Luas Cork Alignment Options and Feasibility

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Luas Cork - Alignment Options and Feasibility Study

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Table of Acronyms

Acronym	Meaning
ACA	Architectural Conservation Area
AM	Morning peak
ASI	Archaeological Survey of Ireland
BCIS	Building Cost Information Service
BCR	Benefit to cost ratio
CAF	Common Appraisal Framework
CAP	Climate Action Plan
CASP	Cork Area Strategic Plan
CBA	Cost Benefit Analysis
CCC	Cork County Council
CH	Cultural Heritage
CCCMS	Cork City Centre Movement Strategy
CIT	Cork Institute of Technology
CMA	Cork Metropolitan Area
CMATS	Cork Metropolitan Area Transport Strategy
COMAH	Control or Major Accident Hazards
CUH	Cork University Hospital
CSO	Central Statistics Office
CSPCA	Cork Society for the Prevention of Cruelty to Animals
DECLG	Department of the Environment, Community and Local
DoT	Department of Transport
EAR	Environmental Appraisal Report
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
END	Environmental Noise Directive
EPA	Environmental Protection Agency

Acronym	Meaning
EPR	Emerging preferred route
ETE	End-to-End Route Options
EU	European Union
GHG	Greenhouse Gases
GIFA	Gross Internal Floor Area
GIS	Geographical Information Systems
HSA	Health and Safety Authority
HV	High Voltage
IAQM	Institute of Air Quality Management
ICNIRP	International Commission on Non-Ionising Radiation Protection
JT	Journey Time
LCA	Landscape Character Assessment
LAP	Local Area Plan
LRT	Light Rail Transit
LV	Low Voltage
LVIA	Landscape and Visual Impact Assessment
MASP	Metropolitan Area Strategic Plan
MCA	Multi-Criteria Analysis
MTU	Munster Technology University
NBDC	National Biodiversity Data Centre
NDP	National Development Plan
NIAH	National Inventory of Architectural Heritage
NIFTI	National Investment Framework for Transport in Ireland
NPF	National Planning Framework
NPO	National Policy Objectives

Acronym	Meaning
NSO	National Strategic Objective
NSPC	Non-Statutory Public Consultation
NSR	Noise Sensitive Receptors
NTA	National Transport Authority
OHLE	Overhead Line Equipment
0&M	Operations & Maintenance
OSR	Option Selection Report
PAR	Preliminary Assessment Report
PCR	Planning Compliance Report
PM	Evening peak
PMG	Project Management Guidelines
pNHA	National Heritage Areas
PR	Preferred Route
PSC	Public Spending Code
PSO	Public service operators
PT	Public Transport
PVB	Present value of benefits
PVC	Present value of costs
QI	Qualifying Interest
RAPID	Revitalising Areas by Planning, Investment and Development
RMP	Record of Monuments and Places
RPO	Regional Planning Objectives
RPS	Record of Protected Structures
RSES	Regional Spatial and Economic Strategy
SAC	Special Areas of Conservation
SAR	Strategic Assessment Report
SDGs	Sustainable Development Goals

Acronym	Meaning
SILFT	Strategic Investment Framework for Investment in Land Transport
SMR	Sites and Monuments Record
SPA	Special Protection Areas
SR	School Run
SWRM	South Western Regional Model
TEN-T	Trans-European Transport Network
TII	Transport Infrastructure Ireland
TMR	Transport Modelling Report
TUBA	Transport Users Benefit Appraisal
UCC	University College Cork
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URDF	Urban Regeneration and Development Fund

Table of Glossary of Terms

Glossary	Meaning
Area Formation	Formation of LRT corridor options for each area (1-3)
Area Options	Route Sections sifted from Step A are used to form candidate Area Options that are assessed in Step B. Area Options brought forward for further assessment at Step B are used to develop ETE Route Options in Step C that leads to the identification of the EPR
Bus Lane	An on-road carriageway reserved primarily for the use of buses. A bus land forms part of a road link and it is located within contiguous road surface
Construction Phase	The processes and activities on or off site that contribute or are instrumental to the construction of the Proposed Scheme towards, and finally to, the operational phase.
Designated Sites	Selected sites designated with the aim to conserve habitats and species of conservation concern

Glossary	Meaning
Environmental Impact Assessment Report	An Environmental Impact Assessment Report is a report of the effects, if any, which the Proposed Scheme, if carried out, would have on the environment. It is prepared by the developer to inform the EIA process.
Environmental Protection Agency	The Environmental Protection Agency is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. It operates independently under the Department of the Environment, Climate and Communications.
Hydromorphology	Hydromorphology is a term used in river basin management to describe the hydrological (water flow, energy etc.) and geomorphological (surface features) processes and attributes of rivers, lakes, estuaries, and coastal waters.
Invasive Species	An invasive species is a plant, fungus, or animal species that is not native to a specific location
JACOBS	Jacobs Engineering Ireland Limited
Modal Shift	A change from one form of transportation to another
Operational Phase	This phrase refers to the processes and activities implemented following the Construction Phase to ensure the appropriate environmental management of the Proposed Scheme over time.
Receptor	Human or other living organism with the potential to be exposed to and adversely affected by contaminants due to its presence at the source of along the migration pathway.
Route Sections	Individual highways or street sections assessed as part of the Spider Web process in Step A
The Birds Directive	The Birds Directive (formally known as Council Directive 2009/147/EC on the conservation of wild birds) is a European Union directive adopted in 2009. It replaces Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. It aims to protect all European wild birds and the habitats of listed species, in particular through the designation of Special Protection Areas.
Environmental Protection Agency	The Environmental Protection Agency is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. It operates independently under the Department of the Environment, Climate and Communications.

Executive Summary

Introduction

Jacobs Engineering Ireland Ltd. (Jacobs) was commissioned by Transport Infrastructure Ireland (TII) to undertake an Alignment Options and Feasibility Study to determine the Emerging Preferred Route (EPR) for a new Light Rail Transit (LRT) scheme in Cork as included in the Cork Metropolitan Area Transport Strategy (CMATS). A LRT scheme (Luas Cork) has been a long-term objective for the Cork Metropolitan Area (CMA) articulated by the joint Cork Area Strategic Plan (CASP), the Cork City Centre Movement Strategy and given effect by the Cork City and County Developments Plans as primary policy documents.

The design and planning of Luas Cork (also referred to as the Proposed Scheme) is being undertaken by TII in collaboration with the National Transport Authority (NTA) and in consultation with Cork City Council (CCC).

Luas Cork consists of a west-east mass light rai transit, rapid transport corridor, running from the Ballincollig area, in the west, to Mahon Point, to the east of Cork city. The Proposed Scheme will serve a large number of significant destinations, including Ballincollig, Munster Technology University (MTU), Cork University Hospital (CUH), University College Cork (UCC), Cork City Centre, Kent Station, Blackrock and Mahon. It is intended that the Proposed Scheme will commence construction by 2030.

The purpose of this report is to detail the analysis and assessment that was undertaken as part of the Option Selection Study against a defined approach and methodology to identify the Emerging Preferred Route (EPR) for Luas Cork.

Emerging Preferred Route

The EPR for Luas Cork that was determined through the analysis undertaken in this Option Selection Study is shown in Figure 1.

The EPR is comprised of the following elements:

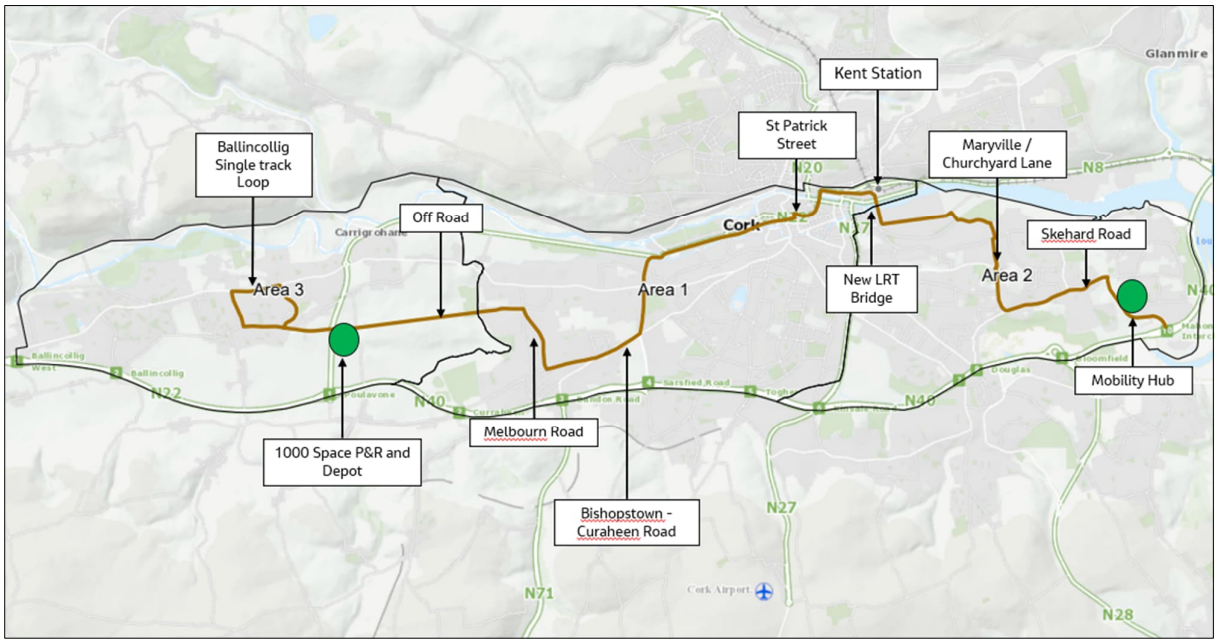


Figure 1 Emerging Preferred Route for Luas Cork

EPR Description

Starting from the western end of the route, the EPR for Luas Cork commences in Ballincollig, where a single-track clockwise loop arrangement is provided through the town centre. The EPR starts along Link Road south of Ballincollig Main Street where a double-track configuration is provided until the Leo Murphy Road junction, at this point the alignment diverges, and a single-track loop arrangement commences for approximately 2.6km. From Carriganarra Road the single-track corridor turns north on to Station Road, in a fully segregated arrangement (not sharing with traffic).

At the Station Road/Carrigrohane Road junction the EPR turns east on to Main Street, Ballincollig and continues running along Main Street until it reaches Leo Murphy Link Road, where it turns south. The proposed route continues along Leo Murphy Road until it reaches the Link Road junction, where it returns eastwards concluding the single-track arrangement and merging into a double-track configuration.

From here, the EPR continues eastwards along Link Road to the Killumney Link East roundabout on the N22. After crossing the Killumney Link East roundabout the EPR proceeds eastwards through agricultural farmlands on a segregated and protected corridor for approximately 2.2km, until it reaches the Munster Technological University (MTU).

From there the EPR proceeds eastwards through MTU grounds running between the existing GAA pitches and Athletics track before joining Institute Road. The EPR then turns south at the Institute Road/Rossa Ave roundabout and runs southbound on Melbourn Road. A one-way general traffic system is proposed on Melbourn Road to achieve a high level of segregation for the Luas whilst also endeavouring to maintain the tree lined suburban feel to the area. In addition to the EPR, the Proposed Scheme includes cyclist and pedestrian facilities to provide good connectivity to MTU.

The EPR turns eastwards from Melbourn Road onto Curraheen Road where part of the track alignment will be segregated, whilst short sections shared with general traffic. The EPR for Luas Cork will utilise the corridor provided as part of BusConnects where possible to provide segregation and less disruption to general traffic in this area. It is also proposed to utilise new signal-controlled junctions with priority for the Luas to ensure operational efficiency along the shared road sections. Along this section of the EPR some land-take will be necessary, mainly on the north side of Curraheen Road, to facilitate both the BusConnects and Luas Cork schemes.

From Curraheen Road the EPR continues eastwards joining Bishopstown Road, sharing with general traffic, until arriving at the Cork University Hospital/Wilton Shopping Centre where the wide streetscape enables segregation for all modes of transport including the EPR and active travel.

The EPR will run segregated along the hospital boundary and turn northwards at the existing Wilton Roundabout. It is proposed to upgrade the existing Wilton Roundabout to a new signal-controlled junction as part of the BusConnects scheme, with some subsequent modifications required as part of the Luas Cork scheme thereafter.

From the new Wilton junction, the EPR travels north along Wilton Road, through Dennehy's Cross, to Victoria Cross where the EPR turns east on to Western Road towards the city centre. On Wilton Road, Luas Cork will utilise the proposed BusConnects corridor, with four lanes provided along its full length, of which two central lanes will be allocated to general traffic and two outside lanes to BusConnects/Luas. A new priority system at the signal-controlled junctions will ensure operational efficiency along this section of the corridor. Some land take is necessary on both sides of Wilton Road, aligning with the BusConnects proposals, to facilitate the four-lane configuration.

As the EPR proceeds through Victoria Cross and on to Western Road, the EPR will again utilise the proposed BusConnects corridor, whereby four lanes are provided in general, two central lanes for general traffic and two outside lanes shared for BusConnects/Luas. Some land take is also necessary along this section of the EPR mainly to the East of Victoria Cross Road.

Along Western Road, the EPR will adopt a similar configuration to the proposed BusConnects scheme, where a mix of three and four lanes are provided, two of which are segregated for buses and trams, with priority signal-controlled junctions for sections where only three lanes are possible.

Four lanes are provided on Western Road from Victoria Cross to Gaol Walk for full bus and Luas segregation with some land take necessary on the south side of the road. A three-lane configuration is proposed from Gaol Walk to the UCC entrance (Donovan Road junction) where the EPR will proceed through a public transport only gate on Western Road with general traffic diverted north on to the adjacent Mardyke Road.

From the public transport gate, the EPR will continue eastwards in a two-lane configuration sharing with buses and local traffic only. Segregated cyclist facilities will also be provided along this section of the Proposed Scheme to enhance connectivity between UCC and the city centre. A third lane is introduced on Washington Street from the courthouse to the Grand Parade junction where general traffic merges with the EPR. Traffic management measures will be introduced to optimise traffic movements and provide priority for public transport where possible. Furthermore, some pedestrian and cycling facilities are included where possible along Washington Street which is currently dominated by general traffic.

Upon reaching the Washington Street/Grand Parade junction, the EPR turns northbound towards St. Patrick's Street where the EPR traverses the city centre area. A catenary free corridor will be provided to minimise the impact on the public realm, as it will result in less clutter on the streets and provide opportunities to enhance the streetscape. Once on St Patrick's Street, the route continues eastwards, maintaining the wide footpaths and streetscape of this important public space in the heart of the city. Crossing St Patrick's Bridge and onto MacCurtain Street and the Victorian Quarter, the EPR shares with buses and general traffic in an eastbound direction and with buses only in a westbound direction.

From the junction with Lower Glanmire Road, the EPR travels towards Kent Station via Alfred Street, sharing with buses in an eastbound direction. A Luas stop will be integrated into the proposed new entrance at the rear of Kent Station to allow for easy transfer to commuter and inter-city rail services, buses, and other interchange facilities.

The EPR then travels southwards on a new public transport bridge over the River Lee from Horgan's Quay to the south docklands at Furlong Street. From here the EPR continues southwards, before returning eastwards on to Centre Park Road, where the tracks will be fully segregated from other traffic.

The EPR will be compatible with the South Docklands Area Based Transport Assessment and integrated with the future Docklands Development, creating an attractive streetscape for public transport, active travel, and access to the docklands and the Marina. The proposed configuration here includes a segregated Luas alignment on grass-track, a two-way road carriageway and bi-directional cycleways and footpaths. Through avenue management and careful landscaping, it is proposed to enhance the tree-lined avenue of Centre Park Road and the Marina setting.

At the Centre Park Road/Marquee Road junction the EPR turns southwards before reaching Monahan Road, where the route runs along the southern boundary of the newly developed Marina Park. Monahan Road will be partly re-aligned to the south to make space for the Luas corridor while limiting as far as possible impacts on the newly developed Marina Park and the mature trees in the area.

After crossing Monahan Road, the Luas corridor will pass to the south of the road, and at this location a Luas stop with a three-track configuration is proposed to serve the stadium. and to facilitate possible service turnback towards the city centre at off-peak times..

The proposed three-track configuration will enable higher Luas capacity services when big events are taking place at Páirc Uí Chaoimh and is designed to minimise impacts on the new park area, which acts as a flood protection basin. Some land-take is required at this location to facilitate the proposed stop and the incline of the track alignment.

From Páirc Uí Chaoimh, the EPR runs southbound on Maryville Lane, up a steep hill to reach the junction with Blackrock Road, sharing with local access traffic only. Regrading works are necessary at the lower part of Maryville to enable Luas services to operate along this section of the route.

The EPR then crosses Blackrock Road and on to Churchyard Lane where a portion of land-take will be required to facilitate the alignment. The EPR continues southbound on Churchyard Lane sharing with general traffic, which will be permitted for local access only, until the Churchyard Lane/Boreenmanna Road junction.

Existing on-street parking on Churchyard Lane will be relocated. From the Boreenmanna Road junction, the potential cross-section offers the opportunity to partially segregate the EPR whilst maintaining a northbound lane for general traffic. and the provision of segregated cycling and pedestrian infrastructure. At the southern end of Churchyard Lane, the EPR turns eastwards on to Skehard Road.

The proposed BusConnects Sustainable Transport Corridor (STC) J proposes a four-lane configuration on Skehard Road until such time as Luas Cork is constructed. It is envisaged that Luas Cork will replace the BusConnects STC J and provide centre running segregated tracks with two segregated outside lanes provided for general traffic. The Skehard Road streetscape provides opportunities for a balanced transport approach, enhancing the environment for walkers and cyclist by providing segregated active travel infrastructure and landscaping. There are small sections of land-take required to implement the proposed scheme successfully, towards the eastern end of Skehard Road.

At the Blackrock Avenue junction, the EPR leaves Skehard Road and turns southbound on to Mahon Link Road, where the alignment will run on segregated track on the west side of the road, parallel to the existing Greenway. A two-lane configuration will be adopted to the east side of the EPR for general traffic, which will result in some land-take and tree replanting along the eastern property boundaries. The EPR will continue southbound following the road alignment to the proposed terminus located to the northeast of the Mahon Link Road/City Gate junction. Segregated cycling and pedestrian facilities will be provided along Mahon Link Road and will lead to the terminus where a proposed potential Mobility Hub would promote and enhance

transport interchange opportunities between private car, public transport, and active travel users. The Mahon Link Road/City Gate junction will also be upgraded as part of the BusConnects proposals, providing enhanced pedestrian and cycling facilities and better connectivity to Mahon Shopping Centre.

Potential P&R and Mobility Hub

As part of the proposed scheme there are the potential Park & Ride and Mobility hub facilities at either end of the EPR such that passengers can conveniently switch transport modes from private car to Luas Cork or interchange between public transport modes and active travel. A Park & Ride with 1,000 spaces would serve the western end of the EPR and could be located directly to the east of Kilumney Link East Roundabout (near Ballincollig). At the eastern end of the EPR, a transport mobility hub will be provided just off the Mahon Link Road/City Gate junction. These strategic locations will enable people to travel to the city centre on the Luas faster and more reliably, than private car, with both sites selected to create easy access from the N22 and the N40.

The Option Selection Process

The approach and methodology developed for this Option Selection study is outlined in detail in chapter 3 of this report. It sets out a seven-step process that aligns with the Public Spending Code (PSC), Common Appraisal Framework (CAF) for transport projects and NTA Project Management Guidelines (PMG).

This process was critical for the successful delivery of the Option Selection Study so that we could identify all the major opportunities and constraints early, to provide confidence and surety that the appropriate option would be identified; provide evidence that all reasonable alternatives were examined; to justify the acquisition of public/private land and document all data that informed the decision to gain buy-in from all the key stakeholders including the public. Figure 2 outlines the overall process, which was undertaken to identify the EPR, beginning with the Projects Aims and Objectives, and then following a logical assessment and refinement of options to determine the EPR.

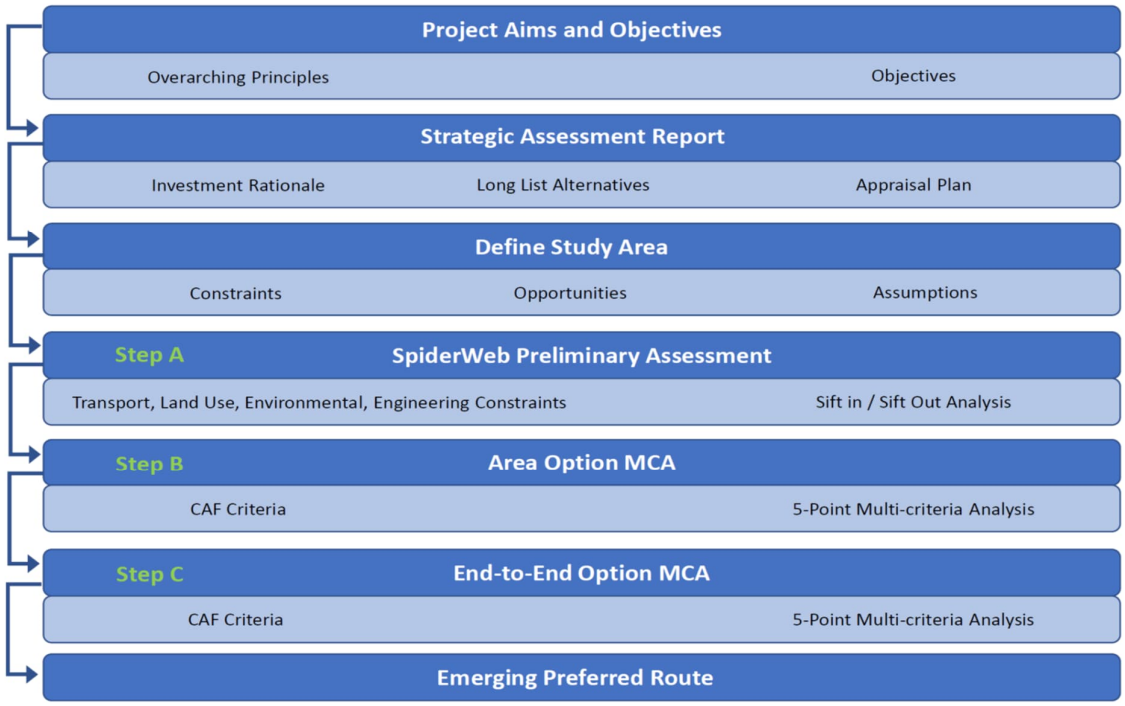


Figure 2 Overall Process to identify the EPR

Proposed Scheme Objectives

The need for the Proposed Scheme is wide ranging, aligning with policy at all levels, catering for current and immediate transport supply and demand deficit, enabling the sustainable growth of Cork City by catering for compact growth and development consolidation and supporting the reduction in transport related carbon emissions. The following outlines the high-level objectives for the Proposed Scheme Alignment Options and Feasibility Study:

- Deliver high quality public transport and journey time reliability to cater for existing and future public transport travel increased demand within the city and its suburbs;
- Support the continued important economic development of the Cork Metropolitan Area, futureproofing for National Planning Framework (NPF) growth and beyond, in a cost-efficient manner;
- Facilitate connection to key trip attractors and support public transport network integration by providing high quality passenger interchange points;
- Plan, construct and operate in an environmentally sustainable manner, facilitate a reduction in urban congestion and contribute to the environmental enhancement of the city and region;
- As part of the scheme, provide a 'strategic Park and Ride' for motorists who currently travel to the City Centre from the N22; and
- Design a modern and attractive light rail system which is accessible to all users, and which integrates appropriately into the existing urban fabric and character of the city.

Study Area

At the commencement of the study a relevant Study Area was defined so all the feasible route options for the Proposed Scheme could be identified and assessed and all the potential benefits and impacts of the route options could be analysed. Due to the size of the overall Study Area (42.1 km^2), for assessment purposes, the Study Area for the Proposed Scheme has been broken down into 3 sub-areas as shown in figure 3 below.

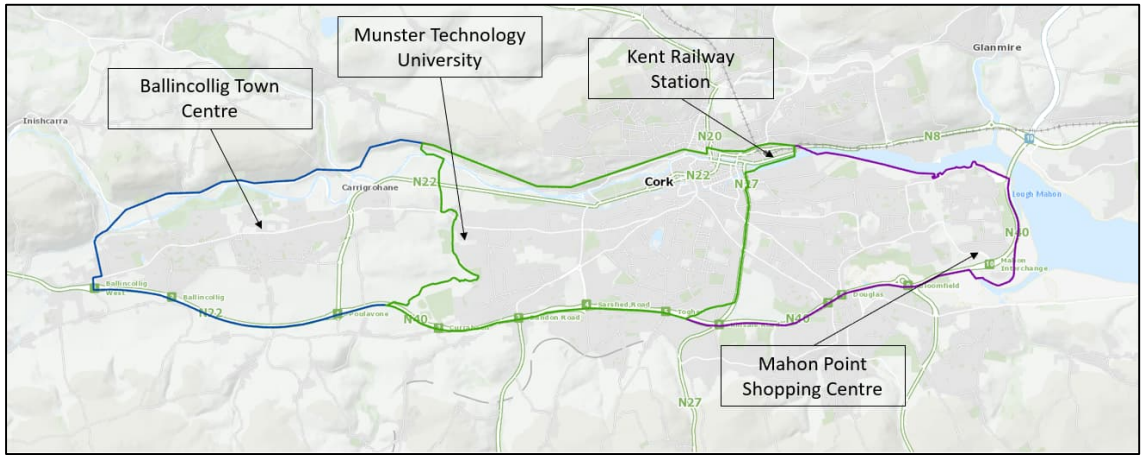


Figure 3 Study Area (and sub areas) for the Option Selection Study

Three Step Process

Once the Projects Aims and Objectives were agreed and the Study Area defined the next steps of the process was broken into three Steps, Step A – C, to logically assess and refine the potential sections and options to determine the EPR. These are as follows:

- Step A: Spider Web Preliminary Assessment;
- Step B: Area Option Multi-Criteria Analysis (MCA); and
- Step C: End-to-End (ETE) Route Option MCA (to identify EPR).

The elements that each of the three steps comprise of are shown in figure 4.

