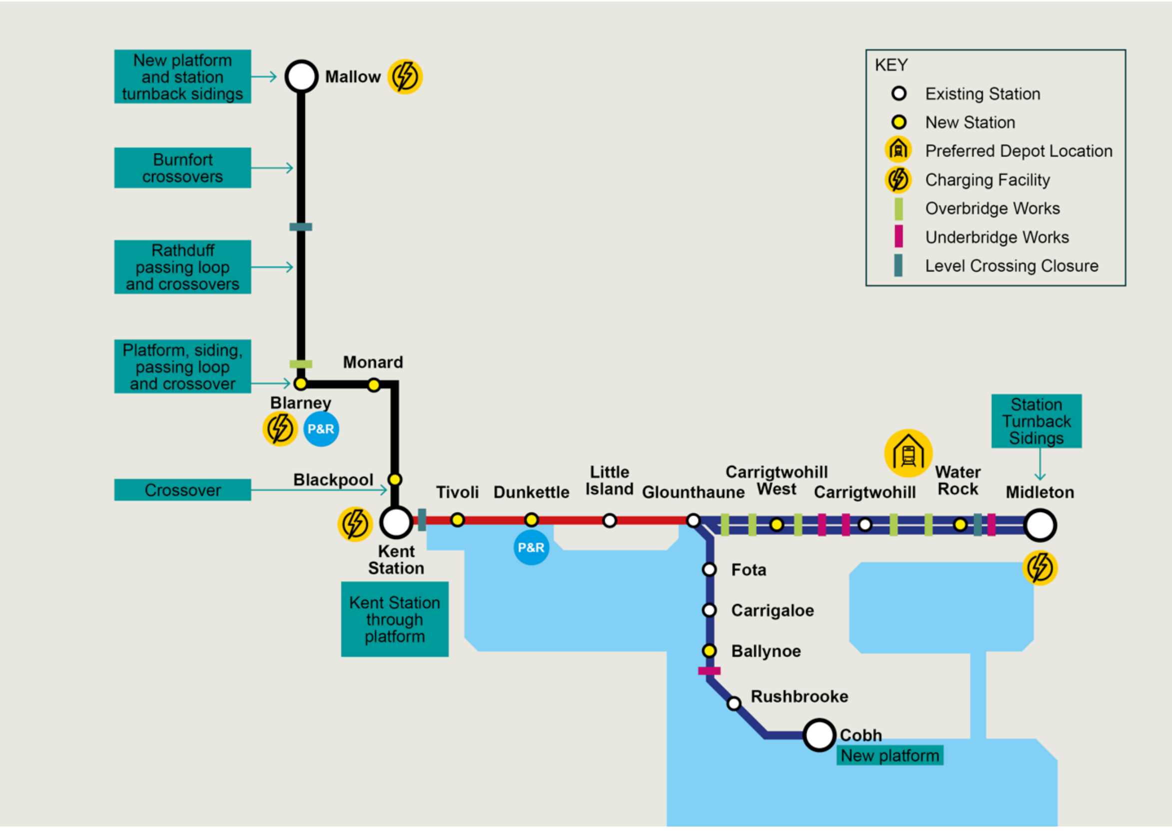

Figure 6-1: Infrastructure Interventions

Appendix C to Appendix E describe any additional infrastructure required for either TSS1, TSS2 or TSS2a respectively. TSS Report (CACR-XX-XX-TN-ACM-OPS-0001) provides additional detail regarding the infrastructure.

6.1 New Stations

The new stations proposed are at Blarney, Monard, Blackpool/Kilbarry, Tivoli, Dunkettle, Ballynoe, Carrigtwohill West and Water-Rock:

The majority of the new stations have been the subject of ongoing design development, consultation and stakeholder engagement prior to the commencement of the Phase 2 study. In some cases, the station concepts had already proceeded to planning (e.g., Blackpool/Kilbarry, Carrigtwohill West and Dunkettle) based on a substantial previous study and consultation. Those that had not advanced to the planning stage (e.g., Blarney, Monard, Tivoli and Water-Rock) had been subject to extensive consideration between IÉ and stakeholders such as Cork City and County Councils, NTA and developers. The substantial body of work already undertaken at these sites was taken as the starting basis for the concept design. Deviations were proposed where existing open issues had to be

3

considered or where the previous work was no longer consistent with the agreed station design principles.

The location of each new station has been the subject of engagement with both Cork City and County Councils. Each new station has site-specific constraints and opportunities which have been assessed throughout the concept design process.

Details about the specific site considerations, options and possible variants for each station are described in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002). Concept designs have been developed for each of these new stations based on an agreed set of station design principles as set out in separate report CACR Station Design Principles (CACR-XX-XX-REP-ACM-AR-0001) and in consideration of the any operational or resilience requirements arising from the TSS assessment. The concept designs consist of 2-dimensional plan drawings at 1:200 showing the stations and access points, coordinated with existing/proposed track alignment and platform positions. The concept design found that it is feasible to provide a station at all locations.

6.2 Existing Stations

Infrastructure improvements are required at four of the existing stations to deliver the TSS options. Improvements are required at these sites as summarised in Figure 6-1. Details about the specific site considerations, options and possible variants for each are set in detail in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

6.3 Car Parking and Access

A Station Access and Parking Strategy (CACR-XX-XX-REP-ACM-HW-0001) has been developed for CACR which considers the parking and access requirements for the eight new stations, and the parking provisions at all the existing stations.

Concept designs have been developed for parking and access at each of the new stations as set out in that document and as summarised in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002). They include proposals for mobility impaired motorists so that they have a short and safe route from parking to the station entrance and proposals to promote sustainable travel to the stations.

Blarney and Dunkettle stations are to be developed as Strategic Park and Ride (SPR) facilities as defined in the NTA Strategy. The six remaining stations will be developed as Local Park and Ride as defined by the NTA and serve local parking requirements only.

6.4 Sidings, Passing Loops, Double Tracking and other Track Improvements

Track improvements are required to either deliver the proposed timetables or to provide resilience of operation. They are required at each of the eight new stations and at some of the existing stations, as shown in Figure 6-1. These track improvements relate to reconfiguration of the railway to provide suitable horizontal and vertical geometry for platforms, to provide crossovers and turnouts and to provide sidings and turn backs. It is a requirement that the Glounthaune to Midleton section of the network is upgraded to double track for the entire section. Track improvements are also required away from the stations in some instances, to provide operational resilience and flexibility.

Details about the specific site considerations, options and possible variants for each of the track improvements are set out in detail in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

6.5 Bridges and Structures

Amendments are required to existing structures or provision of new structures which are mostly related to the other improvements listed in the previous sections. The following structural improvements are required:

- Overbridge replacements: required to achieve horizontal clearance for double tracking on the Midleton branch, and an overbridge replacement required at Blarney to accommodate the passing loop
- Under-bridges and Culvert replacement or extension: required to accommodate double tracking on the Midleton branch
- New and amended retaining structures: required to accommodate double tracking on the Midleton branch, at the O´Regan´s road bridge, and for the new through platform at Kent Station
- New Platforms, new footbridges and other station structures (e.g., shelters): required at each of the eight new stations. New overbridges required at each new station and at Kent
- Amended station footbridge: required at Mallow to extend the footbridge to a new fourth platform
- Amended road bridge: required at O´Regan´s bridge to provide alternative access to Mertyl Hill due to the level crossing closure
- Relocated Signalling, Electrical and Telecommunications (SET) structures: required to accommodate double tracking on the Midleton branch. This includes SET ducting, poles, signs gantries and cabins
- New SET structures: required for re-signalling (e.g., cable routes, poles, gantries etc.), electrification substations and overhead fix bar contact structures for charging of the trains at each of the proposed charging locations
- Power supply structures: required to provide a power route from the closest 110kv AC substations to each of the proposed charging locations. This is to be determined by the power supplier but could be a mix of overhead cables with associated tower supports or buried underground cable routes

Details about the specific locations of each of these infrastructure elements including detail of specific site considerations, options and possible variants for each are set out in detail in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

6.6 Signalling

Signalling improvements are required to either deliver the proposed timetables or to provide resilience of operation. They are required in the section from Mallow to Glounthaune to cater for the planned service headways. Additional signalling improvements are required at the new and existing stations. They are needed where improvements are required along the Midleton branch for double tracking and in the section from Blarney to Mallow for operational resilience. A summary of the signalling improvements required are:

- Provision of new lineside signalling infrastructure (signals, cabling, cable containment, equipment housings, etc.) on the existing track configuration to cater for the proposed headways and ETCS Level 1
- Station re-signalling at Mallow, Kent, Cobh and Midleton for new track configurations
- New bi-directional signalling between Blarney and Mallow
- New station signalling for the eight new stations
- New passing loop signalling at Rathduff and Blarney passing loops
- New crossover signalling at new crossovers at Burnfort, Blarney, Blackpool and Ballyrichard

Details about the possible signalling upgrades and interventions are provided in CACR Signalling Technical Note (CACR-XX-XX-REP-ACM-SIG-0001).

There are a total of six existing level crossings on the network. Three of the crossings are on the Mallow to Cobh line and three are on the Glounthaune to Midleton branch. It is not proposed to introduce any new level crossings as part of the CACR Programme. A summary of the proposals for each of the six existing level crossings are:

- XC229 Buckley crossing to be formally closed

- XC238 Myrtle Hill CCTV level crossing to be closed and new access to Myrtle Hill Terrace to be provided from OBC409A O´Regan´s Bridge
- XC249 Fota Estate crossing to be maintained and opportunities to enhance the safety features at this crossing to be investigated
- XY009 Water Rock CCTV level crossing to remain operational with modification to accommodate the additional track for the Midleton branch double tracking
- XY010 Ford CCTV level crossing be closed
- XY012 Mill Road, R626 CCTV level crossing to be maintained.

Further details are given in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

6.7 Electrification

The electrification for the Mallow, Blarney, Kent and Midleton stations will be a 4 x 2MW Traction Transformer substation fed by a 110kV supply with fixed bar contact charging. At the depot, the electrification will have an overhead wire contact charging system instead of the fixed bar. The differences on the electrification amongst the above stations are the following:

- Mallow Station: substation coincident to the train pantograph in 2 sidings and 2 platforms
- Blarney Station: substation coincident to the train pantograph in 1 siding and 1 platform
- Kent Station: substation coincident to the train pantograph in 3 platforms
- Midleton Station: substation coincident to the train pantograph in 2 platforms and 1 siding

Details about the specific locations of each of these infrastructure elements including detail of specific site considerations, options and possible variants for each are set out in detail in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

At each of the charging sites, electrical power feeders will have to be provided from the nearest 110kV grid substation to the Traction Power Substation (TPSS) sites. The exact power feeding arrangements will have to be agreed with the supplier (EirGrid). The approximate distance from the closest 110kV substation to the above site shas been identified as follows:

- Mallow station – Mallow Power Station: 2400m
- Blarney station – Kilbarry Power Station: 6000m
- Kent station – Marina Power Station: 800m (other side of the River Lee)
- Midleton station – Midleton Power Station: 2000m
- Depot – Cow Cross Power station: 1800m

6.8 Depot and Stabling

A number of possible depot sites were identified and developed based on the fleet and stabling requirements. The details of the site identification process, the development of site layouts, the consideration of issues and constraints and the assessment of each of the identified sites is set out in a separate report, the Phase 2 Depot and Stabling Strategy (CACR-XX-XX-REP-ACM-ROL-0002).

In summary, six possible sites have been identified, developed and assessed and a preferred site at Ballyrichard More has been selected as the most feasible site for a CACR Programme depot. The depot is intended to cater for the maintenance of the entire new fleet of BEMU rolling stock for CACR Programme, which has been estimated at up to 28 trains. The stabling strategy proposes that eight of the trains will overnight stable outside the depot at Mallow (two trains), Kent (four trains) and Midleton (two trains). The stabling area in the depot will therefore accommodate up to 20 trains overnight.

A concept layout for the Ballyrichard More site has been developed and is presented in detail in the CACR Scheme Feasibility Report (CACR-XX-XX-REP-ACM-DM-0002).

7. Service Improvement Options

7.1 Timetable Options

At the SAR stage, an initial long list of options were shortlisted following clear direction from Irish Rail to resolve issues and choices relating to:

- A Cobh or Midleton to Glounthaune shuttle service was ruled out as unacceptable because it would be a deterioration on today's connectivity.
- Prioritisation of Cobh, Midleton, or both, for through service to Kent or beyond: it was agreed for Midleton to have priority over Cobh for through services, due to higher demand coming from a larger catchment area, but the option of Cobh through services at Kent was retained for further examination
- The frequency of suburban trains to Mallow: it was agreed that six suburban trains per hour plus the Intercity service would be an over-provision, but options of two and four services per hour to Mallow were retained for further examination
- Intercity services stopping at Blarney (for park and ride) was ruled out given need to minimise journey times on key Cork (Kent)-Dublin services
- A Blarney-Mallow shuttle was ruled out as operationally complex with little passenger benefit.

Two issues remained which were the focus for subsequent optioneering:

- Prioritisation of Midleton, or both Cobh and Midleton, for through service beyond Kent
- Optimal suburban service provision at Mallow which is a significant distance from the rest of the network (see Figure 7-1)

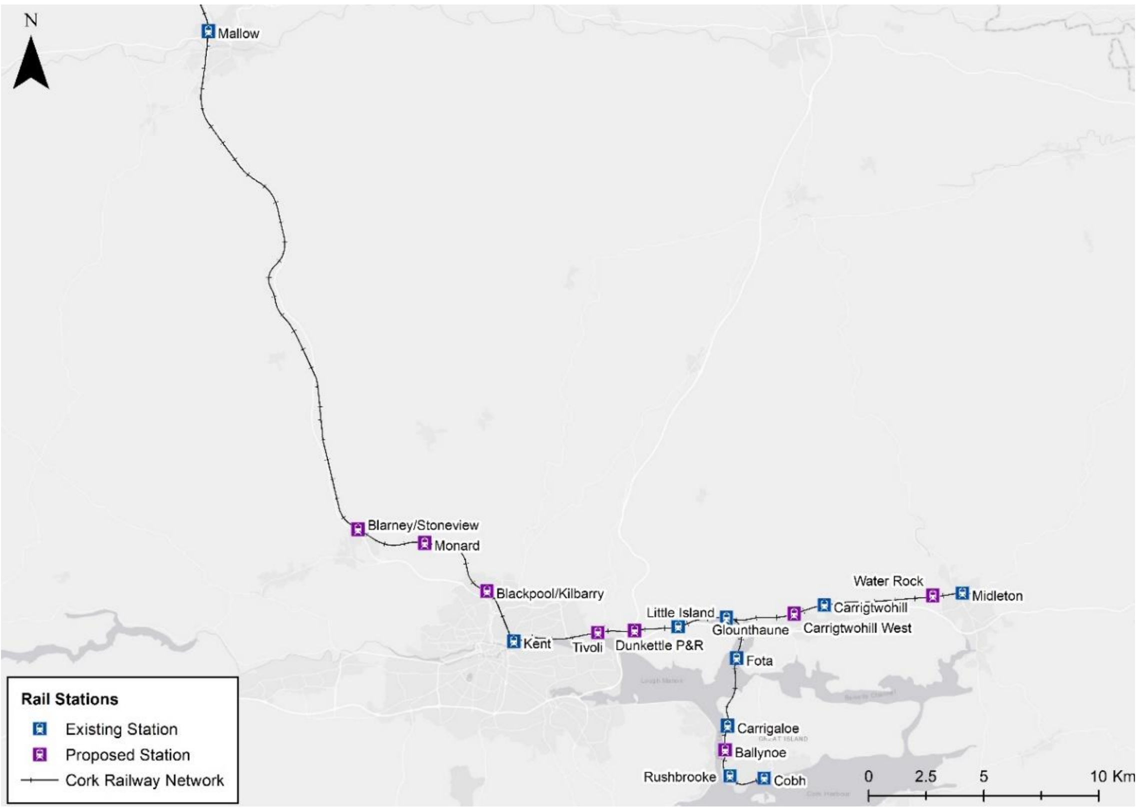

Figure 7-1: Existing and Proposed Stations

Figure 7-2 explains the detailed analytical process to identify the Train Service Specification (TSS) options that would provide the 10-minute service. A set of assumptions was developed, and data was gathered in collaboration with IÉ to produce the station-to-station journey times and the TSS options. The options were assessed, including a validation and a sensitivity analysis exercise, and finally, the following elements were developed.

- Timetables
- Turnaround and charging strategy
- Operational flexibility requirements
- Fleet size
- Infrastructure requirements

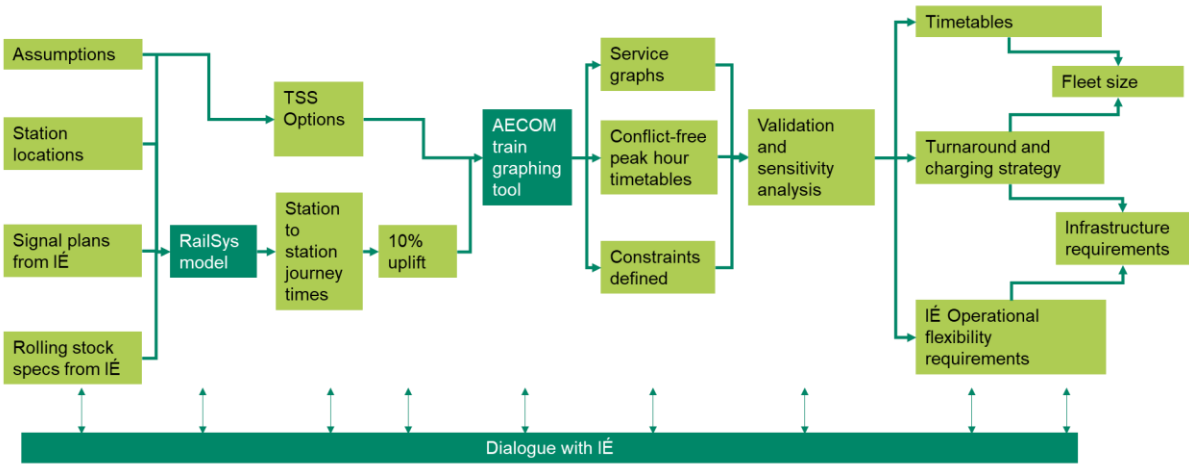

Figure 7-2: Analytical Methodology

This focus resulted in three options which may have implications for the fleet requirement, infrastructure requirements and the associated costs and benefits. These are shown in Figure 7-3 and Table 7-1. The infrastructure interventions required to deliver each TSS have been developed in parallel (see Section 6).

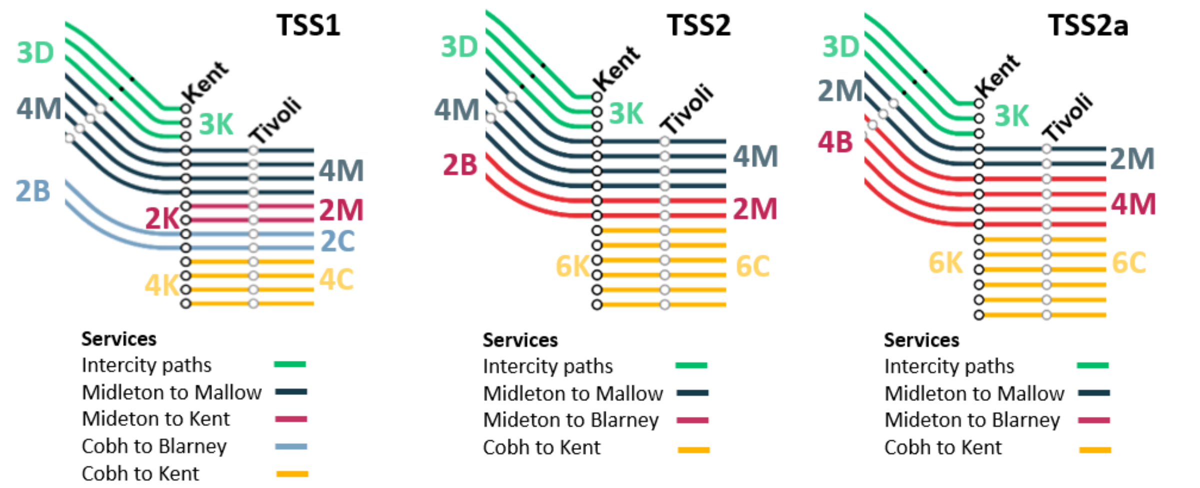

Figure 7-3: TSS Options

Table 7-1: TSS Shortlisted Options Summary

Option	TSS1	TSS2	TSS2a
Positive features	Consistent with CMATS principles (six tph; cross city from Cobh)	Significant improvements in services for passengers from Cobh, in comparison to Do-Minimum, while through services are operating on the corridor with the greatest potential for economic and population growth (Mallow-Midleton)	
		Consistent O&D patterns for CACR services	Realistic alignment with demand north of Blarney Infrastructure allows for scale up of commuter services to Mallow if required
Negative features	Irregular interval between Kent and Blarney or a wait at Kent	Interchange necessary from Cobh branch to west of Kent	
		3rd turnback facility and charger in Mallow	Reduced service to Mallow

Each TSS is presented in detail in Appendix C to Appendix E, and further detail can be found in the TSS Technical Note, ref CACR-XX-XX-TN-ACM-OPS-0001.

7.2 TSS Options Assessment Approach

This section provides a summary of the methodology and inputs to develop the overall assessment. The outcomes are outlined in Appendix C to Appendix E for each TSS option.

7.2.1 Demand Modelling

The Modelling Assumption Note, dated September 2021, provides detailed descriptions of the transport network and land-use assumptions underpinning the transport modelling.

The South-West Regional Model (SWRM) is one of five transport demand models in the NTA's Regional Modelling System and includes Cork and its surrounding commuting area. The full extent of the SWRM is shown in Figure 7-4, it is notable that the CACR area is a small part of the total modelled area. SWRM includes all surface access modes for personal travel and goods vehicles, including private vehicles (taxis and cars), public transport (bus, rail, light rail), active modes (walking and cycling) and goods vehicles (light goods vehicles and heavy goods vehicles). The model covers the AM (07-10:00), Lunchtime (LT, 10-13:00), School Run (SR, 13-16:00) and PM (16-19:00) periods.

SWRM is a multi-modal tour model and consists of four input elements, as follows:

- Public Transport (PT) Model – (e.g., rail/bus/light rail services and separate P&R module)
- Walking and Cycling Model
- Highway Model – (e.g., road links/junctions and parking model) and
- Demand Model – Total transport demand is taken from the National Demand Forecasting Model (NDFM) which outputs travel demand to the SWRM for iteration through the choice, destination and assignment modules. The demand in the NDFM is built up based on the Census of Anonymised Records (CSO POWSCAR), NTA Household Travel Surveys, Transport Surveys and other transport related datasets. During the model run, mode and destination choices are undertaken based on current costs for each mode for each origin and destination pair.

Figure 7-4: SWRM Extent

Scenarios have been developed within SWRM based on the CMATS. The demand projections in these scenarios take account of employment, population and education projections at Small Area level. SWRM assesses the impact of interventions on people's travel choices in relation to time of travel, mode of travel and route of travel.

For the CACR programme, SWRM forecasts the overall modal share, boarding and alighting movements at each station, relative impact on the road network, giving a basis to evaluate the proposed measures. Three service plan options for the CACR Programme have been tested against two alternative Do-Minimum (Standard and Dynamic) scenarios, for both an opening year (2030) and future design year (2050) by using the SWRM. The Standard scenarios include only funded and committed transport schemes in the CMA and surrounding region. The Dynamic scenarios includes projects outlined within the CMATS in addition to those projects included in the Standard scenarios. The forecast demand for each TSS option is presented in Appendix C to Appendix E.

7.2.2 Cost Estimates

Cost estimates for the options were developed based on the Concept Designs outlined in the Scheme Feasibility Report, ref: CACR-XX-XX-REP-ACM-DM-0002. As the infrastructure requirements for each of the options are similar as presented in Section 5, a single cost estimate has been developed. Details of the cost estimate can be found in the Preliminary Cost Estimate Report, ref; CACR-XX-XX-REP-ACM-QS-0001, dated November 2021. The cost estimate has been prepared in accordance with the NTA Cost Management Guidelines and includes the costs associated with:

- New stations including car parks, access arrangements and associated works
- Alteration works at stations
- Depot development
- Double tracking of rail from Glounthaune to Midleton
- Rathduff passing loop
- Signalling enhancements
- Closure of Myrtle Hill Level crossing
- New sidings at Mallow, Blarney, Midleton
- BEMU fleet
- Electrical works for BEMU charging

Estimates for fleet were based actual from the DART+ BEMU fleet contract with fleet costs for each option adjusted to reflect differences in fleet size requirements. A contingency of three additional trainsets was allowed.

An estimate for the replacement of existing overbridges and track lowering to facilitate Overhead Line Equipment (OLE) on the Cork Area Commuter Rail network has been completed separately, ref CACR-XX-XX-SC-ACM-QS-0001, dated November 2021.

The cost estimate is based on the following key assumptions:

1. Works have been priced on the basis of working in normal hours except where specific allowances have been made
2. Cost Basis is Q1 2021, and 25% escalation is included based on a 2027 midpoint
3. Risk allowances are informed by the factors applied in the NTA Contingency Calculator. 40% risk has been applied in all cases
4. All rates are based on various recent railway infrastructure projects, rate build ups, market available rates or price books, as appropriate

The estimate is an AACE class 4 estimate, as defined by the stage of design development during which the estimate has been prepared, see Figure 7-5 for details.

				Expected Range of Accuracy		
AACE Class	ANSI Classification	Typical Use	Project Definition	Low Expected Actual Cost	High Expected Actual Cost	Other Terms
Class 5	Order-of-Magnitude	Strategic Planning; Concept Screening	0% to 2%	-50% to -20%	+30% to +100%	ROM; Ballpark; Blue Sky; Ratio
Class 4		Feasibility Study	1% to 15%	-30% to -15%	+20% to +50%	Feasibility; Top-down; Screening; Pre-design
Class 3	Budgetary	Budgeting	10% to 40%	-20% to -10%	+10% to +30%	Budget; Basic Engineering Phase; Semi-detailed
Class 2	Definitive	Bidding; Project Controls; Change Management	30% to 75%	-15% to -5%	+5% to +20%	Engineering; Bid; Detailed Control; Forced Detail
Class 1		Bidding; Project Controls; Change Management	65% to 100%	-10% to -3%	+3% to +15%	Bottoms Up; Full Detail; Firm Price

Figure 7-5: AACE Estimate Classes, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries

7.2.3 Economic Benefits

The economic benefits have been calculated based upon standard parameters, available in the PSC and CAF.

At this point it is assumed that the current CAF will form the basis for the appraisal. However, DoT will be engaged with to understand the potential publication date of the updated CAF and the implications of the update for this appraisal. Any potential update to the shadow price of carbon will be considered when known.

The economic variables used in the appraisal were primarily based on values contained in the PSC, CAF and supplemented by values in Unit 6.11 of the TII Project Appraisal Guidelines Unit where a value is not otherwise available.

Some of the main parameters used in the analysis include:

- An appraisal period of 30 years
- A residual value period of a further 30 years
- A test discount rate of 4% for years 0-30 and 3.5% for years 31-60
- A shadow price of public funds of 130% and the shadow price of labour of 100%
- CAF values of time for commuting, business and other trips
- PSC values for the shadow price of carbon
- Fuel consumption parameters from UK WebTAG (necessary for the TUBA software and comparable to CAF parameters)
- Non-fuel costs from CAF
- CO2 emissions factors from CAF
- Vehicle fleet shares by propulsion type subject to availability in CAF.

The analysis assessed 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.)
- Vehicle operating costs
- Net transport operator benefits
- Investment costs
- Operating and maintenance costs
- Revenue
- Grant/subsidy payments

7.2.4 Accessibility and Social Inclusion Assessment

The CACR programme aims to enhance the rail network by providing a more frequent, higher capacity, rail service, to more people. The introduction of new additional stations on the railway network could also provide higher accessibility and connectivity for people. The accessibility and social inclusion assessment focus on the factors affecting people's connection with the rail network based on demographic and deprivation data. The purpose of this assessment is:

- To evaluate the impact of the service frequency and train capacity on the passengers' trips
- To calculate the delivery of a more reliable and efficient railway network
- To measure and then enhance the population within close proximity of the rail
- To identify the socially deprived areas and households with no car ownership for improving their connectivity

Further details on the accessibility and social inclusion analysis and results are presented in Section 7.4 and in Appendix H0.

7.2.5 Environmental Impacts

A robust environmental assessment was conducted for each of the options to identify the preferred options from an environmental perspective, through a structured appraisal process. No significant differences in potential environmental impacts have been identified between the TSS options, since the infrastructure used on all options is almost identical. The main difference is in the number of trains per hour. Further details on the environmental analysis and results are presented in Section 7.4 and in Appendix H0.

7.3 TSS Comparative Assessment

This section provides a comparative assessment summary of each of the TSS options, providing insight a to the outcomes that can be expected from implementation.

In general, all three TSS options score well against the Do Minimum option. Little variance between them was identified, due to the CACR scheme objective to provide a 10-minute service interval.

For further detail as to the individual assessment of each TSS option refer in Appendix C to Appendix E.

7.3.1 Service Plan

A total of 12tph are proposed for each option across the whole CACR network however the patterns differ across the various TSS options.

TSS1 complies with the principles of CMATS in connecting both Cobh and Midleton with direct trains to Blarney/Mallow but has an irregular service pattern between Kent Station and Blarney. Cobh-Kent services charge at Kent, with trains using the three existing bay platforms. Cobh-Blarney services charge at Blarney, while Midleton-Mallow services charge at both termini.

TSS2 meets the CMATS objective with a 10-minute service on each branch and a regular 5-minute frequency between Glounthaune and Kent Stations. Cobh-Kent services charge at Kent, Midleton-Blarney services charge at Midleton and Midleton-Mallow services charge at both termini. The Midleton line is prioritised over the Cobh line for through services because it has the bigger catchment and growth potential owing to the amount of development proposed in that corridor.

TSS2a is a derivation of TSS2 where the service to Mallow is reduced from four to two trains per hour. It has the advantage of requiring a smaller fleet to operate. The option meets the CMATS objective in the same way as TSS2. The charging strategy is the same as TSS2, but the lower frequency at Mallow means that only one turnback/charging siding is required there.

7.3.2 Fleet requirements

The fleet requirement differs slightly between the different TSS options considered.

As shown in Table 7-2, whereas TSS1 and TSS2 require fleets of 25 and 24 trainsets respectively, the fleet requirement for TSS2a reduces to 21 due to the curtailment of some services and the reduction in annual fleet kilometres.

Table 7-2: Fleet Requirements per TSS

Option	Base requirement	10% spares	Trainsets required
TSS1	22	24.2	25
TSS2	21	23.1	24
TSS2a	19	20.9	21

7.3.3 Demand Forecast

A summary of the demand forecast is presented in Appendix F. Data has not been provided for the 2050 Dynamic scenario due to issues with lack of model convergence, as described in the Transport Modelling Report (TMR).

Do Minimum

Due to significant population and employment growth, there is a significant step change in public transport demand between the Base Year and the 2030 Do-Minimum (110,000 additional daily trips across the South West region equating to a 77% increase) which results in an increase in public transport mode share from 7.8% to 11.5%.

In the 2050 Do-Minimum scenario, the step change in public transport demand from the Base Year is significantly greater (197,000 additional daily trips across the South West region equating to a 138% increase) resulting in public transport mode share of 12.5%.

Despite the growth, levels of demand are forecast to be accommodated within available seated capacity in 2030. However, by 2050, capacity utilisation is forecast to be much higher with demand in excess of seated capacity by 60% to 175% between Midleton and Kent in the westbound direction in the AM Peak.

Service improvement options

Each TSS option provides necessary additional service capacity, as well as generating additional demand, relative to the Do-Minimum.

The transformative effect of each TSS option can be seen most clearly in terms of the additional boardings on Irish Rail services, which ranges between approximately 40% and 50% depending on scenario.

This increase in rail boardings translates into:

- An additional 50-100% increase in maximum line demand on the CACR network
- An additional 4-6% increase in daily public transport trips across the South West region
- An additional 0.4-0.8% increase in public transport mode share across the South West region

Despite the significant increase in rail demand with each TSS option, the forecasts show that capacity utilisation will reduce in all options as a result of the additional service capacity provided. All forecast options show that AM Peak demand will be accommodated within seated capacity except Option TSS2a southbound from Mallow to Blarney in 2050.

Table 7-3: Demand Forecast – Comparative Assessment

Analysis Elements	Scenario	Base Year	Do Minimum 2030	Do Minimum 2050	TSS1 2030	TSS1 2050	TSS2 2030	TSS2 2050	TSS2a 2030	TSS2a 2050
Irish Rail Boardings	Standard	14,853	14,151	19,193	20,418	28,576	20,265	28,809	19,484	27,830
	Dynamic	N/A	15,039	-	22,481	-	22,253	-	21,621	-
Public Transport Daily Trips	Standard	142,094	251,860	338,663	261,759	360,599	261,652	357,745	261,504	357,660
	Dynamic	N/A	257,845	-	268,370	-	268,451	-	267,996	-
Public Transport Daily Mode Share	Standard	7.8%	11.5%	12.5%	11.9%	13.3%	11.9%	13.2%	11.9%	13.2%
	Dynamic	N/A	11.7%	-	12.2%	-	12.2%	-	12.1%	-
Maximum Link Passenger Load, AM Peak	Standard	400	600	1,000	1,000	1,600	900	2,000	1,000	1,900
	Dynamic	N/A	600	-	1,100	-	1,100	-	1,100	-
Line Capacity, AM Peak	Standard	Significant spare capacity. No more than 30% of seats utilised	At or just below seated capacity between Midleton and Kent westbound. No more than 50% of seats utilised	Significantly above seated capacity (60-175%) between Midleton and Kent westbound. Otherwise no more than 80% of seats utilised	Significant spare capacity. No more than 50% of seats utilised.	No more than 60% of seated utilised except between Mallow and Kent southbound (80-100% of seats utilised)	Significant spare capacity. No more than 50% of seats utilised.	No more than 75% of seats utilised) except between Mallow and Blarney southbound (90% of seats utilised)	No more than 40% of seats utilised except between Mallow and Blarney southbound (80% of seats utilised)	No more than 70% of seats utilised) except between Carrigtwohill and Glounthaune northbound (90% of seats utilised) and Mallow and Blarney (25% in excess of capacity)
	Dynamic	N/A	At or just below seated capacity between Midleton and Kent westbound. Otherwise no more than 60% of seats utilised	-	Significant spare capacity. No more than 60% of seats utilised.	-	Significant spare capacity. No more than 60% of seats utilised.	-	No more than 50% of seats utilised) except between Mallow and Blarney southbound (90% of seats utilised)	-

7.3.4 Infrastructure Requirements

As shown in Table 7-4, the infrastructure requirements are the same for all the TSS options, with a single minor difference related to TSS2 which requires an additional turnback facility with charging facilities at Mallow.

Table 7-4: Summary of Infrastructure

	Intervention	TSS1	TSS2	TSS2a
Mallow	1 turnback facility, independent of Intercity	√	√	√
	Charging facility in 1 turnback	√	√	√
	2 turnback facilities, independent of Intercity	√	√	√
	Charging facility in 2 turnbacks	√	√	√
	3rd turnback facility, independent of Intercity	-	√	-
	Charging facility in 3rd turnbacks	-	√	-
Mallow to Blarney	Signalling for 3min headway	√	√	√
	Bi-Directional Signalling & Crossovers	√	√	√
	Passing loop at Rathduff	√	√	√
Blarney	New station with offline platform	√	√	√
	Siding Extension of turnback platform	√	√	√
	Passing loop at Blarney	√	√	√
	Charging facility in turnback	√	√	√
	Charging facility in platform	√	√	√
Blarney to Kent	Signalling for 3min headway	√	√	√
	Turnback crossover at Blackpool	√	√	√
Kent	Charging facility in 2 bay platforms	√	√	√
	Charging facility in 3rd bay platform	√	√	√
	Through platform	√	√	√
	Enhanced turnback facility for third Intercity service	√	√	√
Kent to Glounthaune	Signalling for 3min headway	√	√	√
Glounthaune to Midleton	Second track throughout	√	√	√
Glounthaune to Cobh, Midleton	Signalling for 7min headway	√	√	√
Midleton	Charging facility in 2 platforms	√	√	√
	Additional facility for 3rd train with charging	√	√	√
Cobh	2nd Platform	√	√	√

7.3.5 Environmental Impact

No significant difference in the potential environmental impacts was identified between the TSS options.

7.3.6 Costs and Economic Performance

The capital cost estimate for the infrastructure requirements described in Section 6 is €886.7 million. It includes a turnback at Mallow Station which is only needed forTSS2; however, TSS2 requires one less trainset than TSS1. TSS2a requires four fewer trainsets than TSS1.

Table 7-5 presents comparative fleet size and estimated cost for each timetable option. Each trainset is estimated to cost around €11.46m, resulting in a cost difference of around €45.84m between TSS2a, with the smallest fleet, and TSS1, with the largest fleet. The overall capital cost estimate for the programme allows for an additional three trainsets as contingency.

Table 7-5: Comparative Fleet Costs for TSS Options

Annual base costs (incl. VAT)	TSS1	TSS2	TSS2a
Trainsets required	25	24	21
Fleet Cost (million, incl. escalation but excluding contingency)	€286.5	€275.1	€240.7

The operational costs are derived from differences in fleet kilometres, traction energy costs, vehicle maintenance costs and staffing requirements. They differ only slightly between each TSS, as shown in Table 7-6. TSS2a has the lowest operational cost but not by much.