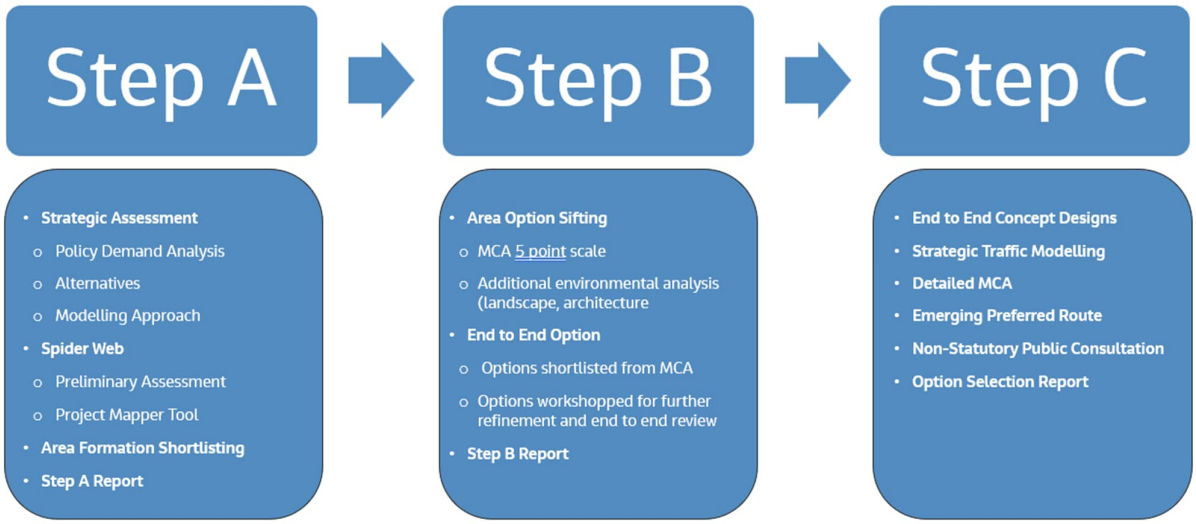


Figure 4 Three Step process, and components

Step A Spider Web, Preliminary Assessment, and Area Formation Shortlisting

The aim of the Step A Spider Web process was to identify all feasible and practicable route sections within each sub-study area, that may meet the objectives of the proposed scheme. Route sections were identified based on roads and streets of consistent typology, land use or width or function, as well as potential for segregated running at opportunity sites and green field areas.

The feasibility of the route sections was reviewed individually in the context of transport planning, engineering (physical constraints), and environment. This allowed identification of the long list of Area Options for further screening at Step B (Area Option Screening using MCA).

In total 294 route sections were assessed during step A. Of these, 181 route sections across the three sub areas were brought forward to Area Formation Shortlisting. The first step in the Area formation process was to determine geometrically feasible area options for each Study Area. This process was based on a high-level assessment and assessment of the LRT design standards, such as minimum radii and longitudinal gradients.

In addition to the geometrically feasible area options being assessed on their individual merits against the scheme objectives, in some instances, area options were also screened relative to each other, allowing some area options to be ruled out if similar, more suitable alternatives existed. For example, if one area option served some key trip attractors or defined areas of demand more directly with better network legibility compared to an option that served the same trip attractors less directly it was reasonable to rule out this latter option based on this comparative assessment.

Finally, consideration was also given to the interaction of options between Study Area sections to ensure that all suitable connections between Study Areas were considered prior to the Step B Area Option MCA Stage.

The conclusion of Step A resulted in 14 options being brought forward in Study Area 3, 10 options from Study Area 1, and 15 options from Study Area 2.

Step B Multi Criteria Analysis (MCA)

Step B comprised a more detailed qualitative and quantitative assessment, using criteria established to compare area options in each Study Area. As with the Step A there was a need to be flexible at this stage so not to unduly rule out potential options solely on physical and environmental constraints. A flowchart highlighted the key tasks and decision points undertaken during Step B is shown in figure 5.

Figure 5 Flowchart of key decision points during Step B.

For the area options identified, an initial design for these was developed to a sufficient level of detail to support a robust assessment of the area options prior to a more detailed development of shortlisted options. The level of detail included horizontal simplified alignment drawings (only straight sections and curves, no transition curves) to a scale which allowed high-level impacts and overall footprint areas of stops to be determined.

An appreciation of constraints and opportunities within each Study Area as well as the defined project objectives, informed the establishment of project-specific route options assessment criteria. These were tailored to have commonality to the 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport (DOT), March 2016 (updated October 2020).

The Step B Area Option assessment was carried out with the adoption of a Multi Criteria Analysis (MCA), undertaken in line with the CAF criteria. The assessment was of a comparative nature (options compared against each other), founded on professional judgement and expertise in respect of the items to be qualitatively evaluated, and comprehensively assessed the key relevant criteria in accordance with good industry practice.

The analysis compared the relevant area options, identifying and summarising the comparative merits and disadvantages of each alternative under all the applicable criteria and sub-criteria. Following the Step B Area Options MCA process the best performing Area Options were combined to create a 12 End-to-End (ETE) option short-list for final assessment in Step C. Where certain Area Options did not have a corresponding Area Option in the adjacent sub-area these options were excluded from further consideration.

Step C Assessment of ETE Route Options

The Step C assessment of the short-list of 12 ETE Route Options identified as part of Step B was carried out with the adoption of a detailed MCA, undertaken in line with the CAF criteria. The Step C assessment methodology followed the same overall approach as Step B. A comparative assessment was undertaken for each ETE Route option, where in general, for each positively scored ETE Route Option there should be an opposing negatively scored option. The comparison of ETE Route Options was informed by the baseline receiving environment, the significance of the environmental receptor to be impacted (i.e. legislative protection afforded to it) and the characteristics of the potential impacts during both the construction and operational phases where feasible at this stage in the process.

Each of the 12 ETE Route Options was scored on a comparative five-point scale. For reference, this five-point scale was coloured coded, with ETE Route Options showing significant advantages over other routes graded "dark green", significant disadvantages over other routes graded "red", and "orange" and "light green" being adopted for "some" disadvantages/advantages. Options that have similar environmental impact are assigned a scoring of comparable. A degree of professional judgement was used as part of the assessment taking into consideration the comparative likely potential impact and the significance value of the environmental factor to be impacted. The summary outcome of this assessment is presented in Chapter 10.

Emerging Preferred Route

As outlined in the approach and methodology process for Luas Cork the key output was the determination of the EPR. That is, the route which, based on evidence and assessment, presented the best opportunity to meet the Proposed Schemes objectives.

Following the outcomes of the Step C MCA, and a subsequent City Centre Alignment Study, the conclusion was that ETE Route Option 8, which follows St Patrick Street through the city centre section, should form the EPR for Luas Cork.

ETE Route Option 8 provides a comparably direct route between the western extents of the scheme at Ballincollig to the eastern extents in Mahon. Of the six CAF Criteria assessed, Option 8 scored best or equal best in the following sub-criteria:

- Economy – BCR;
- Economy – Patronage;
- Integration – Land Use Policy, Residential Population & Employment Catchments
- Integration – Rail Integration;
- Integration – Traffic Network Integration;
- Integration – Active Modes;
- Accessibility & Social Inclusion – Key Trip Attractors;
- Safety – Road Safety (segregation);
- Safety – Cycling & Pedestrian segregation & priority; and
- Physical Activity – Cycle Facilities available.

In addition to comparatively assessing the ETE options we also analysed and outlined the performance of the EPR against the high-level objectives for Luas Cork, established at the outset of the study. Table 1 summarises this EPR performance against the scheme objectives.

Table 1 Scheme objectives and EPR Performance

Objectives	EPR response to Objective
Deliver high quality public transport and journey time reliability to cater for existing and future public transport travel increased demand within the city and its suburbs.	The EPR alignment delivers a largely segregated, high quality, reliable service, particularly through the city centre sections, providing a more direct route to the docklands and Mahon, lending well to Journey time reliability for Luas Cork.
Support the continued important economic development of the Cork Metropolitan Area, futureproofing for NPF growth and beyond, in a cost-efficient manner	The EPR brings additional resilience to the transport network, allowing for future growth, with the ability to cater for current and future demand. The EPR will also catalyse important economic regeneration across Cork City.
Facilitate connection to key trip attractors and support public transport network integration by providing high quality passenger interchange points	The selected alignment will serve a high number of major city trip attractors, such as Ballincollig, Munster Technology University, Cork University Hospital, Cork City Centre and Mahon. The EPR for Luas Cork has been closely coordinated with the proposed BusConnects scheme, to minimise operational conflicts and provide public transport network integration.
Plan, construct and operate in an environmentally sustainable manner, facilitate a reduction in urban congestion and contribute to the environmental enhancement of the city and region.	Robust Environmental appraisal and Transport Modelling considerations have been used to select the EPR, while at points minimising the network impacts when compared to other options.
As part of the scheme, provide a 'strategic Park and Ride' for motorists who currently travel to the City Centre from the N22	The Proposed Scheme will provide a strategic park & ride with a capacity of 1,000 spaces adjacent to the Link Rd on the outskirts of Ballincollig adjacent to the N22. A future transport mobility hub will also be provide at Mahon.
Design a modern and attractive light rail system which is accessible to all users, and which integrates appropriately into the existing urban fabric and character of the city.	The EPR for the Proposed Scheme utilises a range of cross sections to mitigate impacts on existing street links as well design for full priority on off-line sections. The links that will be integrated with Luas Cork, will also benefit from improved public realm and accessibility for all.

Conclusion

At the close of this study, it has been determined that ETE Route Option 8 is the EPR for Luas Cork. This corridor is anticipated to deliver best against the six CAF criteria and objectives of Luas Cork in tandem with presenting a deliverable solution for Luas Cork and BusConnects Cork to form an integrated transport network.

Next Steps

With the completion of the Luas Cork Options Selection Report, the Proposed Scheme will move into the next phase, which will primarily focus on a Non-Statutory Public Consultation (NSPC) on the EPR. Based on the

feedback received on the EPR during this round of consultation any changes or amendments which are appropriate will be incorporated to determine the Preferred Route (PR), which will undergo a second round of NSPC.

1 Introduction and Background

1.1 Background

Jacobs Engineering Ireland Ltd. (Jacobs) was commissioned by Transport Infrastructure Ireland (TII) to undertake an Alignment Options and Feasibility Study to determine the Emerging Preferred Route (EPR) for a new Light Rail Transit Scheme in Cork (Cork LRT) as included in the Cork Metropolitan Area Transport Strategy (CMATS).

The design and planning of Luas Cork (also referred to as the Proposed Scheme) is being undertaken by TII in collaboration with the National Transport Authority (NTA) and Cork City Council. The design and planning of the Proposed Scheme has been developed with full adherence to the following documents:

- National Transport Authority – Cost Management Guidelines for Public Transport Investment Projects (1 September 2020);
- National Transport Authority – Project Management Guidelines (December 2011);
- Department of Transport, Common Appraisal Framework for Transport Projects and Programmes (March 2016, updated October 2021); and
- Department of Public Expenditure and Reform – Public Spending Code (December 2019).

Luas Cork is the proposed Cork LRT scheme which consists of a west-east mass light rail, rapid transport corridor, running from the Ballincollig area, in the west, to Mahon Point, in the east of Cork City. The Proposed Scheme has been a long-term objective for the Cork Metropolitan Area (CMA) articulated by the joint Cork Area Strategic Plan (CASP), the Cork City Centre Movement Strategy and given effect by the Cork City and County Developments Plans as primary policy documents.

A commitment to study the feasibility of this corridor and system was confirmed by the publication of both the Project Ireland 2040 National Planning Framework (NPF) and the National Development Plan (NDP) 2021-2030. The NPF envisages that Cork will become the fastest growing city region in Ireland with a projected 50% to 60% increase in its population by 2040. This projected population and associated economic growth will result in a significant increase in the demand for travel. The CMATS 2040 was developed by the NTA, in collaboration with TII, Cork City Council and Cork County Council (CCC). CMATS represent a co-ordinated land use and transportation strategy to cover the period up to 2040.

CMATS provides a coherent transport planning policy framework and implementation plan around which other agencies involved in land use planning, environmental protection, and delivery of other infrastructure such as housing and water can align their investment priorities.

CMATS will deliver an integrated transport network that addresses the needs of all modes of transport, offering better transport choices, resulting in better overall network performance and providing capacity to meet travel demand and hence support economic growth.

In line with CMATS, it is envisaged that investment in LRT will occur alongside a high frequency bus service (BusConnects) and Active Travel infrastructure (cycling and walking) to deliver an integrated transport network for the Cork Metropolitan Area.

It is envisaged that the Proposed Scheme may be preceded by a high-frequency bus service between Mahon and Ballincollig, which will be delivered to underpin higher development densities along the corridor including the long-awaited regeneration of the Cork City Docks.

The Proposed Scheme will provide a high-capacity, high-frequency and reliable public transport link from the Eastern to the Western suburbs of Cork. It will serve a large number of significant destinations, including

Ballincollig, Munster Technology University (MTU), Cork University Hospital (CUH), University College Cork (UCC), Cork City Centre, Cork South Docklands/Kent Station, Blackrock, Pairc UI Chaoimh and Mahon. It is intended that the Proposed Scheme will commence construction post 2030.

1.2 Overview of Approach

The Strategic Assessment Report (SAR) developed in-line with Public Spending Code policy, at the outset of the project sets out the investment rationale and strategic alignment of the Proposed Scheme with Government policy. It identified the study objectives, initial consideration of options and alternatives, the transport modelling and appraisal processes and an identification of risks. The SAR was critical for early scrutiny of objectives and examined the rationale for potential policy interventions to ensure that potential projects and programmes fit with Government policy, in particular the Project Ireland 2040 NPF and NDP 2021-2030.

The SAR also set out the problem definition and investment rationale for the Proposed Scheme, as well as the Appraisal Plan for the scheme going forward. Upon completion of the SAR, work commenced on the Alignment Options Selection Study for the Proposed Scheme.

The approach and methodology developed for this study is outlined in detail in chapter 2 of this report. The conclusion of the study identifies the EPR for the Proposed Scheme.

Once the EPR for the Proposed Scheme has been identified, Stage 2 commences with the first round of Non-Statutory Public Consultation (NSPC) on the EPR. Based on the feedback received on the EPR during this round of consultation any changes or amendments which are appropriate are incorporated to determine the EPR. To conclude Stage 2, a second round of Public Consultation will be undertaken based on the EPR and shall include the rationale for any updates to the EPR.

Stage 3 incorporates the steps required to carry out the concept design development of the EPR, the development of the cost estimate for the Preferred Route (PR) and the production of the Preliminary Appraisal Report (PAR) for the PR.

Table 1.1 outlines the three stages of the Alignment Options and Feasibility study.

Table 1.1: Overview of the three Stages of the Alignment Options and Feasibility Study

Stage 1	**Option Selection Process (current stage of Proposed Scheme)** 1) The SAR developed in accordance with the requirements of the Public Spending Code (2019); 2) All relevant data collection undertaken, with supporting research, studies and assessments to support a robust and comprehensive options selection process leading to the identification of an EPR for the Proposed Scheme; 3) Development of a comprehensive and robust Cork Alignment Options and Feasibility Study for the Proposed Scheme; assessed from Step A to Step C to deliver an EPR. Within this process all feasible and practicable route options were identified; 4) Concept designs for relevant options developed, leading to identification of a range of end-to-end options to deliver an optimal LRT scheme linking the suburbs of Ballincollig and Mahon Point to Cork City Centre and Kent Station; 5) A preliminary Environmental Assessment undertaken to ensure significant impacts could be avoided of all end-to-end options; and 6) Production of a comprehensive Alignment Options and Feasibility Study report which concludes with the identification of the EPR to be brought forward for NSPC.

Stage 2	**Non-Statutory Public Consultation** • NSPC one on the EPR; and • NSPC two on the Preferred route (PR).
Stage 3	**Preferred Route (PR) Concept Design and Appraisal** 1. Concept Design Development for the Preferred Route, including Environmental Assessment; 2. Preparation of a Feasibility Working Cost Estimate for the Preferred Route; and 3. Production of an NTA 'Stage 2' Project Appraisal Report to build upon the various studies, surveys and modelling undertaken within the various sections of Multi Criteria Analysis (MCA) undertaken at Stage 1.

1.3 Study Area

At the commencement of the study a relevant Study Area was defined so all the feasible route options for the Proposed Scheme could be identified and assessed, and all the potential benefits and impacts of the route options could be analysed. Due to the size of the overall Study Area (42.1 km^2), for assessment purposes, the Study Area for the Proposed Scheme has been broken down into 3 sub-areas. The Study Area and associated sub-areas are shown in Figure 1.1 and outlined as follows:

- Sub-Area 1 - City Centre: Sub-Area 1 is approximately 15.2km^2 and extends from Munster Technology University to Kent Station. The Proposed Scheme will serve the key attractors in the City Centre, including but not limited to Cork University Hospital, University College Cork (UCC), Cork City Centre, terminating in close proximity to Kent Station. The corridor in this area is approximately 7km long; and;
- Sub-Area 2 - Cork Eastern Area: Sub-Area 2 is approximately 11.9km^2 and takes in the Cork Eastern Area – including the south docklands - and extends from the South Docks/Kent Station to Mahon Point. The corridor in this area is approximately 5km long; and
- Sub-Area 3 - Cork Western Area: Sub-Area 3 is approximately 15.0km^2 and takes in the Cork Western Area and extends from the N22 in the Ballincollig area to Munster Technology University. The corridor in this area is approximately 6km long.

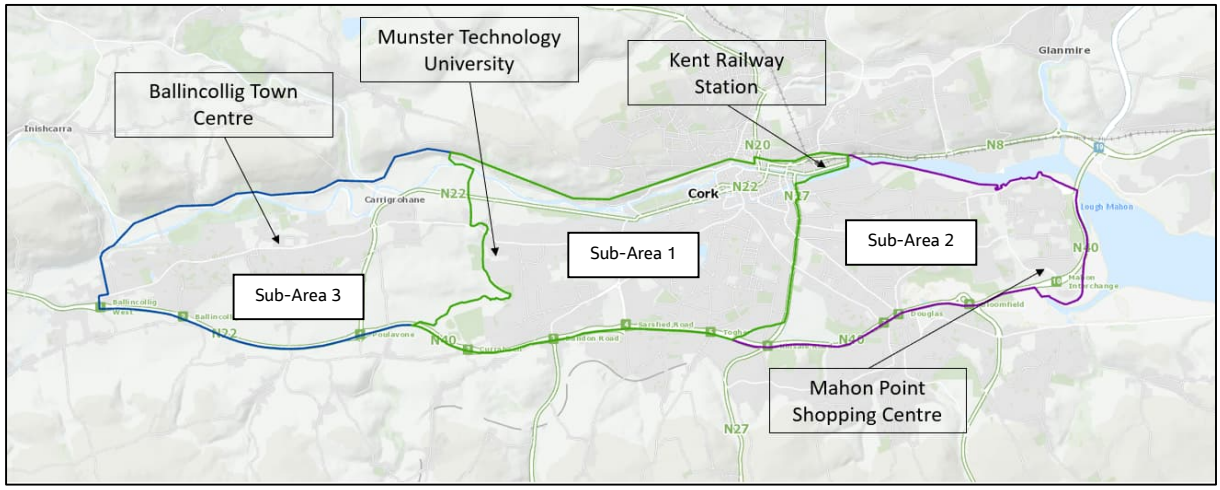


Figure 1.1: Study Area (and sub areas) for the Proposed Scheme

1.4 Need for the Proposed Scheme and High-Level Objectives

The need for the Proposed Scheme is wide ranging, aligning with policy at all levels, catering for current and immediate transport supply and demand deficit, enabling the sustainable growth of Cork City by catering for compact growth and development consolidation and supporting the reduction in transport related carbon emissions.

The need for the Proposed Scheme is supported by policy at an international, national, regional and local level. Key policies such as the 2030 Agenda for Sustainable Development, the Trans-European Transport Network (TEN-T) Policy NPF, NDP, Southwest Regional Spatial and Economic Strategy (RSES), Climate Action Plan 2023 (CAP23), and Cork Metropolitan Area Transport Strategy (CMATS) all align with the need to provide an east-west LRT system for Cork.

The over-reliance on private cars is a key challenge in delivering sustainable transport for Cork, which results in the current low public transport mode share. Current public transport network deficiencies compound these challenges reducing the reliability of sustainable transport to the advantage of the private car. Luas Cork will offer an attractive alternative to the private car for cross-city connections, supported by some rebalancing of the existing capacity levels for the private car across the network.

The delivery of the NPF 2040 target growth levels for Cork is fundamentally underpinned by compact and sustainable growth, with, in particular, the proposed City Docklands Regeneration identified as a key enabler. The provision of an east-west mass transit system will provide a sustainable means by which to cater for the movement of the existing and future population within Cork. The provision of the Proposed Scheme will provide a much more sustainable and fuel-efficient transport mode in comparison to cars because of the capability to transport more passengers in a more efficient and reliable manner, resulting in fewer carbon emissions.

The following outlines the high-level objectives for the Proposed Scheme Alignment Options and Feasibility Study:

- Deliver high quality public transport and journey time reliability to cater for existing and future public transport travel demand within the city and its suburbs;
- Support the continued economic development of the Cork Metropolitan Area, futureproofing for NPF growth and beyond, in a cost-efficient manner;

- Facilitate connection to key trip attractors and support public transport network integration by providing high quality passenger interchange points;
- Plan, construct and operate in an environmentally sustainable manner, facilitate a reduction in urban congestion and contribute to the environmental enhancement of the city and region;
- As part of the scheme, identify a 'strategic Park and Ride' for motorists who currently travel to the City Centre from the N22; and
- Design a modern and attractive light rail system which is accessible to all users, and which integrates appropriately into the existing urban fabric and character of the city.

1.5 Report Structure

This Alignment Options and Feasibility Study is presented as follows:

- Executive Summary and Emerging Preferred Route;
- Introduction and Background;
- Policy and Key Legislation;
- Approach and Methodology;
- Step A – Overview and Outcomes;
- Step B – Overview and Outcome;
- Step C – Overview:
    - End to End Options Development;
    - Traffic Modelling;
    - Multi-Criteria Analysis (MCA) of End-to-End Options; and
    - EPR.
- Project Appraisal Balance Sheet; and
- Conclusion and next Steps.

2 Policy and Key Legislation

2.1 Overview

This chapter sets out the Options Study's strategic alignment with policy at all levels; international, national, regional and local. It provides a comprehensive overview of policy, guidance and studies relevant to the Proposed Scheme. Table 2.1 provides a summary of these documents. European and National Level policy documents are summarised within Volume 7: Planning and Key Legislation of this OSR.

Table 2.1: Overview of Policy Hierarchy for the Proposed Scheme

International Level
• 2030 Agenda for Sustainable Development
European Level (outlined in Volume 7)
• European Union (EU) Transport White Paper • EU Green Deal • Sustainable and Smart Mobility Strategy 2020 • TEN-T
National Level (outlined in Volume 7)
• National Planning Framework Project Ireland 2040 • National Development Plan 2021 – 2030 • Climate Action Plan 2021 (CAP21) and Climate Action Plan 2023 (CAP23) • The Sustainable Development Goals National Implementation Plan • Smarter Travel – A Sustainable Transport Future • National Sustainable Mobility Policy • DoT Statement of Strategy • Investing in Our Transport Future – Strategic Investment Framework for Investment in Land Transport • National Investment Framework for Transport Infrastructure (NIFTI) • TII Sustainable Implementation Plan: Our Future (2021) • TII Climate Adaptation Strategy 2022 • TII Climate Action Roadmap 2022
Regional Level
• Regional Spatial and Economic Strategy for the Southern Region (RSES) 2020 • Cork Metropolitan Area Transport Strategy 2040 (CMATS) • Metropolitan Area Strategic Plan (MASP) *(outlined in Volume 7)*
Local Level
• Cork County Development Plan 2022 – 2028 • Cork City Development Plan 2022 – 2028 • Cork City Centre Movement Strategy *(outlined in Volume 7)* • Draft Cork City Docks Area Based Transport Assessment 2018

2.2 International Level

2.2.1 2030 Agenda for Sustainable Development

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future.

The United Nations ("UN") has published 17 sustainable development goals, illustrated in Figure 2.1, that consider sustainability in its widest perspective. These sustainable development goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges humankind faces,

including poverty, inequality, climate change, environmental degradation. Peace and justice must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth – all while tackling climate change and working to preserve our land and marine ecosystems. The UN Sustainable Development Goals have in turn, been reflected and considered in the NDP 2021-2030 and in the development of Ireland's National Strategic Outcomes (NSOs).

The NPF published in June 2018, is the Government's strategic framework to guide development and investment to enhance the wellbeing and quality of life of Irish people. There is significant alignment between the UN Sustainable Development Goals (SDGs) and strategic outcomes from the NPF Project Ireland 2040.

Figure 2.1: United Nations Sustainable Development Goals
(Reproduced from https://www.un.org/sustainabledevelopment/)

The Proposed Scheme identifies eight key strategic goals which align with the SDGs. The Proposed Scheme objectives were mapped against the UN SDGs to understand material impacts of the Proposed Scheme and its sustainability. The eight sustainability goals of the project are:

- Distributing sustainable growth throughout Cork;
- Providing a resilient transport solution will adapt to a growing city;
- Drive the transition to low carbon transport;
- Reduce Greenhouse Gas Emissions (GHG) emissions to address global climate change;
- Integrate into and enhance the surrounding environment;
- Support a cleaner, quieter environment;
- Enhance accessible transport networks; and
- Encourage collaboration and participation.

The SDGs are embedded into the aims of the Proposed Scheme. The approach to Sustainability is an over-arching issue and it cannot be addressed within one assessment criteria (e.g. Environment) and must be considered within all assessment criteria. Sustainability is at the core of the Proposed Scheme and this section

will outline how sustainability and its context with international and national sustainability measures are addressed. The Proposed Scheme aims to align with all 17 of the SDGs, but those which are particularly relevant to the development of the Proposed Scheme, and how they will be achieved, are as follows:

GOAL 3: Good Health and Well-being: Ensuring healthy lives and promoting well-being for all is essential to sustainable development. The Proposed Scheme aims to improve access to health care and amenities to all people within the Study Area. The Proposed Scheme aims to improve sustainable and active travel. Human health has been assessed through topics such as air quality, noise and vibration, water quality, and others. As the Proposed Scheme development progresses, further assessment to identify the positive and negative impacts to health, and mitigation measures, will be provided as required;

Goal 5: Gender Equality: Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world. A gender lens will be applied to the design of the Proposed Scheme, providing a more complex understanding of mobility in Cork city and the surrounds.

Goal 7: Affordable and Clean Energy. Achieving energy and climate goals will require continued policy support and a massive mobilization of public and private capital for clean and renewable energy. Renewable Energy may be available to provide the energy requirements for the Proposed Scheme.

GOAL 8: Decent Work and Economic Growth. Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs. The Proposed Scheme will be important in facilitating access to employment and amenities for all people in the Study Area and in the wider strategic network;

GOAL 9: Industry, Innovation and Infrastructure: Investment in infrastructure is crucial to achieving development. The Proposed Scheme ensures the most appropriate use of investment funds by ensuring the most practical option with the greatest benefits for all is brought forward;

GOAL 11: Sustainable Cities and Communities: A future in which cities provide opportunities for all, with access to basic services, energy, housing, transportation and more is vital. The Proposed Scheme aims to reduce inequalities and improve accessibility for all people within the Study Area in relation to access to health care, employment, amenities etc.

GOAL 12: Responsible Consumption and Production: In order to ensure development is sustainable, consumption and production of materials need to be responsible. As the design of the Proposed Scheme progresses, consideration will be given to the material usage, the circular economy, the minimisation of waste, to ensure the Proposed Scheme is as sustainable as possible;

GOAL 13: Climate Action: Climate change is a global challenge that affects everyone, everywhere. The Proposed Scheme aims to minimise GHG as far as reasonably practicable, promote sustainable and active travel, support mitigation of the potential impacts of the Proposed Scheme on climate change. It aims to ensure the future adaptability of the Proposed Scheme to the localised impacts of climate change as Cork City moves towards becoming one of Europe's first climate neutral cities;

GOAL 15: Life on Land: Seeks to Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss. The Proposed Scheme aims to ensure that terrestrial habitats in the Study Area are protected whenever possible, and that opportunities are sought to enhance or restore;

GOAL 17: Partnerships for the Goals: Revitalise the global partnership for sustainable development. Partnerships across government departments, the private sector and the public will be required to ensure the success of the Proposed Scheme.

A well-designed transport system that is integrated into land-use planning generates important economic, environmental, and societal benefits. Effective and efficient public transport provides people with mobility and access to employment, community resources, medical care, and recreational opportunities.

The Proposed Scheme will provide significant benefits not only to those who choose to use it, but also to other transport system users, by reducing the demand for scarce road space, and so creates the opportunity for the road transport system to achieve optimum levels of efficiency and effectiveness.

The incorporation of the Proposed Scheme into broader economic and land-use planning will also help the community to expand business opportunities and create a sense of community through integrated transport and land-use development. For these reasons, the areas along the alignment of the EPR for the Proposed Scheme will offer positive advantages to businesses and individuals working or living nearby.

2.3 Regional Level

2.3.1 Regional Spatial & Economic Strategy for the Southern Region (RSES) 2020

Cork City lies within the Southern Region, one of three regions in Ireland. The RSES supports the implementation of the NPF, providing key principles for environmental, economic and social development of the region. Regional Planning Objectives (RPO) and the RSES was finalised by the Southern Regional Assembly in January 2020.

The RSES provides a broad, strategic framework for development of the Southern Region up to 2026 and 2031 to accommodate the additional 340,000 to 380,000 people and 225,000 jobs by 2040 envisaged by the NPF. To ensure the delivery of sustainable regeneration and compact growth, the RSES recognises that significant infrastructure led growth and investment across different agencies will be required to make sustainable travel more viable.

The RSES follows the NPF NSOs including Compact growth, Enhanced Regional Accessibility, Sustainable Mobility, and Sustainable Planned and Infrastructure led development. Cork is recognised as one of the three cities in the region providing the focus to drive the development of the region. The role of transport is highlighted in the 'Transport Vision for the Southern Region' which sets out a number of objectives including:

- To provide for the integrated development of sustainable transport infrastructure, including walking, cycling (including emerging e-modes) and public transport to accommodate the necessary switch from private car, for the travel needs of all individuals in the region, in line with the stated government transport policy to support improved strategic and local connectivity;
- To expand attractive public transport and other alternatives to car transport;
- To provide reliable and resilient connectivity to international and local markets; and
- To provide for the safe and most efficient movement of people and goods.

A number of principles are set out to inform the integration of land use and transport planning in the region which include:

- Supporting compact and smart growth through the achievement of mutual consistency between land use and transport planning investment, and service provision;
- Strengthening intra-regional connectivity between metropolitan areas and large towns, and within large towns to improve public transport services and reliable journey times;
- Protecting the strategic capacity and safety of the Region's transport network; and
- Meeting the safe travel requirements of all people irrespective of age or mobility and transport mode.

Section 6.3.6.3 of the RSES sets out the transport priorities for the Cork Metropolitan Area which makes specific reference to transport investment being identified and prioritised through the Cork Metropolitan Area Transport Strategy (CMATS) (p176).

The RSES's Transport Strategy states that there is evidence of an overreliance on the private car for travel to work and education, with approximately 14% of the Region's population travelling to work/education by green modes in 2016 – lower than the State average (17%) (CSO, 2016). The RSES recognises the challenge it must address in relation to reducing car dependency and achieving a modal shift.

Section 6.3.6.3 of the RSES sets out the following transport investment objectives for the CMA relevant to this Study:

- Development of an enhanced metropolitan area-wide public transport system, including:
- A high-capacity public transport corridor providing for long-term growth on an east-west axis.

A Metropolitan Area Strategic Plan was also developed specifically for the Cork Metropolitan Area (CMA) as part of the RSES and is included in Volume 2.

The Proposed Scheme is aligned with the aspirations and transport objectives of the RSES as it will form part of an enhanced public transport system and improve the accessibility of Cork City Centre and suburbs.

2.3.2 Cork Metropolitan Area Transport Strategy 2040 (CMATS)

The Cork Metropolitan Area Transport Strategy 2040 (CMATS) was finalised and published in February 2020 and is a key policy document for the Proposed Scheme. The CMATS presents a coordinated land use and transport strategy for the CMA, setting out a framework for the planning and delivery of transport infrastructure and services to support the sustainable development of the City region up to 2040, in line with the Project Ireland 2040 NPF and the RSES. The CMATS set out proposals for:

- **Walking**: Ensure that the pedestrian environment is significantly enhanced, more attractive and safer than at present;
- **Cycling**: Develop a comprehensive network of safe primary, secondary, inter-urban and Greenway cycling routes;
- **BusConnects**: Prioritise the early delivery of BusConnects services that will deliver an efficient, frequent and reliable bus network enabling interchange with rail, light rail, and Park and Ride;
- **Suburban Rail**: Improve existing suburban rail network to support better integration with land use and public transport. Provide for: through running at Kent Station, eight new rail stations, integrated timetable and network between Mallow, Middleton and Cobh;
- **LRT**: Development of an east-west mass transit, rapid transit corridor in the form of LRT;
- **Roads and Streets**: Maintain, renew, manage and operate the existing road infrastructure. Provide for multi-modal travel on new roads, increasing liveability and place-making functions of the urban street network;
- **Parking Management:** Provide a guidance on the provision and viability of Park and Ride, Local Mobility Hubs, Parking Management, On and Off-street parking and levels of parking provision needed for new developments in the City; and

- **Supporting Measures:** To promote the delivery of sustainable transport projects across the City to 2027, providing network resilience and additional travel options to compliment higher frequency and higher quality public transport offering.

2.4 Local Level

2.4.1 Cork County Development Plan 2022-2028

The Cork County Development Plan 2022-2028 (CCDP) is an important document assisting in the economic recovery and sustainable growth of the county, enhancing the attractiveness of the county as a place in which to live, work, invest and enjoy; and supporting national policy and legislation in an integrated manner. One of the key placemaking principles of the CCDP for placemaking include ease of movement: '*To promote accessibility and local permeability by making places that connect with each other and are easy to move through, putting people before traffic and integrating land uses and transport*'. (p.71).

The CCDP promotes the Cork MASP as the primary driver for growth in the Cork and its metropolitan areas, seeking to regenerate and develop as an international City and Metropolitan Area. The CCDP contains policy objective TM12-1, *'support the delivery of the Cork Metropolitan Area Strategic Plan'* (p.19). The Cork MASP reinforces the relationship between the city centre, metropolitan area and wider region as complementary locations, each fulfilling strong roles to create quality placemaking at the core and is fully supported by objective CS2-3, specifically part D: *'Within the Cork Metropolitan Area, and most notably along the existing rail corridor, plan for development to provide the homes and jobs that are necessary to serve the long term planned population prioritised in the following locations, Midleton, Carrigtwohill, Cobh and Little Island'*. (p.49)

Objective TM12-7: CMATS supports the implementation of the Cork MATS.

Objective CS 2-7 states: '*Critical population growth, service and employment centres within the Cork Metropolitan Area, providing high levels of community facilities and amenities with infrastructure capacity high quality and integrated public transport connections should be the location of choice for most people especially those with an urban employment focus*'. (p. 54)

The Plan sets out a strategic vision based on nine strategic objectives for Cork driving local and regional growth, embracing diversity and inclusiveness and growing as a resilient, healthy, age-friendly and sustainable compact city.

These strategic Objectives align with the United Nations Sustainable Development Goals and the NSOs of the NPF. Those most relevant to the Proposed Scheme include:

- SO3 – Transport & Mobility: Integrate land-use and transportation planning to increase active travel (walking and cycling) and public transport usage. Enable the key transport projects in the Cork Metropolitan Area Transport Strategy (CMATS) delivering multi-modal usage and smart mobility, accessible for all; and
- SO4 – Climate & Environment: Transition to a low-carbon and climate resilient society. Implement climate mitigation and adaptation measures that reduce our carbon footprint including sustainable energy consumption, sustainable transport, circular economy, green construction and flood risk mitigation and adaptation.

The Proposed Scheme aligns with the objectives set out in the development plan by creating a more attractive city whilst enhancing facilities for pedestrians and cyclists and prioritising public transport, helping to shift towards a more sustainable mode of transport and combat climate change.

2.4.2 Cork City Development Plan 2022-2028

The Cork City Development Plan was adopted in August 2022 representing an important step in the evolution of the strategic planning for Cork City. The Cork City Development Plan sets a framework to achieve the ambition of Cork City against the following core principles:

- Sustainable Development;
- Health;
- Compact Growth;
- Creation of liveable Communities & Places; and
- Climate Resilience and complimenting Nature.

The Cork City Development Plan provides a strategic vision for Cork City to be a world class city that drives both local and regional growth based on the following key strategic principles:

- Compact Growth: 'Integrate land-use and transport planning to achieve a compact city with 50% of all new homes delivered within the existing built-up footprint of the City on regenerated brownfield, infill and greenfield sites identified in the Core Strategy, to achieve higher population densities aligned with strategic infrastructure delivery.';
- A City of Neighbourhoods and Communities: 'Develop a sustainable, liveable city of neighbourhoods and communities based on the 15-minute city concept, ensuring that placemaking, accessibility and safety is at the heart of all development.';
- Sustainable and Active Travel: 'To implement the Cork Metropolitan Area Transport Study (CMATS) and develop a transformed sustainable transport system with a significant shift toward walking, cycling and public transport and to enshrine this principle in all developments across the City.';
- Enhanced Built and Natural Heritage: 'Protect, enhance, support and develop our built and natural heritage, our open spaces and parks, and our green and blue infrastructure, and expand our built heritage with new buildings, townscapes and public spaces achieved through the highest standards of architecture and urban design.';
- A strong and diverse economy: 'Support Cork City's role as the economic driver for the region and the creation of a strong, resilient, diverse and innovative economy.';
- A resilient city: 'Contribute to a framework for the transition to a low-carbon and climate-resilient City, resilient to extreme weather events, pandemics, economic cycles and other potential shocks.';
- A healthy, inclusive and diverse city: 'Build on Cork City's status as a World Health Organisation designated Healthy City, offering an inclusive and vibrant environment for all whilst promoting healthy living and wellbeing.';
- A connected city: 'Cork City will continue to be a highly connected city providing local, regional, national and international connectivity.'; and
- A city of learning and culture: 'To build on Cork's designation as a United Nations Educational, Scientific and Cultural Organisation (UNESCO) Learning City and the city's rich cultural heritage and to foster learning, culture, heritage and the arts throughout the City.'

The Cork City Development Plan supports the ambitious 2040 growth targets of Cork City through long term strategic planning and proactive land management to sustain investment and growth, whilst also tackling climate change and protecting the city's natural and heritage environment. With the projected growth of Cork City, the Cork City Development Plan states the need for this growth to be supported by an integrated transport system (p. 106) linking existing modes with future schemes such as BusConnects and development of a Light Rail System (the Proposed Scheme).

2.4.3 Draft Cork City Docks Area Based Transport Assessment (2018)

The development of the City Docks transport network was undertaken to align with future land use for the City Docks and the wider CMA to ensure close integration of land use and transport proposals.

- The vision is for walking and cycling to be the primary modes of choice within the City Docks. Pedestrian and Cycle Priority Streets will provide strategic north-south movements through the City Docks and act as a network of quiet ways for pedestrians and cyclists. The Greenway Routes along the North and South quays will facilitate strategic east-west movements;
- BusConnects Cork will provide a significant step-change in public transport connectivity with destinations across the CMA. Transit-Oriented Development will play a critical role in enabling low-carbon development, by creating walkable neighbourhoods focused around public transport stops and stations;
- A new LRT corridor will bisect the South Docks through Centre Park Road and includes new stops that cover the catchment area of the entire City Docks. The highest intensity of land uses will be around the LRT stops;
- Three new City Docks Bridges will provide multi-modal connectivity between the North and South Docks, and Tivoli Docks; and
- Kent Station will be the epicentre of activity in the North Docks and will play a significantly increased role as a multi-modal interchange hub with the LRT corridor, the enhanced Cork Suburban Rail Network, InterCity services and BusConnects services.

2.5 Integration of Sustainability throughout this Report

Table 2.2 illustrates how sustainability, including the key elements from the policy documents above has been addressed throughout this Cork Alignment Options and Feasibility Study. Further design development pertaining to impact, materials, sustainable drainage, landscape and boundary treatments will continue to be advanced and applied as the Proposed Scheme progresses to the next phase of the Proposed Scheme (Phase 3 Design and Environmental Evaluation) and will be assessed appropriately and proportionately at that time. This is in-line with legislative requirements and national and international guidance.

Table 2.2: Sustainability within this Report

Sustainability Aspect	Scope and Relevance	Section of this Report
Change of Land Use	Loss of land and habitats valuable as carbon sinks have been avoided where possible through effective routing of options. Land important to communities, public health and wellbeing, Biodiversity-Flora and Fauna, Soils, Geology and Groundwater, Hydrology and Flood Risk, Landscape and Visual and Archaeology, Architecture and Cultural Heritage, and the local economy have also been considered in the assessment.	• Volume 6 – Part A Environmental Appraisal Report: Population and Human; Biodiversity-Flora and Fauna; Soil, Geology and Groundwater; Hydrology and Flood Risk; Air Quality & Climate; Noise; Landscape and Visual and Archaeology; Architecture and Cultural Heritage.

Sustainability Aspect	Scope and Relevance	Section of this Report
Human Health	The positive and negative impact on human health as a result of changes in air quality and noise levels, landscape and views, impacts on local businesses and the community, have been considered. Active travel considerations have also been integrated into the Proposed Scheme.	• Volume 6 – Part A Environmental Appraisal Report: Population and Human Health, Noise, Landscape & Visual, Air Quality & Climate, Hydrology and Flood Risk. • Volume 1 – Main Report: Physical Activity Appraisal and Safety Appraisal.
Community Involvement	Community engagement is vital to developing the option which works best for the whole community. Public Consultation will be undertaken with landowners and local people, with Disabled Persons Organisations (DPOs), with local environmental groups and with other relevant stakeholders to ensure they are fully informed and to gain important feedback.	• Volume 1 – Main Report: Non-Statutory Public Consultations. • Volume 6 – Part A Environmental Appraisal Report: Human Health, Noise, Landscape & Visual, Air Quality & Climate and Archaeology, Architecture and Cultural Heritage.
Economy	Investment funds should be used in the most efficient and effective way considering willingness-to-pay of the consumer, the financial impact on transport providers and the effects on government finance. An Option Comparison Estimate and a Cost Benefit Analysis has been conducted for the Route Corridor Options.	• Volume 1 – Main Report: Economic Appraisal
Public Transport and Traffic Management Alternatives and Options	Alternatives were identified and considered in line with the modal hierarchy set out under the NIFTI whereby Public Transport is considered before private vehicle use. Both Public Transport Alternatives and Traffic Management Alternatives were considered. The development and assessment of ETE Route Corridor Options was determined to be the most effective way of achieving the Proposed Scheme Objectives.	• Volume 1 – Main Report: Consideration of Alternatives and Options
Accessibility and Social Inclusion	Transport investments should benefit the whole community, including those in Deprived Geographical Areas and Vulnerable Groups.	• Volume 1 – Main Report: Accessibility and Social Inclusion Appraisal
Integration with transport	Investments should integrate with transport and planning policy to ensure new developments integrate with the existing system, transport modes and infrastructure, as well as existing and proposed land-use. Investments should promote growth and equality regionally and across Ireland and improve connectivity within Ireland and Europe and other parts of the world.	• Volume 1 – Main Report: Integration Appraisal • Volume 6 – Part A Environmental Appraisal Report: Population and Human Health, Landscape & Visual; Archaeology, Architecture and Cultural Heritage.
Sustainable Mobility / Active Travel	Creating provisions for sustainable mobility and active travel will contribute towards improved human health and low-carbon travel.	• Volume 1 – Main Report: Physical Activity Appraisal • Volume 6 – Part A Environmental Appraisal Report: Population and Human Health; Biodiversity-Flora and Fauna; Soil, Geology and Groundwater; Hydrology and Flood Risk; Air Quality & Climate; Noise; Landscape and Visual and Archaeology; Architecture and Cultural Heritage.

2.6 Consideration of Alternative Public Transport Modes

As part of the development of the SAR undertaken in Stage 1 of the Cork Alignment Options and Feasibility Study a comparative analysis of the alternative public transport provisions for the east-west corridor were considered to ensure that the preferred public transport mode meets the requirements of the Common Appraisal Framework – 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport (DOT), March 2016 (updated October 2020) –

and the high-level objectives of the Proposed Scheme. The public transport alternatives considered included the following:

- Option 1: Bus Services;
- Option 2: Bus Rapid Transit;
- Option 3: LRT;
- Option 4: Suburban Rail; and
- Option 5: Metro.

To identify the preferred public transport mode a high-level Multi Criteria Analysis (MCA) of the alternative public transport modes that could accommodate the forecast demand on the strategic East-West Corridor was undertaken. The public transport options identified were then assessed relative to each other.

The analysis concluded that based on the forecast demand along the proposed east-west corridor is commensurate with that of an LRT system, and comparable to recent Luas demand levels. On this basis a LRT system was identified as the recommended public transport mode to meet the Proposed Scheme objectives.

3 Approach and Methodology

3.1 Methodology Overview

This chapter sets out the Stage 1 methodology to undertake the option selection process for the Proposed Scheme. It sets out a seven-step process that aligns with the Public Spending Code (PSC), Common Appraisal Framework (CAF) for transport projects and NTA Project Management Guidelines (PMG).

It was critical for successful delivery to identify all the major opportunities and constraints early, to provide confidence and surety that the appropriate option would be identified; provide evidence that all reasonable alternatives were examined; to justify the acquisition of public/private land and document all data that informed the decision to gain buy-in from all the key stakeholders including the public.

Figure 3.1 outlines the overall process which was undertaken through Step A-C for the Proposed Scheme to identify an EPR. Beginning with the Strategic Assessment Report, the processes followed a logical assessment and refinement of options. Following the identification of the EPR, the Proposed Scheme will progress to Stage 2 which will include a NSPC.

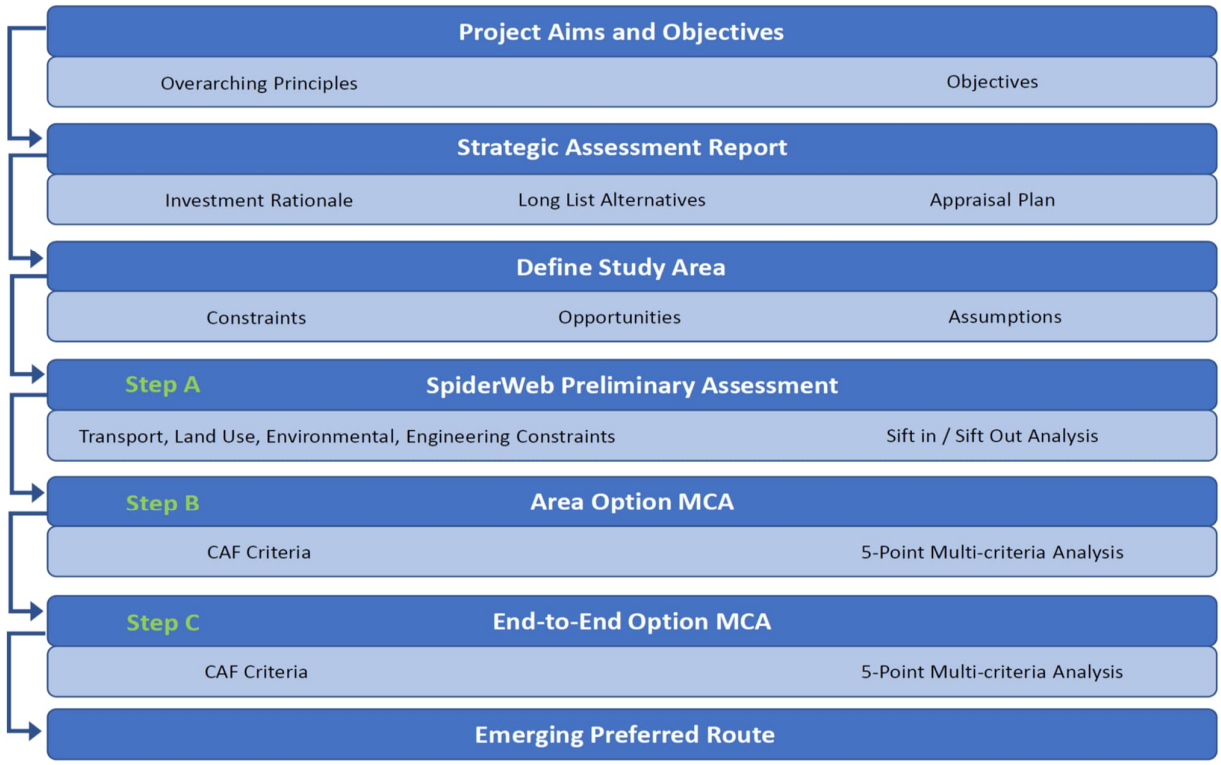
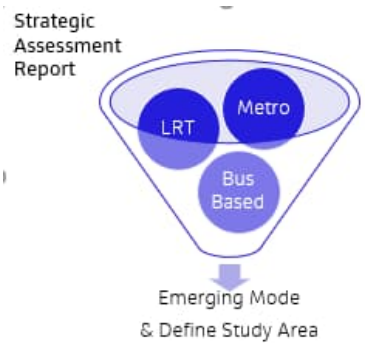
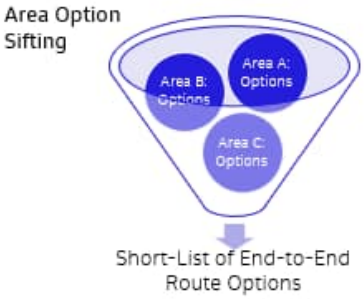
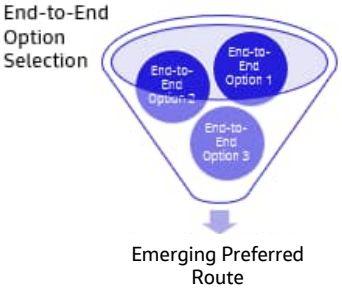


Figure 3.1: Stage 1 Option Selection Methodology

Table 3.1 outlines the refining and sifting process relative to each step of the Proposed Scheme during the Options Assessment and Feasibility Study for Luas Cork.

Table 3.1: Sifting Process

Strategic Assessment Report		• Investment rationale / Problem Definition • Policy Alignment • Demand Analysis • High level CAF review of long-list of alternative modes
Step A		Preliminary Assessment based on: • Environment; • Engineering; and • Transport Planning and Land Use. Approach needs to be flexible enough to allow for inclusion of mitigation or alternatives to dual track where constraints impede but land use may require service.
Step B		MCA in line with CAF: • Economy; • Integration; • Environment; • Accessibility and Social Inclusion; • Safety; and • Physical Activity (Screened out) Apply 5-point scoring system for sub-criteria.
Step C		MCA in line with CAF: • Economy; • Integration; • Environment; • Accessibility and Social Inclusion; • Safety; and • Physical Activity. Apply a 5-point scoring system for sub-criteria.

3.2 Proposed Scheme Aims and High-Level Objectives

Clearly specified aim, objectives and desired outcomes were required at the outset. A clear statement of the Proposed Scheme aims, and high-level objectives is the fundamental platform from which to appraise potential options and, should a proposal proceed, a key input to the process of planning, delivering, and reviewing the investment. The high-level objectives should be "SMART": Specific, Measurable, Attributable, Realistic, and Time-bound. The objectives should also frame the assessing of options, by being evidenced-based, recognising problems, constraints, opportunities, and policy direction.

The high-level objectives for the Proposed Scheme are included in Section 1.4 and restated as follows:

- Deliver high quality public transport and journey time reliability to cater for existing and future public transport travel demand within the city and its suburbs;
- Support the continued economic development of the Cork Metropolitan Area, futureproofing for NPF growth and beyond, in a cost-efficient manner;
- Facilitate connection to key trip attractors and support public transport network integration by providing high quality passenger interchange points;
- Plan, construct and operate in an environmentally sustainable manner, facilitate a reduction in urban congestion and contribute to the environmental enhancement of the city and region;
- As part of the scheme, provide a 'strategic Park and Ride' for motorists who currently travel to the City Centre from the N22; and
- Design a modern and attractive light rail system which is accessible to all users, and which integrates appropriately into the existing urban fabric and character of the city.

3.3 Strategic Assessment Report

The SAR was an important stage gate and is outlined as part of the PSC. The SAR was critical for early scrutiny of the objectives, consideration of options and identification of risks.

This stage critically examined the specific problem to be addressed. The SAR formed an important element of the bridge between the policy and the Proposed Scheme. In addition, the SAR examined the rationale for potential policy interventions and ensured the strategic fit of potential projects and programmes with government policy, in particular the Project Ireland 2040 NPF and NDP 2018-2027.