Table 7-6: Comparative Operational Costs for TSS Options

Annual base costs (incl. VAT)	TSS1	TSS2	TSS2a
BEMU traction energy costs	€2.4 million	€2.3 million	€2 million
Vehicle maintenance	€6.1 million	€6.1 million	€6 million
Labour	€4.1 million	€4.1 million	€3.8 million
Track maintenance	€5.1 million	€5.1 million	€5.1 million
SET maintenance	€6.6 million	€6.6 million	€6.6 million
Stations & structures maintenance	€4.7 million	€4.7 million	€4.7 million
Other network costs	€0.6 million	€0.6 million	€0.6 million
VAT	€2.4 million	€2.4 million	€2.4 million
Annual Base Cost (incl. VAT)	**€32.0 million**	**€31.9 million**	**€31.1 million**
Annual km per train set	**2,809,735**	**2,811,173**	**2,450,943**

The user benefits sub-criterion presents the economic viability of the project through the development of monetised benefits accrued by transport users. From Table 7-7 the user benefits for the three options range between €254 million and €614 million, with TSS1 providing the highest benefits while TSS2a offers the lowest.

Table 7-7: Summarised User Benefits

Options	User benefits (€m)
TSS1 Option	409 - 614
TSS2 Option	303 - 455
TSS2a Option	254 - 381

However, the benefits are the product of assumptions and limitations intrinsic within the SWRM modelling. As such the full benefits associated with the CACR are not reflected and will be captured as part of the Project Appraisal Report.

The public transport benefits, presented in Table 7-8, are higher for TSS2 than for TSS1 by 3% in the Standard scenario and 14.5% in the Dynamic scenario, because of the better service pattern TSS2 offers, particularly to the large catchment in the Midleton branch. TSS2a shows lower public transport benefits than either TSS1 or TSS2, as it offers fewer services.

Table 7-8: Summarised Public Transport User Benefits by Scenario

Options	PT User benefits (€m), Standard	PT User benefits (€m), Dynamic
TSS1 Option	260.5	317.0
TSS2 Option	268.3	359.9
TSS2a Option	234.7	222.9

7.3.7 Achievement of Objectives

All TSS options were developed to comply with the CACR Programme objectives. Each TSS option was examined against each objective and sub-objective to assess if the objective was achieved. It was found that all subobjectives were similarly achieved by the TSS options. The main differences related to sub-objectives 1 and 5. In both cases, the TSS2 and TSS2a options performed better than TSS1. The irregular rail services proposed by TSS1 are the main reason for the lower performance of TSS1, while TSS2 and TSS2a meet the CMATS objective with a regular10-minute service for both directions.

Table 7-9: Achieving the objectives

Analysis elements		TSS1	TSS2	TSS2a
Primary objective	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services.	Achieved similarly by all options		
Sub-objective 1	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services.	Irregular rail services TSS1 provides 12tph with a 106% increase in fleet. The disadvantage of this option is that it has irregular services and does not provide a regular 10-minute headway. Along with the development of the new stations, the rail services will be significantly improved. Estimated user benefits show that the services will potentially support sustainable economic development and population growth	Better performing due to a regular 10-minute service interval and through services from the Midleton branch, which has a larger future catchment than the Cobh branch While TSS1 has irregular services, TSS2 and TSS2a meet the CMATS objective of a 10-minute service for both directions. Therefore, TSS2 and TSS2a perform better than TSS1 in meeting sub-objective 1	
Sub-objective 2	Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth	Achieved similarly by all options The inclusion of new stations will strengthen the connection for the users between the rail and the other public transport modes - BusConnects and light rail within the Cork Metropolitan Area. Intermodal connectivity will also be improved, and the local connectivity, especially for cyclists and pedestrians. There will be a 33% increase in the population that can easily access the rail stations withing 1km and a 31% increase on the number of workers living within 1km from the new stations. Therefore, the CACR Programme will enhance the accessibility to work, towns and other key destinations while improving the integration with other public transport modes		
Sub-objective 3	Develop an integrated suburban rail system improving accessibility to jobs, education and other social and	Achieved similarly by all options		

Analysis elements		TSS1	TSS2	TSS2a
	economic opportunities, inter-modal connectivity, and integration with other public transport services.	Accessibility will be enhanced due to the development of the new stations, enabling more people to shift from car to public transport and to easily access the public transport system. Future land development on the areas close to the rail stations could potentially unlock new opportunities to the next generations		
Sub-objective 4	Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.	**Achieved similarly by all options** The modal shift expected from cars to rail due to more frequent train services and the higher capacity could lead to lower carbon emissions. The environmental analysis showed reduced emissions and air quality improvements, supporting Ireland's emission reduction targets		
Sub-objective 5	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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	**Irregular rail services** The proposed number of trains per hour will enhance the reliability and provide punctual rail services for the users. Improved pedestrian crossings close to the stations, and the provision of cycle parking at stations could also improve the customers' experience and support the shift to active modes.	**Better performing** due to a regular 10-minute service interval and through services from the Midleton branch, which has a larger future catchment than the Cobh branch.	

7.3.8 Key metrics for comparison

Table 7-10 presents the key metrics for each option: fleet size, cost, demand and related indicators, and economic performance. All CACR service improvements are effective in increasing Irish Rail patronage as well as modal shift towards public transport across the Southwest region.

Table 7-10: Comparison of Key Metrics

Analysis Elements		Scenario	Base Year	Do Minimum		TSS1		TSS2		TSS2a	
				2030	2050	2030	2050	2030	2050	2030	2050
Fleet Size	Trainsets (2050)	Common				25		24		21	
Demand forecast	Irish Rail Boardings	Standard	14,853	14,151	19,193	20,418	28,576	20,265	28,809	19,484	27,830
		Dynamic	N/A	15,039	19,460	22,481	32,688	22,253	36,799	21,621	30,920
	Public Transport Daily Mode Share	Standard	7.8%	11.5%	12.5%	11.9%	13.3%	11.9%	13.2%	11.9%	13.2%
		Dynamic	N/A	11.7%	13.5%	12.2%	14.0%	12.2%	14.1%	12.1%	14.2%
	Public Transport Daily Trips	Standard	142,094	251,860	338,663	261,759	360,599	261,652	357,745	261,504	357,660
		Dynamic	N/A	257,845	365,110	268,370	381,106	268,451	384,378	267,996	386,542
Costs	Capital cost (2021 prices, undiscounted)	Common				€1,207 million		€1,196 million		€1,161 million	
	Additional operational cost per annum (2021 prices, undiscounted)	Common				€32 million		€31.9 million		€31.1 million	

7.4 TSS Multi-Criteria Analysis

A Multi-Criteria Analysis (MCA) of the TSS options was undertaken in line with the approach set out in DoT CAF. The CAF criteria to be assessed through the appraisal are as follows:

- Environment: The objective of the environmental appraisal is to assess which option provides the highest level of protection of the environment. The appraisal is based on completion of a high-level environmental constraint's assessment
- Economy: The economic criterion aims to establish which of the proposed options is likely to return the highest economic benefit and the relative potential of each scheme to act as a catalyst for economic activity. The outcomes are largely based on the outputs of the economic appraisal which is mainly quantitative and relates to the consumer and producer effects of each shortlisted scheme.
- Accessibility and Social Inclusion: This appraisal aims to identify the scheme which is likely to have the best impact in terms of improving access to areas of defined social deprivation. A spatial assessment (using ArcGIS) of households with motorised private vehicles was undertaken to inform likely effects
- Integration: The appraisal identified the option which is likely to provide the best integration with existing public transport networks, land use, geography and policy.
- Safety and Security: The safety appraisal aims to identify the shortlisted option which is most likely to result in the highest level of safety for road users
- Physical Activity: The service improvements provided by the CACR Programme will significantly enhance the attractiveness of rail. This will likely lead to increased active travel (walking and cycling) usage by train passengers at either end of their journey to access the train station or their destination. The appraisal identifies which option leads to the greatest increase in physical activity.

An appreciation of constraints and opportunities within the study area, as well as the defined project objectives led to the establishment of sub-criteria for the MCA, were tailored to have commonality with the CAF and specificity for the CACR Programme. These are presented in Table 7-11.

Table 7-11: Summary of CACR MCA Criteria

Key: *Quantitative Indicator* / *Qualitative Indicator*

CAF Criteria	Sub-Criterion	Indicators	Data Source for Appraisal
Environment	Population and Human Health	Reduced reliance on the private car reflected in an increase in rail mode share and corresponding decrease in car mode share. Includes increased walking and cycling to train stations.	SWRM mode share outputs
	Biodiversity	Impact on European sites (SAC / SPAs), nationally designated sites and protected species.	Environmental constraints assessment of options
	Water	Impact on surface water and ground waterbodies.	Environmental constraints assessment of options
	Land, Geology & Soils	Impact on land, soils and geological heritage sites.	Environmental constraints assessment of options
	Landscape & Visual Amenity	Potential visual impacts from new stations and / or overhead wires along the proposed route.	Environmental constraints assessment of options
	Cultural, Archaeological & Architectural Heritage	Impact on protected structures, archaeological sites and cultural heritage sites / features.	Environmental constraints assessment of options
	Noise & Vibration	Reduced noise and vibration from commuter rail operations.	Transition away from diesel-powered fleet
	Air Quality	Reduced transport emissions for the overall transport network in the Cork Metropolitan Area.	Overall network emissions from SWRM results
	Climate	Transition of rolling stock fleet to low emission traction.	Updating of train emissions profile in TUBA
Economy	User Benefits	Ensure value for money (strong benefits), strong demand response, journey time reliability, customer attractiveness and flexibility	Economic, modelling and customer service analysis
	Transport Interchange and Integration	Improved interchange opportunities with other public transport modes, increased modal shift from private car	SWRM results for the increase on daily trips
	Costs	Comparison of capex and opex costs by option	Cost Estimates
Accessibility and Social Inclusion	Impact on passengers	Enhance public transport access to opportunities and services	GIS analysis of number of people within 1km of a high frequency rail line
	Social Impacts	Deliver socially inclusive public transport	GIS analysis on the number of deprived and the percentage of households with no car ownership within 1km of the rail line
Integration	Integration with the road network and local area	Integration with the new stations, depots and parking facilities	Extent of alignment with the road network and the local area
	Public transport	Integration with other public transport modes	Extent of alignment with each public transport mode
	Active modes	Integrations with cycling and walking	Assessment of the new crossing point, cycle parking space and connectivity with the network
	Local and National policies and Guidance	Degree of alignment with other government policies and objectives	Extent of alignment with other government policies and objectives
Safety and Security	Collision Reduction	Improve the safety of the transport system by reducing potential interactions between pedestrian/cyclists and vehicular traffic	Level crossing analysis
Physical Activity	Cycle Facilities at stations	Facilitate access to public transport by active modes through the delivery of cycle parking facilities at new and upgraded stations.	Proposed cycle parking spaces on the
	Permeability and Local Connectivity	Provide a connectivity opportunity for green spaces and recreational facilities	Spatial analysis on green spaces and recreational facilities

The approach is comparative, in line with CAF expectations, and has been undertaken on a similar basis as other appraisals for major transport infrastructure. As set out in the previous sections all TSS options shortlisted perform well against the objectives. The aim of the MCA process is therefore to:

- Determine the best performing Do Something option. The best performing option is determined as that which attains the highest comparative score across all six CAF criteria. While economy is undoubtedly important (though often specifically focused upon), the delivery of a sustainable, high-quality and attractive public transport corridor serving existing and future demand is the overarching requirement of the CACR Programme.
- Assess the viability and expected benefits to the community in providing the CACR Programme. This will include an economic assessment where applicable, but also consideration of non-monetisable benefits.

Each Do Something option entails a different train service pattern. The rail network and stations are the same for all options (see Section 6). The service plan for each option was previously explained in Appendix C to Appendix E.

The criteria and assessment guide the overall MCA process by comparing the Do Minimum and Do Something options against each other providing a means for overall decision making in terms of selecting the optimal option. All criteria and sub-criteria were assessed based on the comparative colour coded ranking scale presented in Table 7-12.

Table 7-12: Scoring System for Option Comparisons

(dark green)	Significant comparative advantage over other options
(light green)	Some comparative advantage over other options
(yellow)	Comparable to other options
(orange)	Some comparable disadvantages over other options
(red)	Significant comparative disadvantage over other options

Table 7-13 provides a summary of the CAF criteria and sub-criteria analysed for the CACR Programme. Appendix H presents the detailed analysis of the MCA. Given the similarities between the TSS options, the criteria and sub-criteria had similar results for each.

The main difference between the options was identified in the transport interchange and integration sub-criterion. The demand analysis shows that, overall, TSS2 leads to more interchange in the network and better complementarity, or integration, with the rest of the CMATS systems, leading to better overall public transport demand and mode share.

Table 7-13: TSS Summary of CACR Programme Assessment Criteria and Sub-Criteria

MCA Criteria	Assessment sub-criteria	Do Minimum	TSS1	TSS2	TSS2a
Environment	Population and Human Health				
	Biodiversity				
	Water				
	Land, Geology and Soils				
	Landscape ad Visual				
	Cultural, Archaeological & Architectural Heritage				
	Sound, Noise and Vibration				
	Air quality				
	Climate				
Economy	User Benefits				
	Transport Interchange and Integration				
	Cost				
Accessibility and Social Inclusion	Impact on passengers				
	Social Impacts				
Integration	Integration with the Road Network and Local Roads				
	Active Modes				
	Local and National Policies and Guidance				
Safety and Security	Safety				
Physical Activity	Cycle Facilities at Stops				
	Permeability and Local Connectivity				

Table 7-14 provides the summarised outcome of the MCA, with all inputs and investigation considered.

Table 7-14: TSS MCA Summary Scoring of Six CAF criteria

MCA Criteria	Do Minimum	TSS1	TSS2	TSS2a
Environment				
Economy				
Access and Social Inclusion				
Integration				
Safety and Security				
Physical Activity				

7.5 TSS Option Selection

Based on the MCA undertaken and summarised in Table 7-14, all three TSS options performed well against the CAF criteria in comparison to the Do Minimum option. Overall, the TSS options performed similarly however TSS2 performs slightly better as it provides a regular 10-minute service with an easy to understand and operate timetable. All Cobh services terminate at Kent whilst services from Midleton, which has higher population catchment than Cobh along the line, continue through Kent. All options provide for operational permutation to allow for special events, changed operational demands or for unknown events.

As differences between the TSS options are small a flexible approach may be practical. The infrastructure for TSS2 can also serve TSS1, giving the flexibility to introduce through services from Cobh to Blarney if the market requires. TSS2a is a variation of TSS2 which could be implemented on an interim basis while demand grows but is less favourable than TSS2 in the long term. Value engineering may reduce the scope and cost of the programme while service itself could be gradually introduced to align with demand and optimise operating costs.

8. CACR Programme Alignment with NIFTI Modal and Intervention Hierarchies

THE CACR Programme, as developed through options presented in this report, is significantly aligned with NIFTI Modal and Intervention hierarchies, as illustrated in Table 8-2. Overall, the programme promotes NIFTI objectives far more greatly than the Do-Minimum option, by maximising the use of the Cork Region heavy rail asset for enhanced public transport services coupled by promotion of active travel.

All hierarchies were assessed for the Do-Minimum and the CACR Programme based on the comparative colour coded ranking scale presented in Table 8-1.

Table 8-1: Scoring System for Option Comparisons

	Significant comparative advantage over other options
	Some comparative advantage over other options
	Comparable to other options
	Some comparable disadvantages over other options
	Significant comparative disadvantage over other options

Table 8-2: CACR Programme Alignment with NIFTI Modal and Intervention Hierarchies in Comparison with Do-Minimum Option

NIFTI Hierarchies			Do-Minimum	CACR Programme
Modal Hierarchy	Active Travel	Sustainable modes, starting with active travel (walking, wheeling and cycling) and then public transport are encouraged for investment over less sustainable modes such as the private car.	The Do-Minimum option does not promote further active travel beyond existing levels	The CACR programme promotes active travel as part of the investment in redesign of the new and existing rail stations leading to more multi-modal trips
	Public Transport		The Do-Minimum option is to maintain the existing rail infrastructure and service within the Cork region. It does not accommodate long term growth.	The CACR programme will improve the public transport infrastructure and service within the Cork region
	Private Vehicles		The Do-Minimum will deteriorate road efficiency in the rail corridor as demand grows, without offering sufficient alternatives.	The CACR programme will reduce car dependency by improving rail-based alternatives.
Intervention Hierarchy	Maintain	Measures which protect the existing transport network and keep it at the standard or capability at which it was designed. This includes all protection and renewal investment, and investments targeted at climate resilience	The Do-Minimum option includes maintenance of the existing heavy rail network within the Cork region, without optimisation or improvement	The CACR programme will maintain the heavy rail network asset, where optimisation is unnecessary, such as existing tracks and stations
	Optimise	Measures which are targeted at increasing levels of service of transport infrastructure through enabling and encouraging more efficient behaviour and sustainable use of the network.	The Do-Minimum option does not include any optimisation to the heavy rail network within the Cork region	The CACR Programme includes improvement of rail signalling, which is a necessary means for improved rail service and increased service frequency
	Improve	Measures which increase the capability of existing infrastructure, through increasing the standards of that infrastructure, or measures which shift existing capacity to more sustainable modes.	The Do-Minimum option does not include any improvement to the heavy rail network within the Cork region	The CACR Programme improves the capacity of the Cork region heavy rail through optimised signalling and telecommunications, some trackwork, and rail station improvements to accommodate longer trains and electrification, for a more sustainable service
	New	Encompasses all measures which entail significant increases to transport infrastructure capacity	The Do-Minimum option does not include any introduction of new infrastructure to the heavy rail network within the Cork region	The CACR Programme entails some new infrastructure, including new stations, new depot, charging points and double tracking to maximise the use of the asset

9. Summary and Conclusion

CACR Programme aims to promote national policy targets for transport decarbonisation while providing a regular 10-min service interval on each line, with through running, as envisaged by CMATS. As shown in Table 8-2, the CACR programme is an outstanding example of how to maintain and optimise an existing asset to prioritise active modes and public transport, in accordance with the NIFTI priorities of decarbonisation, protection and renewal, urban mobility for people and goods, and regional connectivity.

This Phase 2 OSR outlined the options assessment and selection process for key programme components: power and fleet as well as timetable.

For **Fleet and Power** options the aim was to identify a robust and sustainable power option, moving away from diesel to replace the existing fleet, and accommodate fleet growth for increased service frequency and capacity.

The preferred power option identified was the BEMU with 1500V DC charging. The reasons for this include overall lowest costs when supporting infrastructure requirements are taken into account, reduced environmental impact and planning risk as no OLE is required, procurement efficiencies and greater flexibility. The BEMU option allows future electrification of intercity services without conflict and potential for future service expansion beyond Mallow and Midleton.

Other options assessed and rejected included 1500V DC EMU, 25kV AC EMU, and dynamic BEMU with limited OLE. BEMU with 25kV AC charging and hydrogen powered options were eliminated at an early stage as ineffective for CACR requirements.

Fleet size: between 21 and 25 trainsets depending on timetable variation. Based on a fleet of 28 5-car trainsets to allow for contingency, the fleet cost is €320.9 million.

For **Timetable Options** the aim is a 10-minute “turn up and go” service on all branches with a 5-minute service between Glounthaune and Kent. It is not possible for all services to be through running as the Cobh and Midleton branches cannot both feed directly into the Blarney/Mallow branch. Several TSS options that would deliver the CMATS vision were considered. The three short listed options were assessed, all with the BEMU fleet proposed to operate the service.

Option TSS1 is closest to the CMATS vision. It offers through services from both Midleton and Cobh, although some services on both lines would terminate at Kent. The disadvantage is that services between Kent and Blarney would either operate on an irregular service interval, rather than the regular 10-minute interval required, or be held at Kent for up to five minutes to regularise the intervals. Neither alternative offers the truly attractive customer proposition intended.

Option TSS2 offers a simpler customer proposition with regular 10-minute service intervals on each branch. All Cobh services would terminate at Kent, so passengers for Blarney and beyond would change train. All Midleton services would continue to either Blarney or Mallow. Prioritising the Midleton branch is justified by its larger catchment, greater growth potential and greater number of new and existing stations. The demand forecasts support this approach. TSS2 can be operated with 24 trainsets compared with 25 for TSS1.

Option TSS2a is a variation on TSS2 where the number of services to Mallow are reduced from four to two services per hour. It requires only 21 trainsets for operation and has lower operating costs. On the other hand, it has lower demand and offers lower benefits than TSS1 and TSS2.

All three TSS options performed well against the CAF criteria in comparison to the Do Minimum option. Overall, the TSS options performed similarly however TSS2 performs slightly better as it provides a regular 10-minute service with an easy to understand and operate timetable. All options provide for operational permutation to allow for special events, changed operational demands or for unknown events.

Infrastructure requirements are related to the timetable, the fleet and the power. Regardless of TSS option, the significant increase in service frequency and capacity (longer trains), combined with the move from a diesel to BEMU fleet and the development of eight new stations, requires significant changes to the railway infrastructure. These changes are the same for all options with one exception. TSS2 requires an additional turnback with charging facilities at Mallow Station. Infrastructure costs would be slightly higher for TSS2 as a result, though offset by smaller fleet requirements. A key implication is that the TSS2 infrastructure could accommodate TSS1 and TSS2a, but not vice versa.

The capital cost estimate for infrastructure is €887 million, based on requirements for TSS2, which include additional turnback and charging facilities at Mallow that are not required for TSS1 or TSS2a. These works are a very minor part of the overall infrastructure programme and have not been separately costed. The environmental analysis conducted did not present any significant difference regarding the impact of each TSS option on the environment.

The options assessment found that a new BEMU fleet with 1500V DC along with service improvements would best achieve the CACR objectives, for emissions reduction and a “turn up and go” 10-minute service interval across all branches. As differences between the TSS options are small a flexible approach may be practical. The infrastructure for TSS2 can also serve TSS1, giving the flexibility to introduce through services from Cobh to Blarney if the market requires. TSS2a is a variation of TSS2 which could be implemented on an interim basis while demand grows but is less favourable than TSS2 in the long term. Value engineering may reduce the scope and cost of the programme while service itself could be gradually introduced to align with demand and optimise operating costs.

In conclusion, the CACR Programme is well aligned with NIFTI Modal and Intervention hierarchies.

Appendix A Objectives

Table 17: Objectives and Performance Indicators' Alignment to CAF Appraisal Criteria

Objectives & Performance Indicators

Primary Objective

Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services

Primary relevant CAF appraisal criteria

Sub-Objectives	Draft Performance Indicators	Economy	Safety	Integration	Accessibility	Environment	Physical Activity
Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth.	Reduced reliance on the private car reflected in an increase in rail mode share and corresponding decrease in car mode share						
	Uplift in public transport patronage compared to a counterfactual scenario						
	Ensure value for money (strong BCR & NPV)						
Develop an integrated suburban rail system improving accessibility to jobs, education and other social and economic opportunities, inter-modal connectivity, and integration with other public transport services.	Enhance public transport access to opportunities and services measured through an increase in the number of people within 1km of a high frequency rail line						
	Deliver socially inclusive public transport – Increase in population living in areas defined as deprived by Pobal and/or areas with low car ownership levels that are within 1km of a high frequency rail line						
	Increase the number of origins/destinations accessible by rail without interchange						
	Increase in number of trips involving interchange between heavy rail and other modes						
Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the	Increase heavy rail capacity and frequency to cater for growing transport demand						
	Increase rail catchment for major trip attractors in the Metropolitan area						

Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.	Enable Project Ireland 2040 & RSES through the delivery of one of the main elements of the transport network
	Support policies of compact growth and high-density development within the catchment of CACR, measured by the total catchment within 1 km of a high frequency rail line
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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	Reduced transport emissions, both rail-related and for the overall transport network, in the Cork Metropolitan Area, compared to the counterfactual, at a minimum
	Enable the Climate Action Plan 2021 through the delivery of the rail-related actions
	Reduction in transport congestion measured by reduction in overall network delay and average journey times
	Delivery of CACR in a manner that will not compromise future Inter-urban passenger services growth ambitions, and where possible not impede the outcomes of the all-Island Strategic Rail Review or recommendations from the IÉ Rail Freight 2040 Strategy – Identify and quantify and potential impacts on inter-urban and freight services
	Facilitate access to public transport by active modes through the delivery of cycle parking facilities at new and upgraded stations.
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.	Enhanced customer experience measured through provision of new modern rolling stock and improved journey time reliability
	Improve the safety of the transport system by reducing potential interactions between pedestrian/cyclists and vehicular traffic, measured by reduction in car-based mode share relative to segregated public transport and active modes

Appendix B Power and Fleet Options MCA analysis

B.1 Capital Costs

The differential cost of each of the options is driven primarily by the extent of OLE equipment provided, the type of fleet utilised (EMU or BEMU) and the number of charging facilities required where the service is provided by BEMU vehicles. The differential cost of each option is given in Table 18 which summarises the main elements of capital cost which differentiate options. These costs do not include wider infrastructure costs such as station, signalling or depot costs which are common across options.

The cost of electrification has a significant bearing on the overall cost differential of options. Option 2 which includes the full electrification of the network at 25kV AC along the entire 62.5km route has the highest at €483m. This option is impacted significantly by the additional bridge works required to facilitate 25kV AC clearances. These infrastructure costs reduce to €450m where electrification is provided at 1500V DC, and €248m where only limited OLE is provided in Option 5. The lowest infrastructure costs relate to the BEMU Option 3 (€205m). In this option, while provision must be made for battery charging facilities, extensive OLE is not required thus avoiding the need for significant bridge works along the route.

Table 18: Summary of primary differential capital costs (€millions)

	Option 1 1500V DC EMU with OLE	*Option 2 25kV AC EMU with OLE*	*Option 3 1500V DC BEMU*	*Option 5 Dynamic BEMU*
Civil works	79	158	25	32
Electrification costs	162	101	87	101
Planning, Design & EIS	19	21	7	11
Project/Construction Management	22	24	10	12
Additional Land & Property Costs	0.4	0.2	-	0.3
Risk Contingency (40%)	113	122	52	62
Total Infrastructure Costs (ex. vat)	396	426	181	218
Total Infrastructure Costs (incl vat)	450	483	205	248
Fleet costs (€m) (incl vat)	211	231	268	258
Total Cost	€ 661m	€ 714m	€ 473m	€ 505m

In comparing the cost of options, the combined cost of providing full network electrification while utilising lower cost EMU vehicle types must be compared against the cost of providing less OLE or battery chargers and the use of the more expensive BEMU vehicle types.

The fleet selection has a significant bearing on the total capital costs of the project. BEMU vehicles have been found to be 24% more expensive than EMU vehicles. Option 3 uses BEMU vehicles. As shown in Table 18, the capital costs of these vehicles have a significant bearing on the overall cost differential between the options. Using BEMU rolling stock increases fleet costs by up to €57m.

As shown in Table 18, when the cost of electrification and fleet is considered, Option 3 has the lowest overall cost at €473m.

B.2 Operating Costs

Programme wide operational costs for the short-listed options and for a Do Minimum scenario are presented below in Table 19 and Figure 6.

Operational costs include all costs incurred in the operation and maintenance of services including:

- Fleet traction energy costs
- Vehicle maintenance and battery replacement costs (where applicable)

- OLE (overhead line equipment) maintenance
- Track maintenance and renewals
- Station maintenance
- Driver costs, maintenance, operations, and revenue protection staff.

Annual operational costs are presented for the full life of the vehicles. Costs for the DoMin option are based on existing service levels, while costs for the Do Something options are based on the significant additional services outlined in Train Service Specification 2a (See Technical Note– Train Service Specifications, CACR-XX-XX-TN-ACM-OPS-0001, provided separately).

Table 19: Operational Costs for Do Minimum and Do Something Options

		Do Min (DMU)	*Option 1 - 1500V DC EMU with OLE*	*Option 2 - 25kV AC EMU with OLE*	*Option 3 - 1500V DC BEMU*	*Option 5 - Dynamic BEMU*
Annual base cost	Traction	€0.6m	€2.1m	€2.1m	€2.m	€2.m
	Vehicle Maintenance	€3.1m	€5.0m	€5.m	€6.m	€5.9m
	Labour	€0.8m	€3.5m	€3.5m	€3.8m	€3.5m
	Track Maintenance	€2.8m	€5.1m	€5.1m	€5.1m	€5.1m
	SET Maintenance	€3.4m	€10.3m	€7.3m	€6.6m	€7.3m
	Stations & Structures Maintenance	€2.6m	€4.6m	€4.6m	€4.7m	€4.7m
	Other network costs	€0.2m	€0.6m	€0.6m	€0.6m	€0.6m
	VAT	€1.1m	€2.7m	€2.3m	€2.4m	€2.4m
	Annual Base Cost (incl. VAT)	**€14.6m**	**€34.0m**	**€30.5m**	**€31.1m**	**€31.5m**
60-year totals	Total O&M (Market prices incl. inflation)	€2,118m	€4,915m	€4,441m	€4,543m	€4,565m
	Total O&M (Financial NPV - 1.75% discount rate)	€983m	€2,281m	€2,060m	€2,106m	€2,118m
	Total O&M Cost (Economic NPV - 4% discount rate)	€114m	€349m	€316m	€323m	€325m

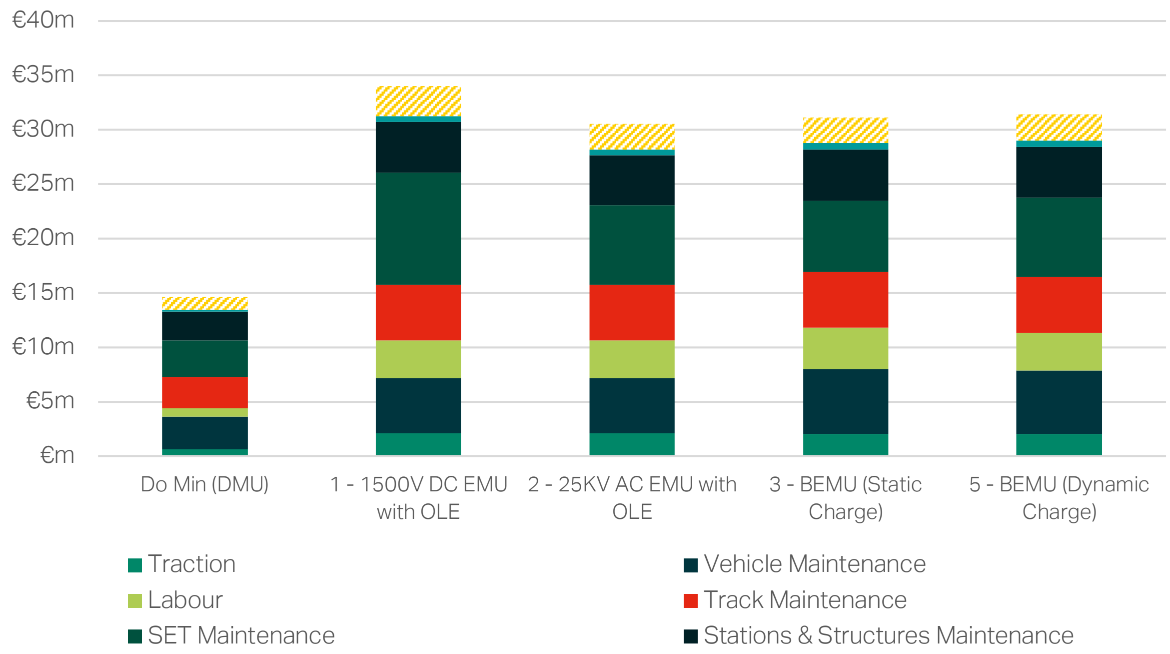

Figure 6: Annual Operational Base Costs (excluding inflation)

The operational costs presented are based on a number of assumptions including:

- Opening year of 2030
- 60-year assessment period
- Discount rates of 1.75% (financial) and 4% (economic)
- Peak hour services as described in TSS 2a, with a reduced service for off peak
- Annualisation factor of 295
- Infrastructure maintenance at 3% of infrastructure costs
- Rolling stock maintenance costs rates as per DART+ framework
- Electricity costs of €0.14 per KWh (excluding vat)
- Cost per labour hour of €25.

Based on these estimates it is evident that annual operating costs differ by €3m between Option 1 (highest) and Option 2 and 3 (lowest).

The operational costs for Option 1 are impacted by OLE maintenance costs. Option 1 includes 13 substations and full electrification of the network, all of which require ongoing maintenance. In contrast, Option 2 (while requiring full electrification) only requires one 25kV AC substation. Option 3 does not have OLE developed across the network and the OLE in Option 4 is greatly reduced. Vehicle maintenance costs also differ between options. Option 1 and 2 utilise EMU vehicles, while Options 3 and 4 use BEMU vehicles which incur higher maintenance cost per vehicle kilometre. Option 3 also requires one additional train set due to the need for static charging of vehicles.

B.3 Safety

While the introduction of additional rail services across the Cork commuter network will result in an associated increase in risk to the public and operations staff, it is considered that the impact of risk associated with high frequency services is the same for all short-listed options. This risk being primarily related to the risk of collisions with rolling stock.

Where risk will differ between options is related to the electrification system being deployed. Option 1, 2 and 5 all require the developed of OLE equipment. Although, Option 1 allows for a 1500V DC network, Option 2 a 25kV AC network, and Option 5 partial electrification of the network, all off these options increase the risk of exposure to high voltage lines by the public and staff.

In comparison, this risk is significantly reduced for Option 3 which only requires the development of isolated sections of OLE at battery charger locations.

B.4 Planning and Environment

The development of rail infrastructure across the Cork commuter rail network is likely to require the granting of a Railway Order. Additionally, the development of associated bridge infrastructure will potentially require the granting of planning permission. Inherent in these statutory processes is the right of individuals to challenge the granting of approvals and to make submissions contenting the appropriateness of the proposed designs.

Option 1 involves the construction of over 60km of OLE and the development of some 35 overbridges, while Option 2 requires the development of 58 overbridges. The OLE will have a visual impact on the landscape along the network while the upgrades to overbridges will result in considerable disruption along the route during construction.

This extensive scope of work will have a notable impact on the communities adjacent to the railway line and this could potentially attract a high level of objection from some members of the public.

In comparison, Option 3 does not require extensive OLE or the modification of existing overbridges and as such is less likely to attract significant objections during planning.

B.5 Operational Impact

Impact on Intercity Electrification

Currently only 2.75% of Ireland's rail network is electrified. With the completion of the DART+ Programme in Dublin this will increase to 10%. Climate change requires the further decarbonisation of the railway with additional electrification of the network outside Dublin as well as an associated switch to clean energy being a key part of this.

Should an alternative traction power solution be progressed between Dublin and Cork, or along other intercity routes at some point in the future, possible options would likely include the development of a 25kV AC system as a 1500V DC network is considered not viable over the distances involved across the intercity network.

Although IÉ have a long history of delivering and maintaining the 1500V DC DART network, 25kV AC systems are more suitable for electrification over long distances due to improved efficiencies and increased distances which are possible between traction substations. The resistive losses from OLE electrification systems are also reduced due to the higher voltages.

In this scenario, the presence of a 1500V DC OLE in Dublin and potentially an electrified network in Cork would need to be considered to ensure that all interfaces between the systems are designed and integrated appropriately.

In Dublin, the existing DART network between Malahide-Howth and Greystones is currently electrified at 1500V DC. This 1500V DC DART network is set to be extended from Dublin city centre to Maynooth, M3 Parkway, Hazelhatch and Drogheda as part of the DART+ Programme.

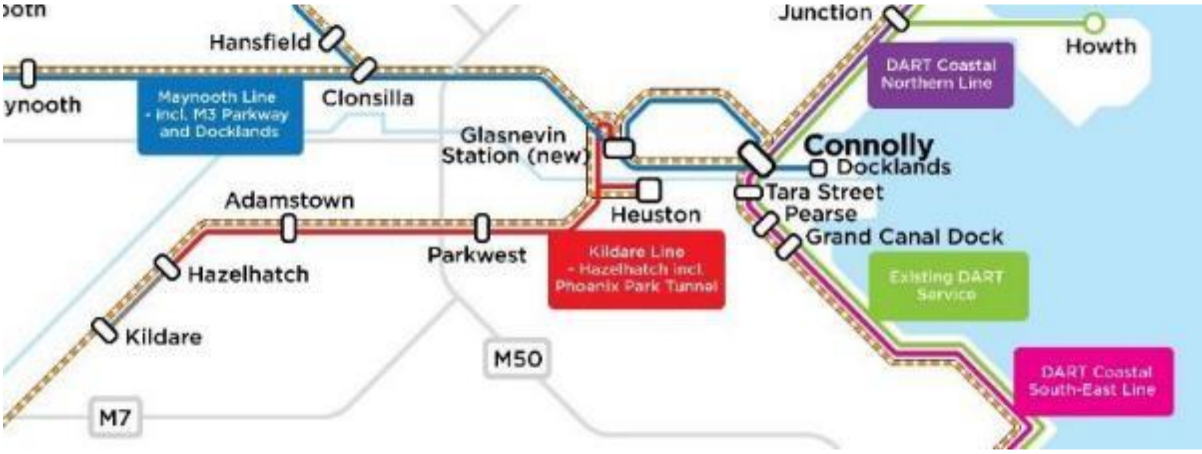

Figure 7: DART+ Network Extract

Where future electrified 25kV AC intercity services between Dublin and Cork interface with the 1500V DC between Hazelhatch and Heuston, its segregation from the 1500V DC DART network will be simpler due to the existing four tracking between Hazelhatch and Park West and the additional four tracking as proposed between Park West and Heuston within the DART+ programme.

Alternatively, operation within a two-system network could be enabled by the specification and development of new dual voltage intercity vehicles. These dual voltage vehicles would be required for electrified Dublin-Cork services should a decision be made to advance such a project.

This same approach could be deployed in other regions later, should electrified systems be required in future. This would result in a two-system electrified network consisting of 1500V DC networks for local services, and a high voltage 25KV AC system for intercity services.

The primary considerations and implications of developing a combination of different electrification systems for commuter and intercity services is summarised in

Table 20 below.

In light of this assessment, should a 25kV AC OLE system be advanced in the future along the 250km line between Dublin and Cork, the development of a 1500V DC OLE system for the CACR Programme will increase the complexity of the interface of the two systems and/or require the procurement of dual voltage vehicles for the intercity services.

Conversely, the development of a 25kV AC system along the commuter line in Cork would simplify the interfaces between the intercity and commuter systems.

Table 20: Summary of Impact of Intercity and Commuter Electrification Systems

		Potential Intercity Electrified Services	
		1500V DC	25KV AC
CACR Programme	1500V DC	– Allows for standardised commuter fleet voltage across all IE fleet including DART+ vehicles. – Results in inefficient electrified intercity network due to long distances.	– Allows for standardised voltage vehicles across commuter networks in Dublin and Cork, as well as other future electrified commuter networks. – Requires dual voltage vehicles for intercity electrified services or provision of new parallel track.
	25KV AC	– Not plausible to develop 1500V DC for Intercity in parallel with 25KV commuter network due to inefficiency of 1500 V DC system over long distances.	– Allows for standardised voltage vehicles across all IE fleets with the exception of existing and future DART fleets which are 1500VDC. – Increases infrastructure costs and technical risk for commuter networks. – Requires assessment and mitigation for EMI (electromagnetic interference).
	BEMU	– Allows for standardised commuter fleet voltage across all IE fleet including DART+ vehicles. – Results in inefficient electrified intercity network due to long distances.	– Interface of 25kV intercity OLE with BEMU charging sites would need further consideration to negate requirement for dual voltage vehicles, particularly where IC and commuter networks overlap.

In the case of Option 3, and the development of a BEMU systems for the CACR Programme, conflict with future intercity electrification is mostly avoided. In this option the BEMU vehicles can be operated within a 25kV AC systems, without any need to interface with the high voltage electrified network. A BEMU system simplifies the integration of the CACR system and the electrification of the Dublin to Cork intercity line, should this be pursued as a project in the future. A BEMU system could operate separately and in parallel with a 25kV AC system or even a hydrogen solution (should the technology become commercially and operationally viable).

Operational Flexibility

For the purpose of this assessment, each of the options have been considered in terms of their operational flexibility, that is, the degree to which the service levels proposed for the Cork commuter area can be delivered in a flexible and efficient manner. This includes the level of flexibility provided to operations staff to change service pattern, switch vehicles at late notice and deploy trains ad-hoc across the network.

Options 1 and 2 utilise EMU's which are in constant contact the OLE and which do not require charging times to be incorporated into service schedules. The source of energy required to drive the train is always present. This provides a high degree of operational flexibility and resilience to an EMU based network. The presence of a continuous OLE network mitigates against the risk of stranded vehicles due to battery depletion, while also allowing the Railway Undertaking / IÉ Operations to deploy replacement and/or rescue vehicles (in the case of failures on the line) at short notice. Similarly, Option 5 utilises dynamic charging and does not require scheduled charging of vehicles.

In contrast, Option 3 uses BEMU's which are reliant on a network of battery chargers and which require vehicles to be charged at terminus stations. This type of network requires an additional level of coordination and planning not necessary for Option 1 and 2, thereby limiting their operational flexibility.

Network Flexibility

Network flexibility is also an important consideration in the performance of each option. For this assessment network flexibility has been taken to mean the extent to which services can be extended beyond the current commuter network.

Option 1 and Option 2 is based a fully developed OLE network, as such the extension of the network beyond Midleton, Mallow and Cobh would require the development of additional OLE, supporting infrastructure and potentially significant civil works. This limits the ability to extend/modify the network quickly, in response to increased demand or changes in operational requirements.

In comparison, Option 3 and Option 5 use BEMU vehicles which are capable of operating outside the OLE network. For example, services could potentially be extended to Charleville from Mallow without the need for additional charging facilities. While this too may require additional investment and approval, the scale of development would be significantly less than the development of an extended OLE solution.

Appendix C - Option TSS1: CMATS Proposal

C.1 Overview

This section presents a detailed analysis of TSS1 service plan, fleet requirements, the turnaround and charging strategy, the potential infrastructure requirements and the demand and economic analysis.

C.2 Service Plan

TSS1, shown in Figure 8, complies with the principles of CMATS in connecting both Cobh and Midleton with direct trains to Blarney and Mallow. It provides 12 commuter services per hour across the network, as follows:

- four trains per hour (tph) from Midleton through to Mallow
- two tph from Midleton, terminating at Kent Station
- two tph from Cobh through to Blarney
- four tph from Cobh, terminating at Kent Station

As shown, each branch provides the minimum 10-minute service frequency. A change at Kent Station would be required for four tph operating between Cobh and Kent Stations for services West of Kent.

This option has the disadvantage of an irregular service pattern (un-even interval between services) between Kent Station and Blarney. This could be resolved by trains waiting at Kent Station by up to 5 minutes; however, this solution is not desirable from an operational or customer perspective.

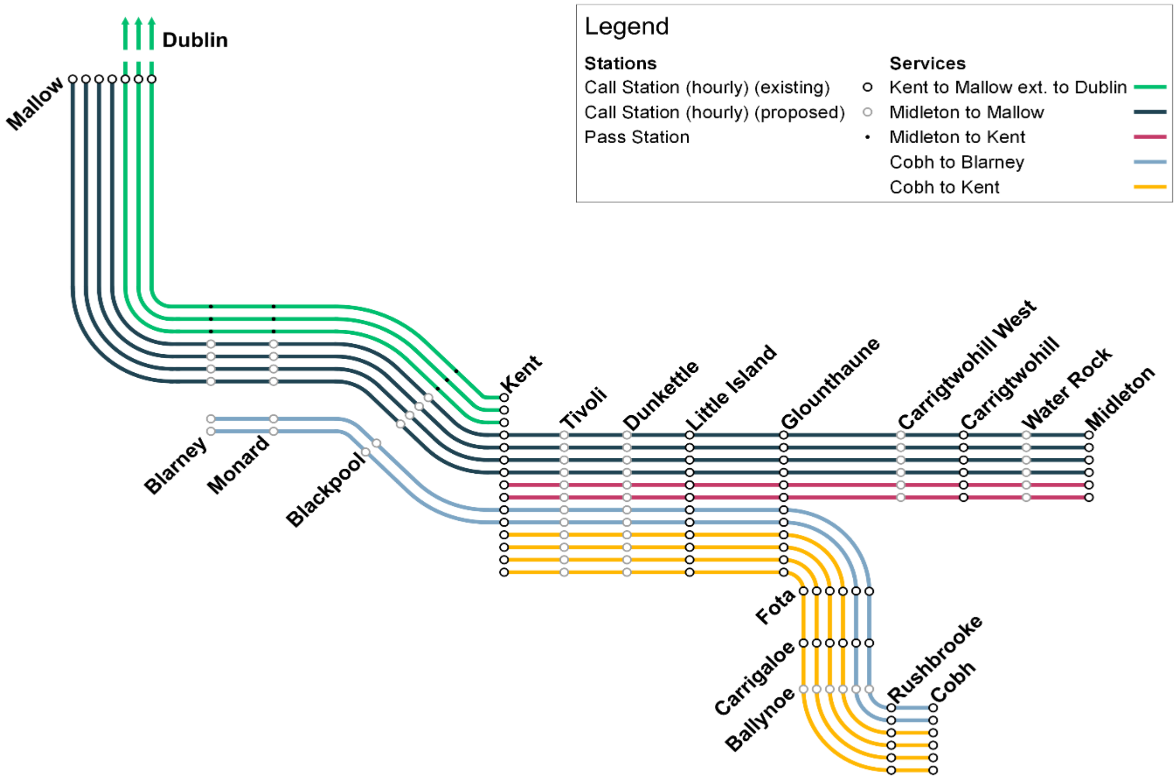

Figure 8: Option TSS1 Service Pattern

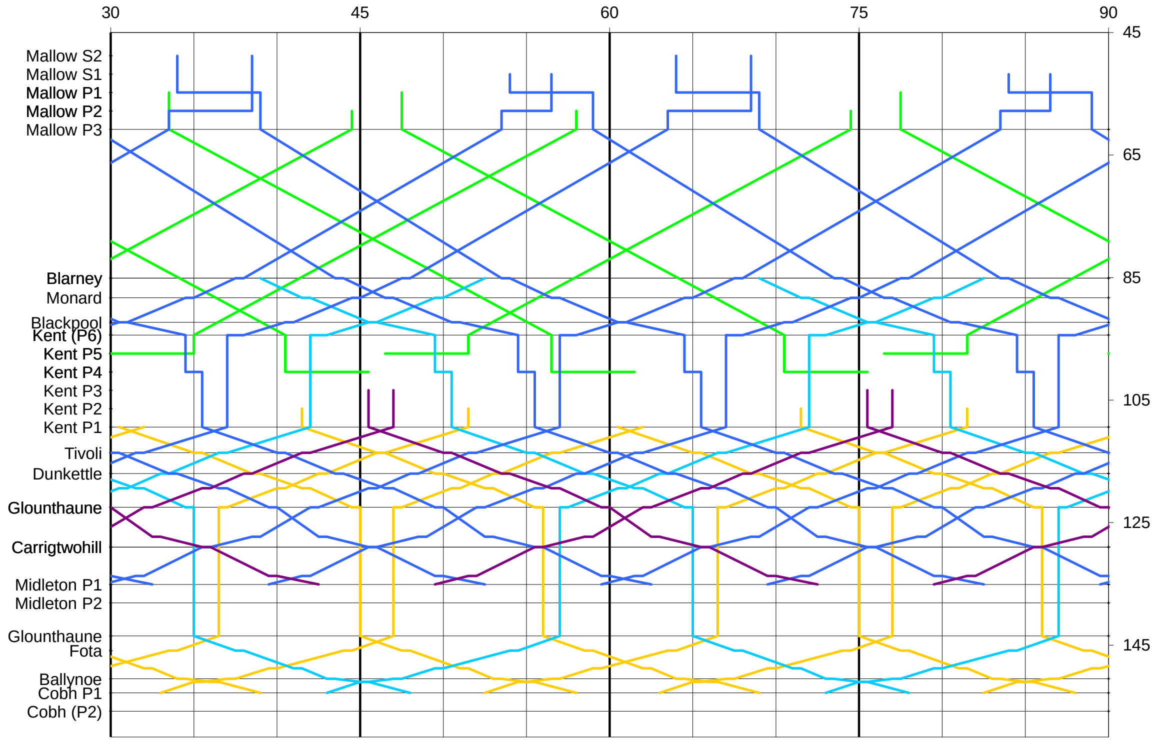

Figure 9: TSS1 Service Graph

Table 21: TSS1 minutes past the hour timetable, Down direction

Mallow P1		34	39		48			59		09		18			29
Mallow P2															
Mallow P3															
Blarney			54				09	14		24				39	44
Monard			57				12	17		27				42	47
Blackpool			01				16	21		31				46	51
Kent P6															
Kent P5															
Kent P4		57	06		16		21	26		36		46		51	56
Kent P3						16							46		
Kent P2				12							42				
Kent P1	01								31						
Tivoli	06		11	17		21	26	31	36	41	47		51	56	01
Dunkettle	09		14	20		24	29	34	39	44	50		54	59	04
Little Island	12		17	23		27	32	37	42	47	53		57	02	07
Glounthaune	15		20	26		30	35	40	45	50	56		00	05	10
Carrigtwohill W			23			33		43		53			03		13
Carrigtwohill			26			36		46		56			06		16
Water Rock			30			40		50		00			10		20
Midleton			33			43		53		03			13		23
Glounthaune	15			26			35		45		56			05	
Fota	18			29			38		48		59			08	
Carrigaloe	22			33			42		52		03			12	
Ballynoe	24			35			44		54		05			14	
Rushbrooke	26			37			46		56		07			16	
Cobh	28			39			48		58		09			18	

Table 22: TSS1 minutes past the hour timetable, Up direction

Cobh	33		43			53		03			13			23	
Rushbrooke	36		46			55		06			16			25	
Ballynoe	38		48			57		08			18			27	
Carrigaloe	40		50			00		10			20			30	
Fota	45		55			04		15			25			34	
Midleton		40			50		00			10			20		30
Water Rock		42			52		02			12			22		32
Carrigtwohill		46			56		06			16			26		36
Carrigtwohill W		49			59		09			19			29		39
Glounthaune	48	53	58		03	07	13	18		23	28		33	37	43
Little Island	51	56	01		06	11	16	21		26	31		36	41	46
Dunkettle	54	59	04		09	13	19	24		29	34		39	43	49
Tivoli	57	02	07		12	17	22	27		32	37		42	47	52
Kent P1	02							32		37	42				
Kent P2						22								52	
Kent P3					17								47		
Kent P4															
Kent P5				22					35			52			
Kent P6		08	13				28			38	43				58
Blackpool		11	16				31			41	46				01
Monard		15	20				35			45	50				05
Blarney		18					38			48					08
Mallow P3															
Mallow P2		34		45			54		58	04		15			24
Mallow P1															

C.3 Fleet requirements

The fleet required to operate services is derived from the specific requirements of the TSS. For TSS1 a fleet of 25 BEMU trainsets is required to operate the associated timetable. This is inclusive of a 22 base and a 10% redundancy to facilitate maintenance activities and failure recovery.

C.4 Turnaround and Charging Strategy

The potential turnaround and charging strategy for use of a battery-operated train under TSS1 is as follows:

- Cobh-Kent services charge at Kent, with trains using the three existing bay platforms (Platforms 1 to 3) in succession so that each one is scheduled to remain there for at least 28 minutes.
- Cobh-Blarney services charge at Blarney. Achieving sufficient turnaround to charge at Cobh would require platforms or sidings to accommodate three trains in the vicinity, which would likely be difficult to provide. The turnaround at Blarney is approximately equal to the 18 minutes required for a full charge. However, after travelling from Blarney to Cobh, each of these trains forms a service back only as far as Kent. This should still be achievable even if minor delays prevent a full charge being achieved at Blarney.
- Midleton-Mallow services charge at both termini.
  - At Midleton the turnaround time is 26 minutes with three trains in the station simultaneously. To achieve a reliable 18-minute charge during that time, both platforms would be connected to a single turnback siding to the east. OLE in this area would permit charging to start on arrival in one platform and continue until just before departure from the other, with short interruptions for the moves to and from the siding. An alternative with charging only in the sidings would require more sidings and provide less charging time.
  - At Mallow there is insufficient charging time for an arrival to form the next departure (six minutes later) or the second departure (16 minutes later), so it must form the third departure (36 minutes

later) and there must be three suburban trains in the station at certain times. This is achieved by having two turnback and charging sidings, where each train waits about 30 minutes so does not also require charging in the platforms. It is necessary for suburban trains to use separate arrival and departure platforms, which are also used by passing Intercity services. If Intercity services become more frequent, it may be possible to run them towards Dublin through Platform 3, with suburban train waiting in Platform 2 until a siding is available.

Table 23: TSS1 Suburban Trains in Service

Location	Number of Trains (at time 60 on graph)	
	Non-battery option	Battery option (11 min charge)
On journey Mallow to/from Midleton	8	8
On journey Blarney to/from Cobh	2	2
On journey Kent to/from Midleton	2	2
On journey Kent to/from Cobh	3	3
Mallow	2	2
Blarney	1	1
Kent	2	2
Midleton	0	1
Cobh	1	1
Total Suburban Trains in Service	21	22

If battery units are not used, one turnback siding is required at Mallow and existing facilities at Midleton are sufficient.

C.5 Demand Forecasts

Demand forecasting forms an important element of the optioneering process and gives insight into the varying attractiveness of each TSS option for passengers. The analysis described in this section is based on the detailed data contained in Appendix F. The modelling will be further refined as CACR moves into the Project Appraisal Report phase which will address any residual inconsistencies in the results.

Change in Daily Trips

An analysis has been undertaken of the absolute change in daily trip levels by mode for CACR Option TSS1 relative to the Do-Minimum. The data shows:

- A significant increase in public transport trips
- A significantly higher increase in public transport trips in 2050 relative to 2030. This is most likely due to higher levels of road congestion and public transport crowding in 2050 which results in the CACR Programme options being relatively more attractive to passengers.
- Reductions in walking and cycling trips, as rail provides a more convenient option for some trips. Whilst this runs contrary to policy objectives, in this instance the reduction in health/wellbeing will likely be outweighed by improvements in safety (through longer-distance trips being attracted off the road). The modelling is focussed on strategic impacts, so this reduction is likely overstated.

Change in Daily Mode Shares

An analysis has been undertaken of the absolute change in daily mode share for CACR Programme TSS1 relative to the Do-Minimum. This shows:

- Increases in public transport mode share up to approximately 0.4% in 2030
- Increases in public transport mode share up to approximately 0.8% in 2050. This higher increase relative to 2030 is in line with the changes in daily total trips i.e., is most likely due to higher levels of road congestion and public transport crowding in 2050 causing the CACR Programme options to provide greater crowding and congestion relief.

Change in Rail Boardings

An analysis has been undertaken of the change in rail boardings by mode in TSS1 relative to the Do-Minimum. This shows:

- A significant step change in use of commuter rail in all options, with between 180-190% additional boardings in 2030 and between 170-230% additional boardings in 2050
- A small reduction in boardings on Intercity services, as the commuter services provide an alternative to Intercity services between Mallow and Kent

The absolute daily boardings on which these figures are based is provided in Table 42.

Table 42: Daily Public Transport Boardings by Mode

	2030				2050			
	Standard DM	Standard TSS1	Dynamic DM	Dynamic TSS1	Standard DM	Standard TSS1	Dynamic DM	Dynamic TSS1
Irish Rail Commuter	3,900	11,000	4,200	12,300	6,300	17,200	6,000	20,200
Irish Rail Inter City	10,300	9,400	10,800	10,200	12,900	11,400	13,400	12,400
City Bus	161,200	160,500	178,800	178,900	217,300	217,800	214,100	213,700
Other Bus	28,200	27,700	28,100	27,700	33,300	32,500	32,900	32,300
Luas	n/a	n/a	n/a	n/a	n/a	n/a	44,300	44,700
Total	203,600	208,600	221,900	229,100	269,800	278,900	310,700	323,400

Line Passenger Demand Profiles

An analysis has been undertaken of Northbound and Southbound AM Peak Hour line passenger demand in the 2050 Standard Do-Minimum and TSS1 scenarios. This shows:

- Compared to the Do-Minimum, there is a significant increase in the use of Mallow and Kent stations
- Significant demand at the new Blarney station and Park and Ride facility
- Significant increase in line loads in the peak direction of travel i.e., Glounthaune – Kent, Mallow – Kent

Line Passenger Capacity

A comparison has been undertaken of Do-Minimum and TSS1 AM and PM Peak Hour line flows with AM and PM Peak Hour service seat capacity. This shows that:

- In the Do-Minimum scenario demand is forecast to exceed seating capacity
    - In the AM Peak northbound between Midleton and Kent
    - In the AM Peak southbound between Mallow and Kent
    - In the PM Peak northbound between Kent and Mallow
- In TSS1, whilst there is a significant increase in passenger demand forecast across the network compared to the Do-Minimum, there is sufficient seating capacity to accommodate that demand, except on AM Peak southbound services from Mallow to Blarney where demand is forecast to be slightly higher than seated capacity.
- In line with the analysis of line profiles, significant changes in line demand are generated at Kent and Mallow with smaller changes forecast at other stations

Economic Performance

For TSS1, economic benefits have been forecast to be in the range €400 million - €600 million for the Standard scenario, and lower for the Dynamic scenario which reflects performance as part of a longer-range public transport network. This range is a product of assumptions and limitations intrinsic within the SWRM modelling. As such they represent a lower bound of potential benefits and do not reflect the full benefits associated with the CACR Programme which will be captured as part of the Project Appraisal Report. At that stage, benefits from a scenario-based modelling approach will be incorporated which will better reflect aspirations for mode shift from the car and transit orientated developments at new stations which are anticipated to generate significantly higher benefits. Furthermore, benefits associated with journey time reliability, agglomeration, safety and other wider economic impacts, as well as other benefits such as those accrued by cyclists, will be accounted for at that stage.

C.6 Infrastructure Requirements

This section highlights any deviations from Section 6 for this TSS Option (TSS1)

New Stations

As per Section 6.1

Existing Stations

As per Section 6.2

Parking and Access

As per Section 6.3

Sidings, Passing Loops, Double Tracking and other Track Improvements

As per Section 6.4

Bridges and Structures

As per Section 6.5

Signalling

As per Section 6.6

Electrification

As per Section6.7.

Depot and Stabling

As per Section 6.8

C.7 Environmental Impacts

An environmental assessment was conducted for each of the TSS options to identify the preferred option from an environmental perspective, through a structured appraisal process. The assessment found that the impact was the same for all options.

Overall, the CACR Programme will have a positive environmental impact over its lifetime, compared to the Do Minimum due to electrification of the rail network and by encouraging a modal shift away from private car, helping in meeting Ireland’s target of net zero emissions by 2050. The increase in services would have a positive impact on population and human health through improved access to community infrastructure, employment sites and training facilities.

Development of the infrastructure will result to changes to the natural and built environment, during construction and operation. Environmental constraints affected include biodiversity, water, soils, land, geology, landscape and the cultural, archaeological and architectural heritage. In operation, the services will increase noise and vibration. Mitigations will be required to ensure that the overall environmental benefit of the programme is delivered.

Appendix H contains a summary of the environmental assessment.

C.8 Costs

Capital costs

For TSS1, scheme capital costs have been estimated as €1,207 million (2021 prices, undiscounted). It includes fleet costs which are assumed to be the same for all options although there are slight differences.

The cost estimate has been prepared in accordance with the NTA Cost Management Guidelines and includes the costs associated with new stations and car parks, a new maintenance depot, double tracking between Glounthaune to Midleton, the Rathduff passing loop, signalling enhancements, the closure of Myrtle Hill Level crossing, new sidings at Mallow, Blarney and Midleton, a new BEMU fleet and all electrical works associated with the development of battery charging infrastructure.

The cost estimate for fleet was based on actual costs from the DART+ BEMU contract. It includes for the purchase of 28 trainsets, to provide for contingency as agreed with IÉ.

Operational

Operational cost estimates for each of the TSS options considered were developed. These estimates reflect the different operational characteristics of the TSS options including:

- Fleet km
- Traction energy costs
- Vehicle maintenance
- Staffing requirements
- Fleet maintenance
- Infrastructure maintenance costs
- SET maintenance costs
- Other network costs

As discussed in Section 5, as the infrastructure requirements are broadly similar for all TSS options, the main differential in operational costs are derived from differences in fleet kilometres, traction energy costs, vehicles maintenance costs and staffing requirements resulting from different service specifications. The operational cost estimate for TSS1 is presented in

Table 43 below.

Table 43: Operational costs for TSS1

Annual base costs (incl. VAT)	TSS1
BEMU traction energy costs	€2.4 million
Vehicle maintenance	€6.1 million
Labour	€4.1 million
Track maintenance	€5.1 million
SET maintenance	€6.6 million
Stations & structures maintenance	€4.7 million
Other network costs	€0.6 million
VAT	€2.4 million
Annual Base Cost (incl. VAT)	€32.0 million
Total O&M Cost (market prices)	€4,681 million
Total O&M Cost (Financial NPV - 1.75% discount)	€2,169 million
Total O&M Cost (Economic NPV - 4% discount)	€333 million
Annual km per train set	2,809,735

C.9 Achievement of Objectives

TSS1 achieves all the CACR objectives and sub-objectives. The way in which TSS1 achieves the CACR Programme objectives is described below in Table 44:

Table 44: TSS1 option objectives achievement

Sub-objectives		Achievement
Sub-objective 1	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services.	TSS1 provides 12tph with a 106% increase in fleet. The disadvantage of this option is that it has irregular services and does not provide a regular 10-minute headway. Along with the development of the new stations, the rail services will be significantly improved. Estimated user benefits show that the services will potentially support sustainable economic development and population growth
Sub-objective 2	Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth	The inclusion of new stations will strengthen the connection for the users between the rail and the other public transport modes - BusConnects and light rail within the Cork Metropolitan Area. Intermodal connectivity will also be improved, and the local connectivity, especially for cyclists and pedestrians. There will be a 33% increase in the population that can easily access the rail stations withing 1km and a 31% increase on the number of workers living within 1km from the new stations. Therefore, the CACR Programme will enhance the accessibility to work, towns and other key destinations while improving the integration with other public transport modes
Sub-objective 3	Develop an integrated suburban rail system improving accessibility to jobs, education and other social and economic opportunities, inter-modal connectivity, and integration with other public transport services.	Accessibility will be enhanced due to the development of the new stations, enabling more people to shift from car to public transport and to easily access the public transport system. Future land development on the areas close to the rail stations could potentially unlock new opportunities to the next generations
Sub-objective 4	Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.	The modal shift expected from cars to rail due to more frequent train services and the higher capacity could lead to lower carbon emissions. The environmental analysis showed reduced emissions and air quality improvements, supporting Ireland's emission reduction targets
Sub-objective 5	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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	The proposed number of trains per hour will enhance the reliability and provide punctual rail services for the users. Improved pedestrian crossings close to the stations, and the provision of cycle parking at stations could also improve the customers' experience and support the shift to active modes.

Appendix D Option TSS2: Regular 10-minute Interval

D.1 Overview

This section presents a detailed analysis of TSS2 service plan, the turnaround and charging strategy, the demand and economic analysis and the potential infrastructure requirements.

D.2 Service Plan

Option TSS2 provides a more uniform service than the CMATS proposal by offering a regular ten-minute interval between services. However, this is at the cost of removing the through service from Cobh to anywhere west of Kent Station. Option TSS2 provides twelve commuter services per hour across the network, as follows:

- four tph from Midleton through to Mallow
- two tph from Midleton through to Blarney
- six tph from Cobh terminating at Kent Station

Passengers travelling on the Cobh Line to stations west of Kent Station would need to transfer at Kent Station.

This option also meets the CMATS objective with a 10-minute service on each branch and a regular 5-minute frequency between Glounthaune and Kent Stations.

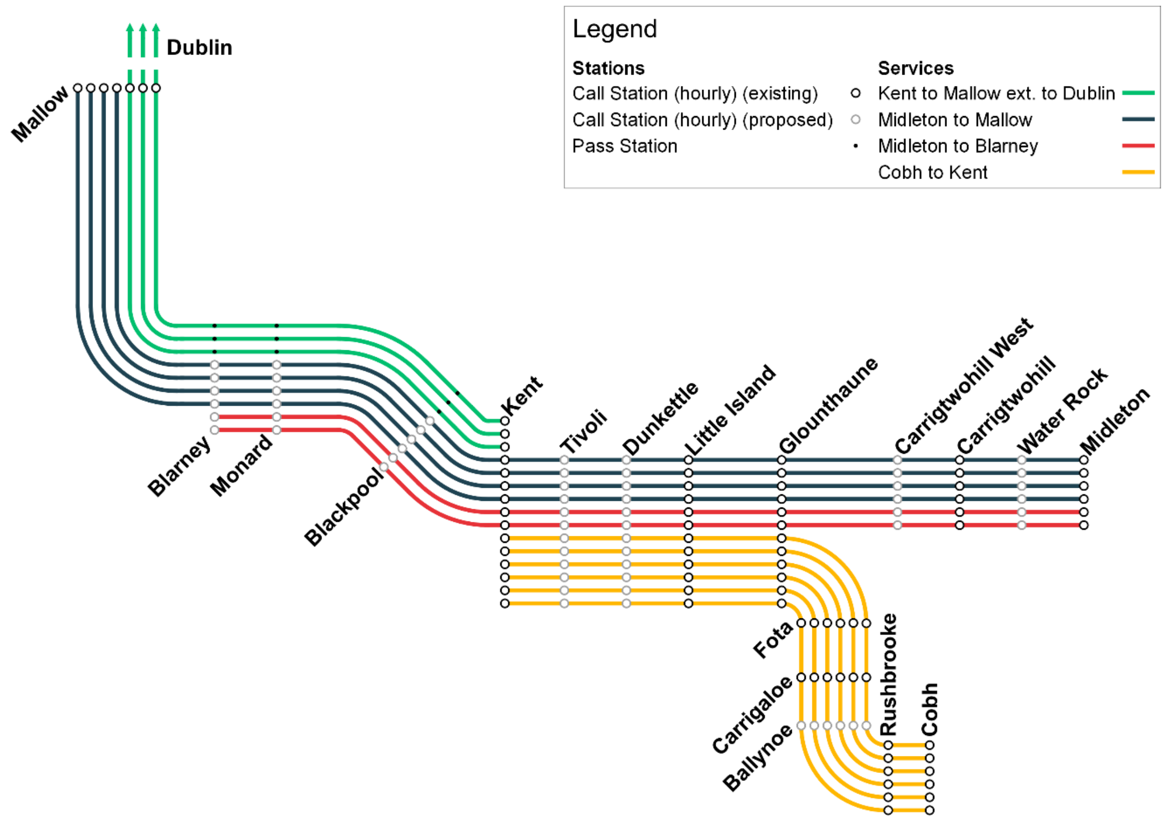

Figure 10: Option TSS2 Service Pattern

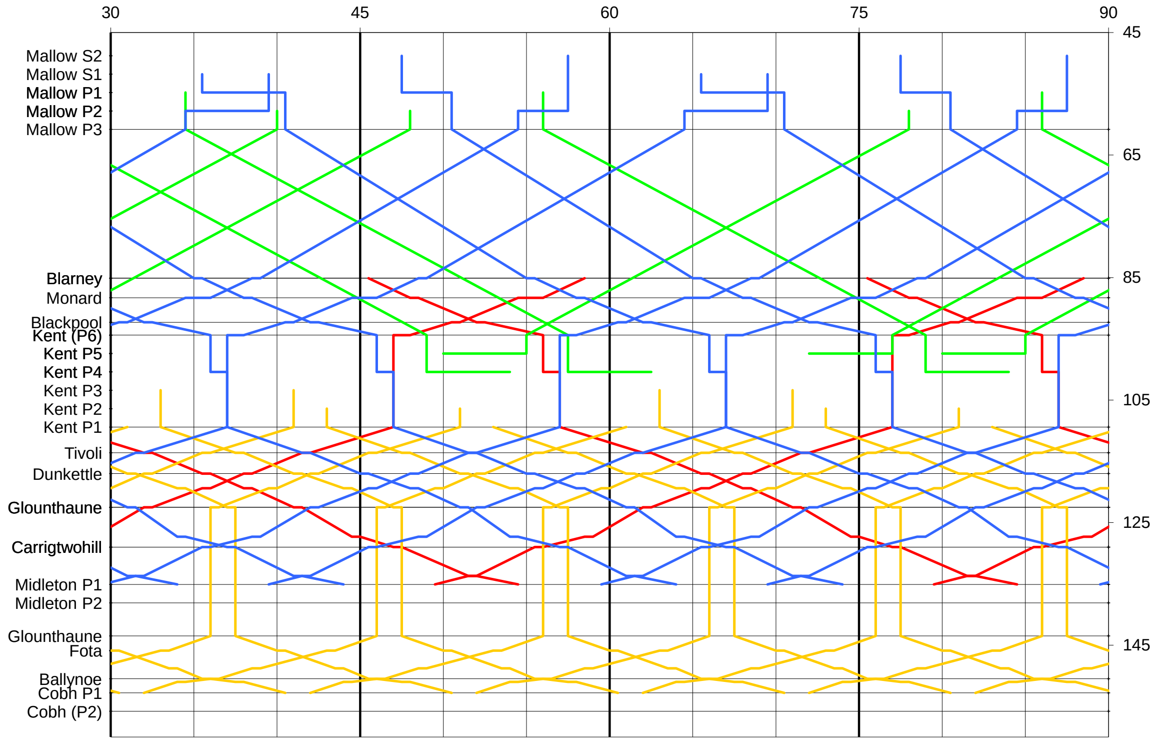

Figure 11: TSS2 Service Graph

Table 45: TSS2 minutes past the hour timetable, Down direction

Mallow P1		41		51		56			11		21		26		35
Mallow P2															
Mallow P3															
Blarney		56		06			16		26		36			46	
Monard		59		09			19		29		39			49	
Blackpool		03		13			23		33		43			53	
Kent P6															
Kent P5															
Kent P4		07		17		18	27		37		47		48	57	54
Kent P3	03							33							
Kent P2			13							43					
Kent P1					23		27				47	53		57	
Tivoli	08	12	18	22	28		33	38	42	48	52	58		03	
Dunkettle	12	16	22	26	32		36	42	46	52	56	02		06	
Little Island	15	19	25	29	35		39	45	49	55	59	05		09	
Glounthaune	18	22	28	32	38		42	48	52	58	02	08		12	
Carrigtwohill W		25		35			45		55		05			15	
Carrigtwohill		28		38			48		58		08			18	
Water Rock		32		42			52		02		12			22	
Midleton		34		44			55		04		14			25	
Fota	21		31		41			51		01		11			
Carrigaloe	24		34		44			54		04		14			
Ballynoe	26		36		46			56		06		16			
Rushbrooke	28		38		48			58		08		18			
Cobh	31		41		51			01		11		21			

Table 46: TSS2 minutes past the hour timetable, Up direction

Cobh	32		42				52		02		12			22	
Rushbrooke	35		45				55		05		15			25	
Ballynoe	37		47				57		07		17			27	
Carrigaloe	39		49				59		09		19			29	
Fota	44		54				04		14		24			34	
Midleton		40			50			00		10		20			30
Water Rock		42			52			02		12		22			32
Carrigtwohill		46			56			06		16		26			36
Carrigtwohill W		49			59			09		19		29			39
Glounthaune	47	53	57		03		07	13	17	23	27	33		37	43
Little Island	50	56	00		06		10	16	20	26	30	36		40	46
Dunkettle	53	59	03		09		13	19	23	29	33	39		43	49
Tivoli	56	02	06		12		16	22	26	32	36	42		46	52
Kent P1	01								31						57
Kent P2							21							51	
Kent P3			11								41				
Kent P4															
Kent P5				17		25							55		
Kent P6		08			18			28		38		48			58
Blackpool		11			21			31		41		51			01
Monard		16			26			36		46		56			06
Blarney		19			29			39		49		59			09
Mallow P3															
Mallow P2		34		40		48		54		04			18		24
Mallow P1															

D.3 Fleet requirements

The fleet required to operate services is derived from the specific requirements of the TSS. For TSS2 a fleet of 24 BEMU trainsets is required to operate the associated timetable. This is inclusive of a 10% redundancy to facilitate maintenance activities and failure recovery.

D.4 Turnaround and Charging Strategy

Turnaround and charging strategy is as follows:

- Cobh-Kent services charge at Kent, with trains using the three existing bay platforms (Platforms 1 to 3) in succession so that each one is scheduled to remain there for 28 minutes. No charging is required at Cobh.
- Midleton-Mallow services charge at both termini.
  - Midleton turnback times and arrangements are the same as TSS1
  - Mallow turnback arrangements are the same as TSS1, but the turnback times are irregular with the shortest time in the siding being around 19 minutes on the graph. This could be increased slightly by shortening the time in the platform before departure.

Midleton-Blarney services charge at Midleton, where charging facilities would have to be provided for the Mallow services. No charging would be required at Blarney.

If battery units are not used, one turnback siding is needed at Mallow, but two sidings could increase the minimum seven minutes turnaround to 17 minutes.

Perturbation and enhanced timetable requirements mean that a third turnback, with charging facilities, it required at Mallow station for the operation of TSS2.

Table 47: TSS2 Suburban Trains in Service

Location	Number of Trains (at time 60 on graph)	
	Non-battery option	Battery option (11 min charge)
On journey Mallow to/from Midleton	8	8
On journey Blarney to/from Midleton	2	2
On journey Kent to/from Cobh	6	6
Mallow	1	2
Blarney	1	1
Kent	1	1
Midleton	0	1
Cobh	0	0
Total Suburban Trains in Service	19	21

D.5 Demand Forecasts

Demand forecasting forms an important element of the optioneering process and gives insight into the varying attractiveness of each TSS option for passengers. The analysis described in this section is based on the detailed data contained in Appendix B. The modelling will be further refined as CACR moves into the Project Appraisal Report phase which will address any residual inconsistencies in the results.

Change in Daily Trips

An analysis has been undertaken of the absolute change in daily trip levels by mode for CACR TSS2 relative to the Do-Minimum. This shows:

- In 2030, the changes in trip levels are similar to the changes shown for TSS1 (refer to Appendix C)
- In 2050, whilst the changes in trip levels follow similar trends to TSS1 (refer to Appendix C), the quantum of changes differ slightly. In the Standard scenario, the increase in public transport trips is slightly lower in TSS2 whilst in the Dynamic scenario, the increase in public transport trips is slightly higher in TSS2

Change in Daily Mode Shares

An analysis has been undertaken of the absolute change in daily mode share in CACR TSS2 relative to the Do-Minimum. This shows:

- In 2030, the changes in mode shares are similar to the changes shown for TSS1 (refer to Appendix C).
- In 2050, whilst the changes in mode shares follow similar trends to TSS1 (refer to Appendix C), the quantum of changes differ slightly. In the Standard scenario the increase in public transport mode share is slightly lower in TSS2 whilst in the Dynamic scenario the increase in public transport mode share is slightly higher in TSS2.