Within the SAR, a long list of Alternative Modes was considered and assessed, supported by the high-level demand analysis and alternative mode option selection undertaken with CMATS and supported by policy at all levels. The SAR identified the appropriate transport mode to be delivered and informed the Study Area definition and the long list of scheme route alignment options considered. The SAR set out the problem definition and investment rationale for the Proposed Scheme, as well as the Appraisal Plan for the scheme going forward.

3.4 Option Selection

The aims and objectives of the Proposed Scheme have been clearly defined. Additionally, the appropriate mode as part of the SAR and the Study Area and associated opportunities and constraints have been identified.

The Options Selection approach was based on three defined streps, as follows:

- Step A: Spider Web Options Identification Process and Preliminary Assessment;

- Step B: Area Option Screening using MCA; and
- Step C: End-to-End Option Selection using MCA.

3.4.1 Option Selection – Step A: Spider Web and Preliminary Assessment

Commencing with the Spider Web, the feasibility of specific sections of potential LRT routes in the context of transport planning, engineering (physical constraints), and environment was reviewed. This allowed identification of the long list of Area Options for further screening at Step B (Area Option Screening using MCA).

The aim of the Spider Web process was to identify all feasible and practicable route sections within each sub-study area, that may meet the objectives of the scheme. Route sections were identified based on roads and streets of consistent typology, land use or width or function, as well as potential for segregated running at opportunity sites and green field areas.

The route sections were then assessed based on a high-level qualitative assessment to determine which sections would be considered in the formation of area options.

The need to be flexible at this stage and not to unduly rule out potential options (and potential mitigation) solely on physical or environmental constraints was critical, and as such the consideration of the land use, transport planning and the need to service the section in question are the most prominent at this stage.

While a segregated dual track arrangement is generally the preferred solution, compromises to this were considered where engineering/physical and environmental constraints could not be overcome, and where land use, transport planning requirements necessitated.

The process of developing the long list included workshops with technical and environmental specialists. At this point in the process, it was important to avoid 'picking winners' or embedding biases. While some options were ruled out, it was important that the long list be made up of a wide range of potential solutions to demonstrate fully that all options have been considered.

3.4.1.1 Area Options Formation

Having established potential sections within each Study Area that might be brought forward for further consideration, geometrically feasible area options were determined for each Study Area. These geometrically feasible area options were based on a high-level assessment and assessment of the LRT design standards.

The first step in identifying the area options was by combining the sections that were brought forward from the Spiders Web/Preliminary assessment. Once the area options were identified, indicative stop locations along each area option were determined based on the analysis undertaken with respect to Transport Planning and Land Use at the Spiders Web/Preliminary Assessment.

An assessment of the initial geometrically feasible area options ruled out area options which clearly did not meet the Proposed Scheme Objectives. In particular, consideration was given to potential demand (existing and future) based on indicative stop locations, proximity to key trip attractors, integration with existing and future Public Transport and the directness of routes. As with the section's assessment carried out as part of the Spiders web/preliminary assessment, consideration was also given to the environmental constraints with constraints avoided where possible.

In addition to the geometrically feasible area options assessed on their individual merits against the objectives, in some instances, area options were also screened relative to each other, allowing some area options to be ruled out if similar, more suitable alternatives existed. For example, if one area option served some key trip attractors or defined areas of demand more directly with better network legibility compared to

an option that served the same trip attractors less directly it was reasonable to rule out this latter option based on this comparative assessment.

Finally, consideration was also given to the interaction of options between Study Area sections to ensure that all suitable connections between Study Areas were considered at the Step B Area Option MCA Stage.

3.4.2 Option Selection – Step B: Area Option MCA

Following the completion of the Step A Spiders Web identification and Preliminary Assessment, the Area Assessment Options which emerged were progressed to the Step B Area Option MCA process. This stage comprised a more detailed qualitative and quantitative assessment, using criteria outlined in Section 3.5 to compare area options in each Study Area. As with the Step A there was a need to be flexible at this stage so not to unduly rule out potential options solely on physical and environmental constraints.

3.4.2.1 Initial Design

For the area options identified, an initial design for these was developed to a sufficient level of detail to support a robust assessment of the area options prior to a more detailed development of shortlisted options. The level of detail included horizontal simplified alignment drawings (only straight sections and curves, no transition curves) to a scale which allowed high-level impacts and overall footprint areas of stops to be determined. The high-level design was in accordance with TII's light rail alignment design standards and clearances, Design Manual for Urban Roads and Streets and applicable railway safety and road safety standards and regulations.

3.4.2.2 Methodology

The 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport (DOT), March 2016 (updated October 2020), requires schemes to undergo a MCA under the following criteria:

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

An appreciation of constraints and opportunities within each Study Area as well as the defined project objectives, informed the establishment of project-specific route options assessment criteria. These were tailored to have commonality to the CAF guidelines where practical.

The Step B Area Option assessment was carried out with the adoption of a MCA, undertaken in line with the CAF criteria. The assessment was of a comparative nature (options compared against each other), founded on professional judgement and expertise in respect of the items to be qualitatively evaluated, and that comprehensively assessed the key relevant criteria in accordance with good industry practice.

The assessment compared the relevant area options, identifying and summarising the comparative merits and disadvantages of each alternative under all the applicable criteria and sub-criteria. The following sub-criteria as identified in Table 3.2 were determined to carry out the comparative MCA. The sub-criteria were also established such that they also aligned with the measurable elements of the objectives.

Physical activity was not considered at this stage of the comparative MCA as it is not considered to represent significant enough differentiator based on the level of design carried out at this stage of the assessment process. It was more appropriate to consider this criteria at step C with more design detail regarding stops, and its associated facilities such as cycle parking and the integration with existing or proposed cycling infrastructure in proximity to the route.

Table 3.2: Step B: Area Option MCA CAF Criteria and Sub-Criteria

Assessment Criteria	Assessment Sub-Criteria	Approach
1. Economy	1.a. Option Cost Estimate	Direct and indirect costs – high level cost estimate, level of detail will be equivalent for each area option
	1.b. Transport Reliability	Qualitative Assessment to assess transport service reliability. Based on level of segregation
	1.c. Journey Time	Assessment of indicative journey times for each area option including dwell times at stops etc
	1.d. Catchment Transport Demand	Geographical Information Systems (GIS) Analysis – 500m and 1km Catchment Analysis – Population and employment per km
2. Integration	2.a. Land Use Policy Integration	Compatibility with existing and future land use
	2.b. Public Transport Integration	Compatibility with existing and future PT network
	2.c. Integration with Other Modes	Compatibility with existing walking, cycling, and traffic
3. Accessibility & Social Inclusion	3.a. Key Trip Attractors	Ability to serve key trip attractors
	3.b. Deprived Geographic Areas (social inclusion)	GIS analysis to Pobal, Central Statistics Office (CSO)
4. Environment	4.a. Material and Cultural Aspects (Archaeology, Architectural and Cultural Heritage)	Based on comparative (quantitative and qualitative) assessment of direct impacts and their likely effects
	4.b Biodiversity	Comparative assessment based on the data collections in relation to biodiversity
	4.c Landscape and Visual	Comparative assessment based on the data collection in relation to landscape and visual
	4.d. Population	Comparative assessment based on the data collection across the areas and locations of importance to people and communities
5. Safety	5.a. Road interfaces	Level of segregation, Interface with roads/junctions, collision data

Following the Step B Area Options MCA process the best performing Area Options were combined to create an End-to-End option short-list. Where certain Area Options did not have a corresponding Area Option in the adjacent sub-area these options were excluded from further consideration.

Table 3.3 outlines the MCA colour coding scoring system applied. The assessment was based on a qualitative five-point scale, generally ranging from delivering significantly better results than the other options, to delivering significantly lower results than the other options.

For illustrative purposes, this five-point scale is colour coded as presented below, with options showing significant advantages over other routes graded "dark green", significant disadvantages over other routes graded "red", and orange and light green being adopted for "some" disadvantages/advantages and yellow being used for options which deliver comparable results to all other options.

The assessment was based on the rule that if only one option is assessed as better than all the other options on a criteria, then that option will be assessed as green (or dark green) and all other similar options were assessed as orange or red.

Table 3.3: Step B MCA Scoring System

Description	Colour
Significant disadvantages over other options	
Some disadvantages over other options	
Comparable to other options	
Some advantages over other options	
Significant advantages over other options	

3.5 Assessment Criteria

This section outlines in more detail the methodology that was used for both the primary and secondary/sub-criteria during the Step B Area option MCA.

3.5.1 Economy (1)

3.5.1.1 Option Cost Estimate (1.a.)

The Option Cost Estimate criteria estimated the summation of the following costs, noting that this is used for comparative purposes only and did not represent an overall scheme cost:

Direct Costs which included the following:

- Indicative scheme infrastructure works cost;
- Land acquisition costs; and
- Major utility diversion costs.

Indirect Costs which included the following:

- Overhead costs; and
- Insurance costs.

It should be noted that these Direct and Indirect Costs represent high-level feasibility working cost estimates, recognising that the level of engineering detail (initial design) for each area option at this stage was limited in terms of engineering design and as a consequence, that all of the other costs were also high-level estimates. An equivalent level of detail was prepared for each assessment option to ensure an equitable comparison of Option Cost Estimates for assessment options.

3.5.1.2 Transport Reliability (1.b.)

The transport reliability criteria assessed the Area Options in terms of the degree to which transport service reliability was likely to be achieved on the Proposed Scheme.

Transport reliability was linked to the level of segregation of the area option and the number of junctions it crosses. If the service is fully segregated, full transport reliability can be achieved.

However, transport reliability was compromised if the service was not fully segregated from other modes (e.g. at-grade running through junctions would necessitate interaction with other road users and has the potential to impact on journey time).

3.5.1.3 Journey Time (1.c.)

This criteria estimated and compared the extent to which journey time savings, and therefore associated economic benefits could be achieved on and between Area Options.

A run time model which took into consideration the following parameters, specific for each area option was utilised:

- Total length of the area option;
- Length of the segregated off-road track;
- Length of the segregated on-street track;
- Length of the shared track with traffic;
- Length of congested shared track sections;
- Number of curves below 35m in segregated sections;
- Number of curves below 60m in segregated sections;
- Number of stops;
- Number of minor junctions; and
- Number of major junctions.

Dwell times of 30seconds at all stops and stop-and-go at all junctions were considered, with minor junctions having been assigned 5 seconds and major junctions 20 seconds average time loss.

3.5.1.4 Stop Catchment Transport Demand (1.d.)

An assessment of transport demand associated with potential Stops identified along Assessment Options was undertaken based on catchment analysis undertaken using GIS. The transport demand of each Area Option is influenced by:

- Stop location;
- Stop catchment (i.e. potential patronage at each station); and
- The number of stops provided on an Area Option.

The effectiveness of any option was determined in large part by the extent to which it could attract passengers and thus deliver benefits to users. Indicator of potential demand per kilometre was used to assess the relative economic efficiency of the area options. Potential demand was estimated via accessibility analysis

overlaid with population and employment numbers derived from Census 2016 datasets, for 500m and 1,000m walking distances.

This was assessed by considering the stops associated with each network option and the accessible walking catchment areas (500m and 1,000m distances) from same, within ArcGIS Network Analyst and was informed by accessibility isochrones, and not buffers, taking into account severance and issues of permeability. The total catchment population per route kilometre (including actual population and employment numbers) served by each option was thus calculated, giving an overall indicator.

3.5.2 Integration (2)

3.5.2.1 Land Use Policy Integration (2.a.)

The Land-use integration criteria identified the extent to which an Area Option would encourage or support existing and established land uses, whilst also supporting planned development and providing for urban regeneration, urban consolidation, and housing, employment, economic and recreation opportunities. This criteria also provided an assessment of the potential for travel demand and patronage on the Proposed Scheme from zoned lands subject to longer term development.

3.5.2.2 Public Transport Integration (2.b.)

This criteria identified the extent to which Area Options have the potential to contribute towards maximising wider public transport usage and reach in terms of facilitating efficient interchange between transport routes and modes.

3.5.2.3 Integration with Other Modes (2.c.)

This criteria identified the extent to which Area Options would integrate with modes other than public transport, namely active modes (being pedestrians and cyclists) and private vehicles. Factors considered under this criteria included:

- Integration with pedestrian/cycle network;
- Reduction in road network capacity (e.g. resulting in reduced traffic lanes or junction capacity); and/or
- Rerouting of traffic.

3.5.3 Accessibility and Social Inclusion (3)

For the step B MCA this criteria was focused on transport accessibility to the wider area.

3.5.3.1 Key Trip Attractors (3.a.)

This criteria assessed the proximity of potential stop locations and improved accessibility identified along Area Options to key trip attractors, such as:

- Education (universities and schools);
- Commercial centres (shopping centres, town centres);
- Healthcare (hospitals);
- Leisure (sport stadiums, theatres, cinemas) etc.; and
- Employment (business parks, large office developments etc.).

3.5.3.2 Deprived Geographic Areas (3.b.)

The possible impact of the Area Options on deprived geographic areas including RAPID (Revitalising Areas by Planning, Investment and Development) areas and HP Deprivation Index were investigated.

RAPID is a focused Government initiative to target the most disadvantaged urban areas and provincial towns in the country and seeks to improve the lives of the residents of its communities through among other things, improving the delivery of public services through integration and coordination.

The Pobal HP Deprivation Index is a method of measuring the relative affluence or disadvantage of a particular geographical area using various datasets from the 2016 census. For the purpose of this assessment, the HP Deprivation Index was examined by small area to determine which Assessment Options served deprived areas.

3.5.4 Environment (4)

The 'Environment' criteria considered the following sub-criteria: Material and Cultural Aspects (Archaeology, Architectural Heritage and Cultural Heritage), Biodiversity, Landscape and Visual Impact Assessment (LVIA), and Population and Human Health.

The Step B Area options MCA was a comparative assessment of the area options. The area options at Step B were designed to determine the route options feasibility and to ensure they met with the Proposed Scheme objectives. The level of design information available directly informed, but also limited, the level of environmental appraisal that was undertaken. The design and assessment becomes more detailed as the Proposed Scheme design evolves, culminating in an Environmental Impact Assessment Report (EIAR).

The Environmental sub-criteria considered at Step B Area Options MCA was established by reviewing the environmental constraints for each of the environmental sub-criteria. A comparative assessment was undertaken of the route options across the study area to determine the potential impact to the Proposed Scheme.

The aim of the environmental assessment was to determine which route options were considered to have environmental advantages or disadvantages compared to other route options.

Following the review and assessment of the routes against the environmental sub-criteria, an overall comparative assessment outcome was provided for each area option. The overall assessment outcome was not an averaging of the outcomes of the individual sub-criteria but took into account the scale of the potential effects and their significance using professional judgement. The significance of the disadvantages and the sensitivity of the receptors was taken into account.

3.5.5 Safety (5)

3.5.5.1 Road Interfaces

In order to assess the safety criteria associated with each of the area options, the following three parameters have been considered:

1. Potential level of segregation: This parameter will be considered based on the evidence that segregated and off-street sections of the current Luas network are proven to be less prone to road traffic accidents and are therefore safer through the reduction of interferences, including with pedestrians and cyclists; and
2. Number of minor and major road junctions: A large majority of road traffic accidents occur at road junctions; a Luas corridor with a limited number of road junctions is therefore considered to be safer.

3.6 Area Options Summary

For each study area section, an area route options summary table was prepared which collates and summarises the appraisal of route options under each of the assessment criteria. The route options summary table for each study area section will be contained within an Appendix with the emerging assessment summary table for each study area section presented in the main report.

For each individual assessment criteria considered, Area Options have been relatively compared against each other based on a five-point scale as outlined above, ranging from having significant advantages to having significant disadvantages over other Area Options.

At the end of each study area options assessment, an overall summary Step B Multi Criteria Appraisal (MCA) table was provided, bringing together each of the individual sub-criteria assessments under the main assessment criteria as set out in Table 3.2.

A qualitative appraisal of, and conclusions from, area options assessment was then provided, highlighting the key issues considered in determining recommended area options ('preferred' and in some instances, where applicable 'next preferred').

It should be noted that a balanced approach was taken when assessing the preferred routes. All criteria were considered in undertaking the assessment and a lower ranking on one criteria, for example, did not necessarily mean that the route was not suitable. The recommended route options from each study area section were collated to provide ETE Route Options which were taken forward to Step C MCA.

3.6.1 Option Selection – Step C: End-to-End Option Selection

The following section sets out the design development process, assessment and MCA. The Step C assessment of the short-list of ETE Route Options was carried out with the adoption of a more detailed MCA, again undertaken in line with the CAF criteria. The assessment was of a comparative nature), founded on professional judgement in respect of the items to be qualitatively evaluated, and that comprehensively assessed the key relevant criteria. The assessment compared the relevant options, identifying and summarising the comparative merits and disadvantages of each alternative under all the applicable criteria and sub-criteria. The sub-criteria also aligned with the measurable elements of the objectives.

The Step C assessment methodology follows the same overall approach as Step B. For each positively scored ETE Route Option there should be an opposing negatively scored option. Figure 3.2 provides an overview of the comparative colour coded scale for assessing the criteria and sub-criteria.

Comparative Multi Criteria Assessment The assessment is based on the rule that if only one option is assessed as better than all the other options on a criterion, then that option will be assessed as green (or dark green) and all other similar options will be assessed as orange or red.	
Significant disadvantages over other options	5
Some disadvantages over other options	4
Comparable to other options	3
Some advantages over other options	2
Significant advantages over other options	1

Figure 3.2: Route criteria and sub-criteria comparative colour coded ranking scale

Each of the 12 ETE Route Options are scored on a five-point scale. For reference, this five-point scale has been coloured coded, with ETE Route Options showing significant advantages over other routes graded "dark green", significant disadvantages over other routes graded "red"; and orange and light green being adopted for "some" disadvantages/advantages. Options that have similar impact are assigned a scoring of comparable.

A key component of the Step C MCA process was the transport demand and economic assessment of route alignment options using the NTA's South West Regional Model (SWRM). Each End-to-End option was coded in the SWRM and outputs were taken into consideration and used to determine such indicators as:

- Transport Benefits (travel time savings, travel cost savings and environmental benefits);
- Passenger boardings and alightings;
- Level of interchange with other public transport services;
- Mode share impacts;
- Volume of trips to key attractors; and
- Road impacts (e.g. V/C at key junctions).

Additionally, the appraisal tool modules for the NTA's regional modelling suite is capable of providing outputs specifically aligned with the CAF criteria, such as Cost Benefit Analysis (CBA), Environmental and Accessibility assessments. These were used to help quantify and quality the impacts of each option assessed.

3.6.1.1 Approach Overview

As outlined above, the best performing area route options from each study area section were collated to generate 'End-to-End' (whole) route options and taken forward for Step C ETE MCA. Each whole route option was subjected to further concept design development at Step C (from initial design at area options stage) in order to provide an additional level of detail in terms of engineering feasibility, likely Option Cost Estimate to deliver the scheme and to inform the assessment of potential environmental impact.

3.6.1.2 Concept Design

Concept Designs were developed for each ETE Route Option, with full horizontal track alignment drawings (centre line only with constant offsets to determine lateral clearances) at a scale of 1:1000, and associated road design (new or modified roads) in plan only. A single set of 1:1000 General Arrangement drawings describing track, road, stops, main architectural features, electricity sub-stations and land-take were also produced for each option (Volume 2: Drawings - Part A – ETE Route Option Drawings of this report).

3.6.1.3 Transport Modelling

The ETE Route Options and associated stop locations were coded into the SWRM, with the benefits accruing from each of the route options and key outputs then being assessed and inputted to the Step C End-to-End MCA process.

The Step C End-to-End MCA assessment compared the ETE Route Options, identifying and summarising the comparative merits and disadvantages of each alternative under all the applicable criteria and sub-criteria. The following assessment criteria and sub-criteria as identified in Table 3.4 were determined to carry out the comparative MCA. The sub-criteria were established to align with the measurable elements of the objectives.

Table 3.4: End-to-End MCA Assessment Criteria and Sub-Criteria

Assessment Criteria	Assessment Sub-Criteria	Approach
1. Economy	1.a Benefit Cost Ratio (TUBA, Capex and O&M costs)	Comparative cost benefit analysis for each End-to-End option.
	1.b Patronage (outputs from SWRM)	Passenger demand figures from model runs.
	1.c Journey Time	Assessment of indicative journey times for each End-to-End option including dwell times at stops etc.
2. Integration	2.a. Land Use Policy, Residential Population and Employment Catchments	Integration with existing residential, educational & leisure uses in this established area.
	2.b. Bus Network Integration	24h modelled transfers between LRT and Bus.
	2.c. Rail Integration	24h modelled transfers between LRT and Rail.
	2.d Traffic Network Integration	Sum of road traffic (2035 AM peak hour) at junctions on the LRT alignment.
	2.e Active Modes (cyclists Pedestrians including vulnerable walkers)	Compatibility with existing walking, cycling, and traffic.
3. Accessibility & Social Inclusion	3.a. Key Trip Attractors	Ability to serve key trip attractors.
	3.b. Deprived Geographic Areas (social inclusion)	Deprivation Index from Pobal deprivation index, based on 2016 Census Data.
4. Environment	4.a. Population and Human Health	Comparative assessment based on the data collection for population and human health to include a review of sensitive receptors on the corridor; 51eveso sites; radiation and stray currents.
	4.b Biodiversity	Comparative assessment based on the data collection/review, site walkovers in relation to biodiversity, to include a review of designated sites & other protected sites, habitats, treelines, birds, mammals, bats and potential new habitats.
	4c. Soils, Geology & Groundwater	Comparative assessment based on the data collection/review for soils, geology and groundwater to include a review of the contaminated land, soil resources assessment to include soil sealing, soil compaction, soil erosion, organic matter.
	4d. Hydrology and Flood Risk	Comparative assessment based on the data collection/review for hydrology; water quality; hydromorphology; designated sites and flood risk.
	4e. Air Quality and Climate	Comparative assessment of the ETE Route Options for air quality included a review of sensitive receptors along the corridor for the construction and operational phases of the Proposed Scheme. Comparative assessment of the ETE Route Options for climate involved a review of the latest EPA GHG emissions data and a review of ETE Route Options for the construction and operational phases.
	4f. Noise & Vibration	Comparative assessment of the ETE Route Options for noise & vibration. To include a review of noise sensitive receptors, vibration sensitive receptors and impacts to sensitive land use/archaeological/cultural heritage receptors.

Assessment Criteria	Assessment Sub-Criteria	Approach
	4g. Landscape and Visual	Comparative summary assessment based on the Landscape walkovers and focussed on the key differences in the likely significant effects on the landscape character, designated landscapes as well as visual receptors between the options.
	4h. Archaeological, Architectural and Cultural Heritage	Comparative assessment of the ETE Route Options based on a review of data and the findings of Step B Archaeological, Architectural and Cultural Heritage report.
5. Safety	5a. Road interfaces	Percentage of the alignment fully segregated from other traffic.
	5b. Active Travel	Level of service in relation to cycle and pedestrian facilities and prioritisation at junctions -Segregation -On road
6. Physical Activity	6a. Infrastructure Upgrade	New infrastructure, is it a loss or gain? Overall benefit/disbenefit
	6b. Space Availability for Cycle Facilities	Number of Luas stops with expected space availability to support Luas Cycle + Ride

The following, Table 3.5 outlines the MCA colour coding scoring system was applied to Step C End-to-End MCA.

Table 3.5: MCA Scoring System

Description	Colour
Significant disadvantages over other options	
Some disadvantages over other options	
Comparable to other options	
Some advantages over other options	
Significant advantages over other options	

3.6.1.4 Assessment Criteria

A summary of the assessment criteria used in the Step 3 End-to-End MCA process is discussed below.

3.7 Economy

3.7.1 BCRs

The BCR criteria assessed the whole route options in terms of the extent to which the economic benefits of the route options are greater than the economic costs of providing the route options. The economic benefits of each ETE Route Options included travel time savings, vehicle operation costs, monetised benefits of reductions in pollutant emissions and monetised benefits of improved safety for the travelling public. The economic cost of the ETE Route Options included construction costs (including land acquisition) and operational and maintenance costs. All costs and benefits are discounted to net present values to reflect the profile of costs and benefits over time. A BCR of greater than 1:1 is an indicator that the benefits exceed the costs. Higher BCR values signify a better economic return on the investment.

The BCR ratios are used to compare combined options against one another and are not a scheme BCR. The costs on which the BCRs are based are indicative as noted below and are subject to further assessment.

3.7.1.1 Option Cost Estimate

The Option Cost Estimates of the ETE Route Options were considered under this criteria and represents more detailed cost estimates from what was considered in the Step B Area Options MCA. 'Option Cost Estimate' is a measure of the money required to construct the ETE Route Options, together with costs to operate and maintain over a specified period of time and is assessed as a criteria to give a measure of the actual expenditure required to realise the potential monetised benefits.

The Option Cost Estimate criteria was made up of a number of elements and quantified in a uniform table of rates (e.g. cost per linear metre of track / OHLE). These rates were applied to the elemental quantities so as to determine the approximate direct construction cost of each ETE Route Option.

The uniform rates were built up using cost data taken from available local and national market rate, historical cost data and other cost information sources where applicable.

These Direct and Indirect Costs were used for comparative purposes only, again recognising that the level of engineering detail (concept design) for each option at Step C is limited in terms of engineering design. An equivalent level of detail is prepared for each option to ensure an equitable comparison of costs. However, these costs are not representative of the total scheme cost and are subject to further assessment once the Preliminary Engineering Design has been developed.

3.7.2 Patronage

The patronage criteria assessed the ETE route option in terms of how many passengers they will attract, i.e. what level of patronage will be served by the route option. There are many factors that influence patronage on the route option, mainly stop location, competition or integration with other modes and other public transport services, connectivity to desired destinations and journey time. The NTA's South Western Regional Model (SWRM), which takes all the major influencing factors into account, was used to provide passenger boarding forecasts for each whole route option.

3.7.3 Journey Time

The 'Journey Time' criteria remains as that set out for Step B Area Options MCA. However, the additional level of detail in the design gives an opportunity for more accurate runtime simulations, for example Step C has more clarity on shared/segregated sections which have a significant bearing on commercial speed, as well as on junctions' priority.