Change in Rail Boardings

An analysis has been undertaken of the percentage change in public transport boardings by mode in TSS2 relative to the Do-Minimum. This shows similar trends to TSS1 (refer to Appendix C), except in the Dynamic scenario where the increase in Irish Rail commuter boardings is significantly higher in TSS2.

The results show a significant step change in use of commuter rail in all options, with between 180-190% additional boardings in 2030 and between 170-230% additional boardings in 2050

The absolute daily boardings on which these figures are based is provided in Table 48.

Table 48: Daily Public Transport Boardings by Mode

	2030				2050			
	Standard DM	Standard TSS2	Dynamic DM	Dynamic TSS2	Standard DM	Standard TSS2	Dynamic DM	Dynamic TSS2
Irish Rail Commuter	3,900	10,500	4,200	12,100	6,300	17,000	6,000	23,800
Irish Rail Inter City	10,300	9,700	10,800	10,200	12,900	11,800	13,400	13,000
City Bus	161,200	161,000	178,800	179,300	217,300	216,900	214,100	214,500
Other Bus	28,200	27,700	28,100	27,700	33,300	32,500	32,900	32,200
Luas	n/a	n/a	n/a	n/a	n/a	n/a	44,300	45,800
Total	203,600	208,900	221,900	229,300	269,800	278,200	310,700	329,300

Line Passenger Demand Profiles

An analysis has been undertaken of Northbound and Southbound AM Peak Hour line demand in the 2050 Standard Do-Minimum and TSS2 scenarios. These show similar trends to TSS1, although demand is noticeably higher in the northbound direction in TSS2.

Line Passenger Capacity

A comparison has been undertaken of Do-Minimum and TSS2 AM and PM Peak Hour line flows with AM and PM Peak Hour service seat capacity. This shows that:

- The profiles show similar trends to TSS1
- Whilst demand is noticeably higher in the AM Peak northbound direction and PM Peak southbound direction in TSS2 (compared to TSS1), there is still sufficient seating capacity to accommodate demand
- Unlike TSS1 (in which demand is forecast to be slightly higher than seated capacity), demand is forecast to be slightly lower than seated capacity from Mallow to Blarney in TSS2.

Economic Performance

For TSS2, for the Standard scenario, economic benefits have been forecast to be in the range €300 million - €450 million. This is less than for TSS1; however, the economic benefits emerging from the Dynamic scenario, which reflects performance as part of a longer-range public transport network, are higher for TSS2 than TSS1 suggesting a better integration with the wider network. Public transport benefits for TSS2 are 3% higher than TSS1 in the Standard scenario and 14.5% higher in the Dynamic scenario. This range is a product of assumptions and limitations intrinsic within the SWRM. As such they represent a lower bound of potential benefits and reflect the full benefits associated with the CACR Programme which will be captured as part of the Project Appraisal Report. At that stage, benefits from a scenario-based modelling approach will be incorporated which will better reflect aspirations for mode shift from the car and transit orientated developments at new stations which are anticipated to generate significantly higher benefits. Furthermore, benefits associated with journey time reliability, agglomeration, safety and other wider economic impacts, as well as other benefits such as those accrued by cyclists, will be accounted for at that stage.

D.6 Infrastructure Requirements

Section 5 sets out the infrastructure improvements required for CACR Programme as a result of the stated objectives and the outcome of the various TSS assessments. This section highlights any deviations from Section 5 for this TSS Option (TSS2).

New Stations

As per Section 6.1

Existing Stations

As per Section 6.2

Parking and Access

As per Section 6.3

Sidings, Passing Loops, Double Tracking and other Track Improvements

As per Section 6.4

Bridges and Structures

As per Section 6.5

Signalling

As per Section 6.6

Electrification

As per Section6.7.

Depot and Stabling

As per Section 6.8

D.7 Environmental Impacts

As per Appendix C, slight differences in the service pattern and infrastructure requirements associated with TSS2 are insufficient to affect the environmental assessment.

D.8 Costs

Capital Costs

For TSS2, scheme capital costs have been estimated as €1,196 million (2021 prices, undiscounted).

TSS2 requires one less trainset than TSS1, and an additional turnback with charging at Mallow Station.

Operational

Operational cost estimates for each of the TSS options considered were developed. These estimates reflect the different operational characteristics of the TSS options including:

- Fleet km
- Traction energy costs
- Vehicle maintenance
- Staffing requirements
- Fleet maintenance
- Infrastructure maintenance costs
- SET maintenance costs
- Other network costs

As discussed in Section 5, as the infrastructure requirements are broadly similar for all TSS options, the main differential in operational costs are derived from differences in fleet kilometres, traction energy costs, vehicles maintenance costs and staffing requirements resulting from different service specifications.

The operational cost estimate for TSS2 is presented in Table 49 below.

Table 49: Operational costs for TSS2

Annual base costs (incl. VAT)	TSS2
BEMU traction energy costs	€2.3 million
Vehicle maintenance	€6.1 million
Labour	€4.1 million
Track maintenance	€5.1 million
SET maintenance	€6.6 million
Stations & structures maintenance	€4.7 million
Other network costs	€0.6 million
VAT	€2.4 million
Annual Base Cost (incl. VAT)	€31.9 million
Total O&M Cost (market prices)	€4,666 million
Total O&M Cost (Financial NPV - 1.75% discount)	€2,162 million
Total O&M Cost (Economic NPV - 4% discount)	€332 million
Annual km per train set	2,811,173

D.9 Achieving the objectives

The analysis focused on evaluating the objectives of the CACR Programme that were achieved by each TSS option is presented below in Table 50. A description of the objectives is given in Section 2.4.

Table 50: TSS2 option achieving the sub-objectives

Sub-objectives		Achievement
Sub-objective 1	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services.	TSS2 provides 12tph, as does TSS1. TSS1 has irregular services, while TSS2 meets the CMATS objective with a 10-minute service for both directions. Therefore, TSS2 performs better than TSS1 in meeting the sub-objective 1.
Sub-objective 2	Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth	As per Appendix C
Sub-objective 3	Develop an integrated suburban rail system improving accessibility to jobs, education and other social and economic opportunities, inter-modal connectivity, and integration with other public transport services.	
Sub-objective 4	Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.	
Sub-objective 5	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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	

Appendix E Option TSS2a: Reduced Mallow Commuter Services

E.1 Overview

This section presents a detailed analysis of TSS2a service plan, the turnaround and charging strategy, the demand and economic analysis and the potential infrastructure requirements.

E.2 Service Plan

A derivation of TSS2, called TSS2a was identified, with the option of curtailing two of the suburban services to Mallow at Blarney. This option has the advantage of requiring a smaller fleet to operate services. TSS 2a reduces the overall annual service kilometres and associated traction electricity costs, and also reduces labour costs associated with the delivery of servics. Overall, the annual operational base cost for TSS2a is €31.1m, compared to €32m and €31.9m for TSS1 and TSS2 respectively.

Option TSS2a provides twelve commuter services per hour across the network, as follows:

- two tph from Midleton through to Mallow
- four tph from Midleton through to Blarney
- six tph from Cobh terminating at Kent Station

Passengers travelling on the Cobh Line to stations west of Kent Station would need to transfer at Kent Station.

This option also meets the CMATS objective with a 10-minute service on each branch and a regular 5-minute service between Glounthaune and Kent Stations. This is shown in Figure 12.

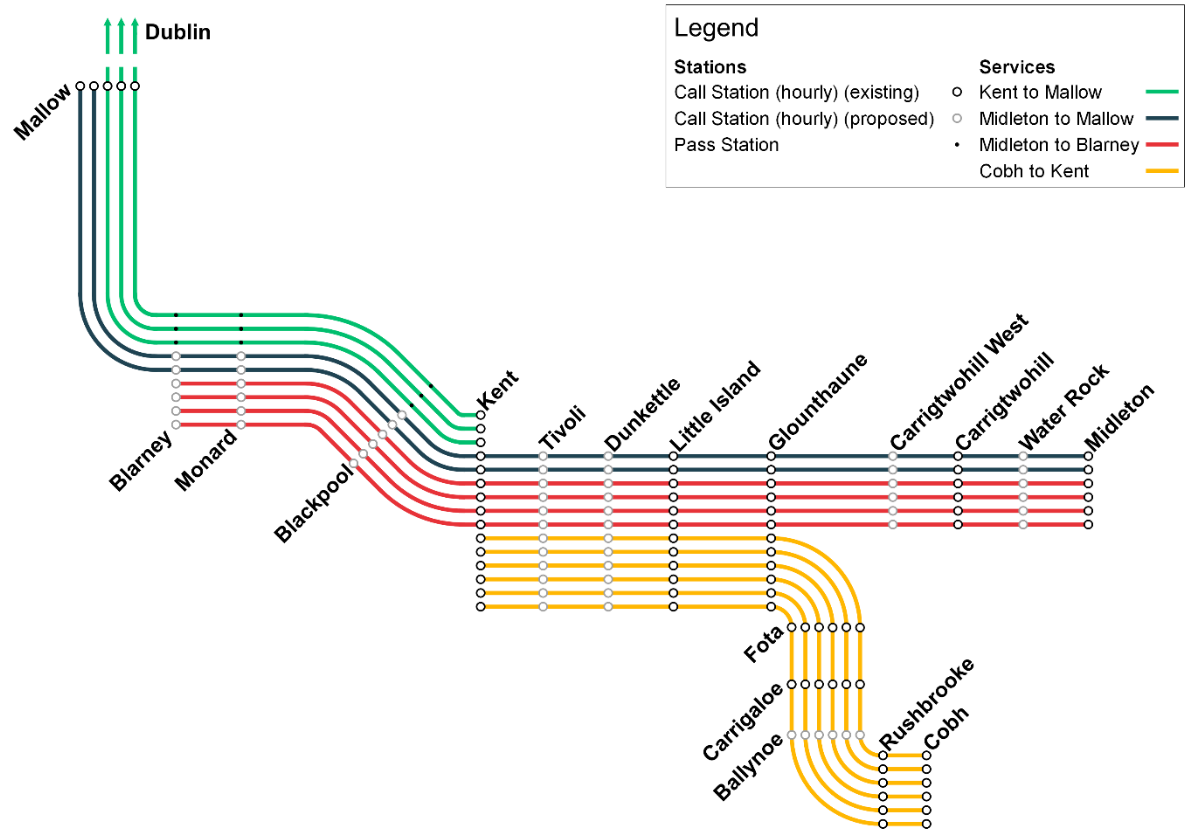

Figure 12: Option TSS2a Service Pattern

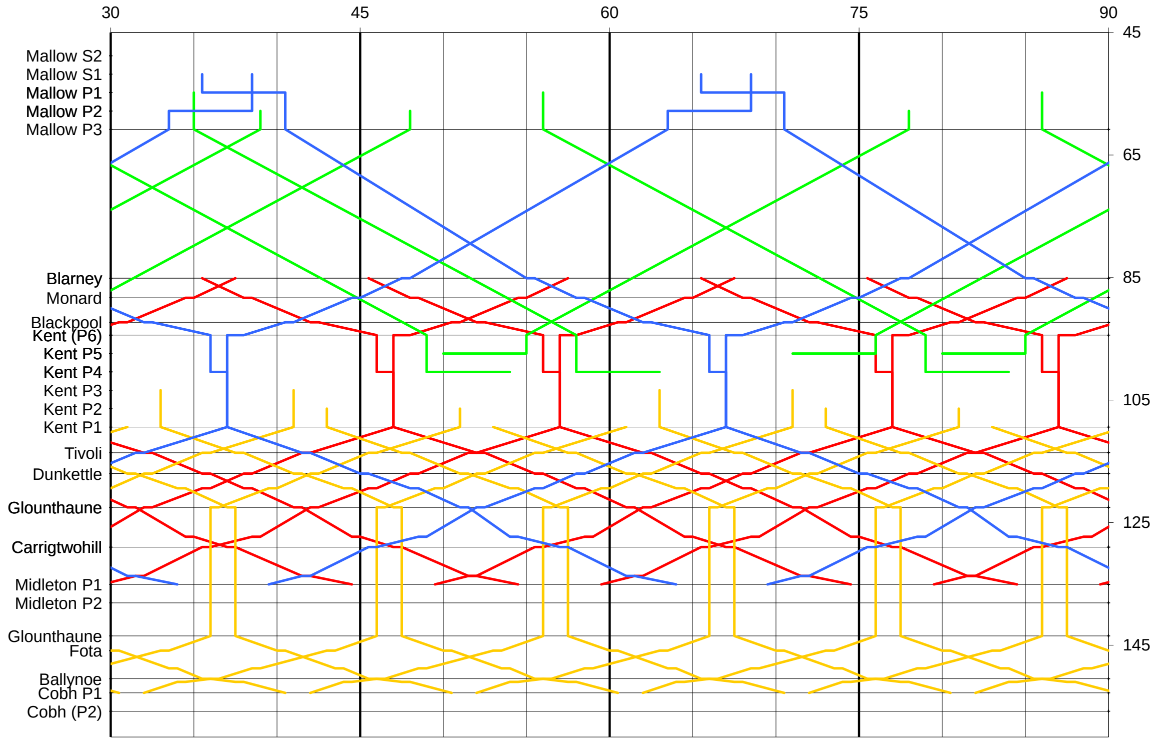

Figure 13: TSS2a Service Graph

Table 51: TSS2a minutes past the hour timetable, Down direction

Mallow P1		41				56			11				26		35
Mallow P2															
Mallow P3															
Blarney		56		06			16		26		36			46	
Monard		59		09			19		29		39			49	
Blackpool		03		13			23		33		43			53	
Kent P6															
Kent P5															
Kent P4		07		17		18	27		37		47		48	57	58
Kent P3	03							33							
Kent P2			13							43					
Kent P1					23		27				47	53		57	
Tivoli	08	12	18	22	28		33	38	42	48	52	58		03	
Dunkettle	12	16	22	26	32		36	42	46	52	56	02		06	
Little Island	15	19	25	29	35		39	45	49	55	59	05		09	
Glounthaune	18	22	28	32	38		42	48	52	58	02	08		12	
Carrigtwohill W		25		35			45		55		05			15	
Carrigtwohill		28		38			48		58		08			18	
Water Rock		32		42			52		02		12			22	
Midleton		34		45			55		04		15			25	
Fota	21		31		41			51		01		11			
Carrigaloe	24		34		44			54		04		14			
Ballynoe	26		36		46			56		06		16			
Rushbrooke	28		38		48			58		08		18			
Cobh	31		41		51			01		11		21			

Table 52: TSS2a minutes past the hour timetable, Up direction

Cobh	32		42				52		02		12			22	
Rushbrooke	35		45				55		05		15			25	
Ballynoe	37		47				57		07		17			27	
Carrigaloe	39		49				59		09		19			29	
Fota	44		54				04		14		24			34	
Midleton		40			50			00		10		20			30
Water Rock		42			52			02		12		22			32
Carrigtwohill		46			56			06		16		26			36
Carrigtwohill W		49			59			09		19		29			39
Glounthaune	47	53	57		03		07	13	17	23	27	33		37	43
Little Island	50	56	00		06		10	16	20	26	30	36		40	46
Dunkettle	53	59	03		09		13	19	23	29	33	39		43	49
Tivoli	56	02	06		12		16	22	26	32	36	42		46	52
Kent P1	01								31						57
Kent P2							21							51	
Kent P3			11								41				
Kent P4															
Kent P5				16		25							55		
Kent P6		08			18			28		38		48			58
Blackpool		11			21			31		41		51			01
Monard		16			26			36		46		56			06
Blarney		18			29			38		48		58			08
Mallow P3															
Mallow P2		34		39		48				04			18		
Mallow P1															

Table 53: TSS2a Suburban Trains in Service

Location	Number of Trains (at time 60 on graph)	
	Non-battery option	Battery option (11 mins)
On journey Mallow to/from Midleton	4	4
On journey Blarney to/from Midleton	5	5
On journey Kent to/from Cobh	6	6
Mallow	1	1
Blarney	1	1
Kent	1	1
Midleton	0	1
Cobh	0	0
Total Suburban Trains in Service	18	19

The timetable for TSS2a is identical to TSS2, except that two of the suburban services continuing to Mallow under TSS2 are curtailed at Blarney. This results in a near-even combined interval of suburban and Intercity services at Mallow, except that the non-Dublin Intercity service is off pattern.

E.3 Fleet requirements

The fleet required to operate services is derived from the specific requirements of the TSS. For TSS2a, a fleet of 21 trainsets is required to operate the associated timetable. This is inclusive of a 10% redundancy to facilitate maintenance activities and failure recovery.

E.4 Turnaround and Charging Strategy

The charging strategy is the same as TSS2, but the lower frequency at Mallow means that only one turnback/charging siding is required there.

E.5 Demand Forecasts

Demand forecasting forms an important element of the optioneering process and gives insight into the varying attractiveness of each TSS option for passengers. The analysis described in this section is based on the detailed data contained in Appendix B. The change in daily trips and daily mode shares are presented for the Cork Commuter Area (as shown in Appendix B). The modelling will be further refined as CACR moves into the Project Appraisal Report phase which will address any residual inconsistencies in the results.

Change in Daily Trips

An analysis has been undertaken of the absolute change in daily trip levels by mode in TSS2a relative to the Do-Minimum. This shows:

- In 2030, the changes in trip levels are similar to the changes shown for TSS1 and TSS2 (refer to Appendix C).
- In 2050, whilst the changes in trip levels follow similar trends to TSS1 (refer to Appendix C), the quantum of changes differ slightly and are more in line with TSS2. In the Standard scenario, the increase in public transport trips is slightly lower in TSS2a whilst in the Dynamic scenario, the increase in public transport trips is slightly higher in TSS2a

Change in Daily Mode Shares

An analysis has been undertaken of the absolute change in daily mode share in TSS2a relative to the Do-Minimum. This shows:

- In 2030, the changes in mode shares are similar to the changes shown for TSS1 and TSS2 (refer to Appendix C).
- In 2050, whilst the changes in mode shares follow similar trends to TSS1 (refer to Appendix C), the quantum of changes differ slightly and are more in line with TSS2. In the Standard scenario the increase in public transport mode share is slightly lower in TSS2a whilst in the Dynamic scenario the increase in public transport mode share is slightly higher in TSS2a.

Change in Rail Boardings

An analysis has been undertaken of the change in public transport boardings by mode in TSS2a relative to the Do-Minimum. In both 2030 and 2050, whilst the changes in mode shares follow similar trends to TSS1 and TSS2 (refer to Appendix C), in both Standard and Dynamic scenarios, the increase in Irish Rail commuter boardings is lower in TSS2a compared to TSS1 and TSS2.

The results show a significant step change in use of commuter rail in all options, with between 150-170% additional boardings in 2030 and between 150-210% additional boardings in 2050.

The absolute daily boardings on which these figures are based is provided in Table 22.

Table 22: Daily Public Transport Boardings by Mode

	2030				2050			
	Standard DM	Standard TSS2a	Dynamic DM	Dynamic TSS2a	Standard DM	Standard TSS2a	Dynamic DM	Dynamic TSS2a
Irish Rail Commuter	3,900	9,600	4,200	11,300	6,300	15,700	6,000	18,500
Irish Rail Inter City	10,300	9,900	10,800	10,300	12,900	12,100	13,400	12,400
City Bus	161,200	158,000	178,800	179,300	217,300	213,400	214,100	217,100
Other Bus	28,200	27,800	28,100	27,700	33,300	32,700	32,900	32,100

	2030				2050			
	Standard DM	Standard TSS2a	Dynamic DM	Dynamic TSS2a	Standard DM	Standard TSS2a	Dynamic DM	Dynamic TSS2a
Luas	n/a	n/a	n/a	n/a	n/a	n/a	44,300	46,100
Total	203,600	205,300	221,900	228,600	269,800	273,900	310,700	326,200

Line Passenger Demand Profiles

An analysis has been undertaken of Northbound and Southbound AM Peak Hour line demand in the 2050 Standard Do-Minimum and TSS2a scenarios. This shows similar trends to TSS1 however:

- Demand is noticeably higher in the northbound direction, between Water Rock and Tivoli, in TSS2a
- Demand is noticeably lower in the southbound direction in TSS2a; this is due to a lower frequency (reduction of two tph) between Mallow and Blarney in TSS2a.

Line Passenger Capacity

A comparison has been undertaken of Do-Minimum and TSS2a AM and PM Peak Hour line flows with AM and PM Peak Hour service seat capacity. This shows:

- Similar trends to TSS1
- Whilst demand is noticeably higher in the AM Peak northbound direction in TSS2a (compared to TSS1), there is still sufficient seating capacity to accommodate demand.
- In the AM Peak southbound direction, standing passengers are forecast to be higher in TSS2a (than TSS1) from Mallow to Blarney due to a reduced frequency of two tph between these stations.

Economic Performance

For TSS2a, in the Standard scenario, economic benefits have been forecast to be in the range of €250 million - €400 million, lower than for TSS1 and TSS2. Initial indications are that benefits are also lower in the Dynamic scenario. This is to be expected as it offers fewer services. A range is given to account for uncertainties, particularly in relation to journey time reliability, agglomeration, safety and other wider economic impacts. This range is a product of assumptions and limitations intrinsic within the SWRM modelling. As such it they represent a lower bound of potential benefits and does not reflect the full benefits associated with the CACR Programme which will be captured as part of the Project Appraisal Report. At that stage, benefits from a scenario-based modelling approach will be incorporated which will better reflect aspirations for mode shift from the car and transit orientated developments at new stations which are anticipated to generate significantly higher benefits. Furthermore, benefits associated with journey time reliability, agglomeration, safety and other wider economic impacts, as well as other benefits such as those accrued by cyclists, will be more accurately accounted for at that stage.

E.6 Infrastructure Requirements

Section 5 sets out the infrastructure improvements required for CACR Programme as a result of the stated objectives and the outcome of the various TSS assessments. This section highlights any deviations from Section 5 for this TSS Option (TSS2a).

New Stations

As per Section 6.1

Existing Stations

As per Section 6.2

Parking and Access

As per Section 6.3

Sidings, Passing Loops, Double Tracking and other Track Improvements

As per Section 6.4

Bridges and Structures

As per Section 6.5

Signalling

As per Section 6.6

Electrification

As per Section6.7.

Depot and Stabling

As per Section 6.8

E.7 Environmental Impacts

As per Appendix C, slight differences in the service pattern and infrastructure requirements associated with TSS2a are insufficient to affect the environmental assessment.

E.8 Costs

Capital Costs

For TSS2a, scheme capital costs have been estimated as €1,161 million (2021 prices, undiscounted).

TSS2a requires four trainsets less than TSS1.

Operational

Operational cost estimates for each of the TSS options considered were developed. These estimates reflect the different operational characteristics of the TSS options including:

- Fleet km
- Traction energy costs
- Vehicle maintenance
- Staffing requirements
- Fleet maintenance
- Infrastructure maintenance costs
- SET maintenance costs
- Other network costs

As discussed in section 5, as the infrastructure requirements are broadly similar for all TSS options, the main differential in operational costs are derived from differences in fleet kilometres, traction energy costs, vehicles maintenance costs and staffing requirements resulting from different service specifications.

The operational cost estimate for TSS2a is presented in Table 23 below. As shown, due to the reduction in total annual fleet kilometres from €2.8 million (for TSS1 and TSS 2) to €2.4 million, the annual operational cost is reduced from circa €32 million and €31.9 million for TSS1 and TSS 2 respectively, to €31.1 million.

Table 23: Operational costs for TSS2a

Annual base costs (incl. VAT)	TSS2a
BEMU traction energy costs	€2 million
Vehicle maintenance	€6 million
Labour	€3.8 million
Track maintenance	€5.1 million
SET maintenance	€6.6 million
Stations & structures maintenance	€4.7 million
Other network costs	€0.6 million
VAT	€2.4 million
Annual Base Cost (incl. VAT)	**€31.1 million**
Total O&M Cost (market prices)	€4,543 million
Total O&M Cost (Financial NPV - 1.75% discount)	€2,106 million
Total O&M Cost (Economic NPV - 4% discount)	€323 million
Annual km per train set	**2,450,943**

E.9 Achieving the objectives

The analysis focused on evaluating the objectives of the CACR Programme that were achieved by each TSS option is presented in Table 24.

Table 24: TSS2a option achieving the sub-objectives

Sub-objectives		Achievement
Sub-objective 1	Support compact urban growth and contribute to reducing transport congestion and emissions in the Cork Metropolitan Area by enhancing the existing heavy rail system, providing a sustainable, safe, efficient, and integrated public transport service that will improve the attractiveness of rail services.	TSS2a provides 12tph, as does TSS1 and TSS2. TSS1 has irregular services, while TSS2a meets the CMATS objective with a 10minutes service for both directions; however, it offers two services per hour to Mallow compared with four services per hour for the other options. Operating costs are lower as a result, but so are user benefits, and it is forecast that there may be standing room only in some sections during the morning peak.
Sub-objective 2	Cater for existing heavy rail travel demand and support long-term patronage growth along established rail corridors in the Cork Metropolitan Area through the provision of a higher frequency, higher capacity, electrified heavy rail service which supports sustainable economic development and population growth	As per Appendix C
Sub-objective 3	Develop an integrated suburban rail system improving accessibility to jobs, education and other social and economic opportunities, inter-modal connectivity, and integration with other public transport services.	
Sub-objective 4	Enable consolidation of urban compact growth along existing rail corridors, unlock regeneration opportunities and more effective use of land in the Cork Metropolitan Area, for present and future generations, through the provision of a higher capacity heavy rail network.	
Sub-objective 5	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 Cork Metropolitan Area and which supports the advancement of Ireland's transition to a low emissions transport system and delivery of Ireland's emission reduction targets.	

Appendix F Summary of Infrastructure Requirements

Three Train Service Specifications have been developed, namely TSS1, TSS2 and TSS2a. Each TSS option developed has been reviewed for fleet and associated infrastructure. Those infrastructure requirements have been categorised as follows:

1. Minimum requirements- Infrastructure required to operate the base timetable assuming no perturbation.
2. Perturbation requirements- Additional infrastructure required to deal with disruption (unknown events) such as train or infrastructure failures and delays. This could include turnbacks/sidings and passing loops. A particular issue between Mallow and Kent is the interaction between the new Suburban service and the key Cork-Dublin Intercity service.
3. Enhanced timetable requirements- Additional infrastructure required to cater for additional services and operational flexibility related to known events such as match days, cruise ships at Cobh, and major infrastructure maintenance.

Tables 23 and 24 below present a summary of the requirements.

Table 39: Summary of infrastructure requirements for TSS options

	Intervention	TSS1 Min	TSS2 Min	TSS2a Min	TSS1 Pert/Enh	TSS2 Pert/Enh	TSS2a Pert/Enh
Mallow	1 turnback facility, independent of Intercity	✓	✓	✓	-	-	-
	Charging facility in 1 turnback	✓	✓	✓	-	-	-
	2 turnback facilities, independent of Intercity	✓	✓	-	-	-	✓
	Charging facility in 2 turnbacks	✓	✓	-	-	-	✓
	3rd turnback facility, independent of Intercity	-	-	-	-	✓	-
	Charging facility in 3rd turnbacks	-	-	-	-	✓	-
Mallow to Blarney	Signalling for 3min headway	✓	✓	✓	-	-	-
	Bi-Directional Signalling & Crossovers	-	-	-	✓	✓	✓
	Passing loop at Rathduff	-	-	-	✓	✓	✓
Blarney	New station with offline platform	✓	✓	✓		-	-
	Siding Extension of turnback platform	-	-	-	✓	✓	✓
	Passing loop at Blarney	-	-	-	✓	✓	✓
	Charging facility in turnback	-	-	-	✓	✓	✓
	Charging facility in platform	✓	-	-	-	✓	✓
Blarney to Kent	Signalling for 3min headway	✓	✓	✓	-	-	-
	Turnback crossover at Blackpool	-	-	-	✓	✓	✓
Kent	Charging facility in 2 bay platforms	✓	✓	✓	-	-	-
	Charging facility in 3rd bay platform		-	-	✓	✓	✓
	Through platform	✓	✓	✓	-	-	-
	Enhanced turnback facility for third Intercity service	✓	✓	✓	-	-	-
Kent to Glounthaune	Signalling for 3min headway	✓	✓	✓	-	-	-
Glounthaune to Midleton	Second track throughout	✓	✓	✓	-	-	-
Glounthaune to Cobh, Midleton	Signalling for 7min headway	✓	✓	✓	-	-	-
Midleton	Charging facility in 2 platforms	✓	✓	✓	-	-	-
	Additional facility for 3rd train with charging	-	-	-	✓	✓	✓
Cobh	2nd Platform	-	-	-	✓	✓	✓

Table 40: Summary of infrastructure requirements for worst case TSS

Station/section	Intervention	Minimum Requirement in worse case TSS	Perturbation / Enhanced timetable Requirement
Mallow	Minimum 3 turnback facilities, independent of Intercity	✓	-
	Charging facility in minimum of 3 facilities	✓	-
Mallow to Blarney	Signalling for 3min headway	✓	-
	Bi-Directional Signalling & Crossovers	-	✓
	Passing loop at Rathduff	-	✓
Blarney	New station with offline platform	✓	
	Siding Extension of turnback platform	✓	-
	Passing loop at Blarney	-	✓
	Charging facility in turnback	✓	-
	Charging facility in platform	✓	-
Blarney to Kent	Signalling for 3min headway	✓	-
	Turnback crossover at Blackpool	-	✓
Kent	Charging facility in 2 bay platforms	✓	-
	Charging facility in 3rd bay platform	-	✓
	Through platform	✓	-
	Enhanced turnback facility for third intercity service	✓	-
Kent to Glounthaune	Signalling for 3min headway	✓	-
Glounthaune to Midleton	Second track throughout	✓	-
Glounthaune to Cobh, Midleton	Signalling for 7min headway	✓	-
Midleton	Charging facility in 2 platforms	✓	-
	Third turnback facility, with charging	-	✓
Cobh	2nd Platform	-	✓

Appendix G Demand Forecasts – Graphics

G.1 Option 1

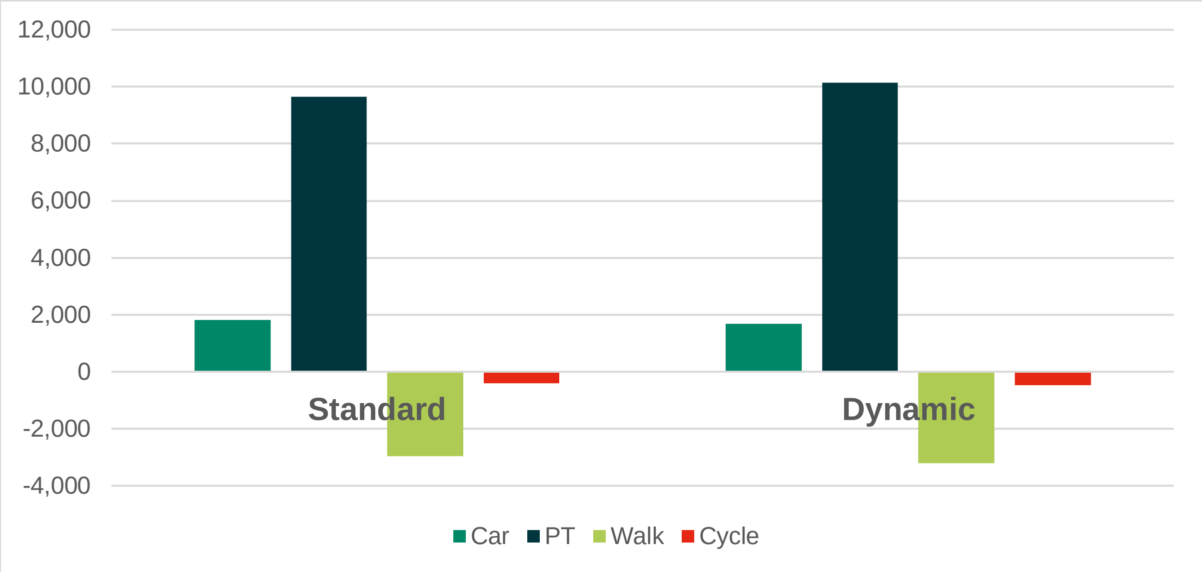

Figure 14: CACR Option 1 absolute change in daily trips relative to Do-Minimum, 2030

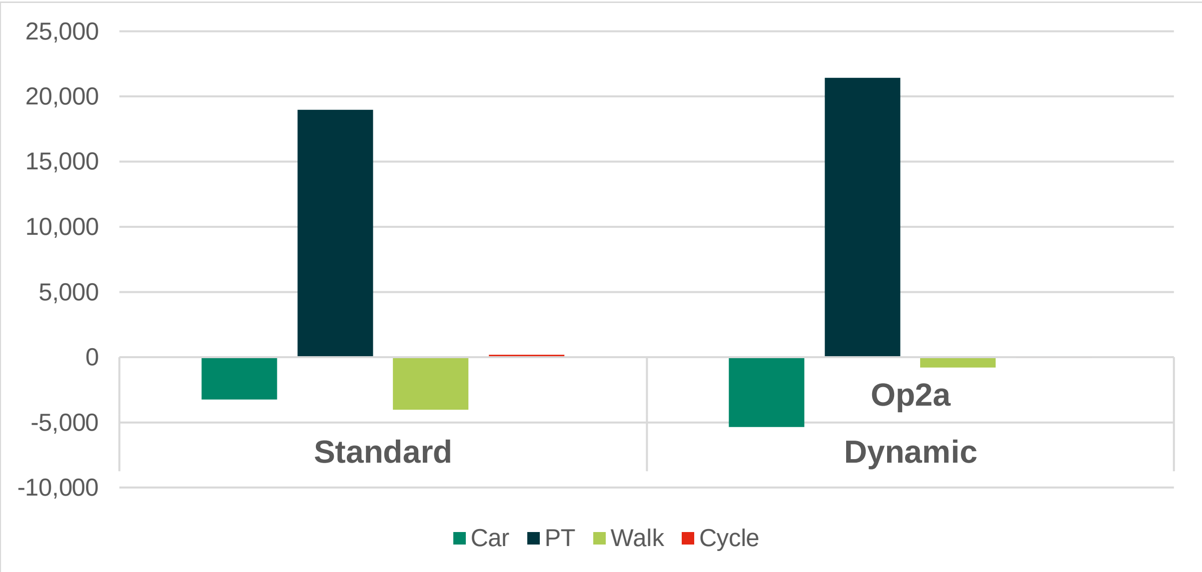

Figure 15: CACR Option 1 absolute change in daily trips relative to Do-Minimum, 2050

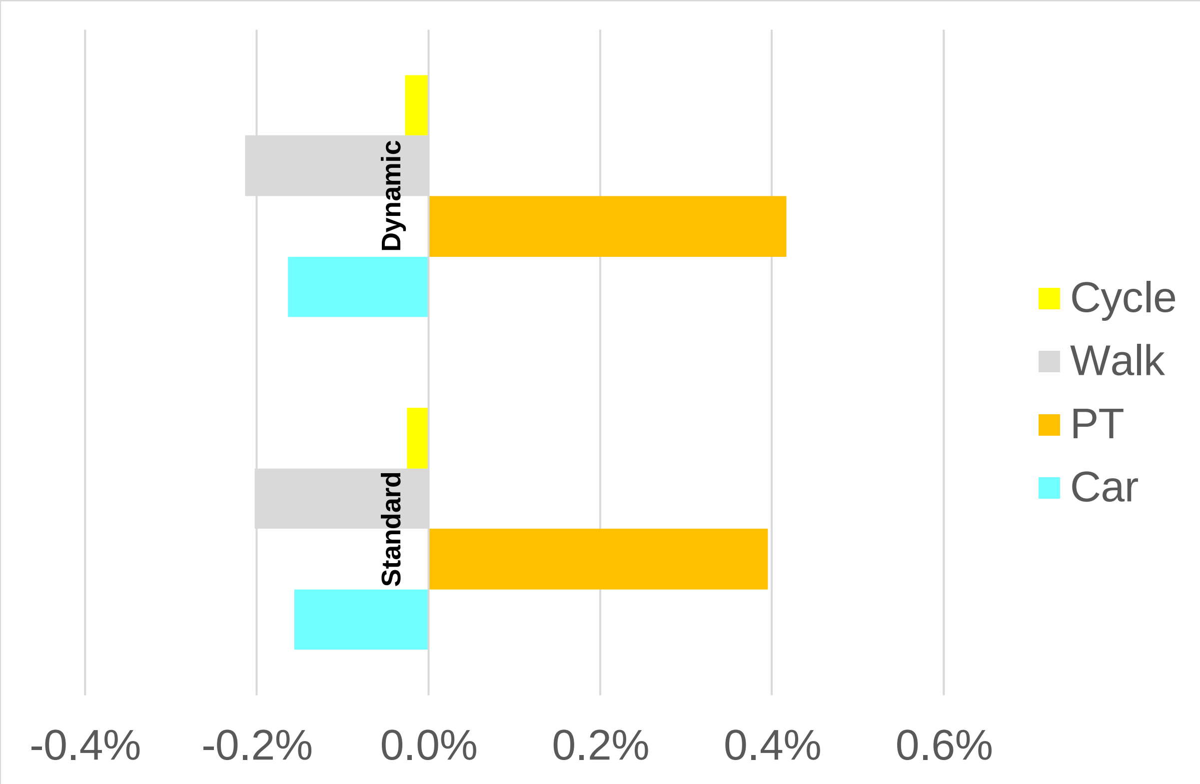

Figure 16: CACR Option 1 absolute change in daily mode share relative to Do-Minimum, 2030

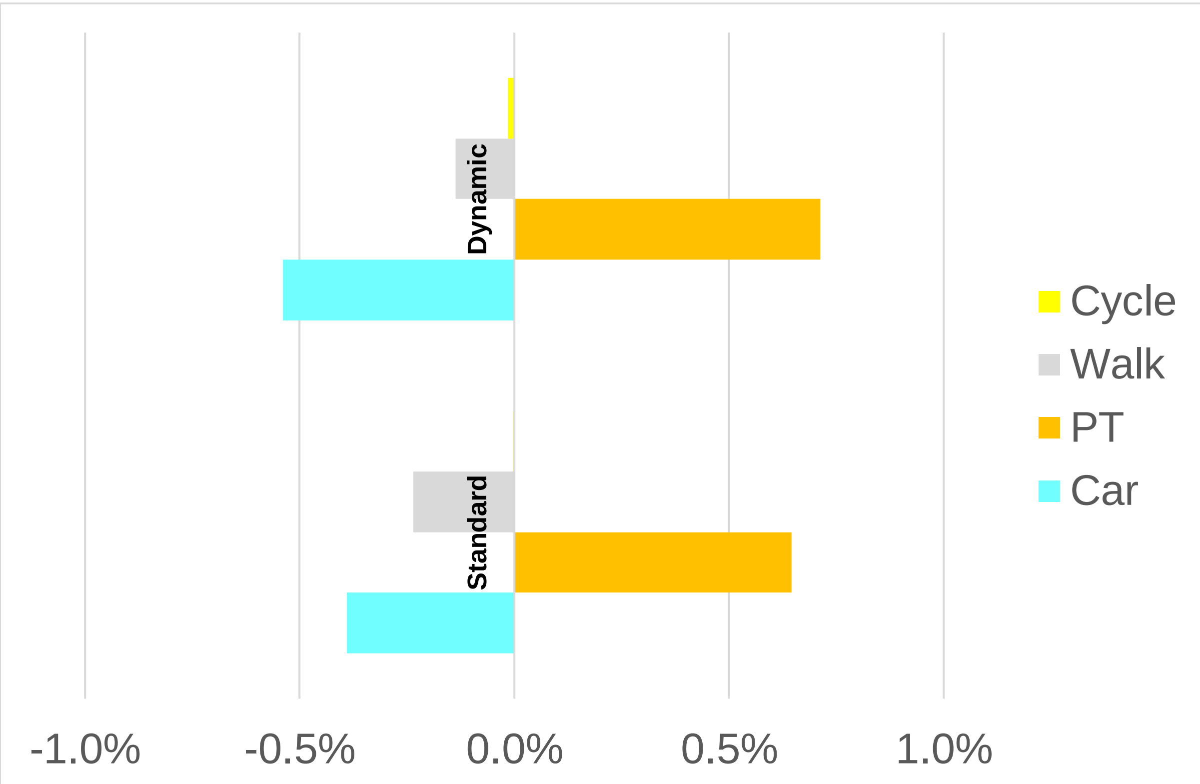

Figure 17: CACR Option 1 absolute change in daily mode share relative to Do-Minimum, 2050

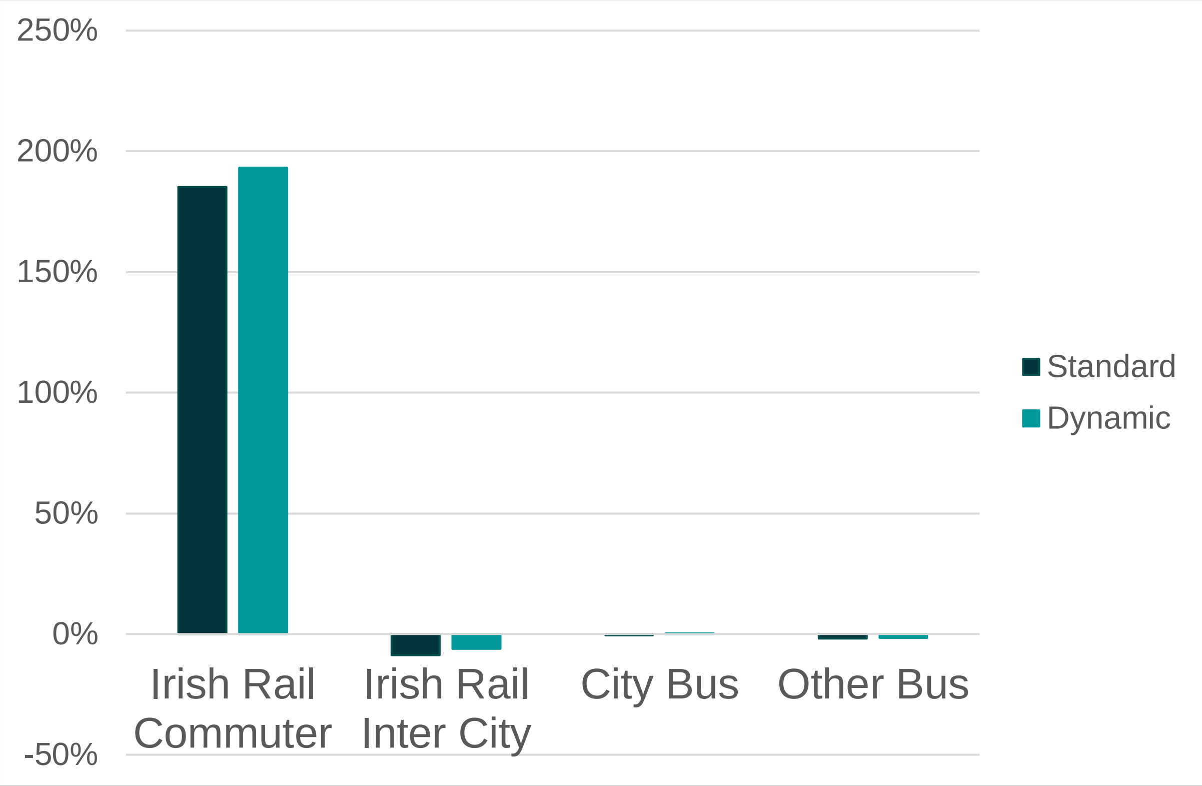

Figure 18: CACR Option 1, % change in Public Transport boardings relative to Do-Minimum, 2030

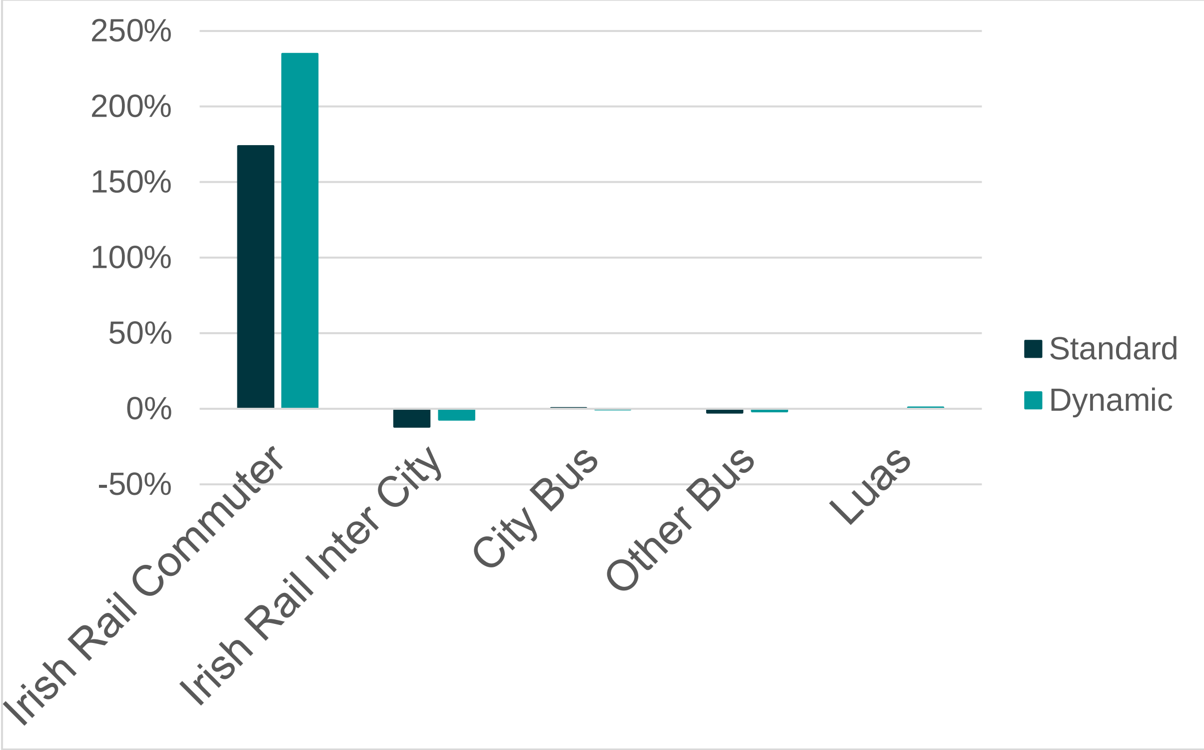

Figure 19: CACR Option 1, % change in Public Transport boardings relative to Do-Minimum, 2050

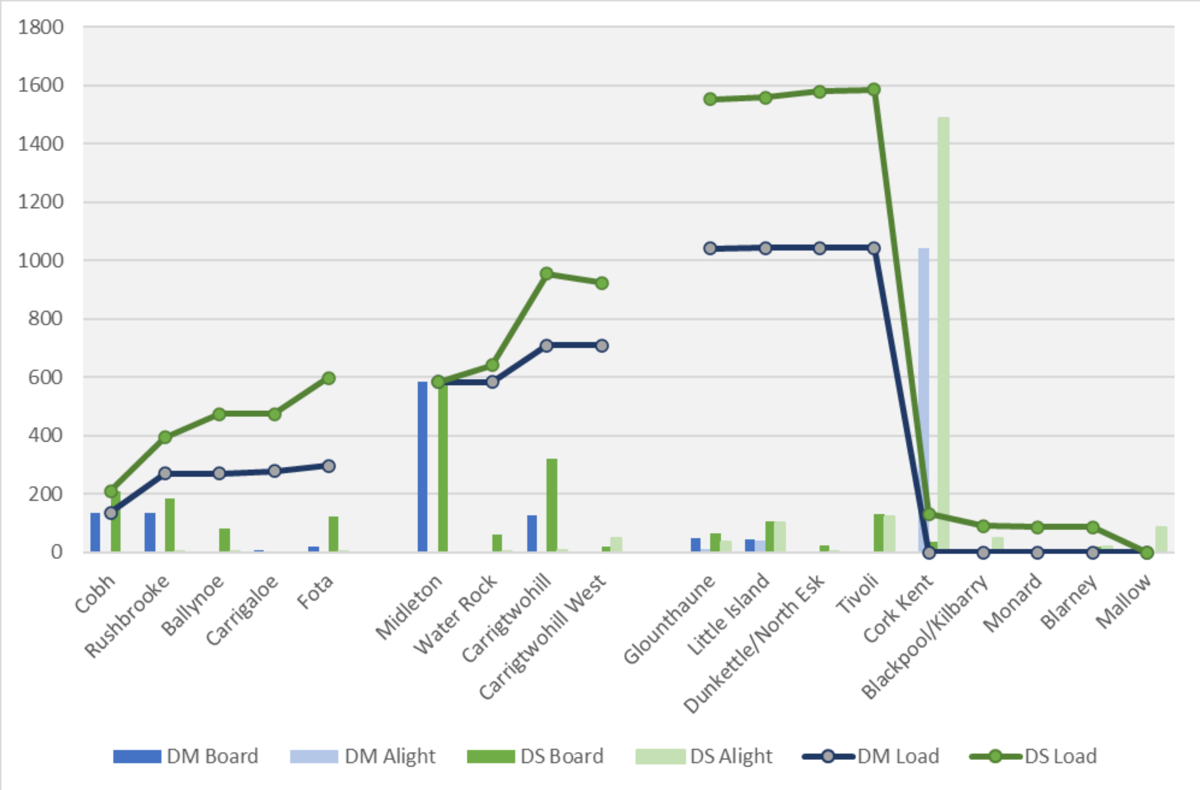

Figure 20: CACR Option 1 Line Demand Profile, 2050 Standard AM Peak Hour Northbound

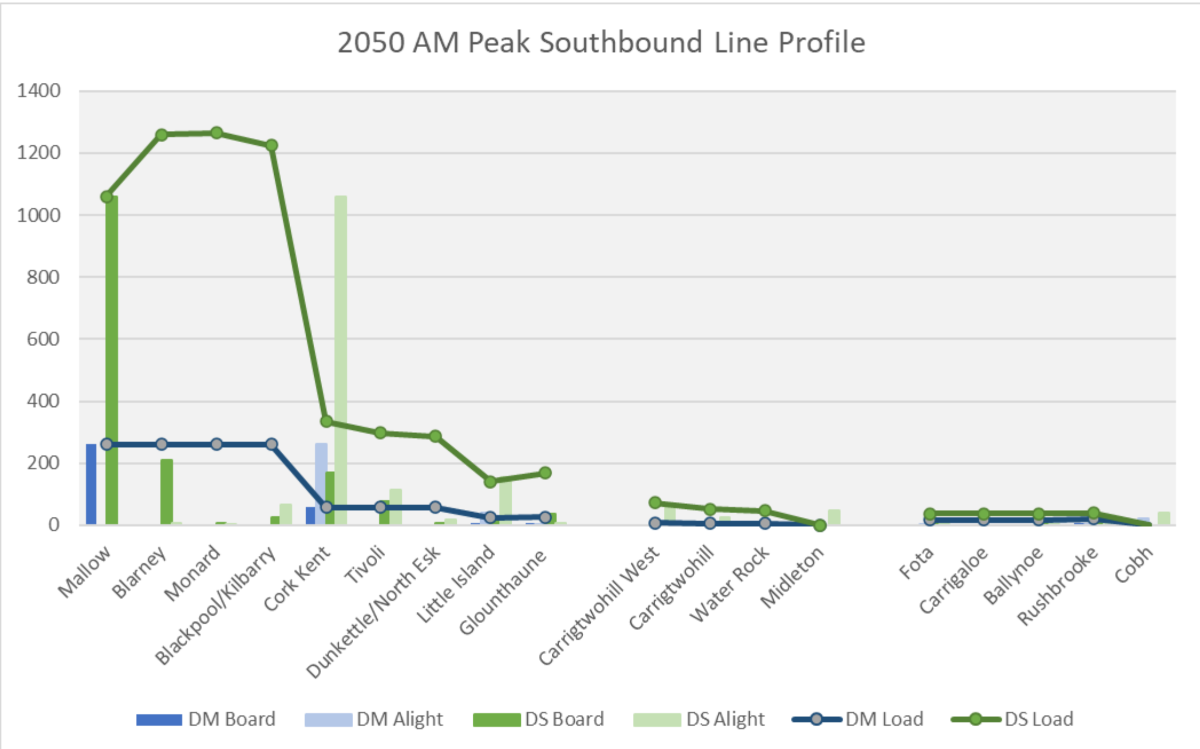

Figure 21: CACR Option 1 Line Demand Profile, 2050 Standard AM Peak Hour Southbound

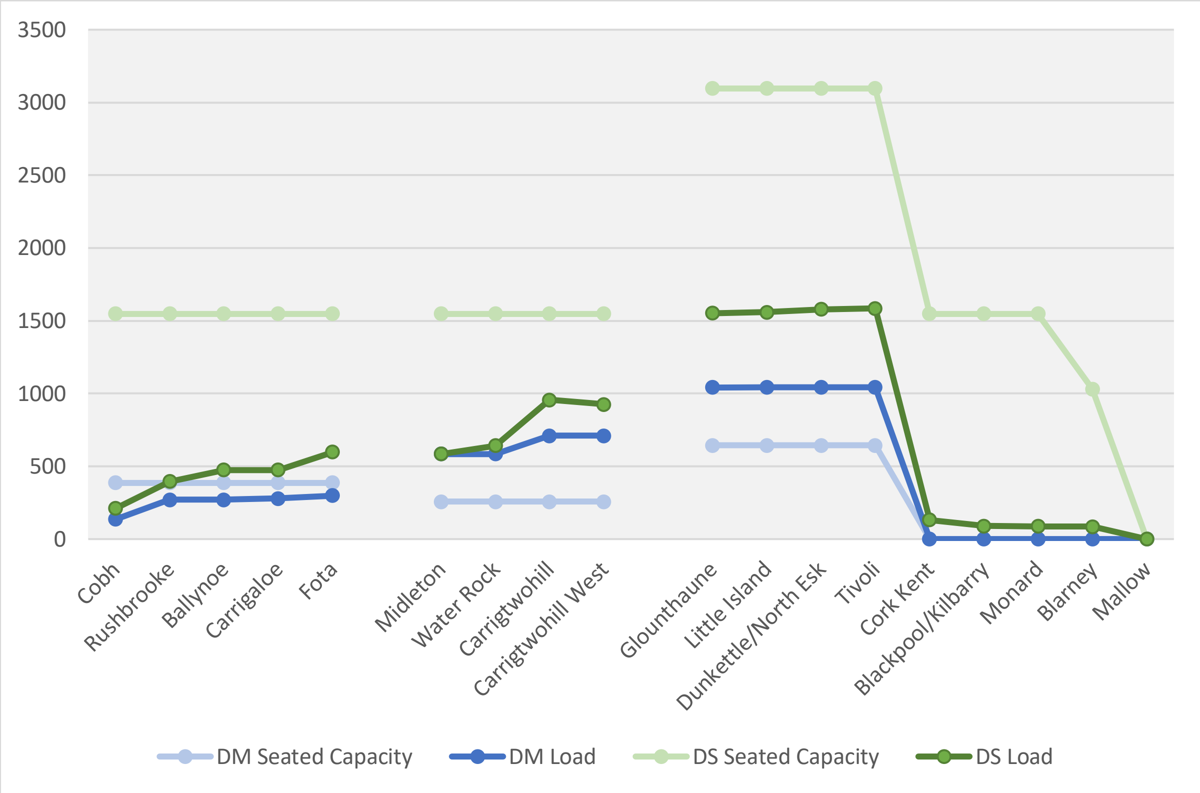

Figure 22: Do-Min & CACR Option 1 Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Northbound

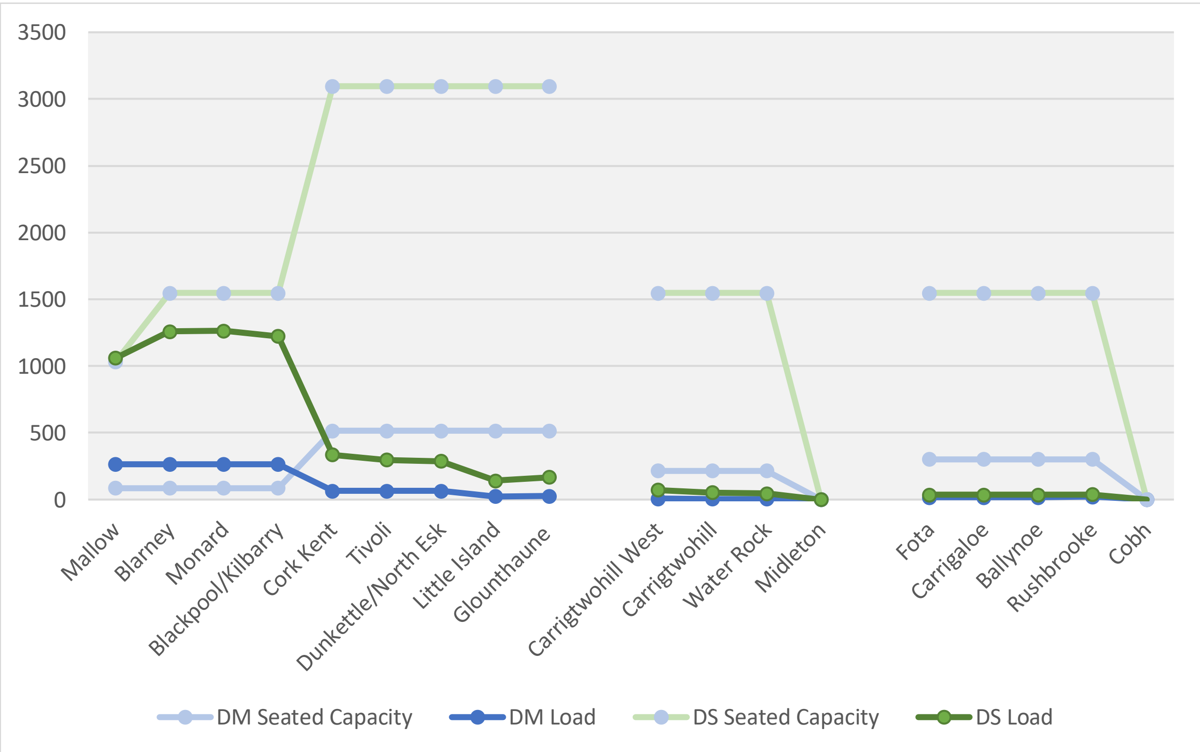

Figure 23: Do-Min & CACR Option 1 Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Southbound

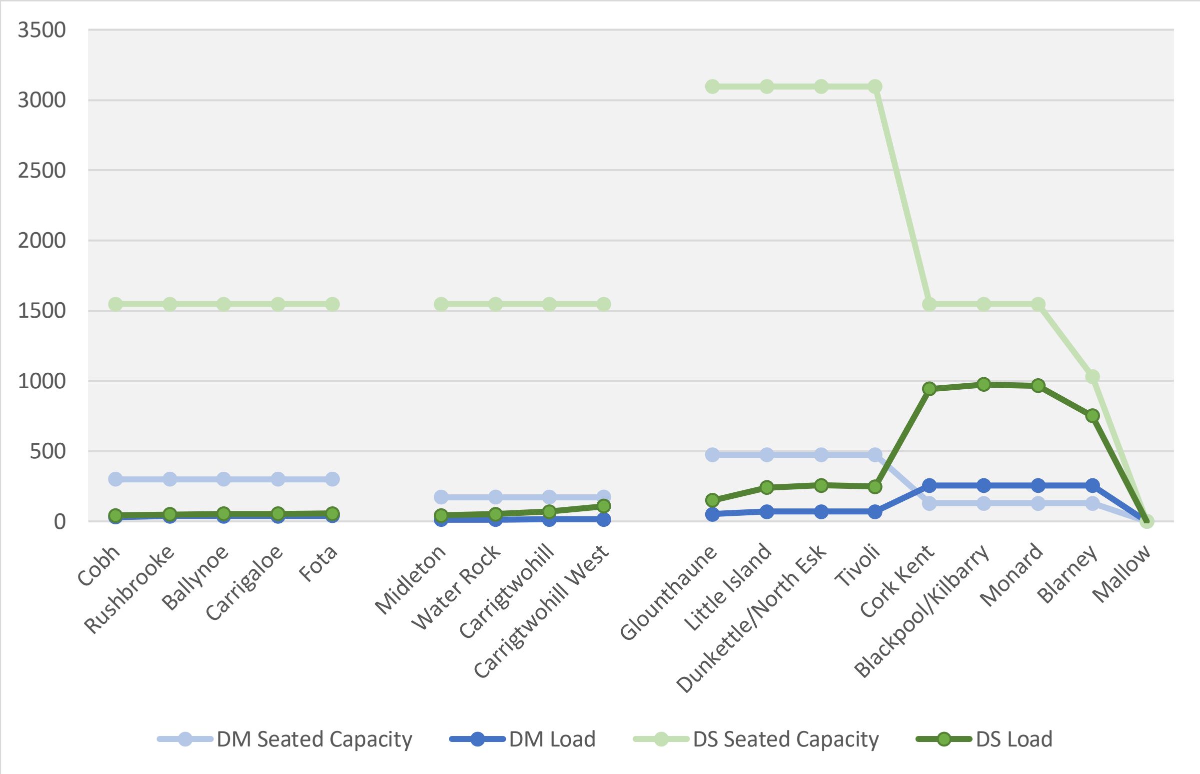

Figure 24: Do-Min & CACR Option 1 Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Northbound

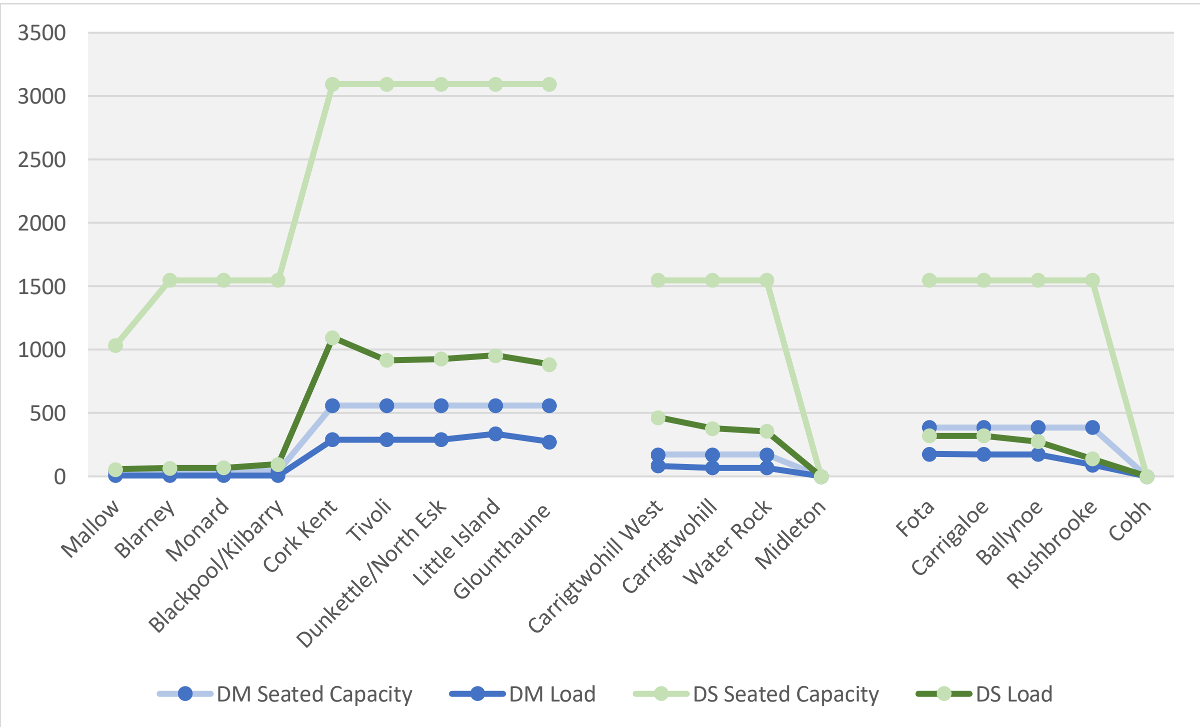

Figure 25: Do-Min & CACR Option 1 Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Southbound

G.2 Option 2

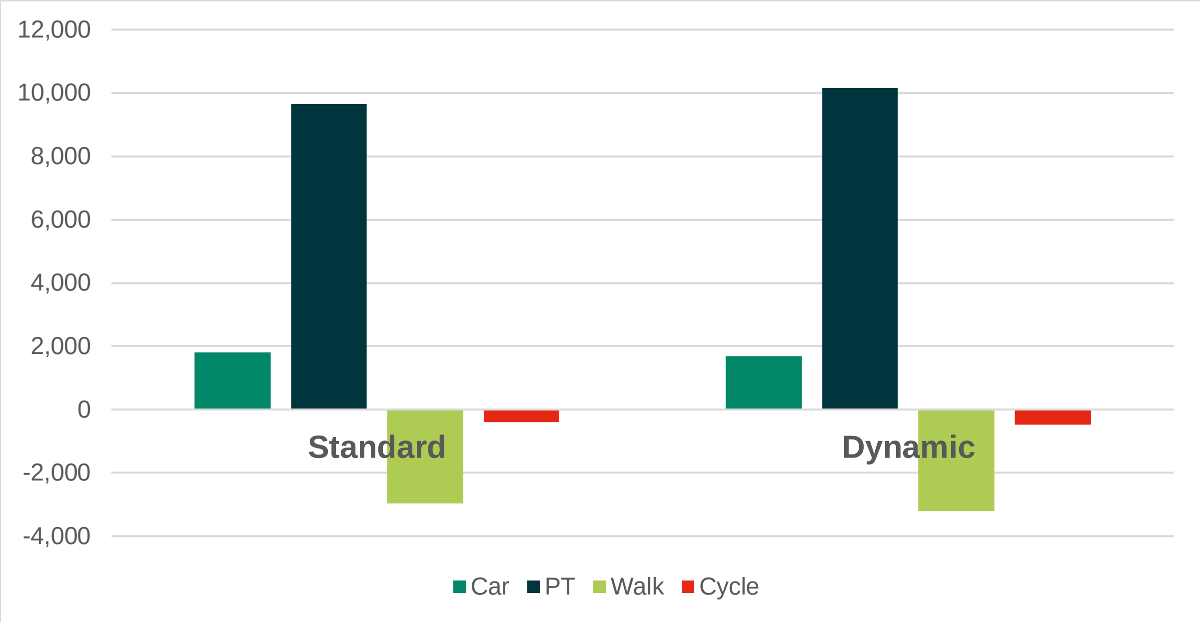

Figure 26: CACR Option 2 absolute change in daily trips relative to Do-Minimum, 2030

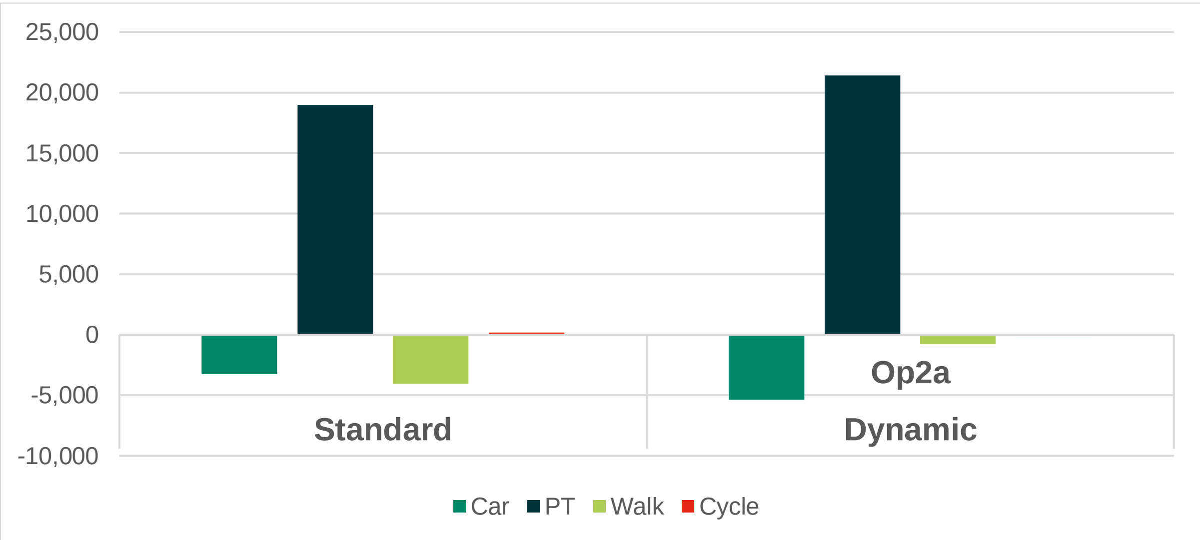

Figure 27: CACR Option 2 absolute change in daily trips relative to Do-Minimum, 2050

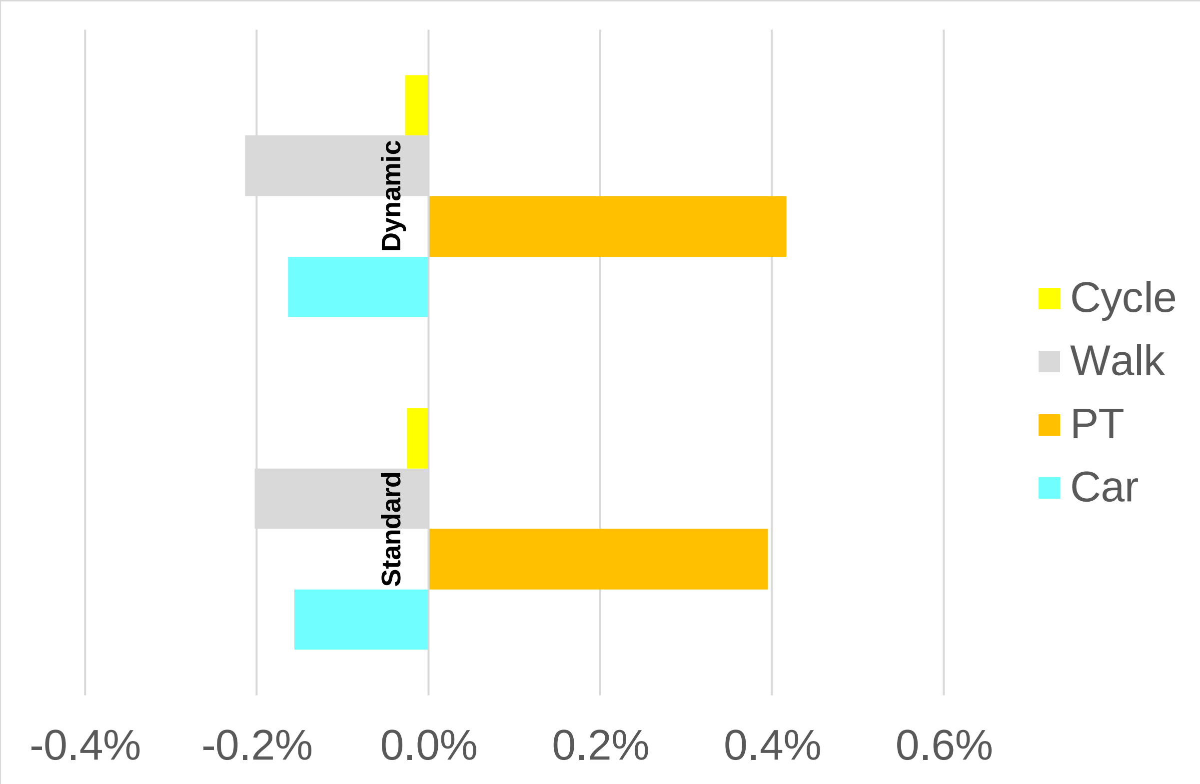

Figure 28: CACR Option 2 absolute change in daily mode share relative to Do-Minimum, 2030

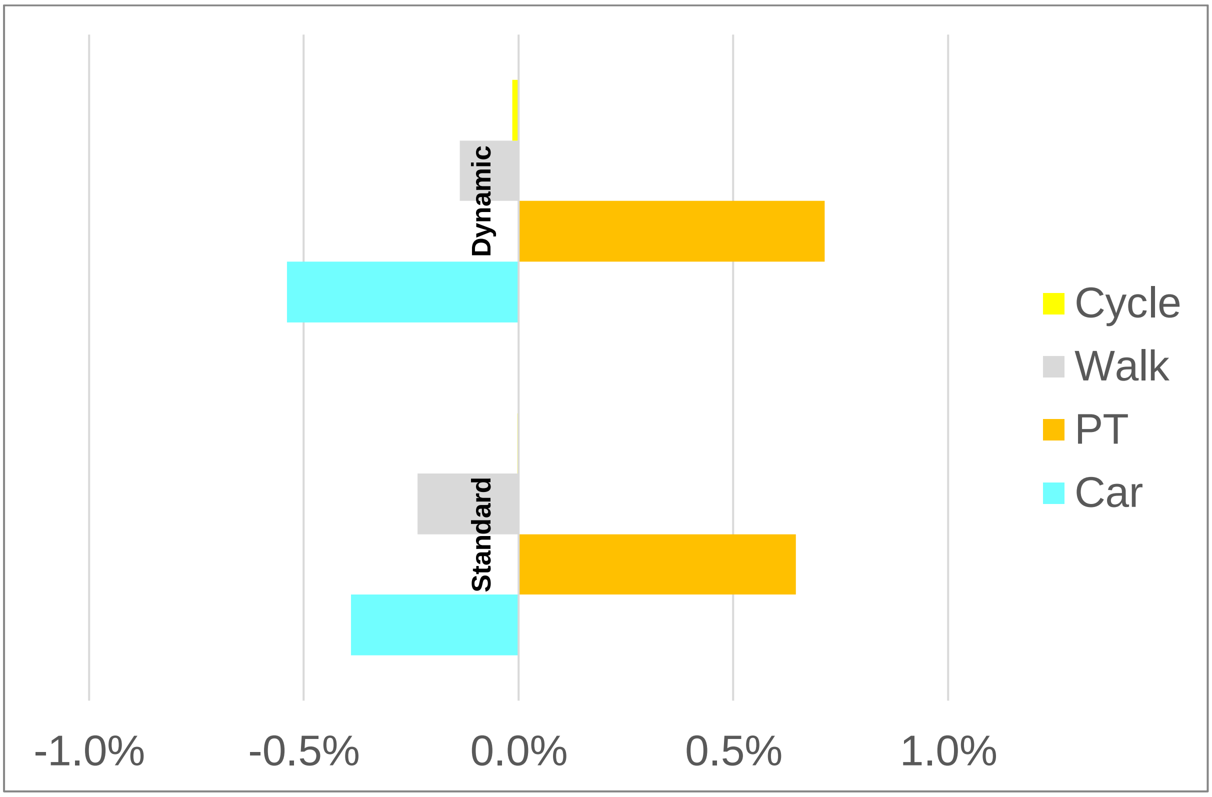

Figure 29: CACR Option 2 absolute change in daily mode share relative to Do-Minimum, 2050