3.8 Integration

3.8.1 Land Use Policy Integration

This criteria remains as that set out for Step B Area Option MCA, as presented in Section 3.5.2 but applied to each whole ETE Route Option.

3.8.2 Bus Network Integration

This sub-criteria assesses the extent that the Proposed Scheme is compatible with the bus network through the metric of 'modelled transfers'. The current bus network in the city centre provides many bus services for the greater Cork area and includes services along the majority of the Proposed Scheme alignments. The number of 24 hour transfers between the two modes was estimated through the models.

3.8.3 Rail Integration

This sub-criteria assesses the extent that the Proposed Scheme is compatible with the rail network through the metric of 'modelled transfers'. Rail Integration expresses modelled transfer between existing Rail and Luas Cork. The number of 24 hour transfers between the two modes was estimated through the models.

3.8.4 Traffic Network Integration

Traffic Network Integration expresses the sum of traffic during 2035 AM peak hour at junctions on the ETE Route Option alignments and the number of road traffic junctions on each alignment. The options comparison for the Traffic Network Integration criteria was estimated through models.

3.8.5 Active Modes

The Active modes (Cyclists, Pedestrians and vulnerable walkers) sub-criteria assesses compatibility with the existing walking and cycling network. The ETE Route Options retain the accessibility and functionality of the footways, and where possible would propose to enhance provision for both pedestrians and cyclists.

3.9 Accessibility and Social Inclusion

3.9.1 Key Trip Attractors and Social inclusion (Deprived Geographical Locations)

These criteria remain as that set out for Step B Area Option MCA, as presented in Section 3.5.3 but applied to each whole route. In addition, the outputs of the transport modelling were also taken into account during Step C.

3.10 Environment

Environmental Assessment is a process and includes information gathered throughout all planning and design phases of the Proposed Scheme. An EIAR will be prepared at the next phase of the Proposed Scheme and the assessment of alternatives to the Preferred ETE Route Option will be considered within it. This Option Selection Report and all associated information gathered during Step C of the Proposed Scheme will contribute to that. The environmental topics considered in this report are based on the topics that will be considered in the Environmental Impact Assessment. The EIA guidelines and principles and TII guidelines have been reviewed to ensure consistency throughout the various stages as far as reasonably practical.

There is no single definitive list of environmental topics for inclusion in an Environmental Impact Assessment process. The 2011 Environmental Impact Assessment Directive (2011/92/ EU, as amended by the 2014/52/EU Directive) as transposed into Irish law, outlines factors for inclusion in an Environmental Impact Assessment Report.

3.10.1 List of Environmental Topics

From a review of the existing environment, reviewed for the Step B MCA and at Step C MCA where design was further progressed, it is possible to categorise the natural and built environment into environmental factors that are consistent with the amended Environmental Impact Assessment (EIA) Directive (2011/92/ EU, as amended by the 2014/52/EU Directive) process and the CAF for Transport Projects and Programmes guidelines (CAF), providing consideration of the EPA guidelines and professional judgement.

The following environmental factors will be assessed for the Step C MCA:

- Population and Human Health;
- Biodiversity;

- Soils, Geology & Groundwater;
- Hydrology & Flood Risk;
- Air Quality and Climate;
- Noise and Vibration;
- Landscape & Visual; and
- Archaeological, Architectural and Cultural Heritage.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each. The comparison of ETE Route Options is informed by the baseline receiving environment, the significance of the environmental receptor to be impacted (e.g. legislative protection afforded to it) and the characteristics of the potential impacts and effects during both the construction and operational phases where feasible at this stage in the process. A degree of professional judgement is used as part of the assessment taking into consideration the comparative likely potential impact and the significant value of the factor to be impacted.

As well as being addressed in this Option Selection Report, these topics will also be included and addressed in more detail in the Environmental Impact Assessment Report which will be conducted during the next phase of the Proposed Scheme.

Each assessment chapter outlines the methodology that was completed, the relevant constraints and the findings of the option selection process that was followed. The findings within each assessment chapter are relevant to that chapter and form one part of the overall Option Selection Report process that was used to select the EPR Corridor.

Any Figures referenced in this document can be found in Volume 2: Drawings of this report.

3.10.2 Specialists and Sub-Consultants

Jacobs is the lead consultant for Environment throughout this process and has provided all environmental specialists.

3.11 Safety

3.11.1 Road Infrastructure

This sub-criteria remains as that set out for Step B Area Options MCA, as presented in Section 3.5.5, but applied to each whole route.

3.11.2 Active Travel

This additional sub-criteria sets out the level of segregation in relation to the new proposed cycle tracks associated with each of the new alignments.

3.12 Physical Activity

This criteria has been added to the Step C End-to-End MCA. The criteria assessed infrastructure and the cycle facilities at stops and space available for cycling provision along each route option.

3.13 Route Options Summary

As with the Step B Area Option MCA, for each End-to-End route option considered at Step C End-to-End MCA, a route options summary table was prepared which collated and summarised the appraisal of route options under each of the assessment criteria.

4 Step A: Spider Web Preliminary Assessment

4.1 Introduction

This chapter sets out the Step A, Spider Web Preliminary Assessment process that was undertaken to determine the feasible and practicable area options that could accommodate the Proposed Scheme and inform the development of a long list of Area Options formation for each of the areas 1-3.

The process adopted for the Step A Spider Web Preliminary Assessment included the identification of all feasible and practical route sections and suitability assessments for the Proposed Scheme, based on land use and transport planning considerations (e.g. trip attractors, population and employment, origin and destinations), as well as environmental considerations, and technical constraints.

The combined study area (areas 1-3) is shown in Figure 4.1

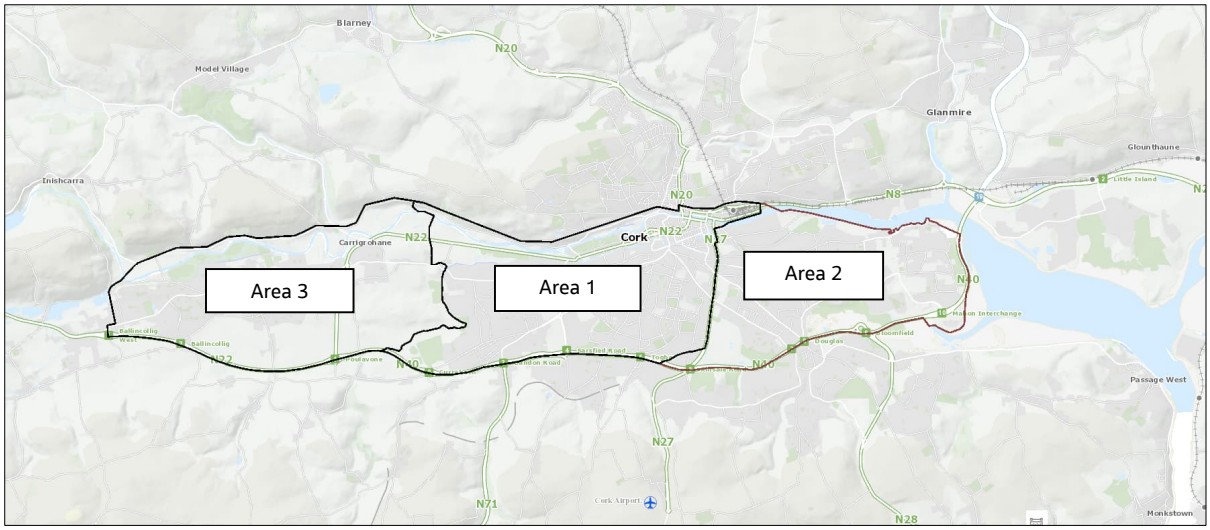


Figure 4.1: Combined study area for Spider Web Appraisal Process

4.2 Spider Web Preliminary Assessment Steps

There are a number of steps that were undertaken as part of the Spider Web Preliminary Assessment. These steps are outlined below and summarised in Figure 4.2:

- The identification of all feasible and practicable route sections – this includes a comprehensive, high-level assessment of all links per study area;
- Suitability Assessments for an LRT system in relation to:
  - Engineering and Space Proofing;
  - Potential Environmental Impact; and
  - Land Use and Transport Planning.
- Spider Web workshop and sifting;
- Sift In / Sift Out Assessment;
- Constraints;
- Opportunities;
- Assumptions; and
- Area Options Formation(Screening and Shortlisting for Step B).

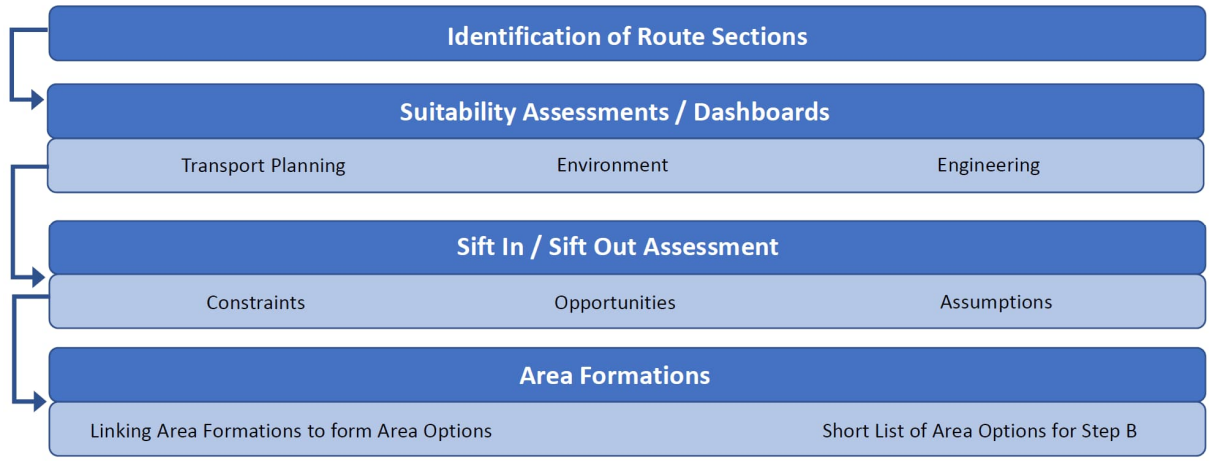


Figure 4.2: Spider Web Appraisal Process

4.3 Identification of Area Sections

The following assumptions were applied to the definition of area sections which enabled all feasible and practicable area sections that could accommodate the Proposed Scheme within Sub-areas 1-3 of the Study Area to be identified:

1. Define sections of streets;
2. Define opportunity routes off-street (notional route alignments);
3. Sections of similar street type;
4. Sections of similar cross-section;
5. Sections of similar land use characteristics; and
6. Avoid impact on constrained residential areas (housing estates, etc.).

4.4 Suitability Assessments

The starting point of the suitability assessment was to assume a double track configuration for each section. Following the identification and definition of individual route sections, each route section was then assessed in terms of suitability for the Proposed Scheme, from physical engineering, environment, land use and transport planning viewpoints.

In general, if the route section failed one of these assessments it was not brought forward to form part of the Area options. There was, however, a need to be flexible at Step A, and not to unduly rule out potential options (and potential mitigation) solely on physical or environmental constraints, based on a dual track arrangement. On this basis, land use, transport planning and the need to service the route section in question were also considered.

4.4.1 Luas Cork Provision Hierarchy

A double-track configuration was considered as the starting point of the suitability assessment, however, local network, engineering or environmental constraints sometimes necessitated land use, transport and accessibility requirements to be considered. To retain streets that can provide such solutions at this stage in the process, the following LRT Space-Proofing Hierarchy was developed (and is presented in Table 4.1 in order of preference).

Table 4.1: LRT Space-Proofing Hierarchy

Cross-Section Type	On-Street	Off-Street
Full Multi-modal Cross-Section	• 2-way LRT, 2-way traffic, cycle paths, footpaths	• 2-way LRT, cycle paths, footpaths
Full Multi-modal Cross-Section with land-take	• 2-way LRT, 2-way traffic, cycle paths, footpaths • Identify if land-take is required	• 2-way LRT, cycle paths, footpaths • Identify if land-take is required
Reduced Cross-Section	• 2-way LRT, footpaths	• 2-way LRT, footpaths
Reduced Cross-Section with land-take	• 2-way LRT, footpaths • Identify if land-take is required	• 2-way LRT • Identify if land-take is required
Alternative LRT Alignment Consideration	a. Single running of tram on different streets b. Interlaced track to address pinch point c. Demolition of structures	a. Single running of tram on different streets b. Interlaced track to address pinch point c. Demolition of structures

4.4.2 Design Criteria

Typical cross-sections were developed for the engineering and space-proofing assessment that could accommodate the Proposed Scheme, and that met the requirements of the ideal and reduced cross-section criteria. Figure 4.3 shows the detail of a typical LRT ideal and reduced cross-section, which give an LRT envelope width of 7.5m on straight sections of track. It should be noted that the cross-sections developed at Step A of the process were high-level, indicative cross-sections to inform the space available for the route section in question.

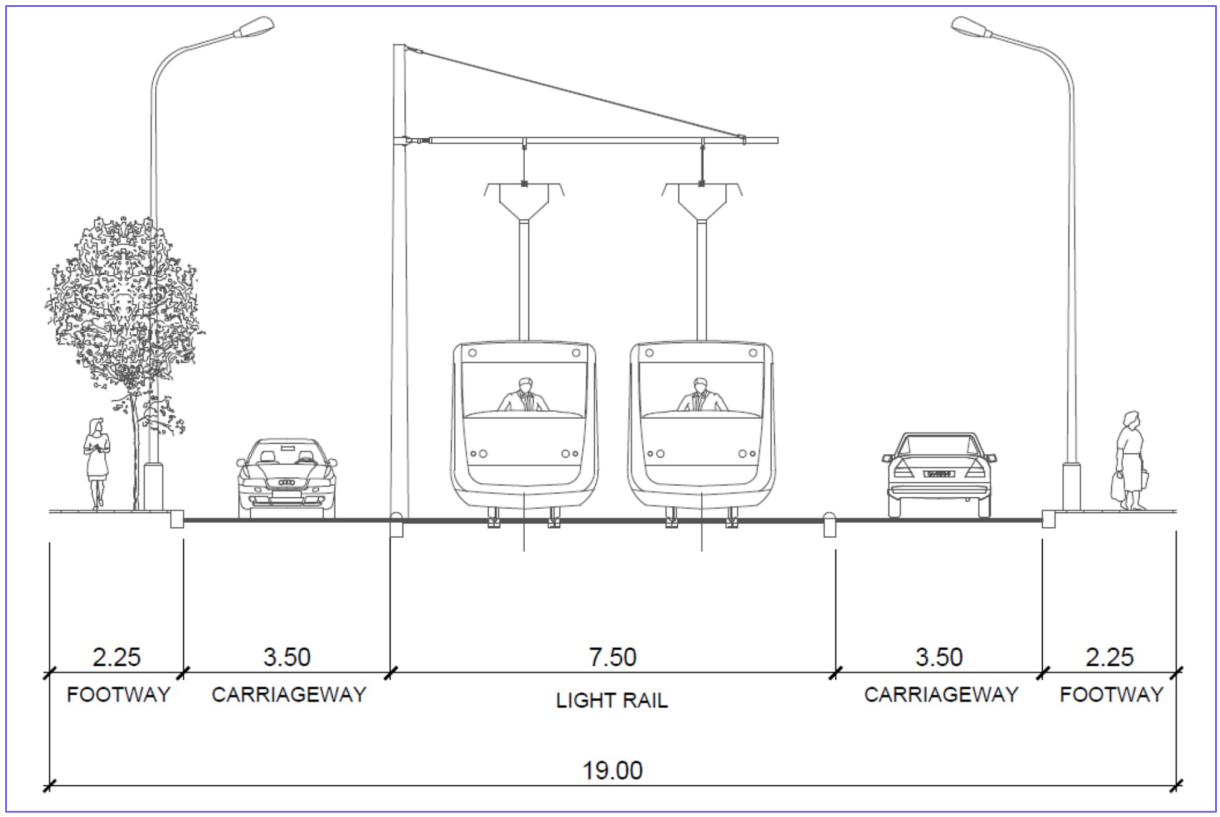


Figure 4.3: Detail of LRT Cross Section

Taking account of the detailed cross-section of the LRT envelope, the following cross-sections were developed for the ideal and reduced cross-section for on-street and off-street sections, shown in Table 4.2 .

For the Spider Web process, the full cross-sectional width was the primary consideration. The arrangement of the Proposed Scheme and traffic was not a factor in this stage of the option development and design process.

Table 4.2: LRT Space-Proofing Hierarchy Cross-Section Widths

Cross-Section Type	On-Street	Off-Street
Full Multi-modal Cross-Section	• 2-way LRT, 2-way traffic, cycle paths, footpaths • **Width: 21.5m**	• 2-way LRT, cycle paths, footpaths • **Width: 14.5m**
Reduced Cross-Section	• 2-way LRT, footpaths • **Width: 11.5m**	• 2-way LRT, • **Width: 7.5m**

4.4.3 Gradients

There are significant topographical challenges and steep gradients in Cork City and suburban areas, mainly associated with two large escarpments that run in an east-west direction, one to the north of the River Lee and the other to the south of the City Centre and River Lee. Gradients on each route section were reviewed and considered as part of the Spider Web sifting process. Typically, where gradients exceeded 10%, the provision of an LRT was identified as not feasible.

4.4.4 Civil Works

The civil works assessment of each route section considered whether there were any civil works required within the section for the following typical construction requirements:

1. Embankments;
2. Retaining walls;
3. Bridges;
4. Underpasses/overpasses; and/or
5. No civil works have been identified.

4.4.5 Step A Environmental Assessment

It was the intention of the Spider Web Environmental assessment to sift out route sections where there were significant challenges or constraints to the proposed LRT corridor. The Spider Web preliminary assessment helped shortlist potential options for the proposed LRT corridor in line with the EIA Directive (2014/52/EU), which requires an assessment of all "reasonable" alternatives or options. The large number of assessed route sections as part of the Spider Web assessment helped to complete this requirement.

Table 4.3: Key Environmental Information Used in Assessment

Ecology	Cultural Heritage	Landscape and Visual	Other Layers
Special Areas of Conservation (SAC) Special Protection Areas (SPA) National Heritage Areas (pNHA)	National Monuments Record of Protected Structures Record of Monuments and Places (RMP)/Sites and Monuments Record (SMR) Historic Gardens and Landscapes	Scenic Routes Landscape Designations Landscape Preservations Zones High Value Areas	Online Sources (including Street view and Google maps) Up-to-Date Aerial Photography City and County

Ecology	Cultural Heritage	Landscape and Visual	Other Layers
Woodland Inventory Woodland Habitats CORINE Land Cover (Coordination of Information on the Environment)	Architectural Conservation Areas (ACA) National Inventory of Architectural Heritage (NIAH) (In some instances, these are collectively referred to as Cultural Heritage (CH sites))		Development Plans

Table 4.3 highlights sources of information for ecology; cultural heritage (including archaeological and architectural) and landscape and visual. These three topics were identified as the key considerations at this stage of the assessment as they allowed differentiation between possible route sections. Assessment of these environmental topics was based on a review of online and desktop information in accordance with relevant environmental guidelines.

Further assessment of environmental topics was undertaken as the Proposed Scheme developed in Step B and Step C. Each route section was assessed on the identified route section in isolation at this stage of the assessment.

4.4.6 Land Use and Transport Planning Assessment

A simple two step approach was applied to the Land Use and Transport Planning Assessment, based on the following criteria. If the answer to any of the questions was "Yes", then the route section was sifted in. If the answer to all was "No", then the route section was sifted out:

- Is there an adjacent Land Use Need?
- Is there a Transport Planning Need?

4.4.7 Land Use Need

To determine whether a route section had a Land Use Need, several factors were taken into consideration, including:

- Existing Developments: Each route section was assessed to determine whether the existing developments it will serve are likely to generate sufficient demand to warrant or require an LRT service. Considerations included development type – residential, amenity, commercial, industrial etc. – as well as scale, density and (linked to the transport need) accessibility and connectivity; and
- Future Developments: Each route section was reviewed in the context of existing Development Plans, Local Area Plans and planning applications, to determine if the route section in question would serve planned future developments which are likely to warrant or require an LRT corridor or could support its delivery driven by other wider existing or new developments. Considerations have again included development type – residential, amenity, commercial, industrial etc. – as well as scale, density and (linked to the transport need) accessibility and connectivity.

4.4.8 Transport Planning Need

For route sections that did not have a specific Land Use Need (as per description above), but served a Transport Planning function, these route sections were sifted in. A route section was considered to have a Transport Planning need if it:

- Allowed a link to a key development or key trip attractor such as a University, Hospital or Business Park;
- Facilitated access to potential strategic Park and Ride sites that could serve the primary road network and offer (subject to the routing and journey times) high-quality access to Cork City Centre and any intermediate key trip attractors;
- Facilitated a connection from one route alignment to another, ideally also offering some genuine accessibility and connectivity benefits in their own right; and
- Had the potential to contribute to routing, journey times and stop locations that were appropriate for an LRT corridor.

4.5 Spider Web Final Sifting

The outcome of the Engineering and Space-Proofing, Environmental Assessment, and Land Use and Transport Planning Assessment was to colour code each route section on GIS ProjectMapper as:

- **Green – Sift In**: Limited or no key considerations were identified; however further assessment required; or
- **Red – Sift Out**: Key considerations have been identified along the route section and may warrant being sifted out.

The sifting of each route section was based on professional judgment to consider the issues that could result from a route section in a particular location, and likely layout and design of the proposed LRT corridor.

4.5.1 Sub-Area 1 Spider Web Sifting and Assessment Outcome

In total, 184 route sections were identified for Sub-Area 1 as illustrated in Figure 4.4. Sub-area dashboards (one for each route section) summarised the individual assessments and outlined a final decision as to whether that route section should be retained or sifted out. Table 4.4 illustrates the final results of the Sub-Area 1 Spider Web Assessment, showing 72 sections sifted out and 112 sections sifted in.

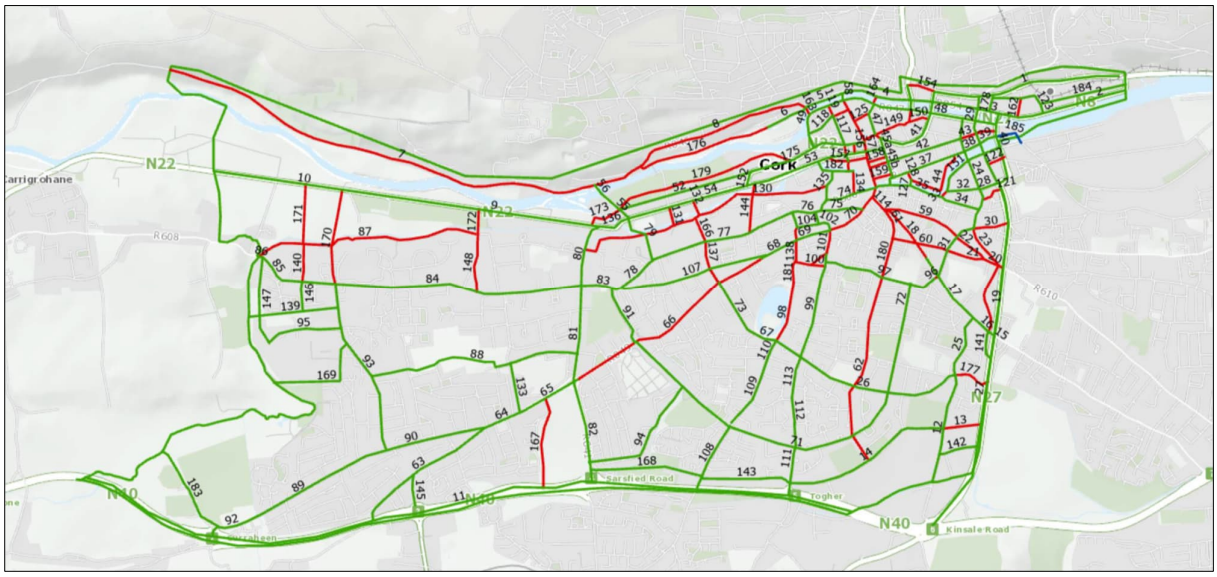


Figure 4.4: Sub-Area 1 Spider-Web Sifting Outcomes (red sifted out / green sifted in)

Table 4.4: Sub-Area 1 Spider Web Sifting Outcome

Engineering	Number
The full multi-modal l two-way cross-section can be accommodated.	63
The full multi-modal two-way cross-section can be accommodated with land-take.	114
A two-way cross section cannot be accommodated.	7
Environment	**Number**
No key considerations have been identified however further assessment required.	36
Key considerations have been identified and require further examination.	148
Key considerations have been identified and section may warrant being sifted out.	65
Land Use and Transport Planning	**Number**
Land use or transport need identified.	81
No land use or transport need identified.	103
Sifting Outcome	**Number**
Sift In	112
Sift Out	72

4.5.2 Sub-Area 2 Spider Web Sifting and Assessment Outcome

In total, 75 route sections were identified for Sub-Area 2 as illustrated in Figure 4.5. Sub-area dashboards (one for each route section) summarised the individual assessments and outlined a final decision as to whether that route section should be retained or sifted out. Table 4.5 illustrates the final results of the Sub-Area 2 Spider Web Assessment, showing 20 sections sifted out and 55 sections sifted in.