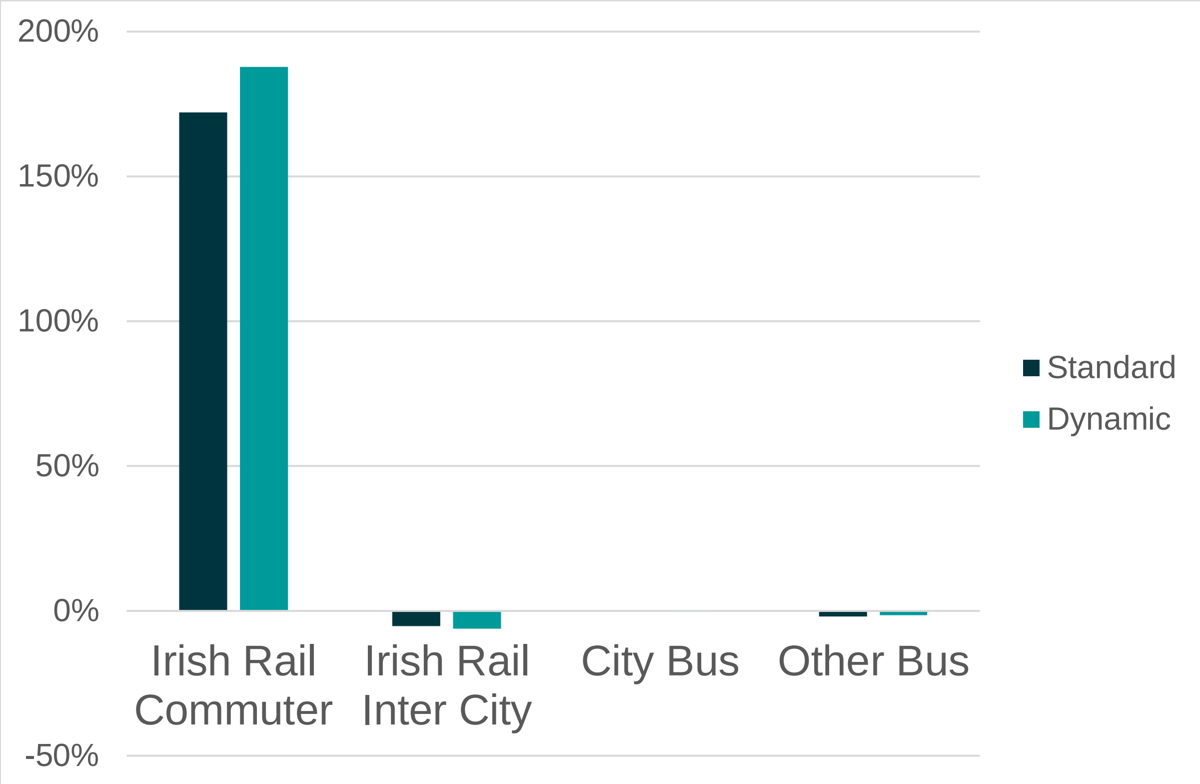

Figure 30: CACR Option 2, % change in Public Transport boardings relative to Do-Minimum, 2030

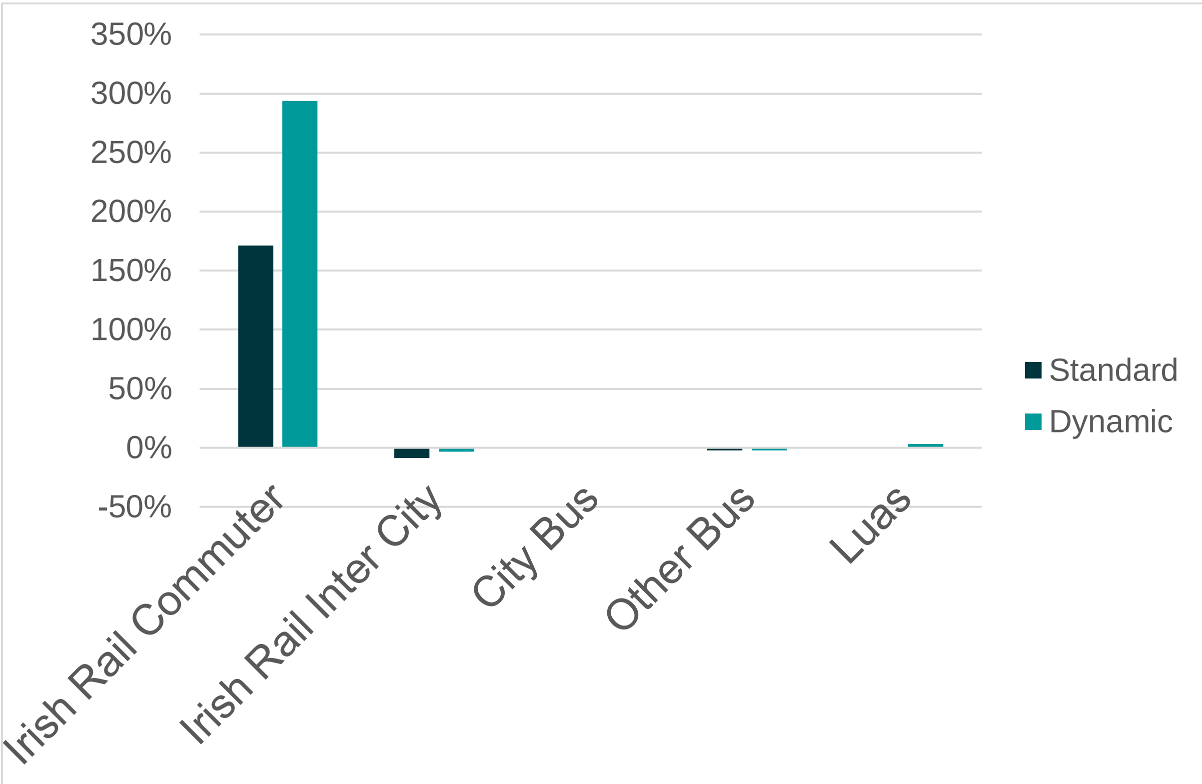

Figure 31: CACR Option 2, % change in Public Transport boardings relative to Do-Minimum, 2050

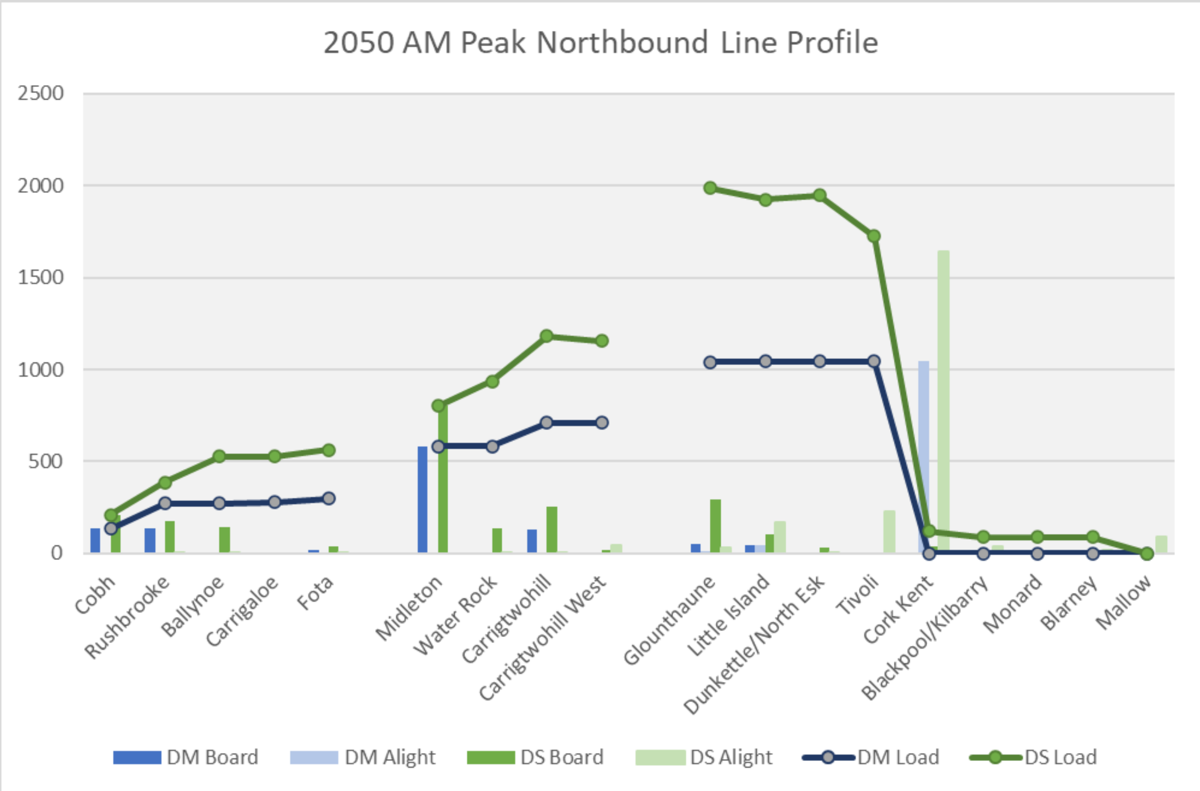

Figure 32: CACR Option 2 Line Demand Profile, 2050 Standard AM Peak Hour Northbound

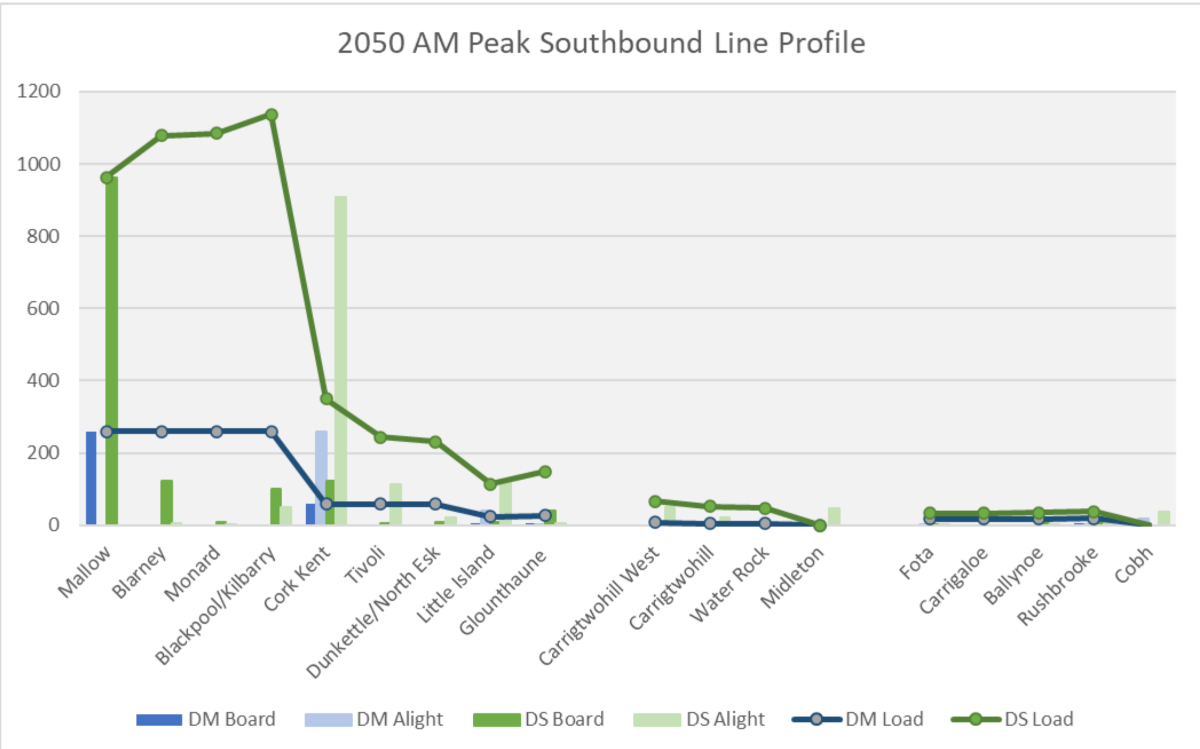

Figure 33: CACR Option 2 Line Demand Profile, 2050 Standard AM Peak Hour Southbound

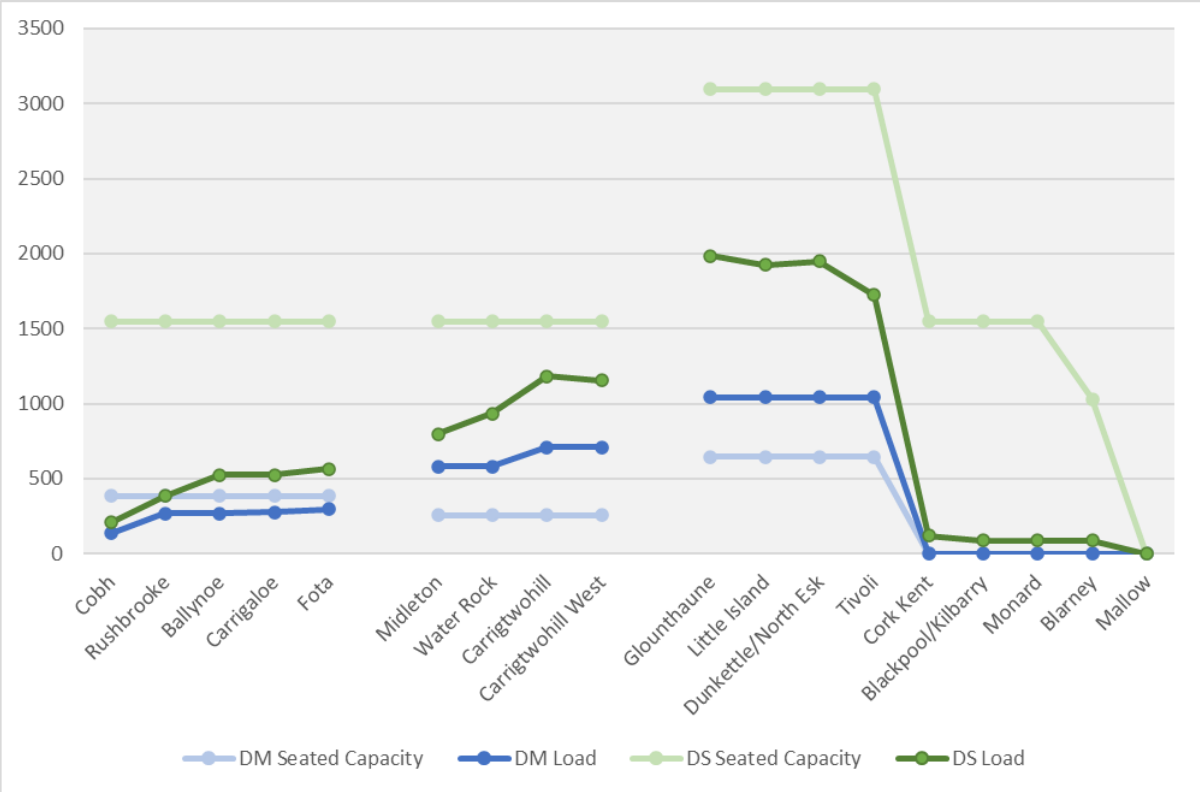

Figure 34: Do-Min & CACR Option 2 Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Northbound

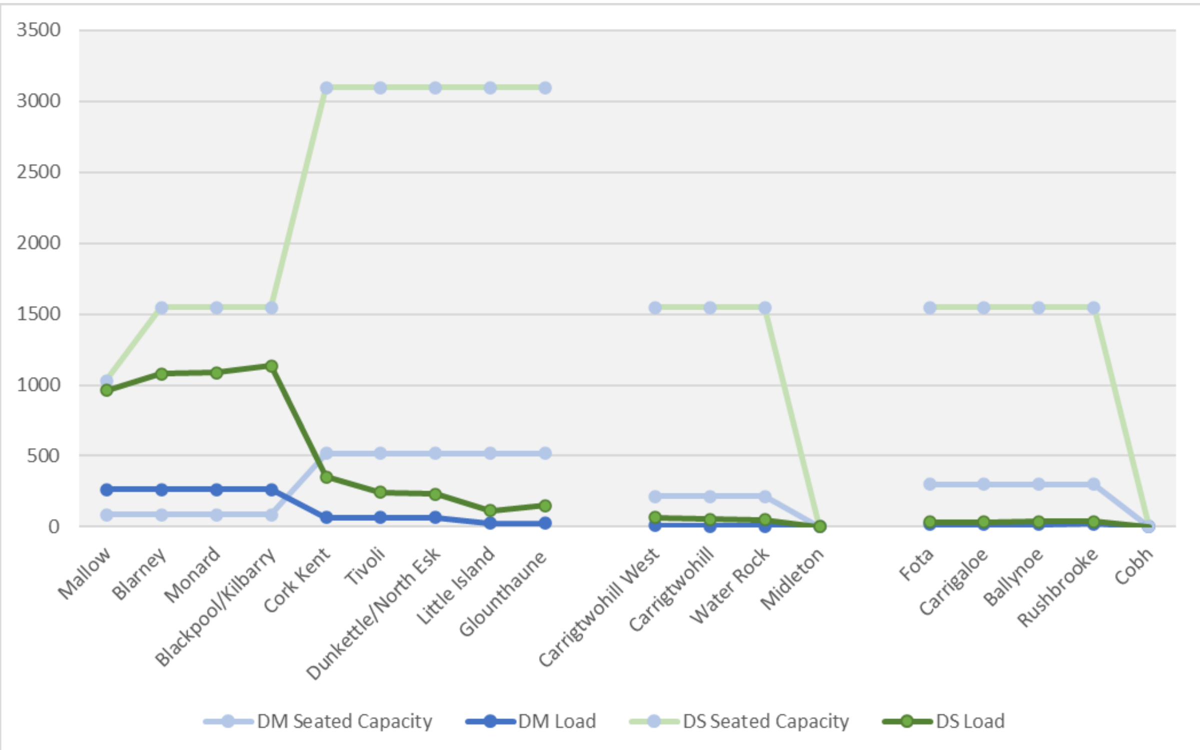

Figure 35: Do-Min & CACR Option 2 Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Southbound

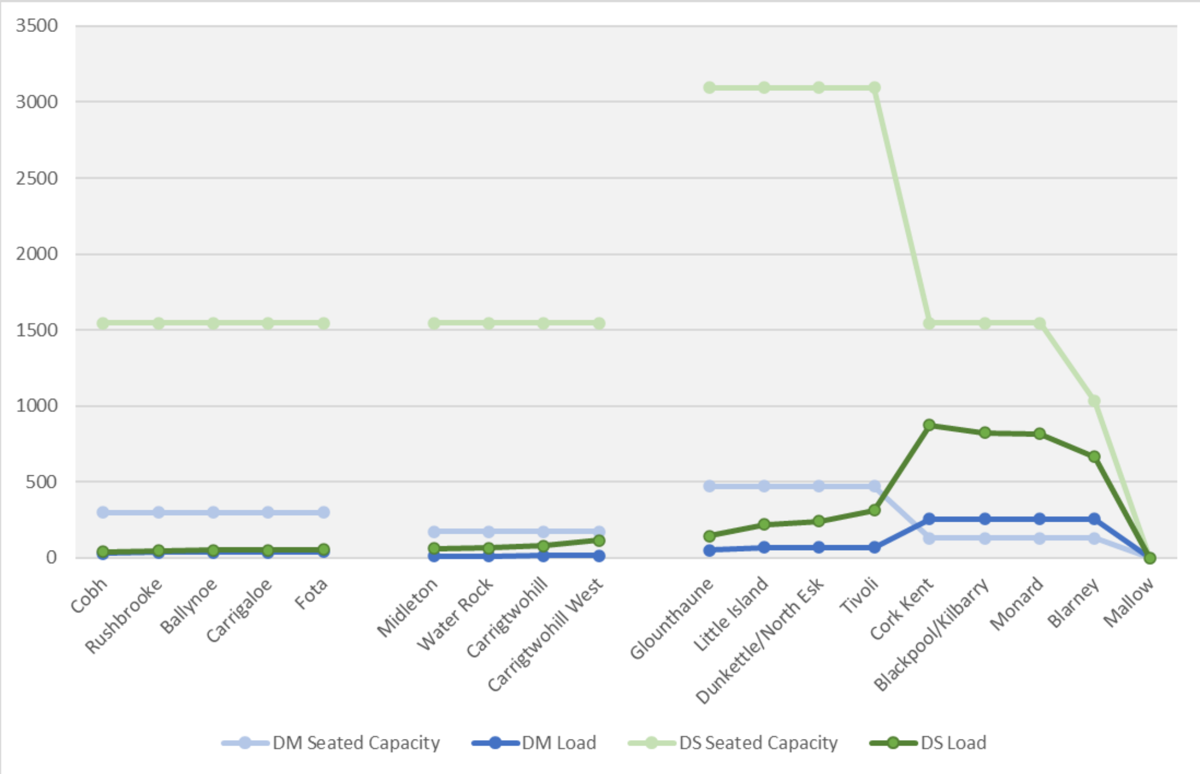

Figure 36: Do-Min & CACR Option 2 Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Northbound

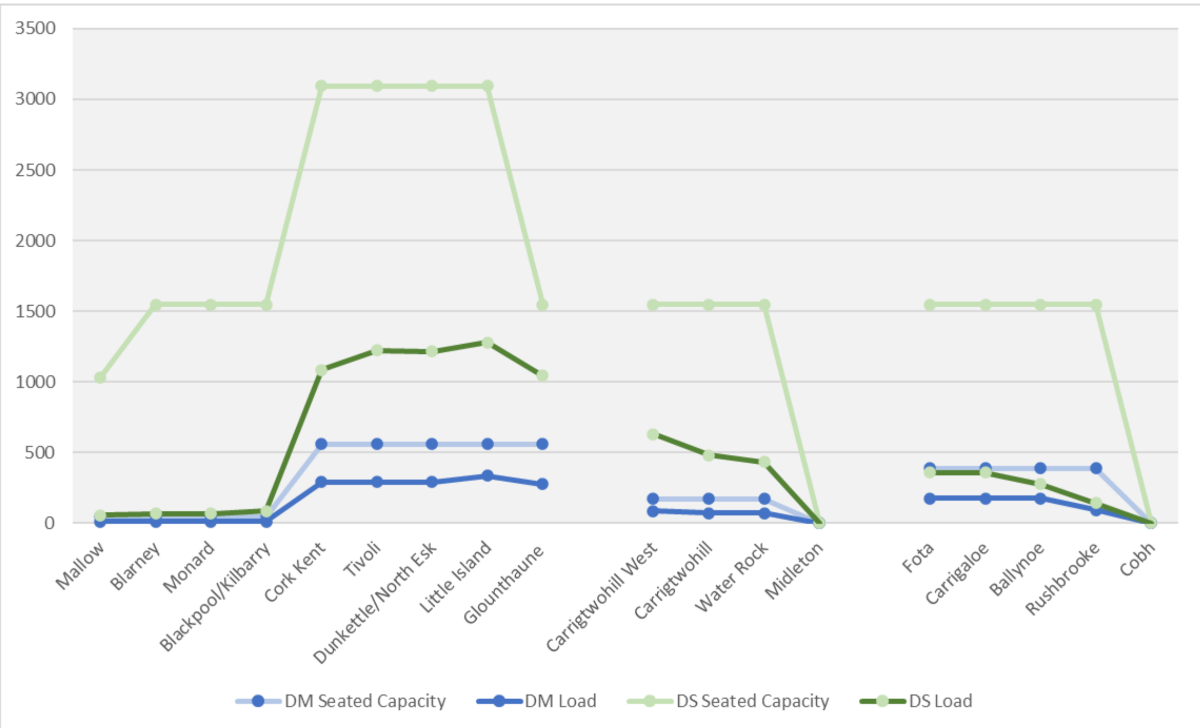

Figure 37: Do-Min & CACR Option 2 Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Southbound

G.3 Option 2a

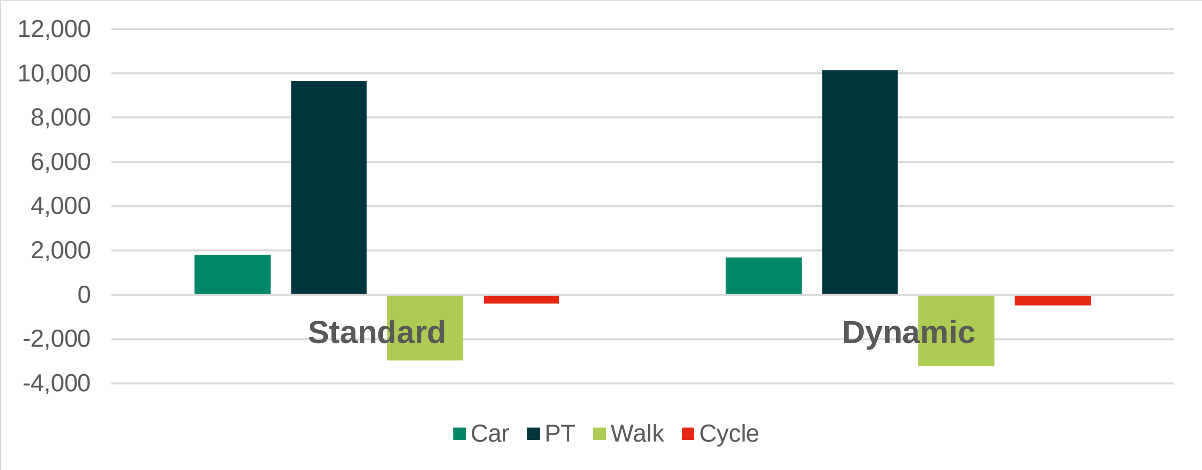

Figure 38: CACR Option 2a absolute change in daily trips relative to Do-Minimum, 2030

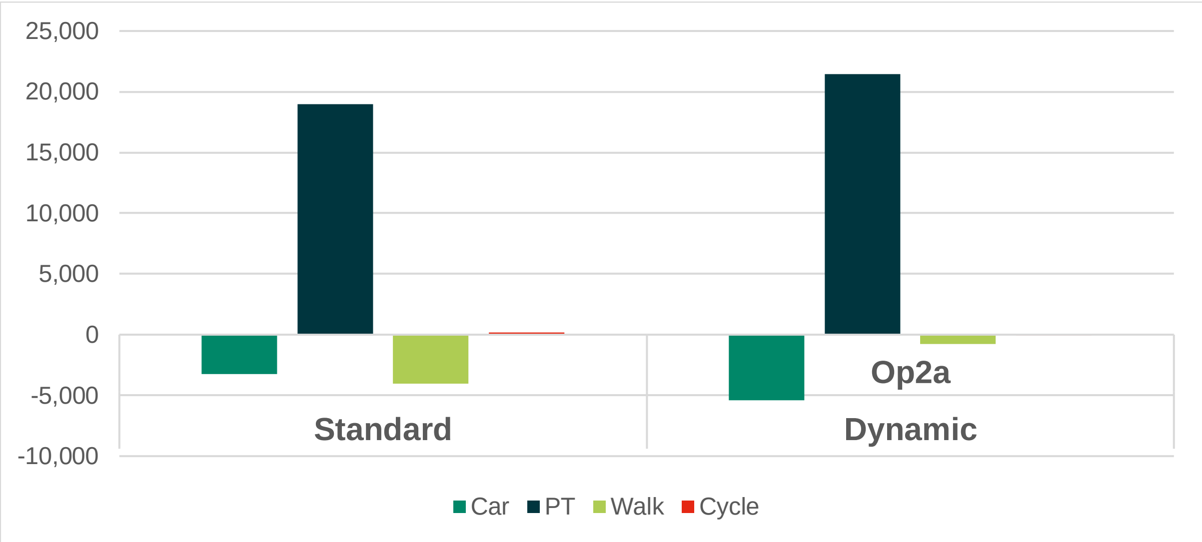

Figure 39: CACR Option 2a absolute change in daily trips relative to Do-Minimum, 2050

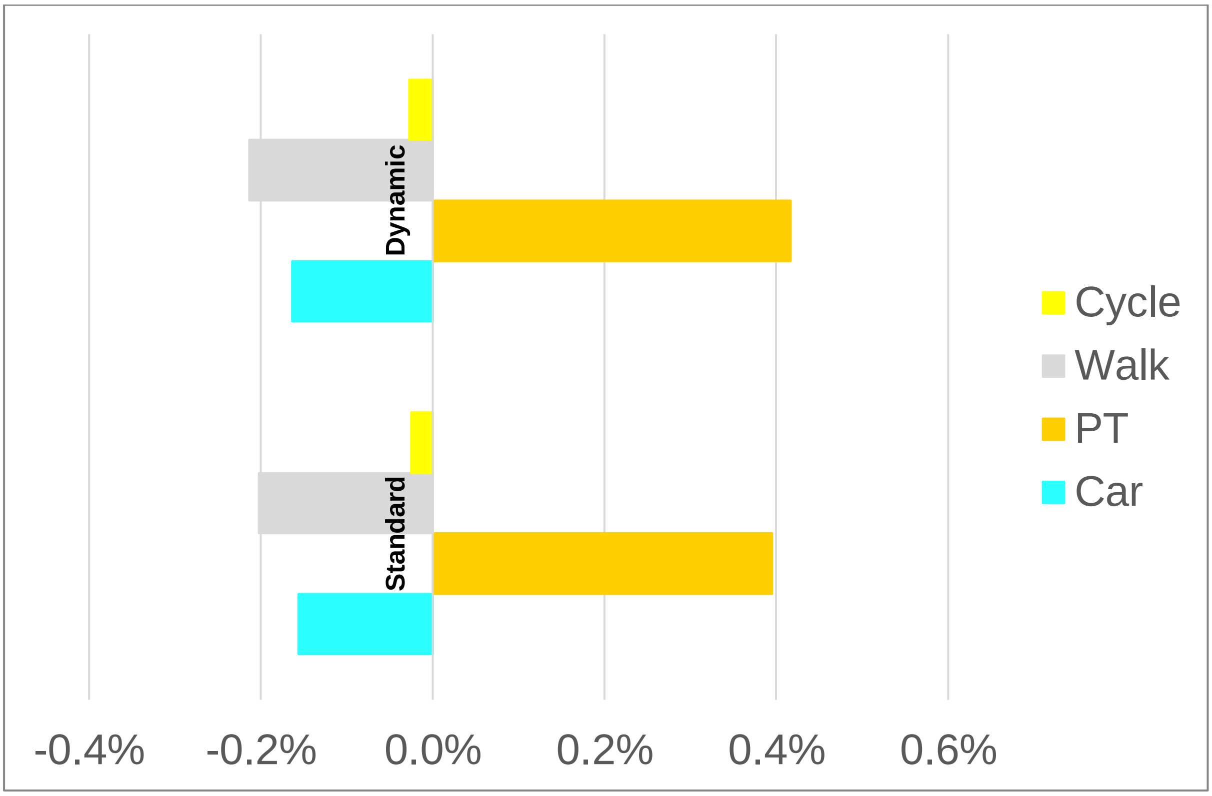

Figure 40: CACR Option 2a absolute change in daily mode share relative to Do-Minimum, 2030

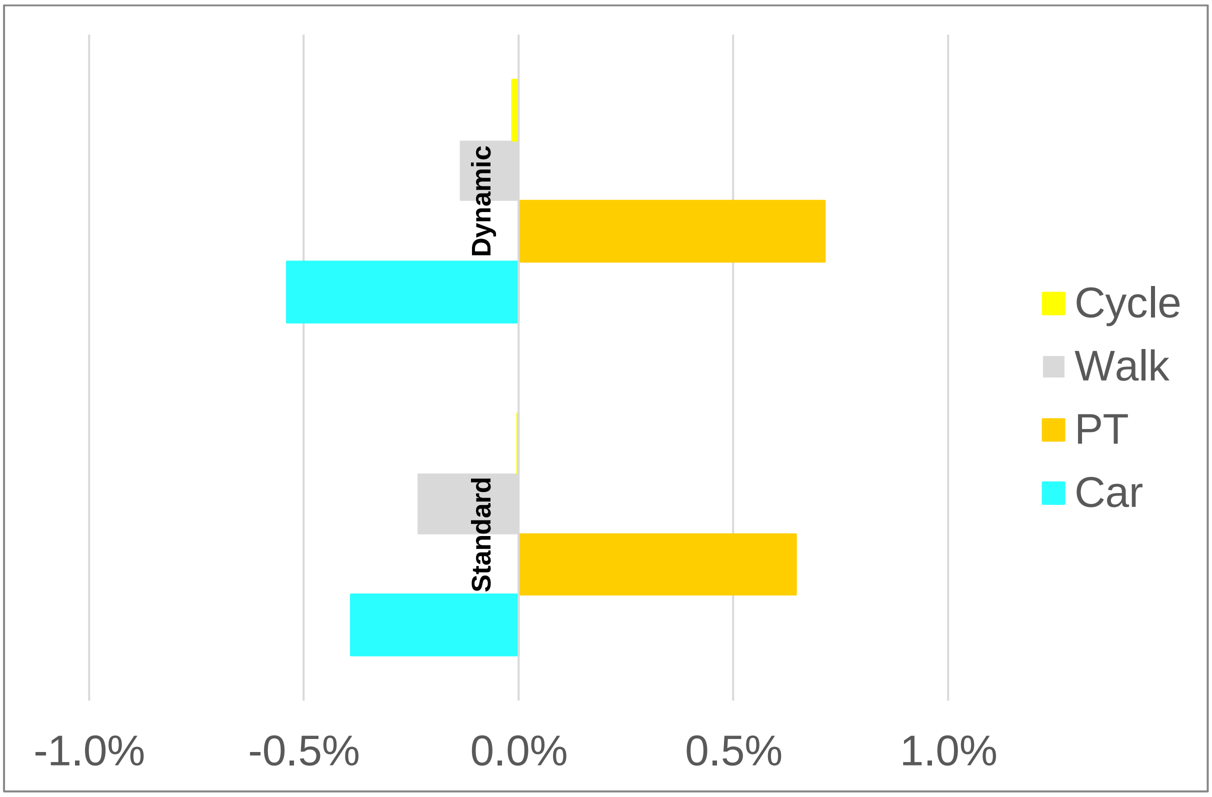

Figure 41: CACR Option 2a absolute change in daily mode share relative to Do-Minimum, 2050

Figure 42: CACR Option 2a, % change in Public Transport boardings relative to Do-Minimum, 2030

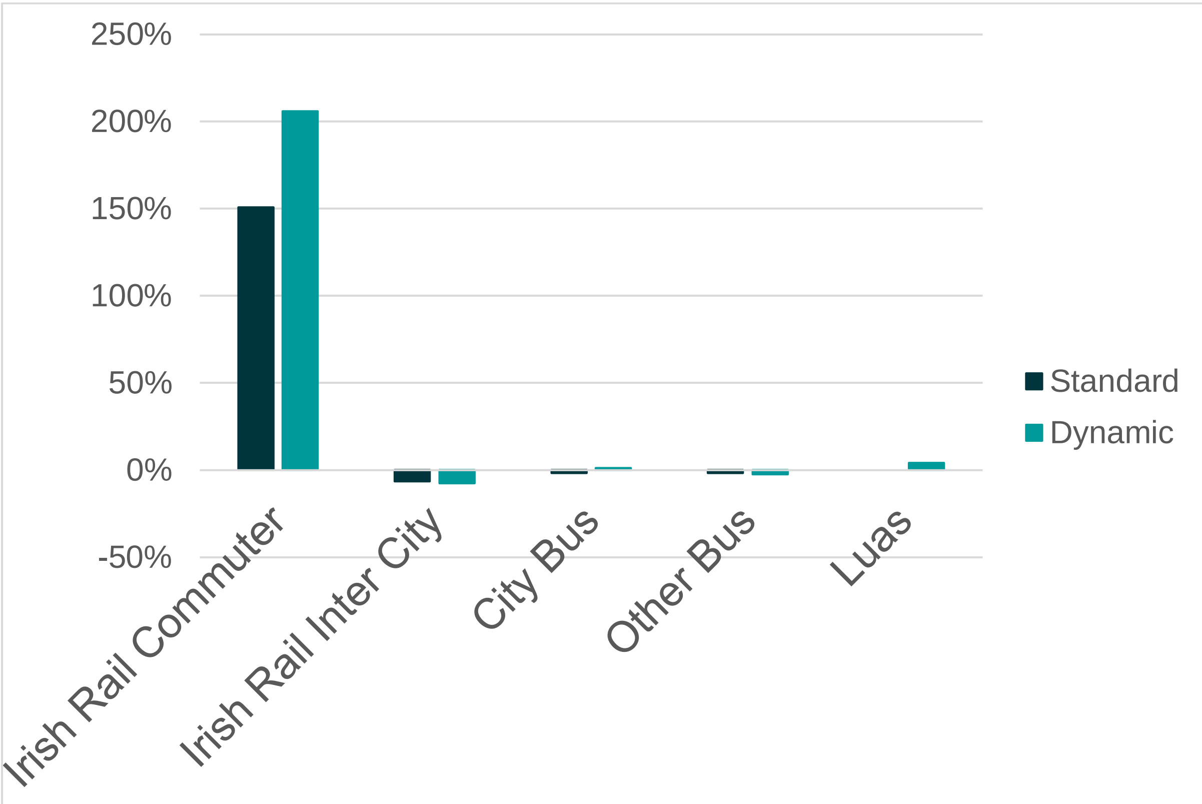

Figure 43: CACR Option 2a, % change in Public Transport boardings relative to Do-Minimum, 2050