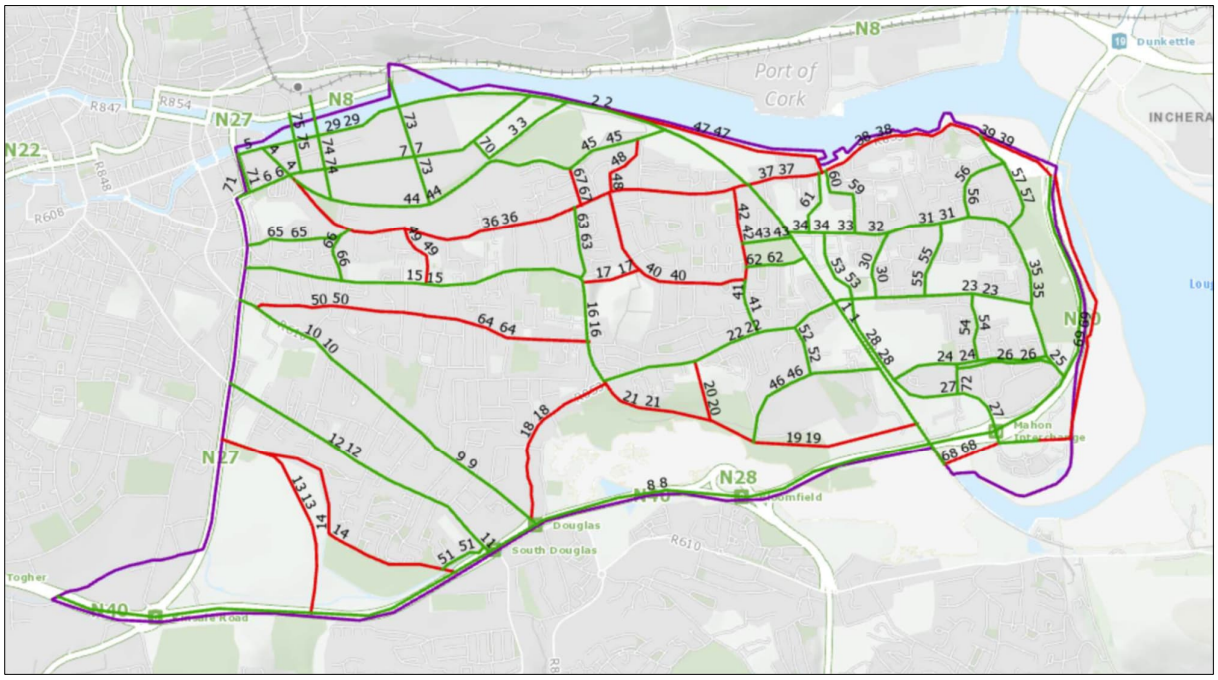


Figure 4.5: Sub-Area 2 Spider-Web Sifting Outcomes (red sifted out / green sifted in)

Table 4.5: Sub-Area 2 Spider Web Sifting Outcome

Engineering	Number
The full multi-modal two-way cross-section can be accommodated.	25
The full multi-modal two-way cross-section can be accommodated with land-take.	46
A two-way cross section cannot be accommodated.	4
Environment	**Number**
No key considerations have been identified however further assessment required.	7
Key considerations have been identified and require further examination.	68
Key considerations have been identified and section may warrant being sifted out.	1
Land Use and Transport Planning	**Number**
Land use or transport need identified.	56
No land use or transport need identified.	19
Sifting Outcome	**Number**
Sift In	55
Sift Out	20

4.5.3 Sub-Area 3 Spider Web Sifting and Assessment Outcome

In total, 35 route sections were identified for Sub-Area 3 as illustrated in Figure 4.6. Sub-area dashboards (one for each route section) summarised the individual assessments and outlined a final decision as to

whether that route section should be retained or sifted out. Table 4.6 illustrates the final results of the Sub-area 3 Spider Web Assessment, showing 21 sections sifted out and 14 sections sifted in.

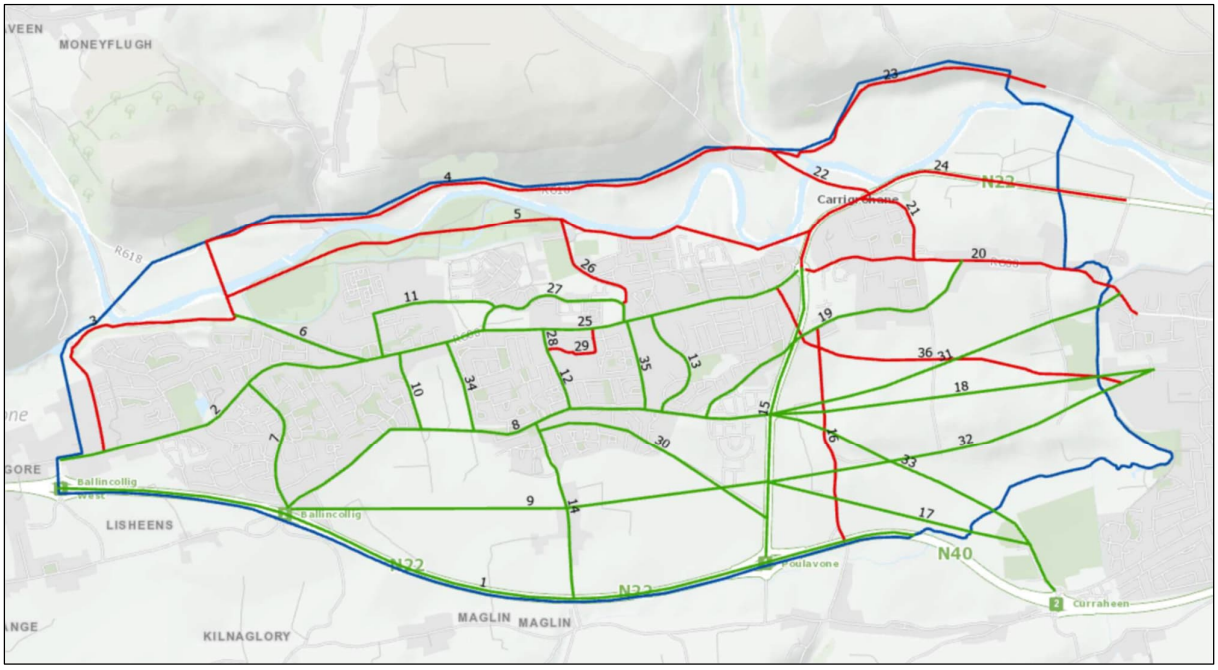


Figure 4.6: Sub-Area 3 Spider-Web Sifting Outcomes (red sifted out / green sifted in)

Table 4.6: Sub-Area 3 Spider Web Sifting Outcome

Engineering	Number
The full multi-modal two-way cross-section can be accommodated.	1
The full multi modal two-way cross-section can be accommodated with land-take.	23
A two-way cross section cannot be accommodated.	11
Environment	**Number**
No key considerations have been identified however further assessment required.	8
Key considerations have been identified and require further examination.	25
Key considerations have been identified and section may warrant being sifted out.	2
Land Use and Transport Planning	**Number**
Land use or transport need identified.	19
No land use or transport need identified.	16
Sifting Outcome	**Number**
Sift In	14
Sift Out	21

Spider Web Sifting Summary Figure 4.7 shows a summary of the sections sifted in (green sections) and sections sifted out (red sections) across Sub Areas 1-3 within the Study area for the Proposed Scheme.

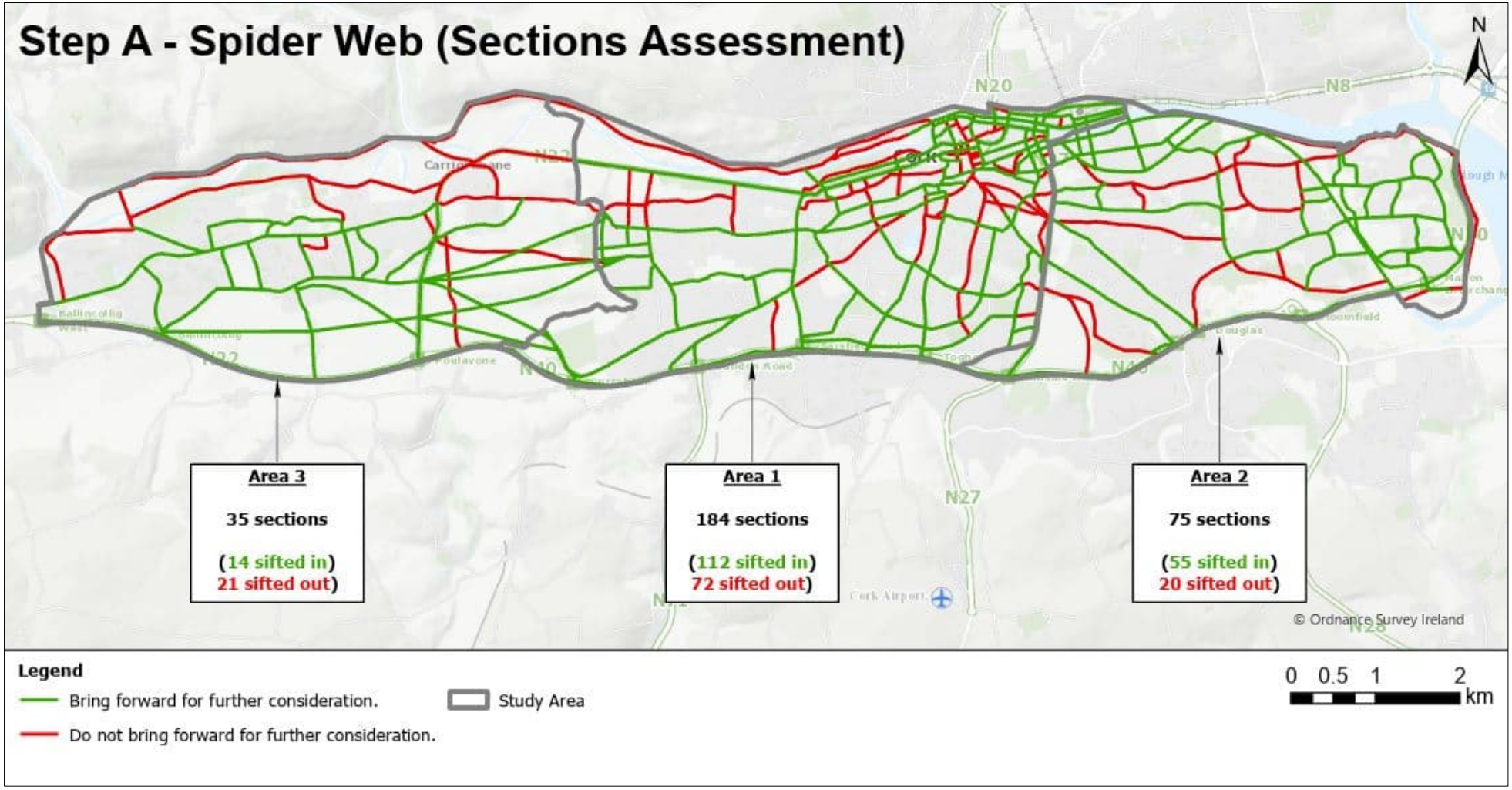


Figure 4.7: Outcome of Sections Assessment for Sub Areas 1-3

4.6 Area Options Formation Mapping

The first step to identify the area options was to combine the sections that were brought forward from the Sifting process.

The area options were then initially assessed to rule out sections which would not meet the Proposed Scheme objectives. In particular, consideration was given to potential demand (existing and future) based on indicative stop locations, proximity to key trip attractors, integration with existing and future Public Transport, and the directness of routes. Indicative stop locations along each area option were determined based on the analysis undertaken with respect to Transport Planning and Land Use at the Spider Web Preliminary Assessment.

Further consideration was also given to the environmental constraints identified in the Environmental Constraints Report at Step A with constraints avoided where possible.

In addition to the (geometrically feasible) area options that were assessed on their individual merits against the objectives, in some instances area options were screened relative to each other, allowing some area options to be ruled out if similar, more suitable alternatives existed. For example, if one area option served some key trip attractors or defined areas of demand more directly with better network legibility compared to an option that serves the same trip attractors less directly, it was reasonable to rule out this option at this stage, based on this comparative assessment.

Finally, consideration was given to the interaction of area options between study area sections to ensure that all suitable connections between study areas were considered at the Step B Area Option MCA Stage.

4.6.1 Sub-Area 1: Area Options Formation

Two core spine routes, running west to east though Sub-Area 1, were identified following the viable combination of the silted-in Area 1 sections. These were the initial geometrically feasible options (prior to further assessment). These were identified as follows:

1. Core Spine 1 – Blue Route; and
2. Core Spine 2 – Red Route.

In addition, five potential links for connecting the Core Spines were also identified, which allowed hybrid options between the two Core Spines to be formed. Being the most central of the three areas, Sub-Area 1 had the most physically constrained sections, in particular in the city centre region. The identified spines and variations reflected these constraints, as well as the need to provide a direct connection between Sub-Area 3 and Sub-Area 2.

4.6.1.1 Summary of Area Options Formation for Sub-Area 1

Following the sifting exercise of potential sections within each sub-area to be brought forward for further consideration, geometrically feasible Area Options were identified for each sub-area as shown in Figure 4.8. These geometrically feasible Area Options were based on a high-level assessment and assessment of the LRT design standards.

Core Spines were identified on the Area Options, with associated variants of each Core Spine driven by inclusion of particular sections. The Core Spines formed the basis of the options that were carried forward for further assessment through MCA.

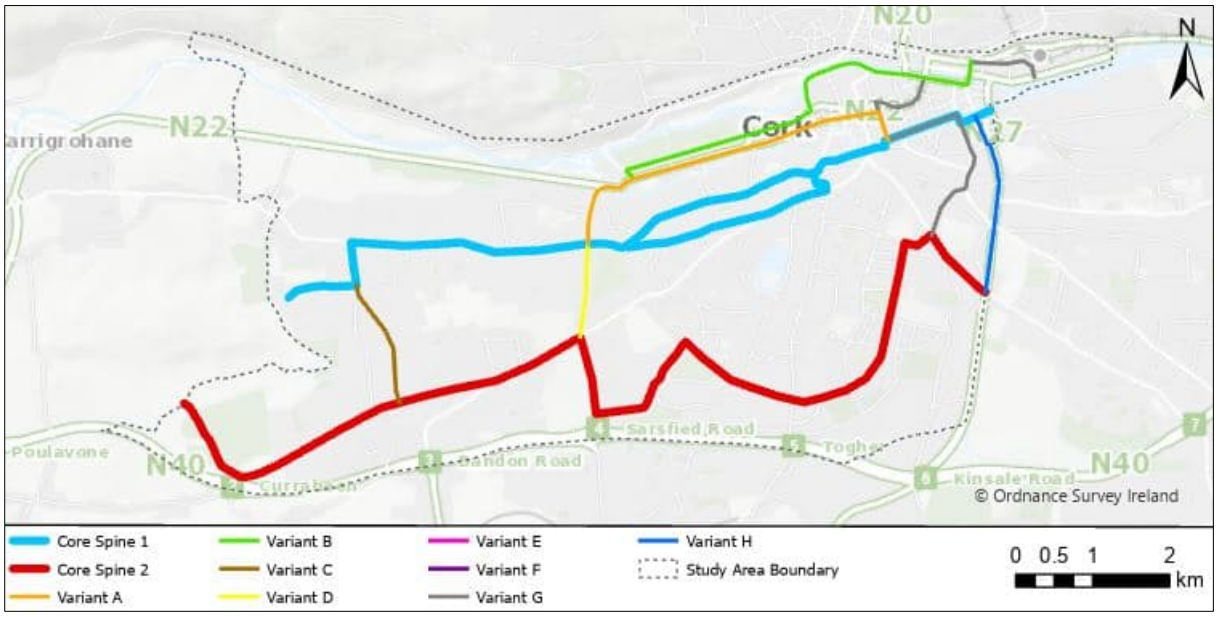


Figure 4.8 Area 1 Core Spines and Variant (connecting) Spines for Area Options

For Sub-Area 1 there were 28 options identified. The list of Area Options is shown in Table 4.8. Following a qualitative review, which in addition to Step A criteria, focussed on wider connectivity of the options across the sub-areas, 10 options were carried forward from Sub-Area 1 formation to the MCA stage.

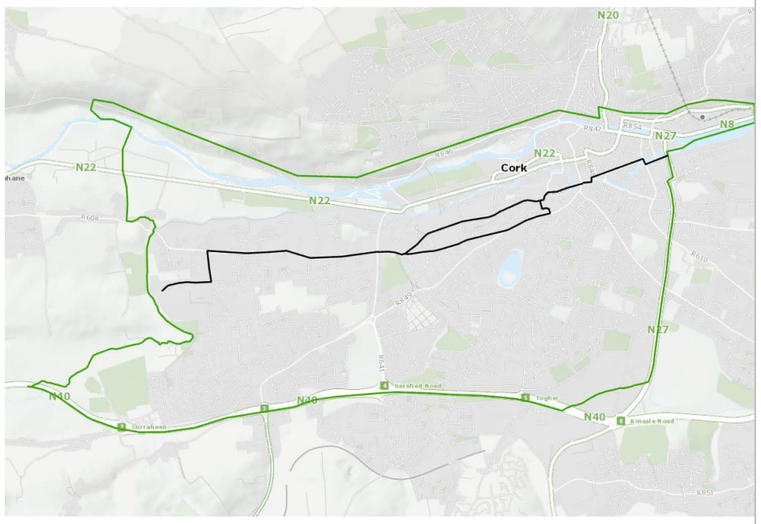
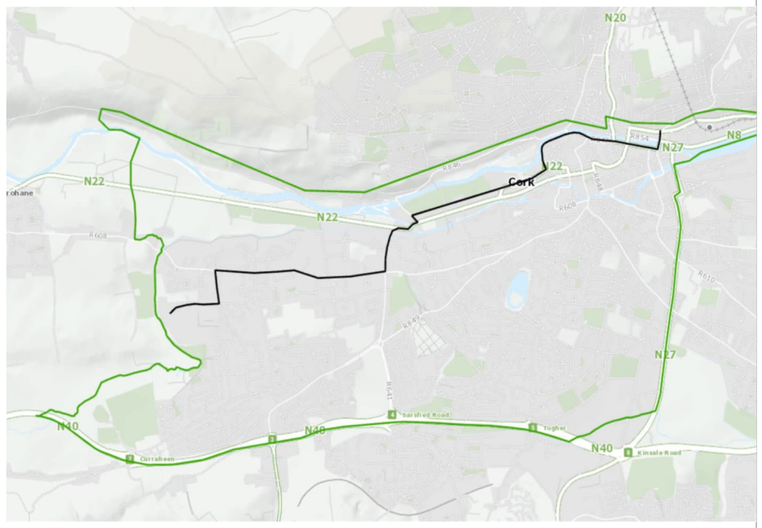
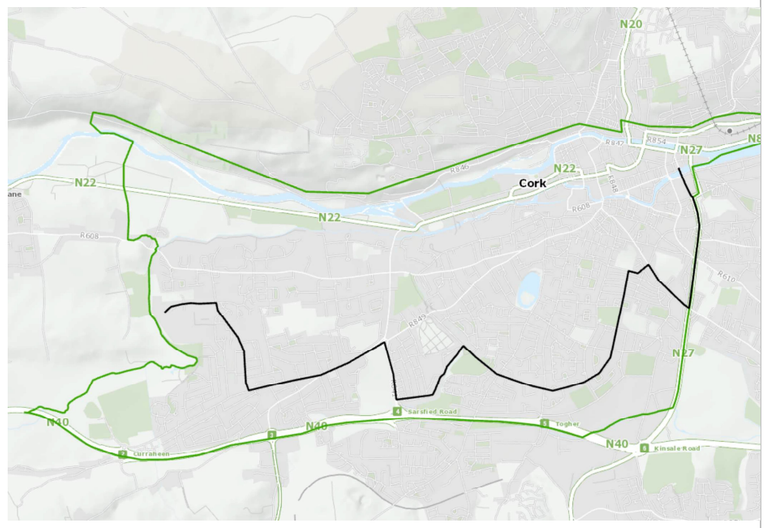
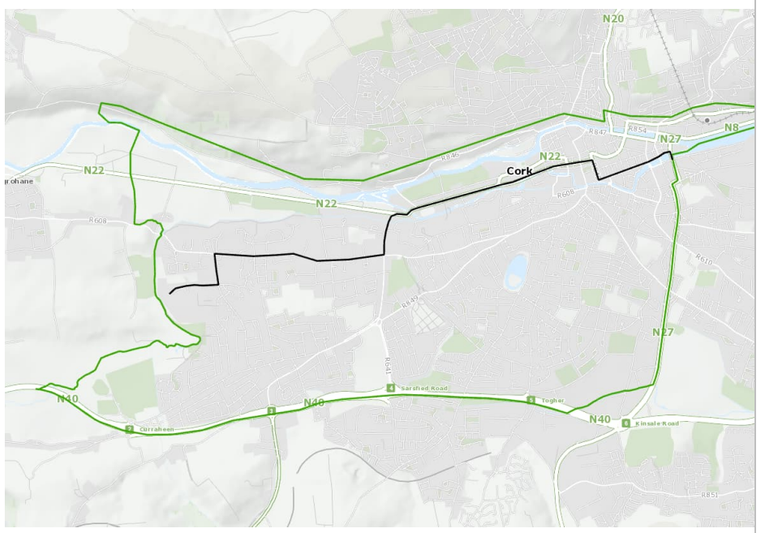
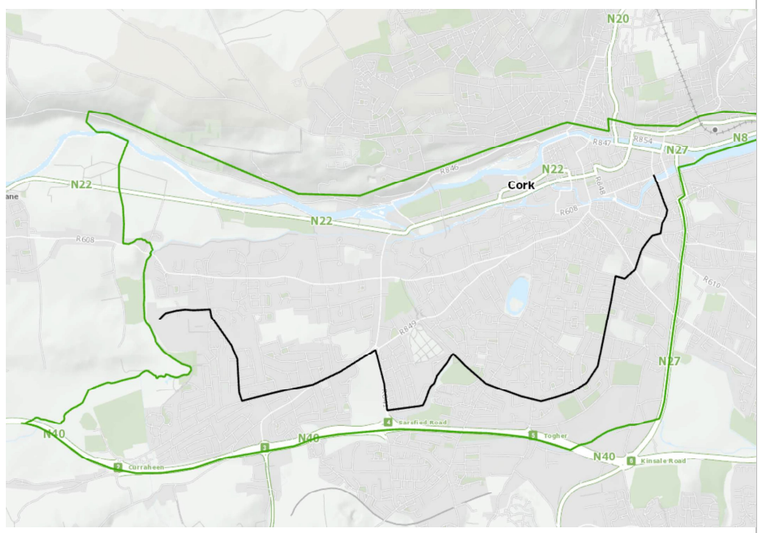
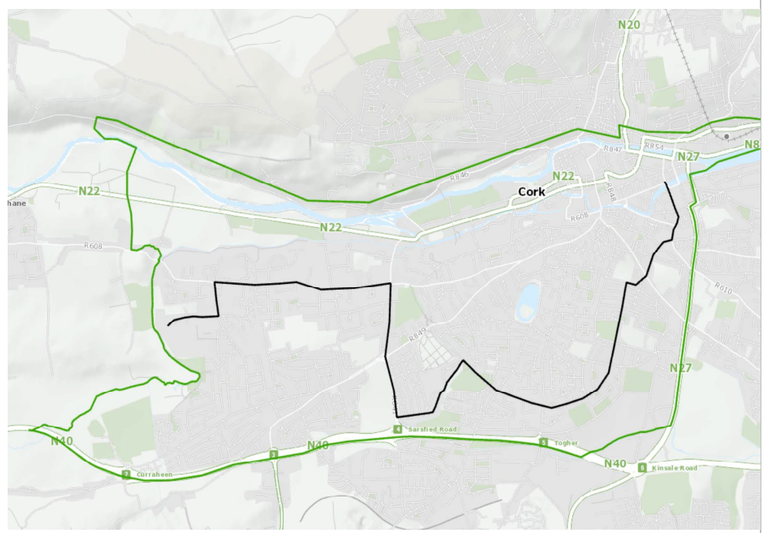
As shown in Table 4.7, the following 18 options were screened out:

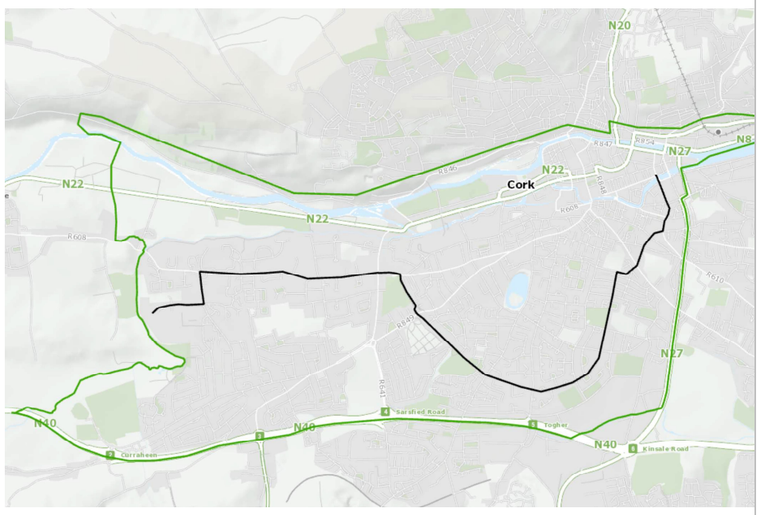
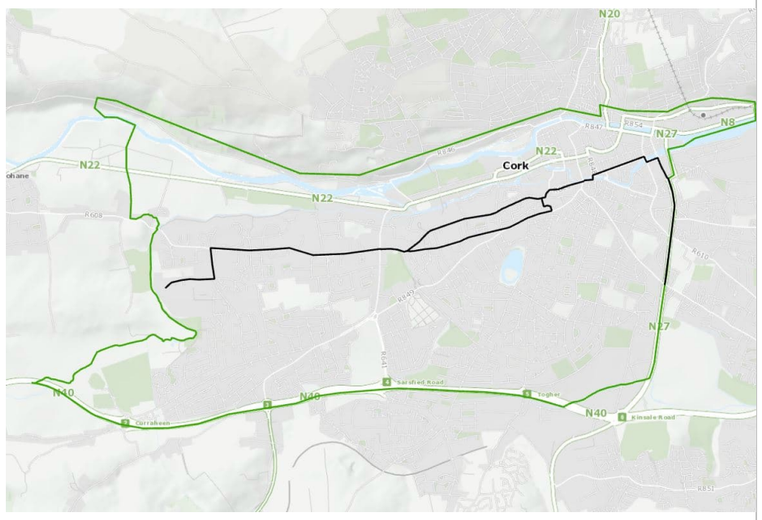
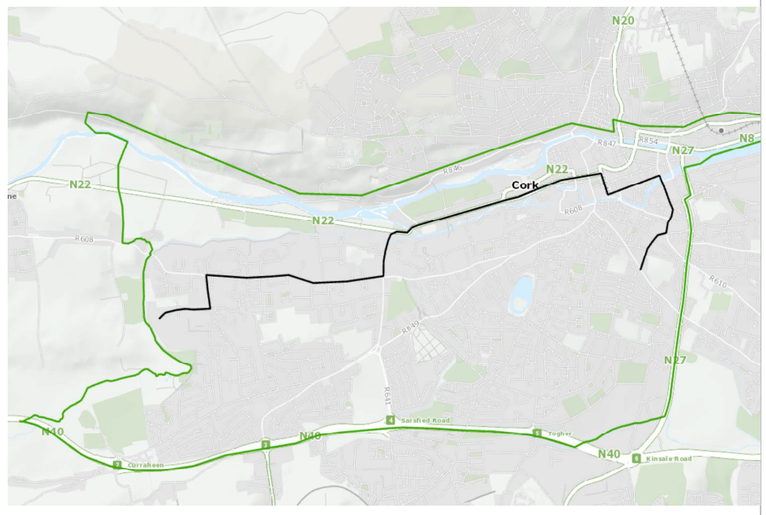
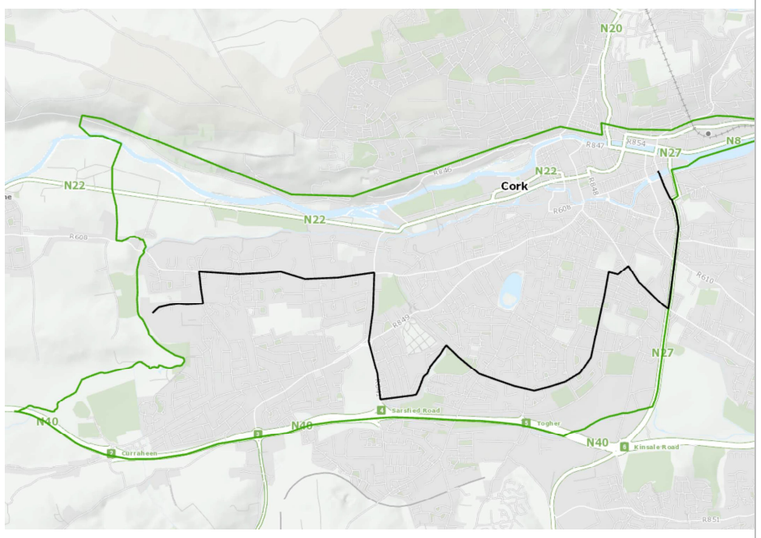
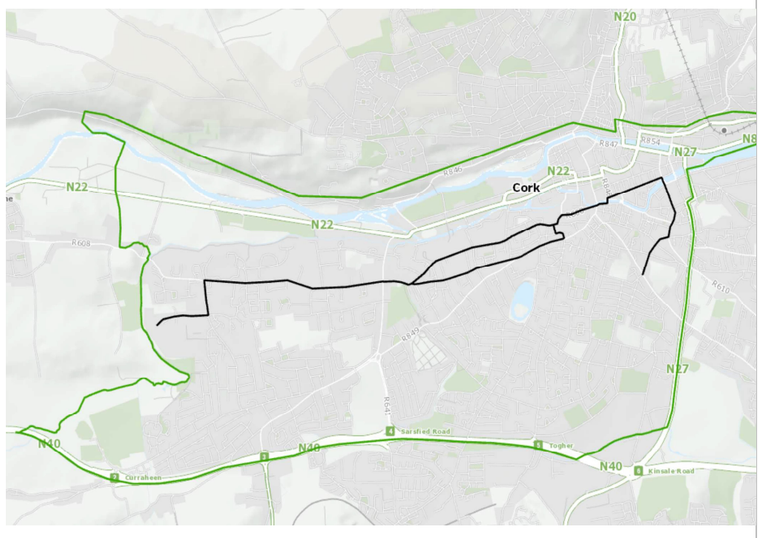
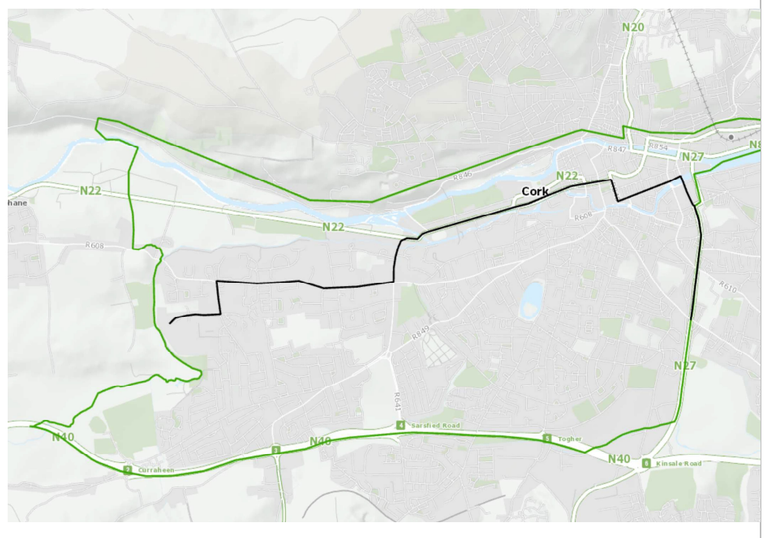
Table 4.7: Sub-Area 1 Screened Out Options

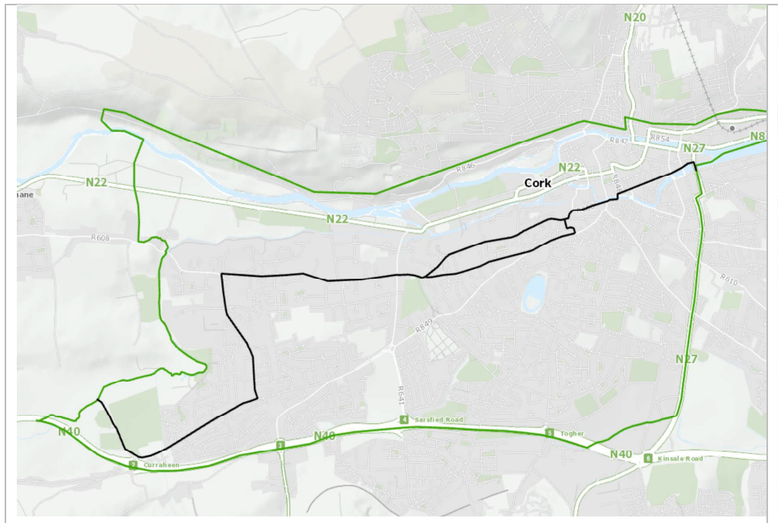
• Option 4	• Option 10	• Option 16	• Option 24
• Option 5	• Option 11	• Option 19	• Option 25
• Option 6	• Option 13	• Option 20	• Option 28
• Option 7	• Option 14	• Option 21	
• Option 8	• Option 15	• Option 23	

These options were screened out as they did not deliver on the high-level objectives of the Proposed Scheme, presented significant engineering challenges or limited connectivity to carry across to Sub-Area 2 and were more convoluted routes (resulting in less competitive journey times).

Table 4.8 Sub-Area 1 Corridor Options (derived from formation maps)

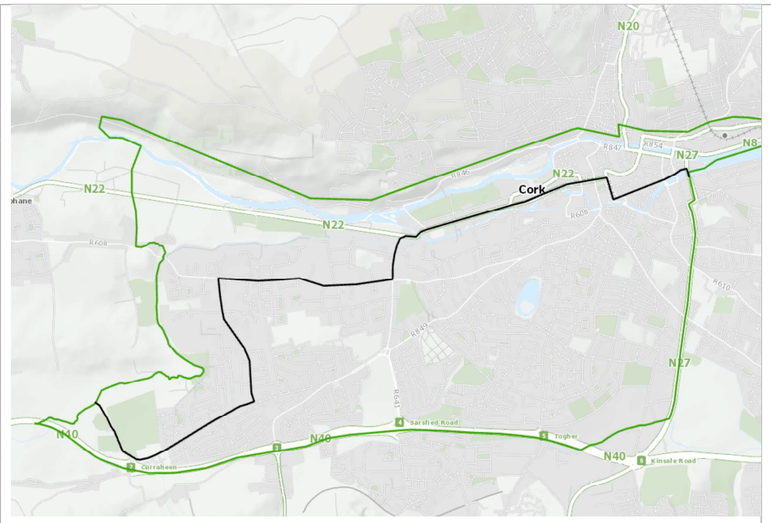
Option 1	Option 3	Option 5
		
Outcome: Taken forward to MCA	Outcome: Taken forward to MCA	Outcome: Ruled Out
Option 2	Option 4	Option 6
		
Outcome: Taken forward to MCA	Outcome: Ruled Out	Outcome: Ruled Out

Option 7  Outcome: Ruled Out	**Option** 9  Outcome: Taken forward to MCA	Option 11  Outcome: Ruled Out
Option 8  Outcome: Ruled Out	Option 10  Outcome: Ruled Out	Option 12  Outcome: Taken forward to MCA
Option 13	Option 15	Option 17