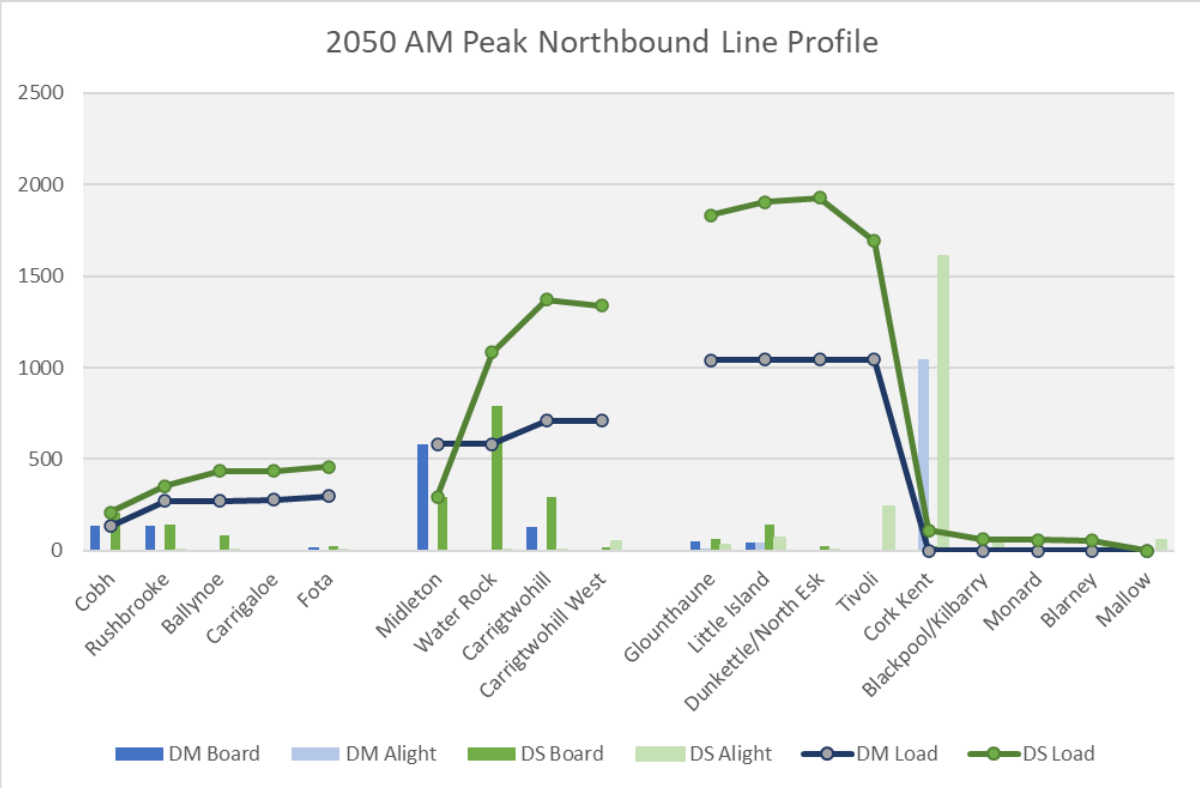

Figure 44: CACR Option 2a Line Demand Profile, 2050 Standard AM Peak Hour Northbound

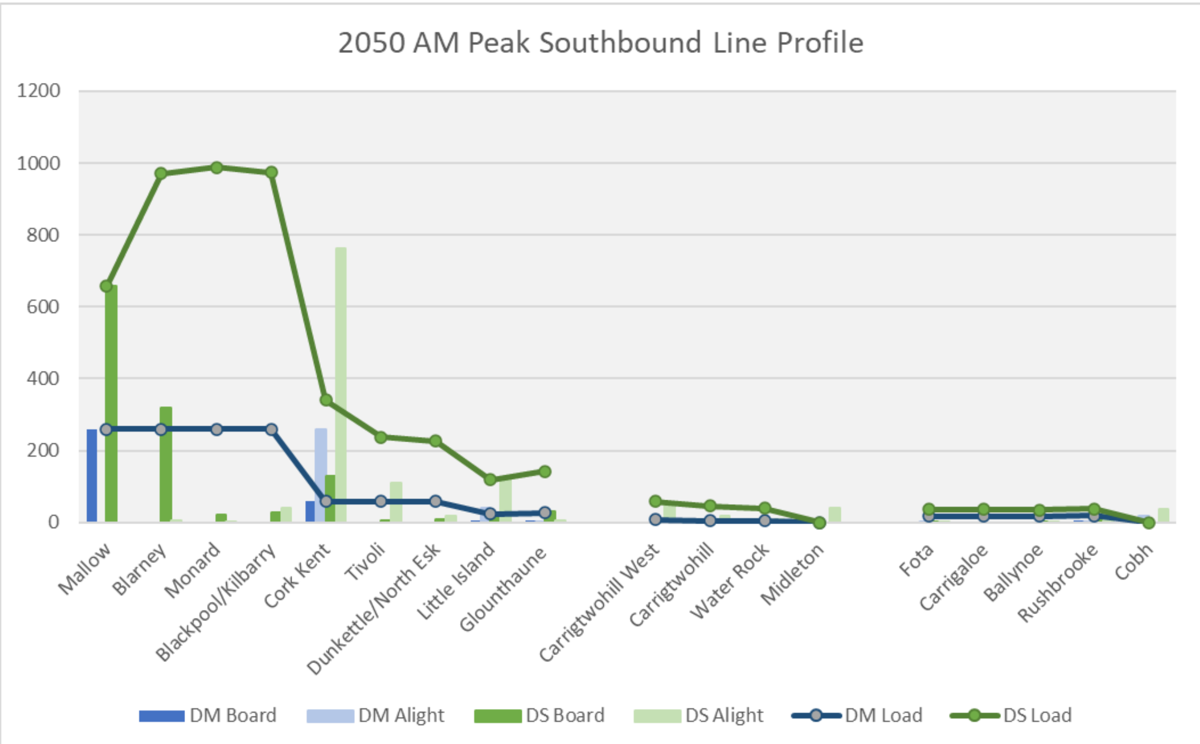

Figure 45: CACR Option 2a Line Demand Profile, 2050 Standard AM Peak Hour Southbound

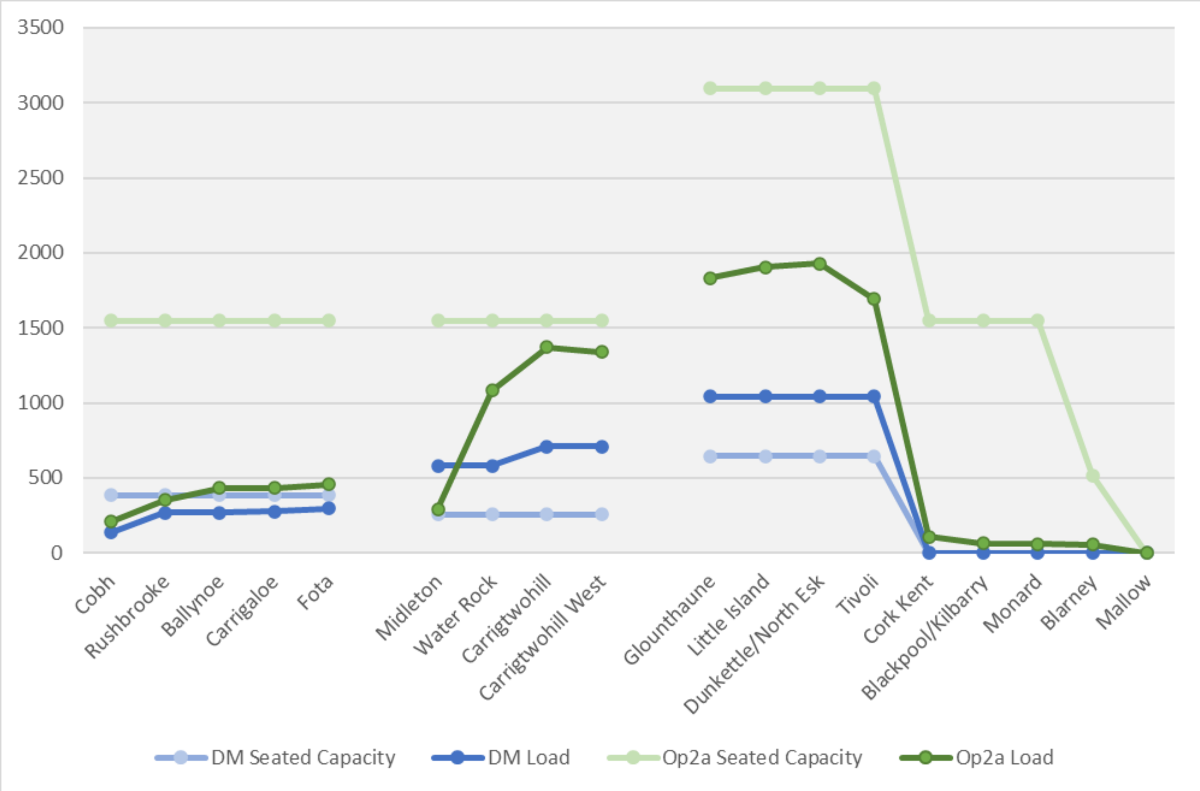

Figure 46: Do-Min & CACR Option 2a Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Northbound

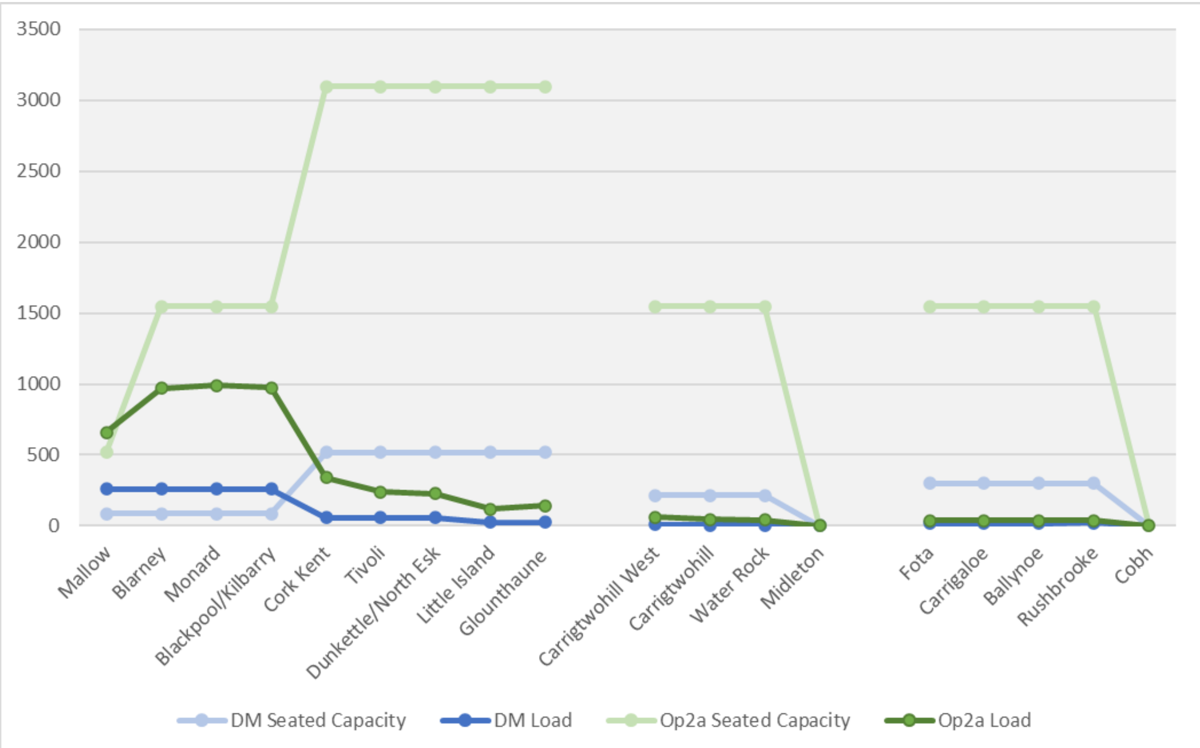

Figure 47: Do-Min & CACR Option 2a Line Loads & Seated Capacity, Standard 2050 AM Peak Hour Southbound

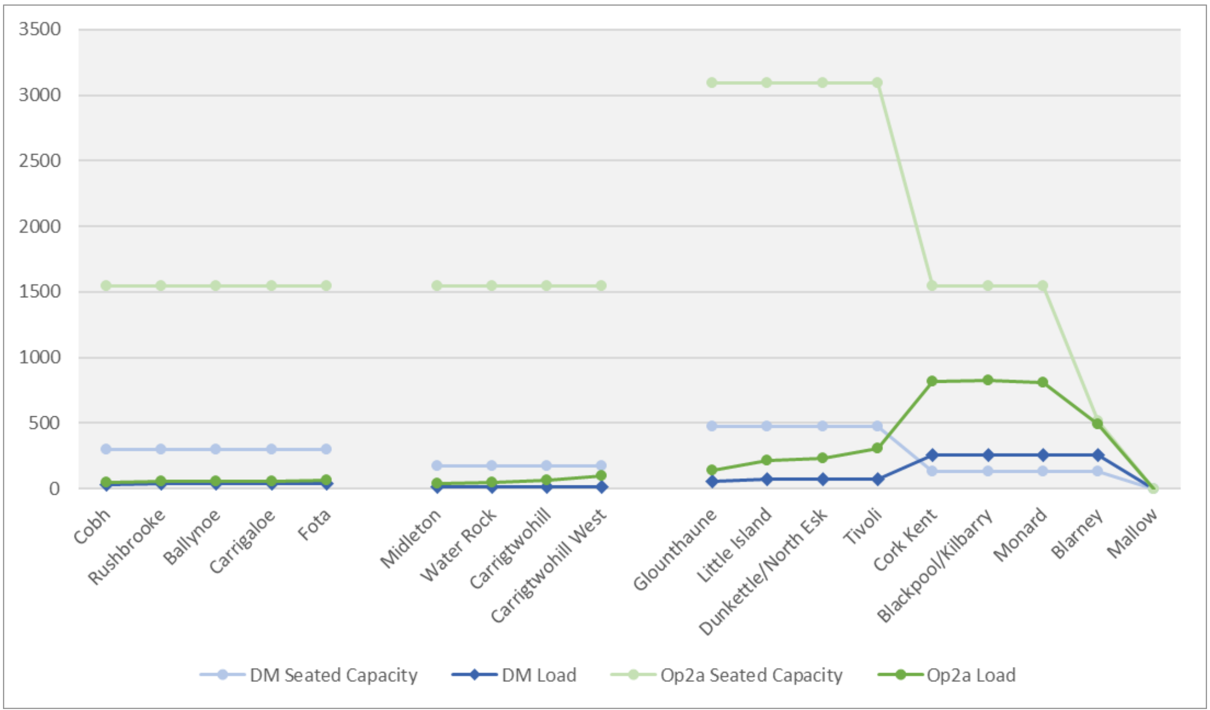

Figure 48: Do-Min & CACR Option 2a Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Northbound

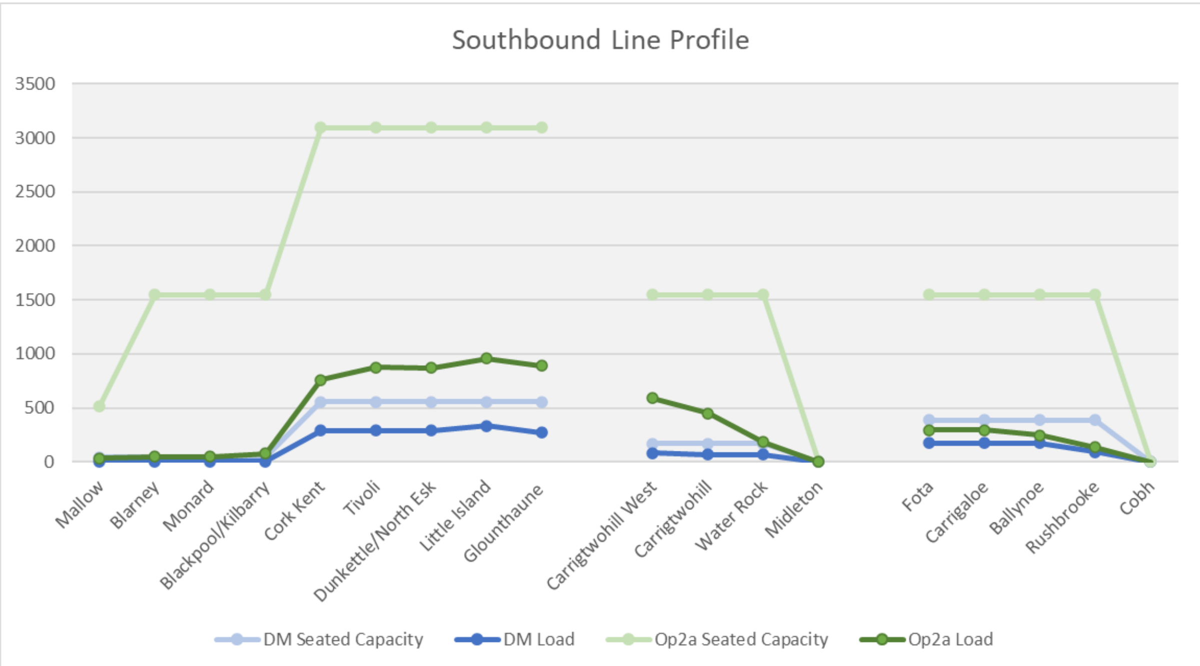

Figure 49: Do-Min & CACR Option 2a Line Loads & Seated Capacity, Standard 2050 PM Peak Hour Southbound

Appendix H – TSS Options MCA analysis

H.1 Environment

Methodology

The appraisal is based on completion of a high-level environmental constraint assessment. This was a desktop-based assessment of the proposed option impacts on items such as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), archaeological, architectural and cultural heritage as well as population and human health, noise and vibration and landscape and visual impacts.

The role that the CACR Programme plays in achieving the targets set out in the Cork Metropolitan Area Transport Strategy (CMATS) will also be set out and the steps taken to ensure the delivery of the programme is undertaken in line with the sustainability vision and priority areas. This environmental assessment includes, but was not limited to:

- Consideration of the vertical alignment of each option in relation to the surrounding urban environment and material requirements/disposal associated with construction.
- Recorded archaeological sites and buildings/structures of architectural heritage.
- Ecological sensitive locations. The screening assessed qualifying interests and conservation objectives when assessing the impact of each option.
- Receptors sensitive to noise, air quality or other environmental emissions. The assessment gave regard to the Cork Agglomeration Noise Action Plan and Local Authority Air Quality publications.
- Impacts on sites of geological interest and consideration of historical land uses in the consideration of soil contamination or other geohazards.
- Impacts on features of significant landscape or visual importance, with regard to Cork Development Plan policy or objectives.
- Consideration of flooding impacts and modification of natural hydrology or artificial drainage systems.
- Impact of railway development on the existing urban fabric, including consideration of impacts of settlement, and vibration on adjacent neighbouring communities.
- Road and traffic impacts, including the consideration of community severance and requirements for new bridge infrastructure associated with options.
- Other relevant environmental impacts identified.

The following sections provide a summary of the environmental assessment for the proposed infrastructure options (e.g., new stations). A summary of the environmental assessment for the TSS options is also included (i.e., the frequency of services). The TSS options are likely to have the greatest impact on air quality, noise and climate.

Population and Human Health

Railway and associated infrastructure development can result in changes to the natural and built environment. These changes can be perceived as positive and negative to different people depending on the value sets that people attribute to the changes. New infrastructure can cause concern to populations within close proximity to the new infrastructure.

<u>Stations, Parking, Platform Configurations and Depots</u>

Construction traffic may impact the residents in close proximity to the stations for accessing some community infrastructure or town centres. Although temporary, it is possible that construction traffic may also impact access to educational facilities and employment sites in the town centre and nearby Business Parks. Inconvenience and disruption may occur due to any negative effects on air quality, noise and neighbourhood amenity during the construction process. During the operational phase, the proposed development will likely have a positive impact on accessibility and active travel through the provision of cycle storage and new pedestrian footbridges close to each new rail station.

Train Service Specifications (TSS) Options

The Do Minimum option would likely have the least impact on population and human health receptors across the study area. The Do Something options would potentially have positive impacts, such as improved access to community infrastructure, employment sites and training facilities, that would be greater than under Do Minimum. As shown in Table 27, TSS1 option, compared to TSS2 and TSS2a, would not alter the distribution of impacts on population and human health receptors across the rail network.

Table 27: Assessment result of the population and human health sub-criteria

Options	Sub-criteria: Population and Human Health
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Biodiversity

A high-level desk study exercise was undertaken to identify designated sites and protected or notable habitats and species potentially occurring in the vicinity of the Constraints Study Area. Screening report was carried out for the Glounthaune to Midleton double tracking element of the Proposed Development. The Constraints study area for this assessment consists of the proposed route alignment with a 2km buffer. A review of the National Parks and Wildlife Service (NPWS) database and the EPA Biodiversity Maps were completed as part of this desk study.

Stations, Parking, Platform Configurations and Depots

Based on the assessment presented above, the double track alignment between Glounthaune and Midleton stations presented a high impact on the biodiversity factor, with Midleton - Box covering extensive, Midleton, Tivoli, Mallow and Dunkettle stations to have a medium impact and the rest of the stations to present a low impact.

Train Service Specifications (TSS) Options

There is marginal difference between any of the Do Something options in terms of potential effects on biodiversity since the options are focusing on the number of trains per hour. The Do Minimum would present a similar score with the Do-something options on biodiversity as presented in Table 28.

Table 28: Assessment result of the biodiversity sub-criterion

Options	Sub-criterion: Biodiversity
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Water

This section was prepared to identify the surface water features that may influence the design of elements of the proposed development. A number of water-related constraints within the study area were identified, including surface water features and floodplains. Major rivers may be a physical constraint, but where there is a requirement to cross rivers, best practice should be incorporated into project design and construction so as to minimise pollution risks. Additional studies and assessments will be carried out as the design progresses.

Stations, Parking, Platform Configurations and Depots

Excavation and infill earthworks may lead to changes to infiltration rates, potentially impacting groundwater levels locally. Groundwater and surface water quality may be impacted with respect to accidental spills and leaks during construction or in the event of any accidental losses of fuel or oils from trains while operating, however such effects are likely to be negligible.

Train Service Specifications (TSS) Options

The Do Minimum option would likely have no additional impact on the water environment across the study area. Given that the service options are focusing on the number of trains per hour, and there is very little difference in this number between the three Do Something options in regards to the water criterion as shown in Table 29.

Table 29: Assessment result of the water sub-criterion

Options	Sub-criterion: Water
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Land, Geology and Soils

The baseline assessment for the sub-criterion identified a number of karst features, fault lines and shallow bedrock along the proposed route. While the proposed route follows existing rail alignments, it is recommended that areas of bedrock outcrop, fault lines and karstified rock are avoided, where possible, to reduce the likelihood of encountering unfavourable construction conditions and of impacts to groundwater. Additional geotechnical and hydrogeological assessments will be required throughout the project, to study geological features on a more local scale.

Stations, Parking, Platform Configurations and Depots

Generally, no potentially significant impacts are foreseen with respect to geology for all stations. The impacts identified for the platform configurations and depots are considered comparable to other options.

Train Service Specifications (TSS) Options

Given that the service options are focusing on the number of trains per hour, and there is very little difference in this number between the Do Minimum and the Do Something options, in terms of the potential effects on land, geology and soils between each option, thus the score of each option is comparable to the others.

Table 30: Assessment result of the land, geology and soils sub-criteria

Options	Sub-criteria: Land, Geology and Soils
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Landscape and Visual Amenity (incl. Lighting)

A desktop exercise was conducted for that factor in order to identify the nature and extent of potential significant landscape and visual effects on the landscape and visual resource of the study area within a 500m study area.

Stations, Parking, Platform Configurations and Depots

The impact during operation will mainly be low for the landscape and visual effects for the majority of stations, depots and platform configurations.

Train Service Specifications (TSS) Options

The landscape and visual baseline will not change as a result of an increase in rail services within the existing rail corridor. Thus, the Do Minimum option is considered of low impact. The Do Something options focus on the train frequency, so each options impact is comparable with the other two as presented in Table 31.

Table 31: Assessment result of the landscape and visual sub-criteria

Options	Sub-criteria: Landscape and Visual
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Cultural, Archaeological and Architectural Heritage

The assessment aimed to identify the nature and extent of significant cultural, archaeological, and architectural heritage constraints within a 500m study area, focussing on heritage in the vicinity of the railway line and associated elements which could be impacted by the proposed works.

Stations, Parking, Platform Configurations and Depots

The majority of stations and platform configurations will have a low impact for the cultural, archaeological and architectural sub-criteria. The Glounthaune to Midleton double track alignment could impact upon unrecorded buried archaeological remains, given the evidence for previous activity in the form of recorded archaeological remains. All depots presented a marginal difference in terms of the potential effects on the sub-criteria between each other.

Train Service Specifications (TSS) Options

The Do-Minimum option would see increased rail traffic along the railway line, potentially impacting the settings of archaeological assets. However, the settings of these assets are already impacted by the railway line and increased rail services will not affect this. The impact is low for the archaeological, cultural and architectural heritage. The Do Something options focus on the train frequency, so each option's impact is comparable with the other two as presented in Table 32.

Table 32: Assessment result of the cultural, archaeological and architectural heritage sub-criteria

Options	Sub-criteria: Cultural, Archaeological and Architectural Heritage
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Noise and Vibration

This section presents an assessment of the potential constraints associated with the proposed development on noise and vibration. The sensitive receptors have been identified within the study areas based on the receptor type. These receptors will be used during the subsequent assessments of construction and operational noise and vibration.

Stations, Parking, Platform Configurations and Depots

All stations, parking and platform configurations presented a low impact from the noise and vibration assessment, apart from the Glounthaune to Midleton double track alignment. The impact between the depots is comparable to one another.

At new stations, the character of the operational noise would change from the sound of passing trains for the existing situation (no station) to that of passing and stationary / accelerating / decelerating trains for the upgraded situation with a new station. This would particularly be the case for diesel powered rolling stock.

Additionally, there would be an increase in the number of trains using the line once the entire CACR project is complete.

<u>Train Service Specifications (TSS) Options</u>

Assuming the line speeds remain the same, the Do Minimum and Do Something options do not change in terms of operational noise and vibration as presented in Table 33.

Battery operated rolling stock typically produces less noise than a diesel equivalent whilst the trains are stationary; at slow speed; and accelerating. As the dominant sound source at speeds of approximately 30 mile/h and above is from the wheels and rails, the battery powered trains would produce the same noise as diesel powered at these speeds. Therefore, we expect to see noise reductions at and near to stations but not across the majority of the route.

Table 33: Assessment result of the noise and vibration sub-criteria

Options	Sub-criteria: Noise and Vibration
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Air Quality

Existing air quality within the study area is considered to be good based on the available EPA monitoring data. There are numerous sensitive human and ecological receptors located within the study area which are sensitive to dust, human health or vegetation effects. As the options develop it will be essential that specific receptors are identified for each scope of works and their potential impacts assessed during both the construction and operational phases.

<u>Stations, Parking, Platform Configurations and Depots</u>

The impact will be low or comparable to other options for almost all stations, parking and configuration options for the air quality factor.

<u>Train Service Specifications (TSS) Options</u>

Currently the air quality in Cork is good, with monitored concentrations below the EU limit values for annual mean nitrogen dioxide and particulate matter concentrations. The overall impact for the Do Something options is unknown; however, taking into consideration the good air quality, it is anticipated to have a low impact.

During the operational phase, additional trains using the station / route would increase passenger capacity and therefore increase the number of vehicles on the local road network as people travel to the stations and use the commuter service. However, it would also result in a decrease in vehicle movements on the wider road network as people use the train service in preference to car journeys.

GHG emissions would occur as a result of construction of the route. GHG emissions as a result of the construction of the route are not anticipated to have a material impact on Ireland's ability to meet its carbon targets. The non-battery option would have greater air quality effects than the battery option, due to the combustions of diesel fuel in the non-battery option. The pollutants that would be released would include NOx and particulates.

A slight increase in operational GHG emissions may occur as a result of an increase in energy consumption (e.g., power for lighting and signs and train movements), disposal of operational waste and embodied carbon associated with replacement materials. However, the entire CACR project once complete is expected to have a net positive impact on climate over its lifetime as a result of its role in improving rail network operations, encouraging a modal shift away from private car. As with construction emissions, there is not expected to be a material difference in operational GHG emissions between the different configurations.

Table 34: Assessment result of the air quality sub-criterion

Options	Sub-criterion: Air quality
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Climate

The lifecycle greenhouse gas (GHG) emissions and the climate change resilience were reviewed for the climate change assessment.

GHG emissions: GHG emissions will be emitted as a result of the Development during construction (e.g., embodied carbon in materials, construction activities, and transportation of materials, waste and workers) and operation (e.g., traction emissions, electricity use for lighting and signage etc, and emissions associated with maintenance, repair and replacement of assets). However, the proposed development is expected to have a positive impact on climate due to electrification of the rail network and by encouraging a modal shift away from private car, helping in meeting Ireland's target of net zero emissions by 2050.

There will be some variation in GHG emissions between options, but any differences are not anticipated to have a material impact on Ireland's ability to meet its carbon reduction targets.

Climate Change Resilience: The proposed development will be exposed to future climate change risks associated with increasing temperatures, wetter winters, drier summers and potentially sea level rise. These impacts must be considered throughout the design of the Development to mitigate potential impacts.

Stations, Parking, Platform Configurations and Depots

GHG emissions associated with all stations, parking and platform configurations are expected to have a low impact on the climate. The impact between the depots is comparable to one another and it is expected to be low for all depots.

The level of exposure to climate change between the various stations, parking and platform configurations are expected to be similar. However, a more detailed review will need to be undertaken during the design of the Development.

Service Specifications (TSS) Options

Given that the service options are focusing on the number of trains per hour between the Do Something options, there is marginal difference in terms of the potential effects on climate between each option. However, Do Something options are expected to have a positive impact on climate over their lifetime compared to the Do Minimum option due to improved rail network operations, encouraging a modal shift away from private car.

Table 35: Assessment result of the climate sub-criterion

Options	Sub-criterion: Climate
Do-Minimum Option	
TSS1 Option	
TSS2 Option	
TSS2a Option	

H.2 Economy

User Benefits

The user benefits have been assessed in terms of travel time benefits, reliability impacts, demand, customer offer and flexibility to evolve to meet customer needs. These are discussed below.

Travel Time Benefits

The user benefits sub-criterion presents the potential economic viability of the project through the development of monetised benefits accrued by transport users. These values are likely to experience significant upward movement as the modelling and appraisal is refined as part of the PAR however, they provide a useful means of comparing options. Table 36 provides the summarised ranges of user benefits and scheme costs which may result from the proposed CACR.

Table 36: Summarised User Benefits and Scheme Costs

Options	User benefits (€m)	Scheme Capital Costs (€m, 2021 prices, undiscounted)	Scheme Annual Operating Costs (€m, 2021 prices, undiscounted)
TSS1 Option	400 - 600	1,207	17.2
TSS2 Option	300 - 450	1,196	17.3
TSS2a Option	250 - 400	1,161	16.5

From the table above, the user benefits for the three options range between €250 million and €600 million, with TSS1 forecast to provide the highest benefits. However, the benefits are the product of assumptions and limitations intrinsic within the SWRM modelling. As such the full benefits associated with the CACR are not reflected and will be captured as part of the Project Appraisal Report. At that stage, benefits from a scenario-based modelling approach will be incorporated which will better reflect aspirations for mode shift from the car and transit orientated developments at new stations which are anticipated to generate significantly higher benefits. Furthermore, benefits associated with journey time reliability, agglomeration, safety and other wider economic impacts, as well as other benefits such as those accrued by cyclists, will be accounted for at that stage.

Given the limitations above the main conclusion is that from a travel time benefit point of view TSS2a could be logically discounted as a preferred option. Furthermore, the analysis of SWRM outputs showed standing passengers forecast between Mallow and Blarney. A phased approach could be adopted whereby, as demand grows to justify the greater cost outlay, TSS2 can be adopted if preferred from a service planning perspective.

Reliability

CACR will deliver a more reliable and efficient network through extended electrification, re-signalling works and other improvements to the network. 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. All DoSomething options will significantly improve the operational efficiency of the network through improved signalling and central control which, together with an increase in the frequency of services throughout the day, will enhance the reliability and resilience of the rail services.

Demand

The introduction of CACR is expected to result in a significant increase in rail usage across all options, Sections C.5, D.5 and E.5 present details demand forecasting results however the key metrics are shown below in Table 37. All TTS options result in 4-6% increase in public transport usage across the entire southwest region but more specifically they result in a 40-90% increase in rail boardings. TTS2 performs strongly for all scenarios due to a regular 10-minute service interval and through services from the Midleton branch, which has a larger future catchment. As was the case in the travel time benefits discussion above TSS2a performs weakest overall.

Table 37: Comparison of Key Metrics

Analysis Elements		Scenario	Do Minimum		TSS1		TSS2		TSS2a	
			2030	2050	2030	2050	2030	2050	2030	2050
Demand forecast	Public Transport Daily Trips	Standard	251,860	338,663	261,759	360,599	261,652	357,745	261,504	357,660
		Dynamic	257,845	365,110	268,370	381,106	268,451	384,378	267,996	386,542
	Public Transport Daily Mode Share	Standard	11.5%	12.5%	11.9%	13.3%	11.9%	13.2%	11.9%	13.2%
		Dynamic	11.7%	13.5%	12.2%	14.0%	12.2%	14.1%	12.1%	14.2%
	Irish Rail Boardings	Standard	14,151	19,193	20,418	28,576	20,265	28,809	19,484	27,830
		Dynamic	15,039	19,460	22,481	32,688	22,253	36,799	21,621	30,920

Customer Offer

Both TSS2 and TSS2a offer an attractive customer offer due to a regular 10-minute service interval and through services from the Midleton branch, which has a larger future catchment. While TSS1 has irregular services, TSS2 and TSS2a meet the CMATS objective of a 10-minute service for both directions. Therefore, TSS2 and TSS2a perform better than TSS1 in meeting sub-objectives 2 and 5.

Flexibility to evolve to meet customer needs

Overall, the analysis shows that all TSS options have a positive impact on the public transport network but also that a phasing plan which aligns service levels on CACR with demand and optimised operating costs. In this context TSS2 offers a lot of flexibility as it has the capability to operate any of the TSS options.

The various sub-criteria above were assessed, and a combined user benefits score was developed. Table 38 presents the scoring results of the user benefits sub-criterion.

Table 38: Assessment result of the user benefits sub-criterion

Options	Sub-criterion: User Benefits
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Transport Interchange and integration

CACR 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.

<u>Daily Mode Share</u>

The change of daily trips per mode for each CACR option relative to the Do-Minimum is shown in the Demand forecast section of Appendix C, D and E. A significant increase on the public transport trips were identified, especially in 2040 compared to 2030, most likely due to higher levels of road congestion and public transport crowding in 2040 causing the CACR options to have a proportionately greater impact.

In summary, the analysis showed that TSS2 has marginally the highest demand of all the options. It provides a higher level of service in comparison to TSS2a due to a higher level of rail service provision between Mallow and Blarney. The Do Minimum options presented the lowest score though the comparison with each Do Something option. The score for the transport interchange and integration sub-criterion is presented below in Table 39.

Integration with Wider Network

The proposed CACR Programme will provide numerous interchange points between transport modes since many of the new rail stations will be connected with the bus and light rail network.

CMATS sets out the need to develop an integrated public transport network to significant increase the attractiveness of public transport. The development of the bus, light rail and rail network represents a step change in the public transport offer to users but it is important to ensure it is delivered in a manner where they complement each other. Table 37 shows the impact of CACR in both the standard (DoMin network plus CACR) and dynamic (CMATS plus CACR). The dynamic scenarios offer good insight into how well CACR will integrate with the other elements of CMATS in place. In terms of overall public transport usage both TSS2 and TTS2a result in the highest overall trips however when it comes to rail usage in the dynamic scenario TSS2 performs strongest. The score for this sub-criterion is presented in Table 39.

Table 39: Assessment result of the transport interchange and integration sub-criterion

Options	Sub-criterion: Transport Interchange and Integration
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Costs

The capex and opex costs are presented in Table 36. Whilst the costs vary between the options given the overall scale it is considered that all options perform equally in MCA terms.

Table 40: Assessment result of the cost sub-criterion

Options	Sub-criterion: Transport Interchange and Integration
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

H.3Accessibility and Social Inclusion

Service Frequency and Capacity

The enhancement of the existing heavy rail network focused on improving the frequency of services and capacity. New stations were proposed on numerous locations along the rail network too that together with the additional fleet will provide a more effective timetabling and better services. The assessment results on the rail frequency and fleet capacity are the following.

- The rail frequency increase between stations along the railway network will be up to 500%.
- The highest frequencies are located between Mallow and Kent stations where the rail services will be drastically improved.
- The future frequencies for stations between Glounthaune, Midleton and Cobh will be around 6 trains per hour, while between Kent and Glounthaune there will be 12 trains per hour.
- The proposed fleet aims to commute 37,000 additional passengers, compared to the existing capacity of 35,000 passengers.

- The 106% increase of the fleet passenger capacity will provide the opportunity to switch more people into rail and therefore improving public transport services.

As shown in Figure 50 the increase of frequencies between stations along the railway network will be up to 500%. The Intercity train services were excluded from the analysis because the trains don't stop on the proposed stations between Mallow and Kent. A separate analysis that considered the Intercity services, presented a 150% increase on the rail services between the stations of Mallon and Kent as presented on the small map of Figure 50. The proposed fleet aims to commute 37,000 additional passengers, compared to the existing capacity of 35,000 passengers. The 106% increase will double the fleet's capacity, providing the opportunity to switch more people to into rail and therefore improving the public transport services as presented in Table 41.

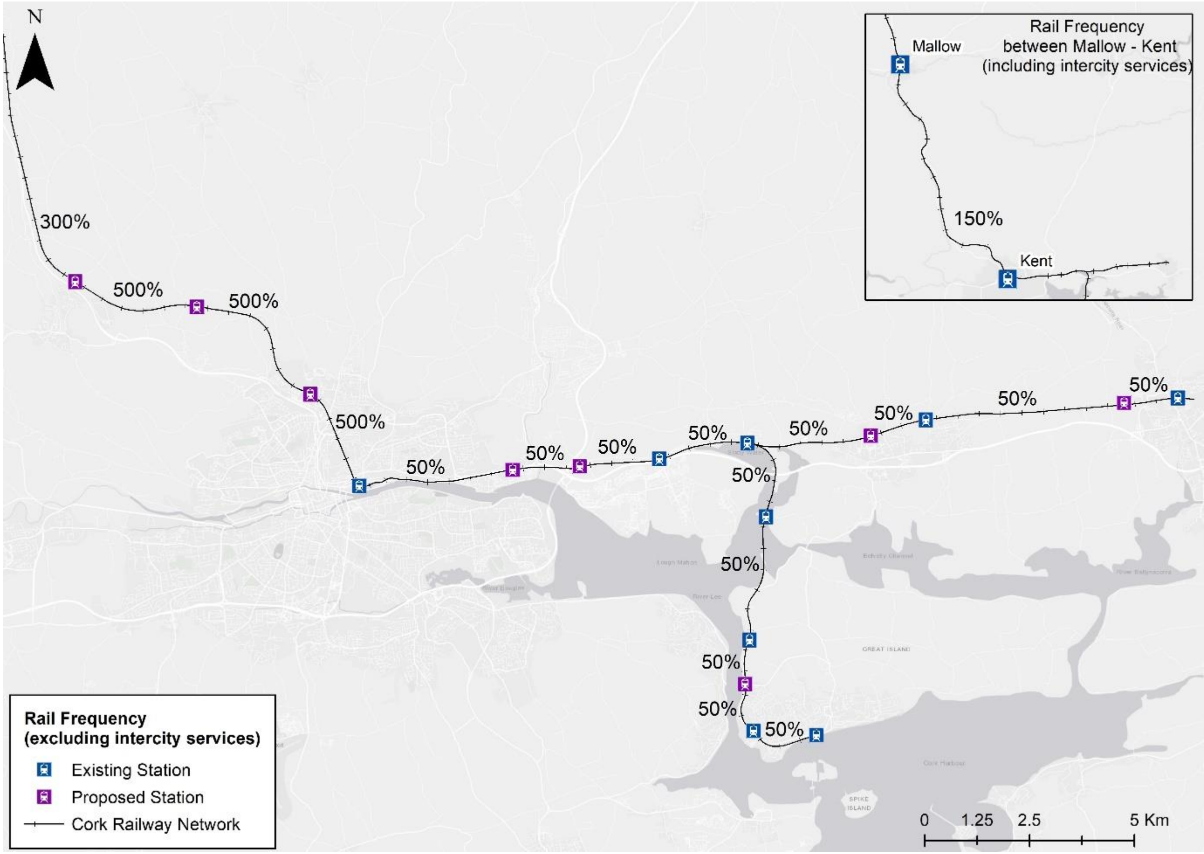

Figure 50: Percentage Increase in AM Peak Hourly Service Frequencies – Do Minimum vs. Do Something

Table 41: Percentage increase on rail frequency per peak period

Stations	Percentage increase on hourly rail frequency			
	AM	Lunch Time (LT)	School Run (SR)	PM
Malllow	150%	200%	200%	100%
Blarney	600%	600%	600%	600%
Monard	600%	600%	600%	600%
Blackpool	600%	600%	600%	600%
Kent	30%	133%	133%	40%
Tivoli	1200%	1200%	1200%	1200%
Little Island	50%	200%	200%	71%
Glounthaune	50%	200%	200%	71%
Carrigtwohill west	600%	600%	600%	600%
Carrigtwohill	50%	200%	200%	100%
Water rock	600%	600%	600%	600%
Midleton	50%	200%	200%	100%
Fota	64%	200%	200%	64%
Carrigaloe	64%	200%	200%	64%
Ballynoe	600%	600%	600%	600%
Rushbrooke	64%	200%	200%	64%
Cobh	64%	200%	200%	64%

Prior to the development, around 36,000 people live within 1km catchment of the existing stations, as presented in Figure 51.

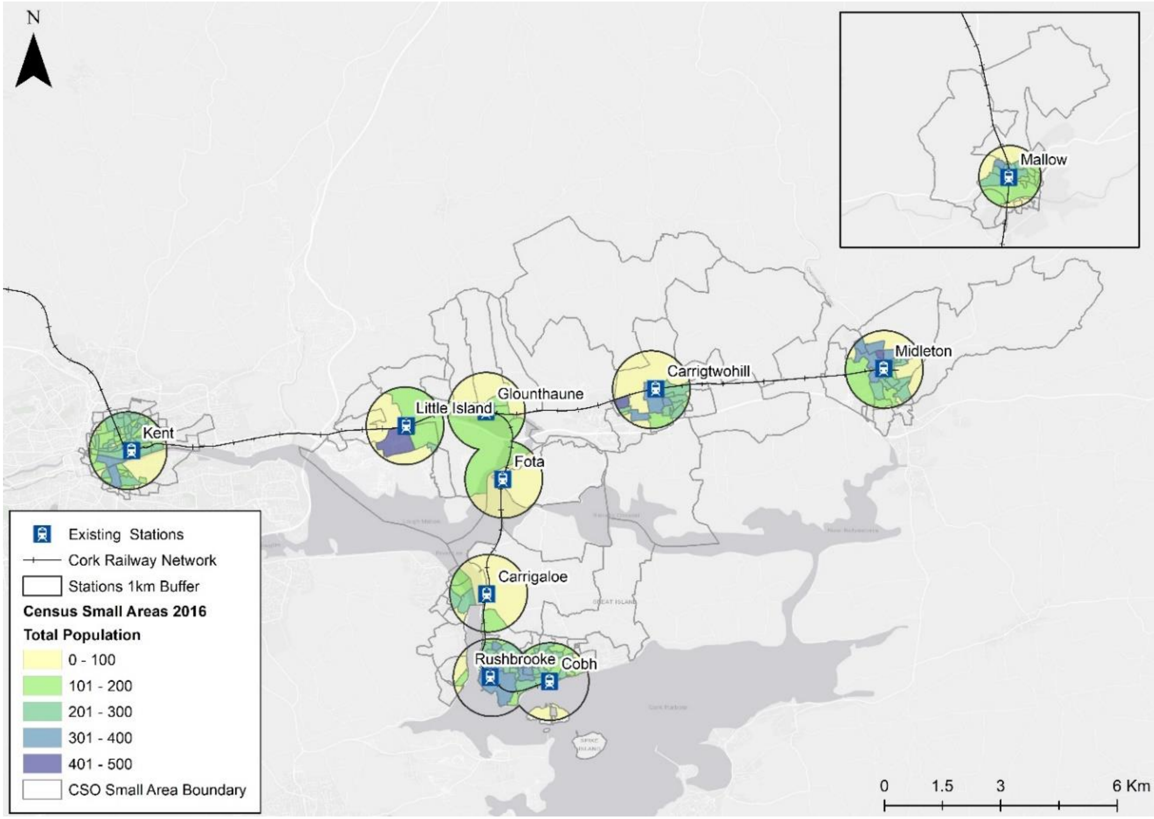

Figure 51: Total Population – 1km buffer from existing CACR stations

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. The introduction of the proposed rail stations into the CACR network will increase the number of workers that are within a 1km catchment from the stations by 31%, compared to the existing conditions that serve around 28,000 workers. The existing and proposed catchment analysis are presented in the following **Error! Reference source not found.** and Figure 53.

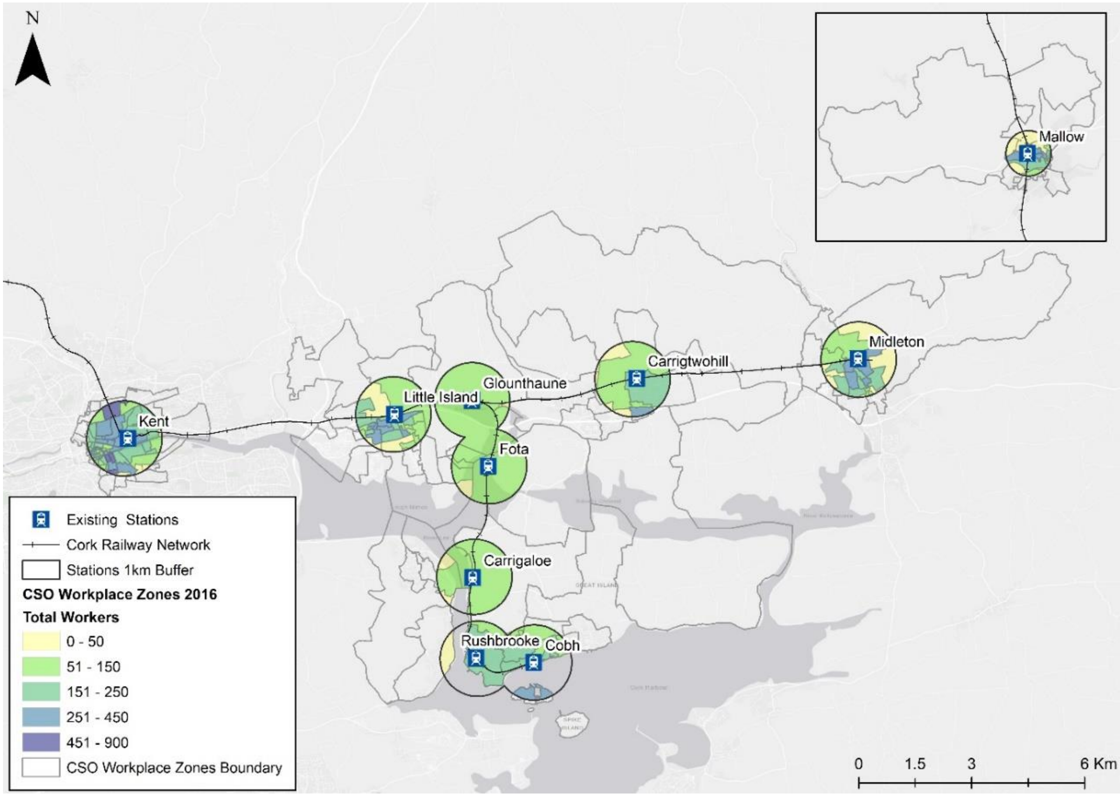

Figure 67: Worker's population per zone – 1km buffer from existing CACR stations

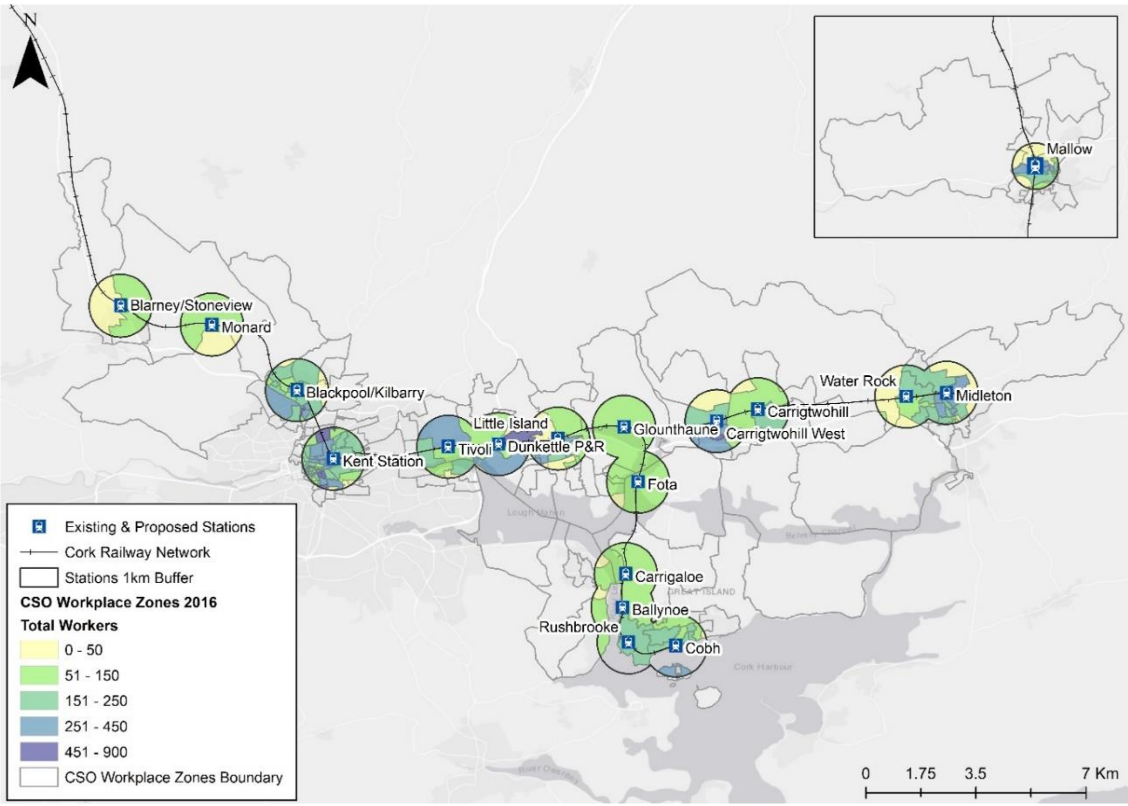

Figure 53: Worker's population per zone – 1km buffer from existing & proposed CACR stations

Access to Higher Quality Public Transport

Increasing the number of stations along the existing railway network, 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 and those who wish to be reliant on public transport. The key findings of the analysis are presented below.

There will be a 33% increase on the population that will easily access the rail stations within a 1km catchment, reaching to 48,000 people from 36,000. The catchment of the future rail stations is shown in Figure 69.

The introduction of the proposed rail stations into the CACR network will increase the number of workers that are within a 1km catchment from the stations by 31%, compared to the existing conditions that serve around 28,000 workers.

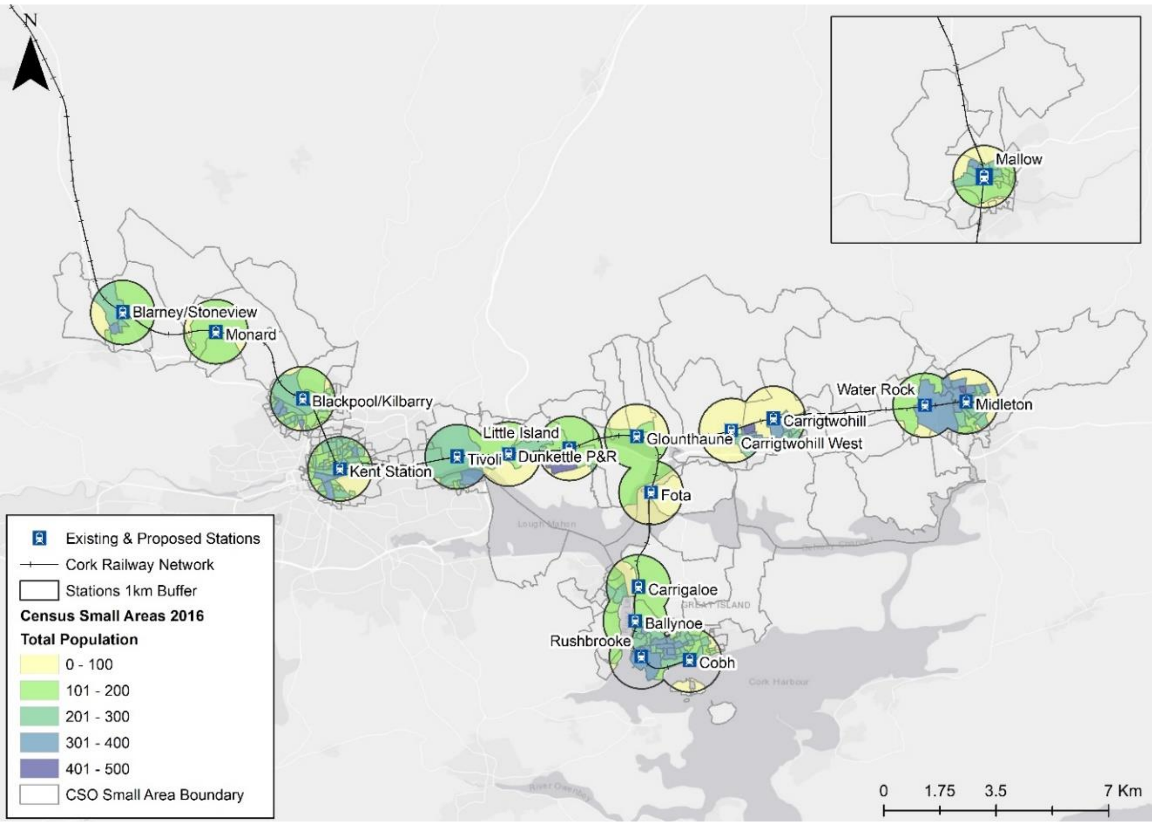

Figure 69: Total Population – 1km buffer from future CACR stations

Table 42 summarises the impact on passengers' sub-criterion scoring that combines the three above factors. The CACR Programme will present a positive impact on the passengers' services, compared to the current conditions expressed on the Do Minimum option. Given that the service options are focusing on the number of trains per hour, and there is very little difference in this number between the Do Something options however given the reduced service between Mallow and Blarney TSS2a is considered slightly weaker than TSS1 and TTS2.

Table 42: Assessment result of the impact on passenger's sub-criterion

Options	Sub-criterion: Impact on Passengers
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Social Impacts

The social inclusion parameter is built on the perspective of the anticipated improvement for disadvantaged areas. Geographical data was extracted from Census 2016 and 2016 Pobal HP deprivation index by Small Area inside the limits of the study area, providing insight into the potential impact on disadvantaged communities. The sub-parameters for this criterion assessment the number deprived and the percentage of households with no car ownership. The analysis results for each factor are outlined below.

- Areas that are mainly defined as disadvantaged will now have access to a high frequency rail commuter service due to the CACR Programme. Those areas are close to Water Rock, Mallow, Blackpool and Ballynoe stations.
- Cork rail commuter will reach an additional 7,500 people living in areas defined as below average or worse by Pobal and increase by 100% the population in disadvantage areas. Table 43 presents the deprivation index impact based on the Pobal dataset.

- Through the CACR the number of households with no car within the stations' radius will be increased and reach the 5,000 households, while prior to the development they were around 4,000. Mainly, the households with no car are located at Mallow, Kent and Cobh stations.

Table 43: Deprivation Index Impact

	Deprivation Index 2016	Existing	CACR
	extremely affluent	-	-
	very affluent	475	786
	affluent	7,551	9,335
	marginally above average	14,581	17,096
	marginally below average	8,941	12,013
	disadvantaged	3,931	7,819
	very disadvantaged	421	852
	extremely disadvantaged	-	-
	Total	35,900	47,901

Table 44 summarises the sub-criteria scoring for social impact. The Do Minimum option would likely have no additional social impact across the study area. Given that the service options are focusing on the number of trains per hour, and there is very little difference in this number between the Do Something options, there is marginal difference in terms of the potential effects on social inclusion.

The analysis on the Pobal Deprivation Index from 2016 showed that the existing Cork rail network travels through areas which are largely classed as 'marginally above average'. Figure 70 shows that it also travels through some areas defined by Pobal as disadvantaged or very disadvantaged particularity in the Cork city centre and around the areas of Midleton and Cobh.

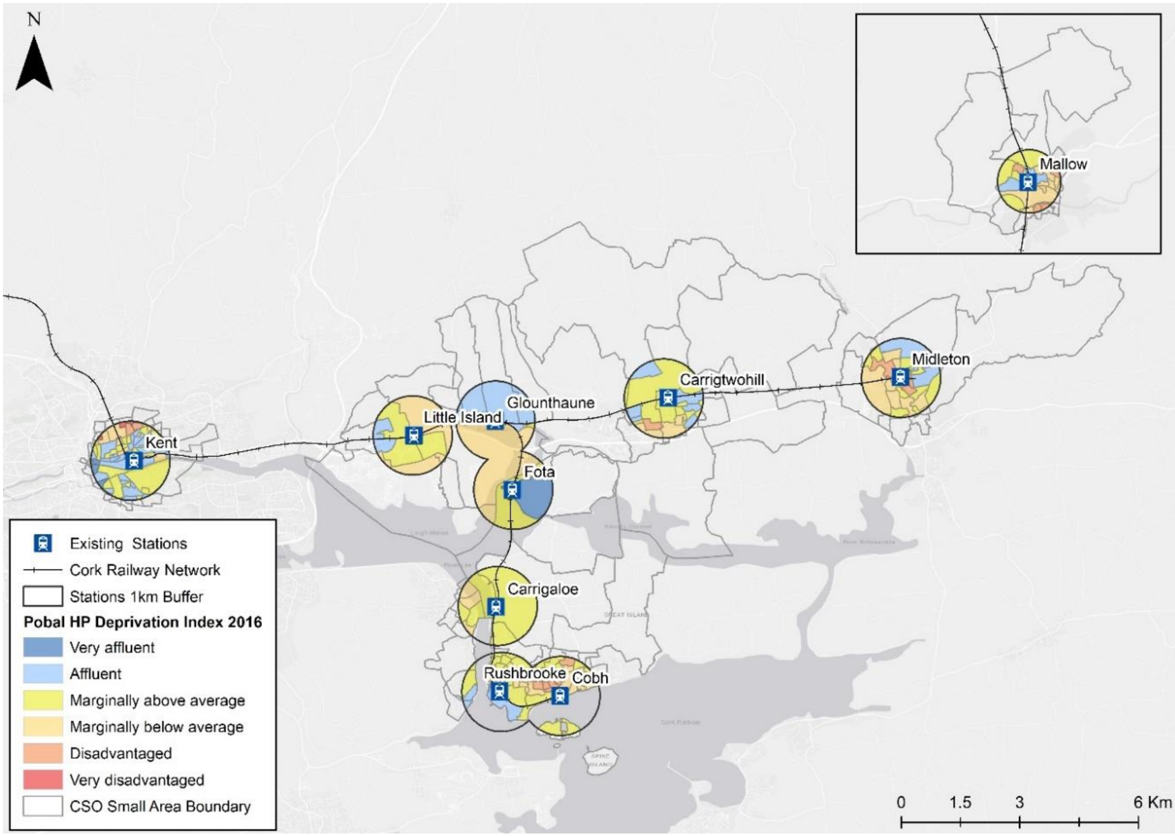

Figure 70: Deprivation Index – 1km buffer from existing CACR stations

The development of new stations along the Cork rail network will open up the rail commuter service to areas that are defined as below average by Pobal especially in areas close to Water Rock, Mallow, Blackpool and Ballynoe stations, as shown in Figure 71. Those areas that are mainly defined as disadvantaged will now have access to a high frequency rail commuter service.

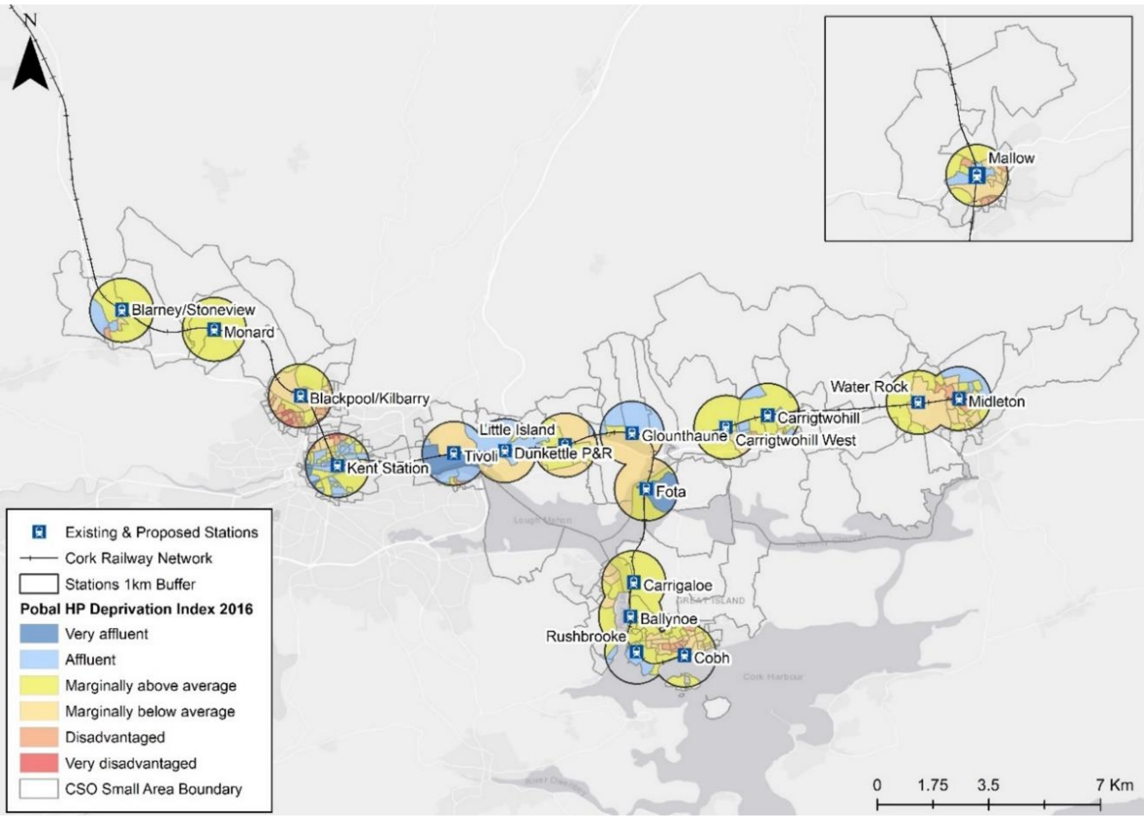

Figure 71: Deprivation Index – 1km buffer from future CACR stations

In addition, households with no car ownership highly depend on the public transport. Mainly, the households with no car are located at Mallow, Kent and Cobh and through CACR the number of households with no cars will be increased, as shown in Figure 72 and Figure 73. Therefore, the CACR will accommodate around 5,000 households with no car, while prior to the developments the number of households was around 4,000.

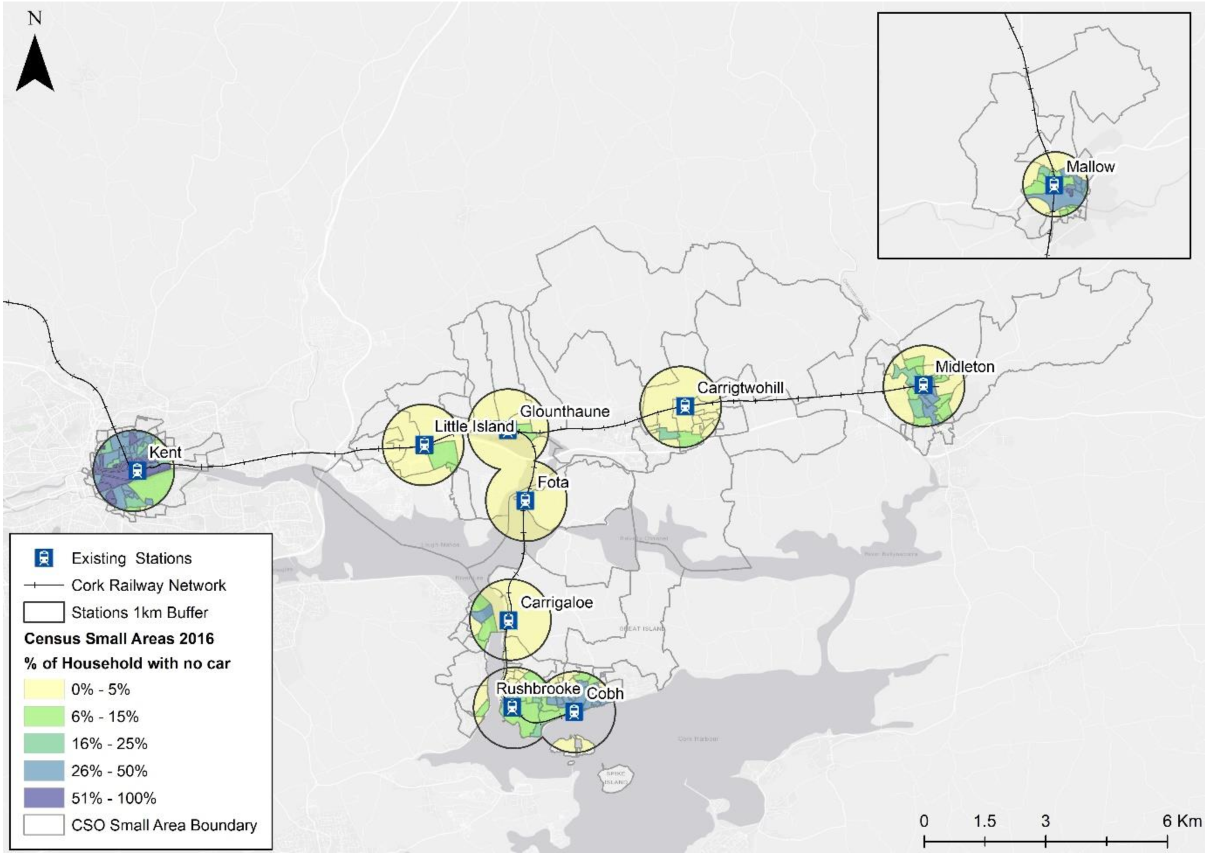

Figure 72: Percentage of Households with no car – 1km buffer from existing CACR stations

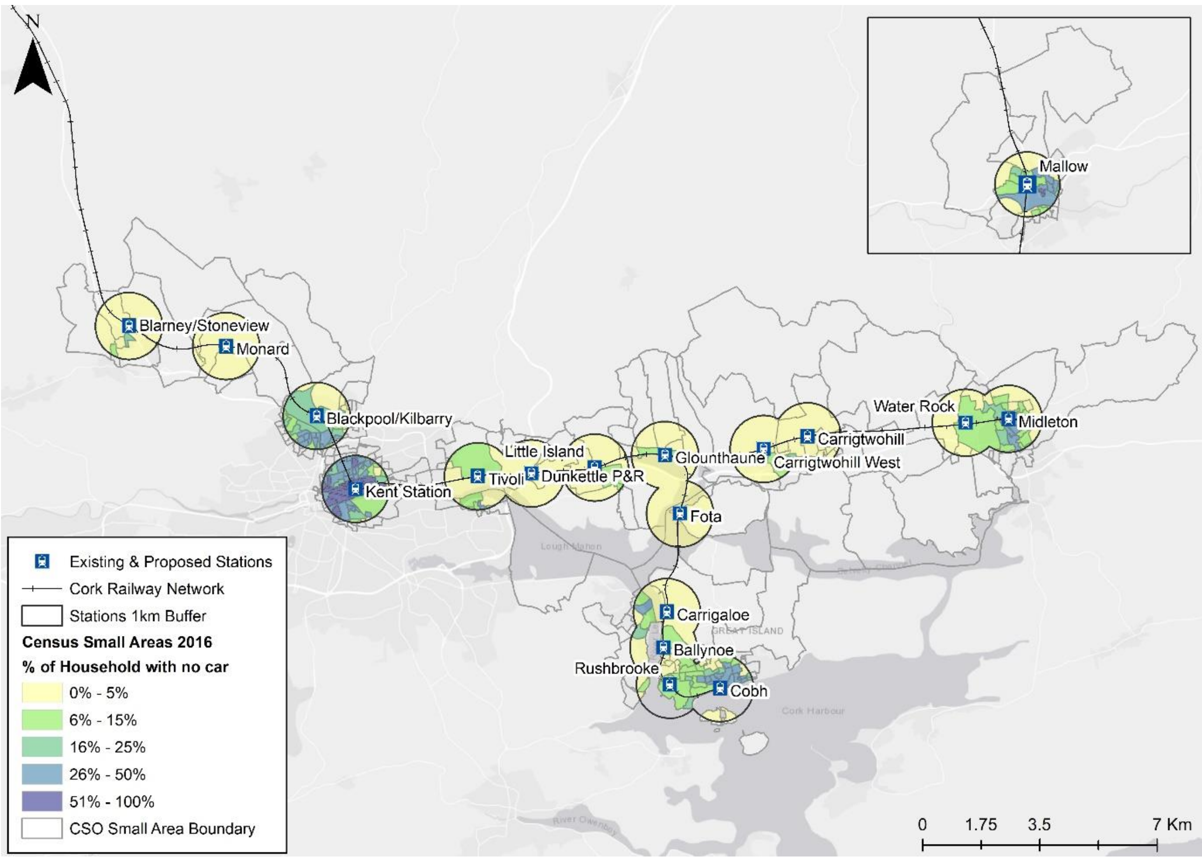

Figure 73: Percentage of Households with no car – 1km buffer from existing & proposed CACR stations

In summary, the development of the CACR will significantly improve accessibility to work, education and community facilities compared to the existing conditions. Literature and academic research affirm the close link between the accessibility to transport and social improvement, and therefore Cork railway is viewed as very positive on this criterion and will act as a catalyst to improve the opportunity of many people along the network.

Table 44: Assessment result of the social impact sub-criterion

Options	Sub-criterion: Social impacts
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

H.4Integration with non-public transport modes and policies

Integration with the road network

CACR will have a positive impact on the surrounding road network as it will deliver a number of new rail stations and associated parking which will integrate with the road network by intercepting trips to existing rail stations. All DoSomething options will have the same broad impact on this sub-criterion.

Table 45: Assessment result of the integration with road network and local area sub-criterion

Options	Sub-criterion: Integrations with the Road network and Local area
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Integration with active mode network (Cyclists and Pedestrians)

The active modes network (walking and cycling) will experience benefits from the development of the CACR Programme in relation to improved local connectivity and integration with surrounding networks. New crossing points of the rail line together with improved cycle parking facilities at stations (new and existing) will make it more attractive to walk/cycle to/from and across the rail network. No work is expected along the railway, so the impact on pedestrians will remain the same. Rail stations represent key hubs in the area and as the active mode network develops in Cork, they will form part of improvements which will benefits both local residents and rail users. Table 46 highlights that the DoSomething options all represent an improvement on the Do Minimum.

Table 46: Assessment result of the active modes integration sub-criterion

Options	Sub-criterion: Active Modes Integration
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Local and national policies and guidance

This criterion seeks to understand to which each option aligns with policies and guidelines on a local, regional and national level. The policies considered for the CACR Programe are the following:

- Cork County Development Plan 2022 -2028
- Cork Metropolitan Area – Transport Strategy 2040
- Project Ireland 2040, including:
  - National Planning Framework
  - National Development Plan 2018-2027

- Rail Freight Strategy 2040
- Iarnród Éireann Strategy 2027
- Climate Action Plan 2021

The CACR Programme, compared to the Do Minimum option, is anticipated to deliver positively on many of the aspirations of the Climate Action Plan, as well as the wider range of regional and national policies and guidelines. However, there will be negligible factors to differentiate between the three Do Something options at this stage of the assessment.

Table 47: Assessment result of the local and national policies and guidance sub-criterion

Options	Sub-criterion: Local and National Policies and Guidance
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

H.5Safety and Security

CACR 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. The efficient connection of the CACR with the BusConnects, light rail and the bus network will also encourage commuters to shift into public transport. 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, reducing the risk of collisions.

A level crossing analysis was conducted on the six existing crossings on the network. The assessment concluded that keeping the crossing point at Myrtle Hill open would not be viable and its closure was proposed. All other crossings could potentially continue to operate viably subject to any further risk assessments and more detailed traffic assessment in later stages of the Programme.

There is marginal difference between any of the Do Something options in terms of potential effects on safety and security since the options are focusing on the number of trains per hour. Therefore, the impact will be similar to the Do Minimum and the same for all future options as presented in Table 48.

Table 48: Assessment result of the safety and security criterion

Options	Criterion: Safety and Security
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

H.6Physical Activity

Cycle Facilities at Stations

The use of public transport modes is strongly connected with active transport modes, such as elevated levels of walking and cycling. The CACR Programme could potentially have a positive impact on physical activity through cycling. The modal shift from cars into public transport could enhance the active modes too. The proposed parking facilities that will be developed at the rail stations according to the CACR Programme, could include safe parking spaces for bicycles too. Therefore, the users transferring to rail for their trip would be able to securely park their bikes and choose cycling for their everyday commute, that would finally benefit their physical activity.

In addition to the impacts on existing walkers and cyclists identified above, the introduction of new stations and 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.

All the Do Something options will present a comparable score for the physical activity sub-criterion, due to the fact that the options' difference is related to the train frequency, but the physical activity will be improved compared to the Do Minimum option. The score for the Do Minimum and Do Something options is presented in Table 49.

Table 49: Assessment result of the cycle facilities at stations sub-criterion

Options	Sub-criterion: Cycle Facilities at stations
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

Permeability and local connectivity

Walking is another active mode that could be positively affected by the CACR Programme. The location of each rail station could significantly contribute to the increase of walking and cycling by connecting with recreational centres, parks and green spaces. The final parameter of the physical activity criterion is based on the connectivity opportunity for green spaces and recreational facilities. The location of the parks and green spaces was identified, but since all the Do Minimum and Do-Something options have the same stations, then this sub-criterion would provide the same score for all options.

Table 50: Assessment result of the permeability and local connectivity sub-criterion

Options	Sub-criterion: Permeability and Local Connectivity
Do Minimum	
TSS1 Option	
TSS2 Option	
TSS2a Option	

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