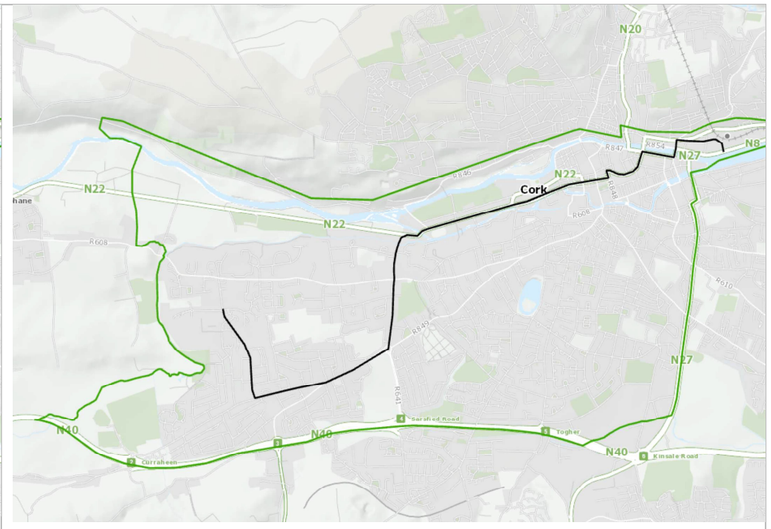
Outcome: Ruled Out

Option 14



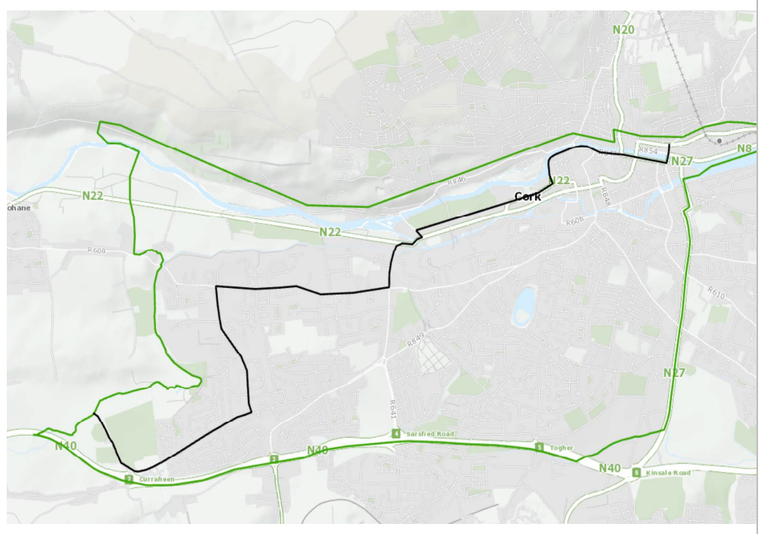
Outcome: Ruled Out

Option 16



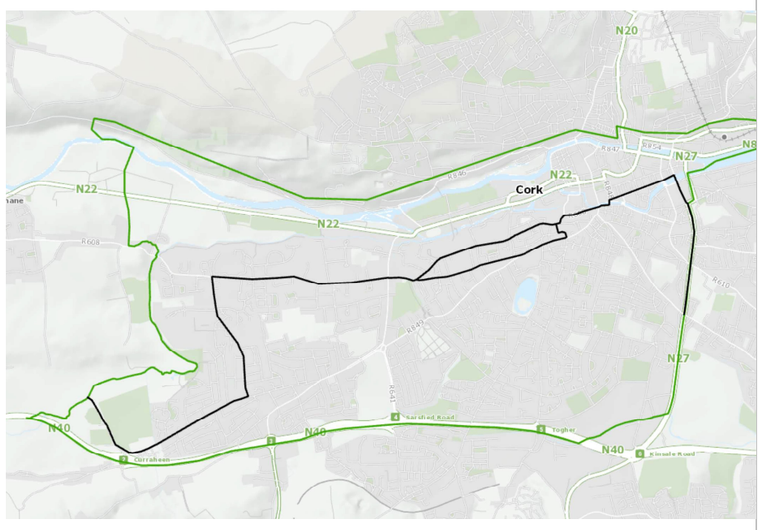
Outcome: Taken forward to MCA

Option 18



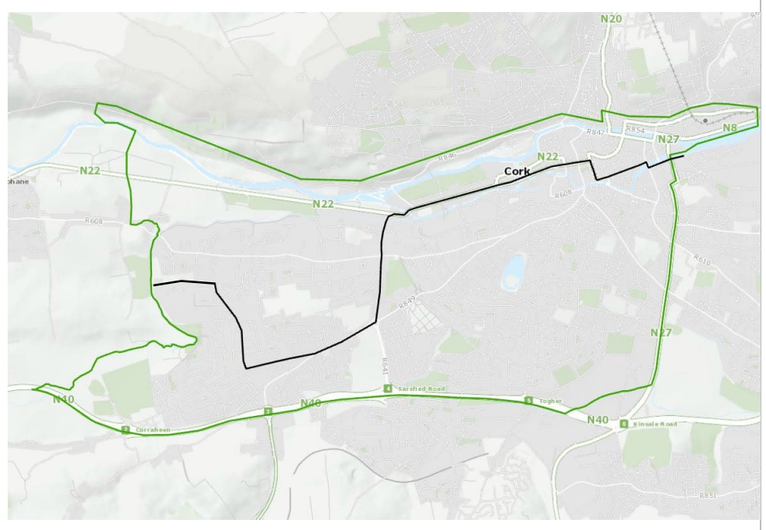
Outcome: Ruled Out

Option 19



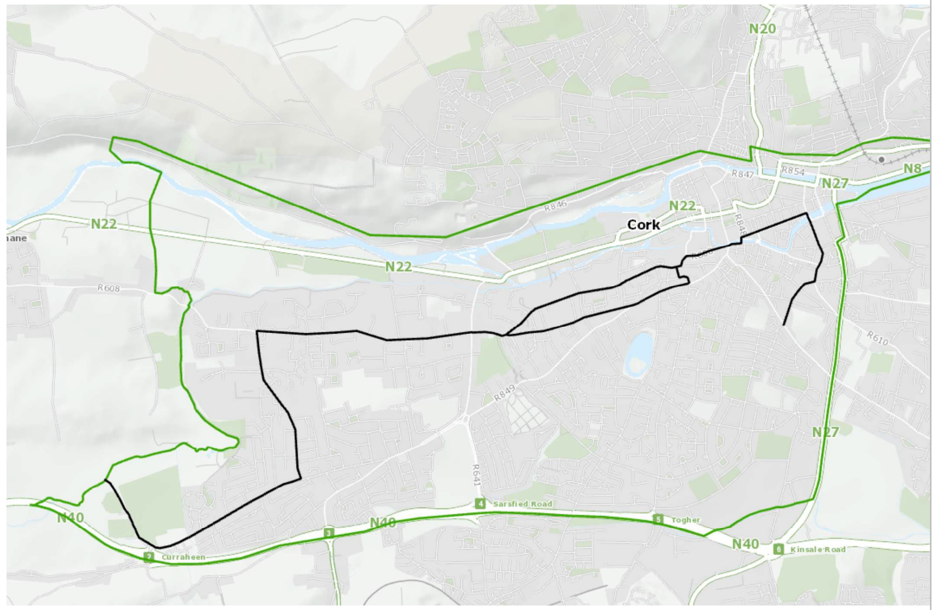
Outcome: Ruled Out

Option 21

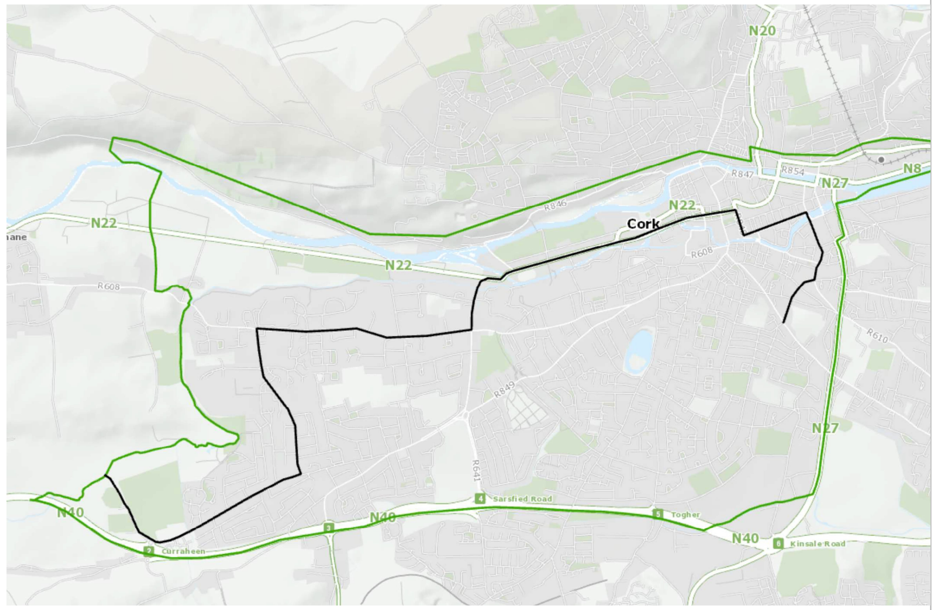


Outcome: Taken forward to MCA

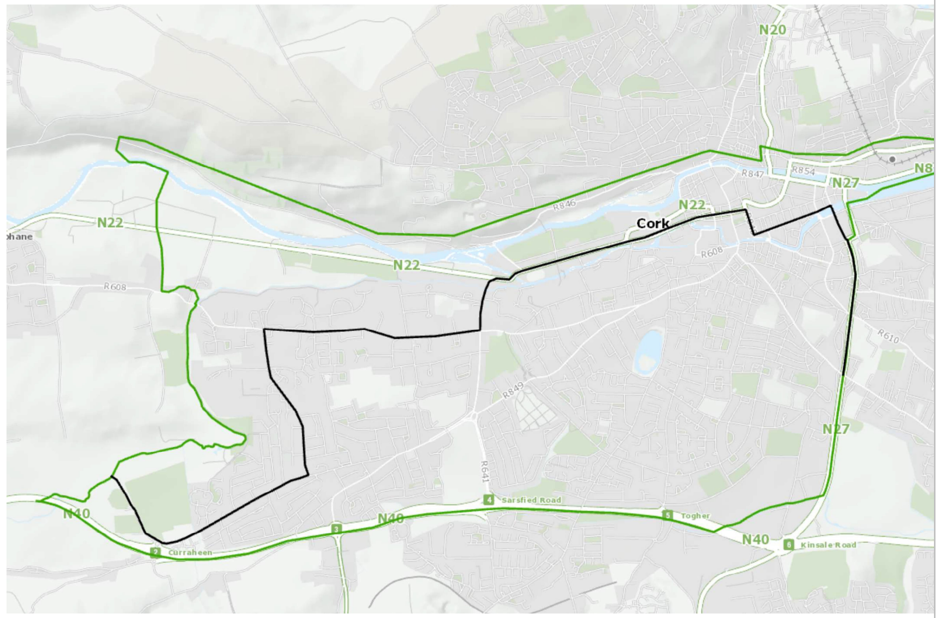
Option 23



Outcome: Ruled Out



Outcome: Ruled Out

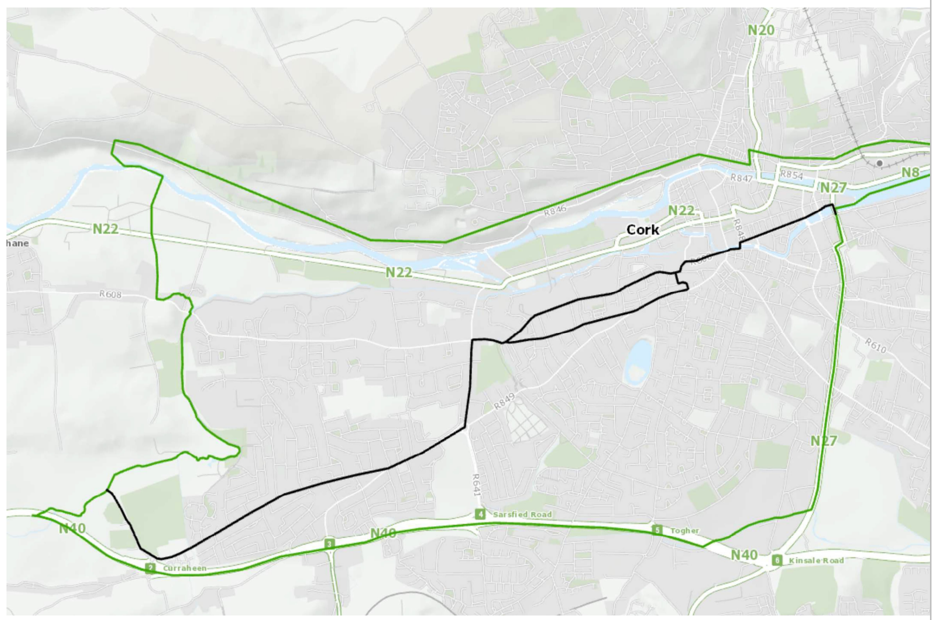


Outcome: Ruled Out

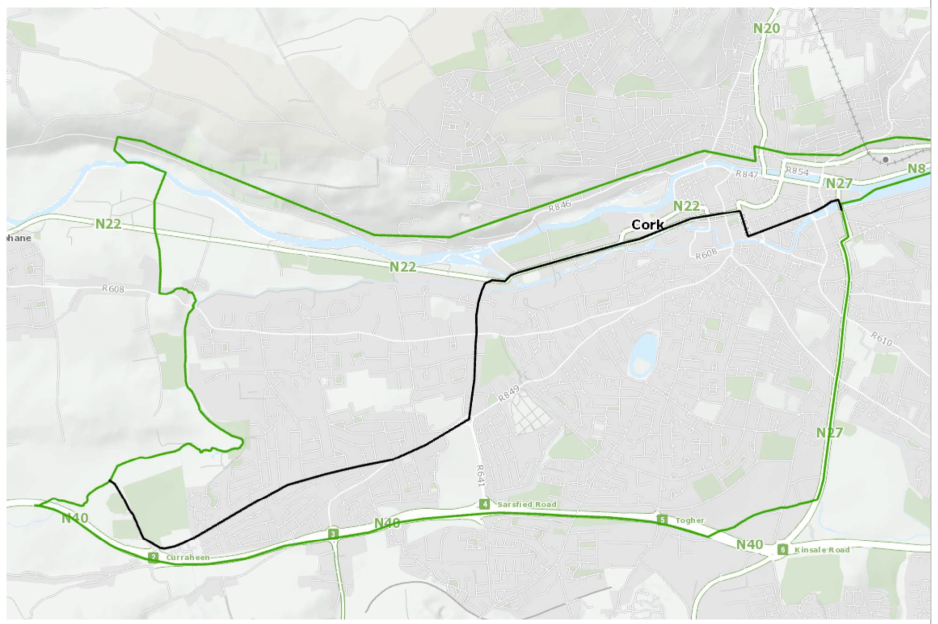
Option 20

Option 22

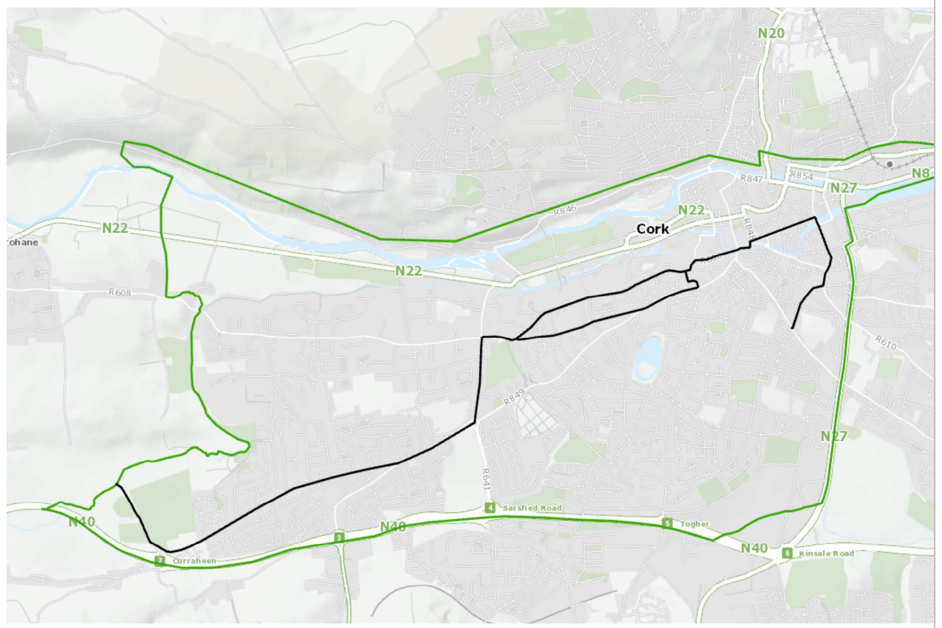
Option 24



Outcome: Ruled Out



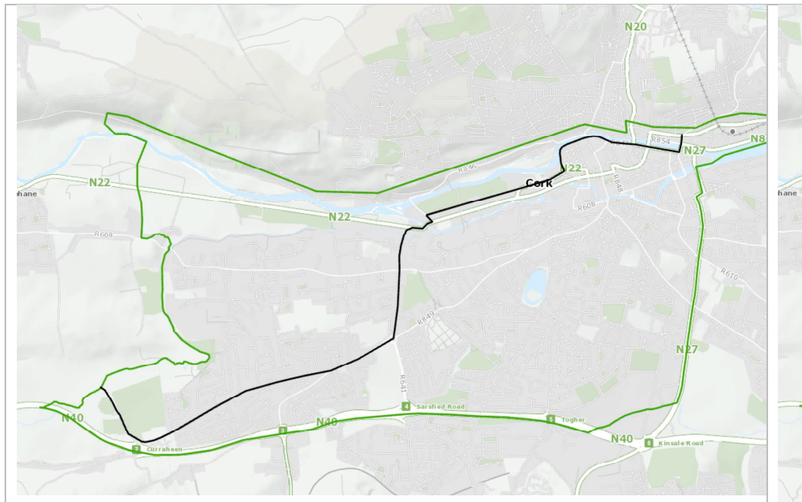
Outcome: Taken forward to MCA



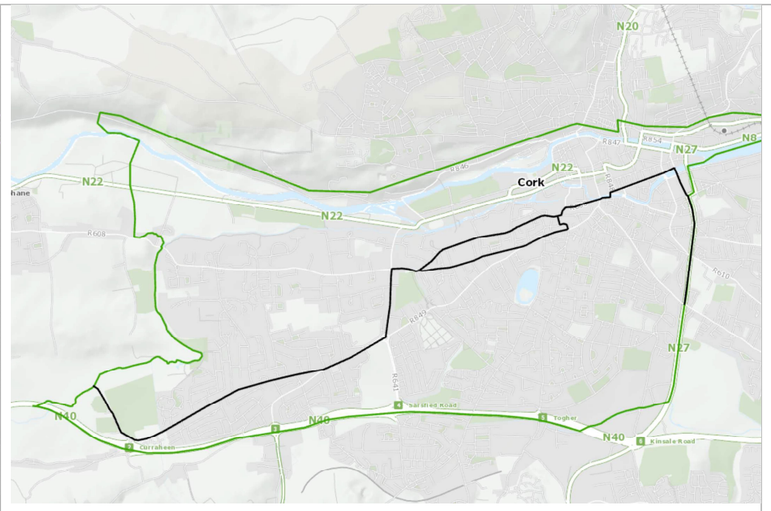
Outcome: Ruled Out

Option 25

Option 27

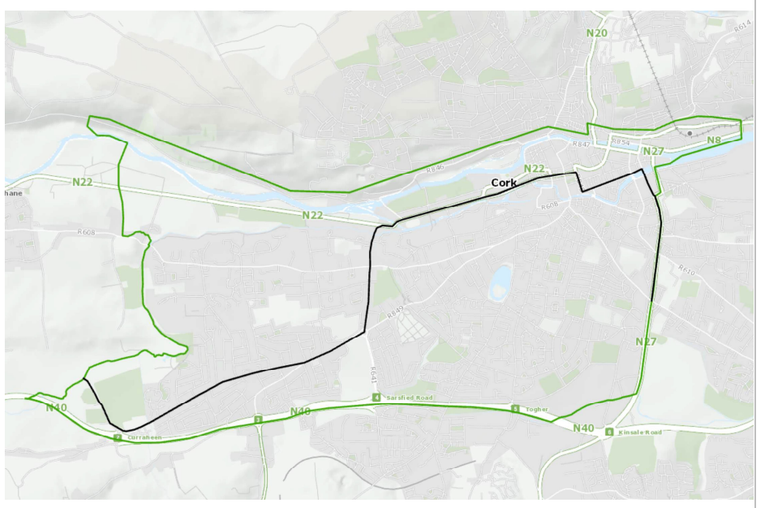


Outcome: Ruled Out



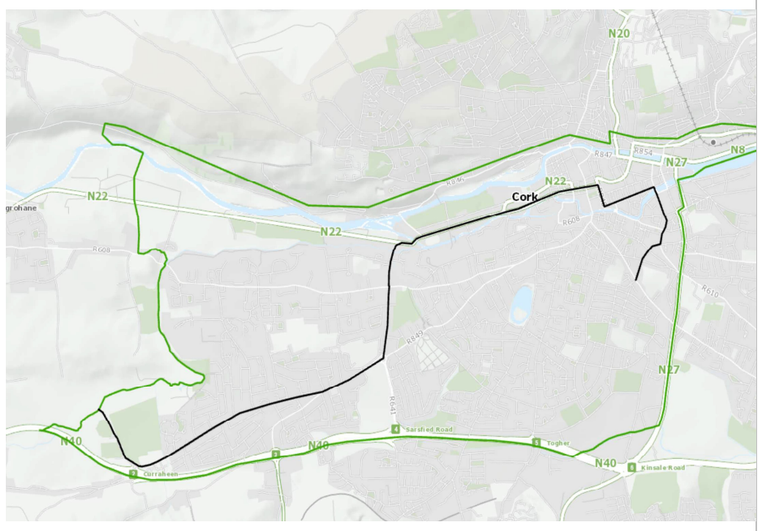
Outcome: Taken forward to MCA

Option 26



Outcome: Taken forward to MCA

Option 28



Outcome: Ruled Out

4.6.2 Sub-Area 2: Area Options Formation

Three core spine routes, running west to east though Sub-Area 2, were identified following the viable combination of the silted-in Sub-Area 2 sections as outlined in Figure 4.9. These were the initial geometrically feasible options (prior to further assessment). These were identified as follows:

- Core Spine 1 – Orange Route;
- Core Spine 2 – Blue Route; and
- Core Spine 3 – Green Route.

Each of these core spines routes could serve a Strategic Park and Ride facility on the eastern extent of each route.

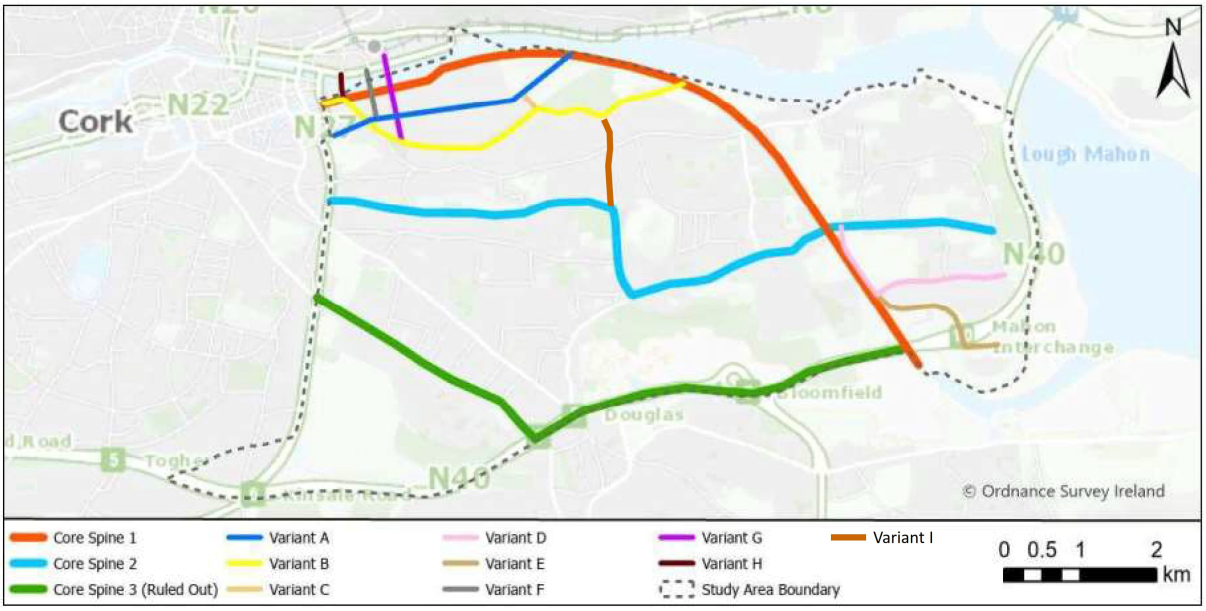


Figure 4.9 Sub-Area 2 Core Spines and Variant (connecting) Spines for Area Option

4.6.2.1 Summary of Area Options Formation for Sub-Area 2

Following the sifting exercise of potential sections within each sub-area to be brought forward for further consideration, geometrically feasible Area Options were identified for each sub-area. These geometrically feasible Area Options were based on a high-level assessment and assessment of the LRT design standards.

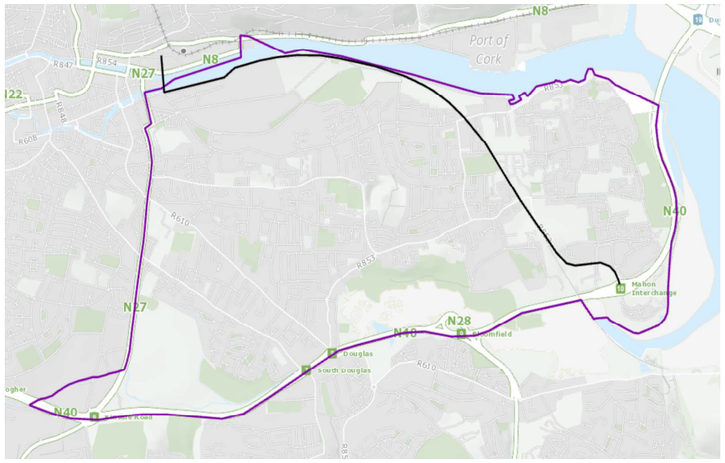
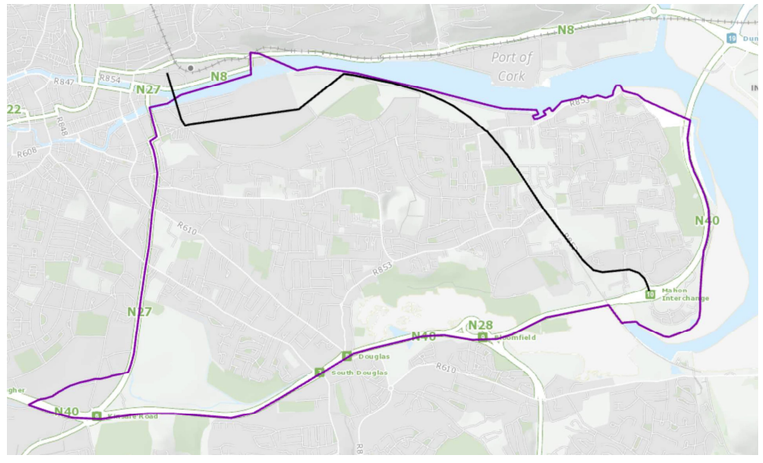
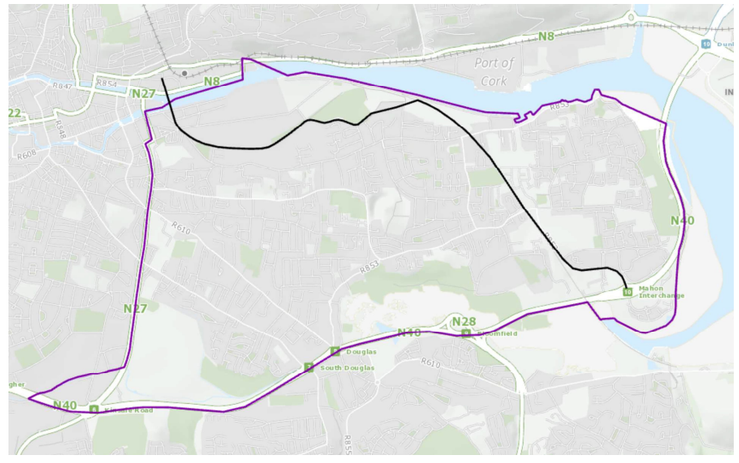
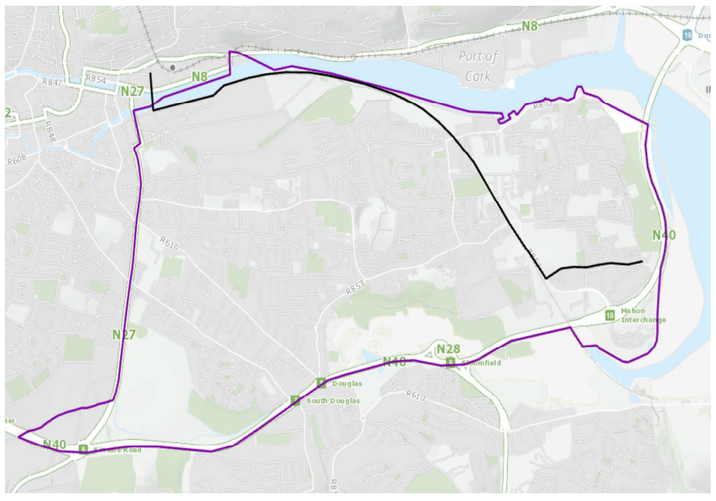
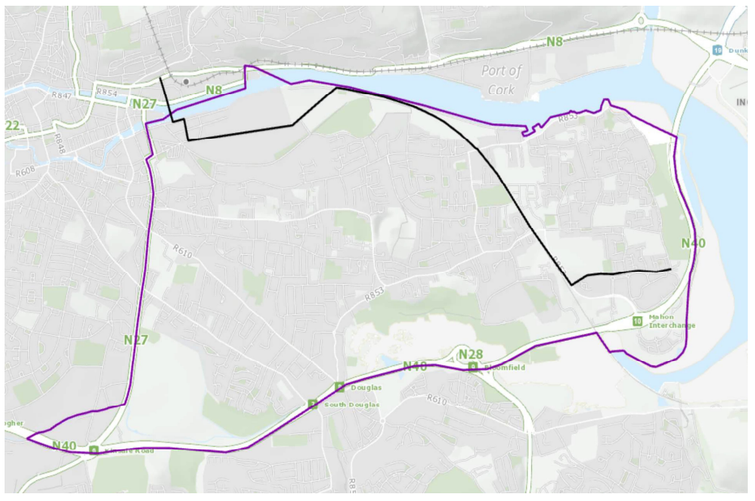
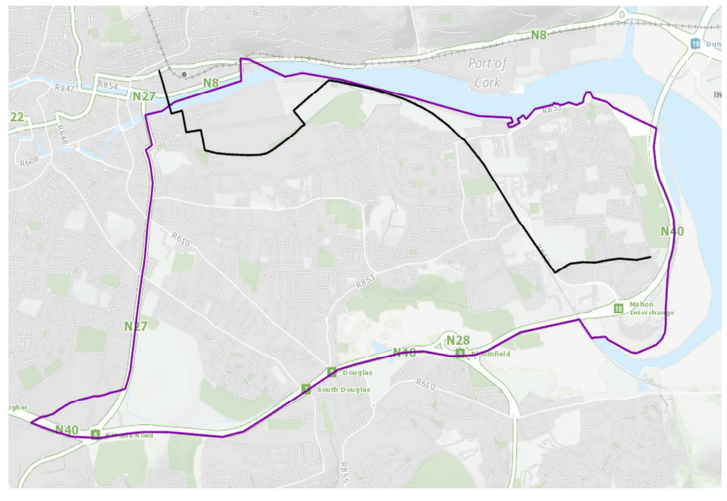
Core Spines were identified on the Area Options, with associated variants of each Core Spine driven by inclusion of particular sections. The Core Spines formed the basis of the options that were carried forward for further assessment through MCA.

For Sub-Area 2 there were 17 options identified. The list of Area Options are shown in Table 4.9. Following a qualitative review, 15 options were carried forward from Sub-Area 2 formation to the MCA stage with the following two options screened out:

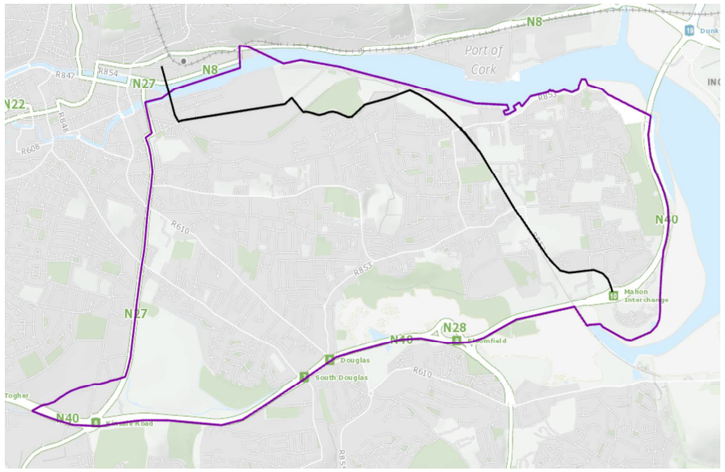
- Option 10; and
- Option 16.

These options were screened out as they did not deliver on the high-level objectives of the Proposed Scheme, presented significant engineering challenges or limited connectivity to carry across to Sub-Area 1 and were more convoluted routes (resulting in less competitive journey times).

Table 4.9 Sub-Area 2 Corridor Options (derived from formation maps)

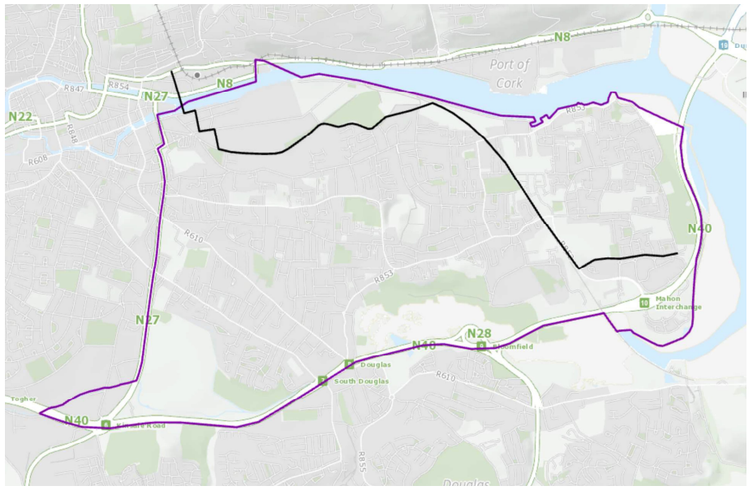
Option 1  **Outcome: Taken forward to MCA**	**Option 3**  **Outcome: Taken forward to MCA**	**Option 5**  **Outcome: Taken forward to MCA**
Option 2  **Outcome: Taken forward to MCA**	**Option 4**  **Outcome: Taken forward to MCA**	**Option 6**  **Outcome: Taken forward to MCA**

Option 7



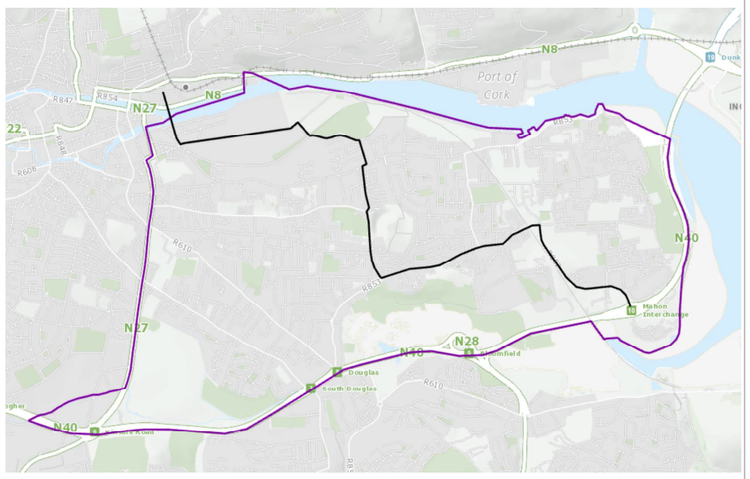
Outcome: Taken forward to MCA

Option 9



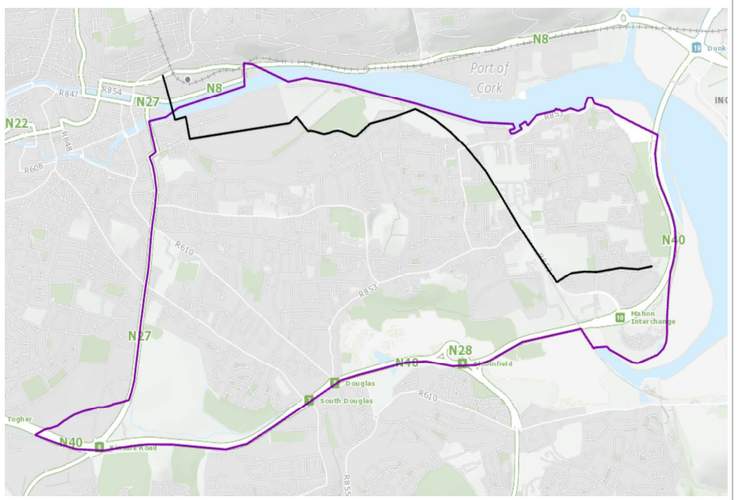
Outcome: Taken forward to MCA

Option 11



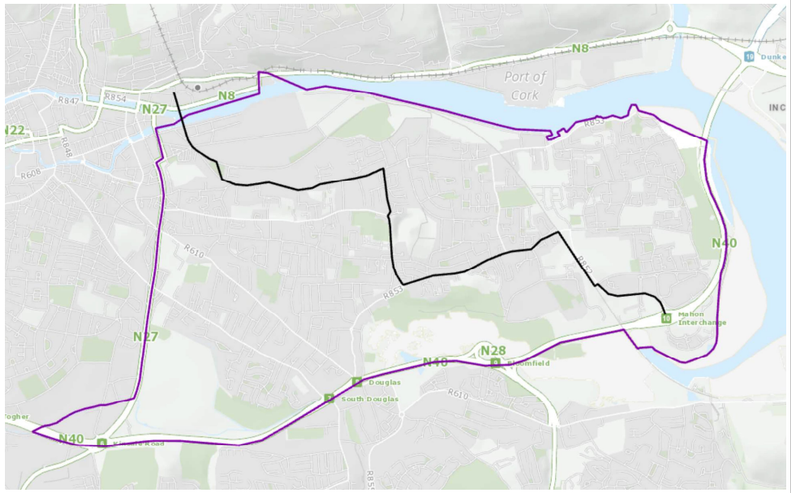
Outcome: Taken forward to MCA

Option 8



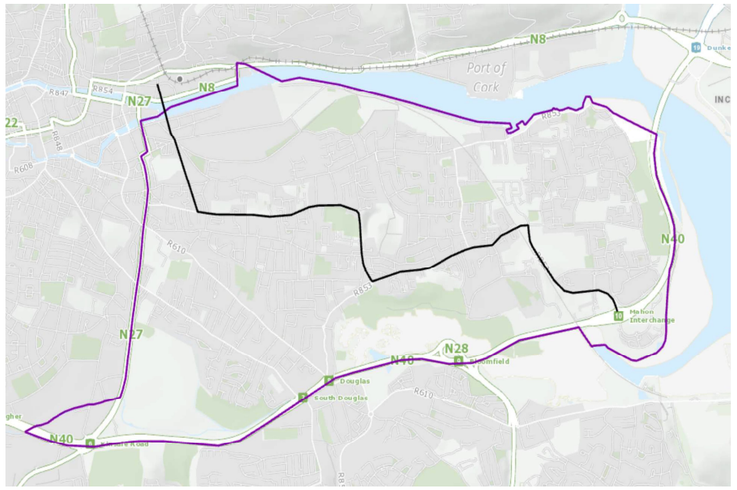
Outcome: Taken forward to MCA

Option 10



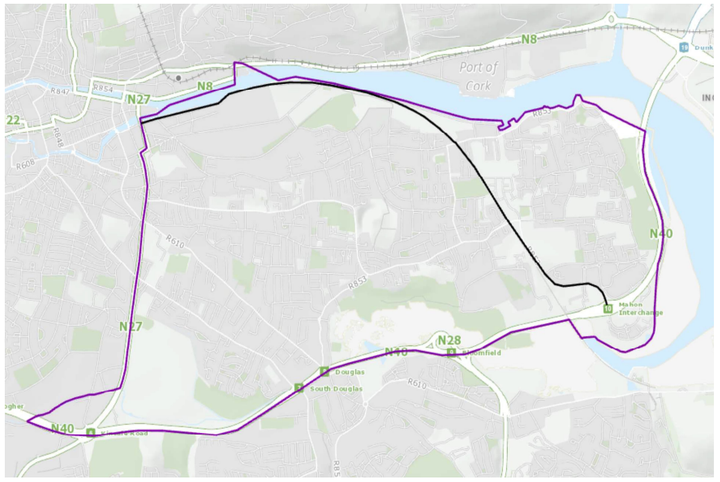
Outcome: Ruled Out

Option 12



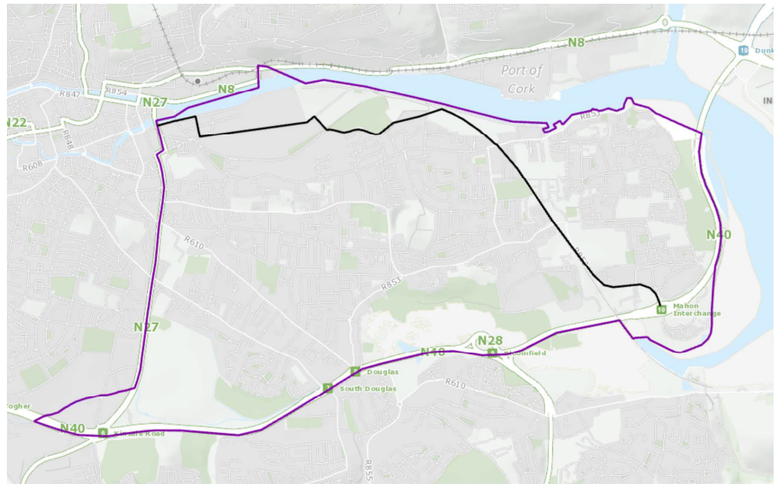
Outcome: Taken forward to MCA

Option 13



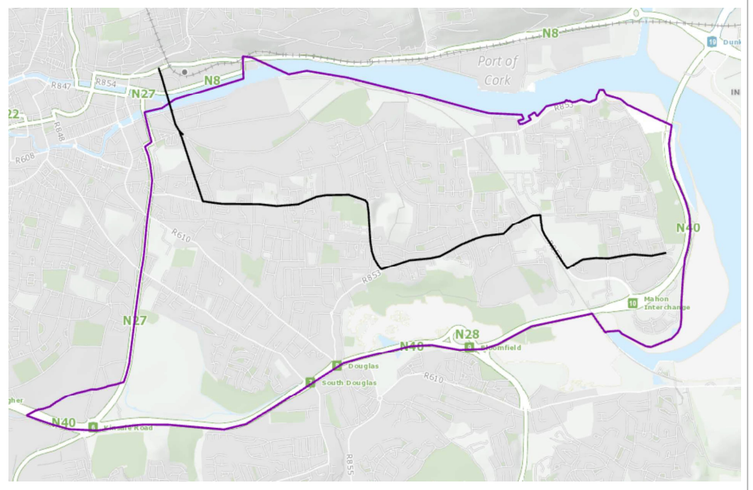
Outcome: Taken forward to MCA

Option 15



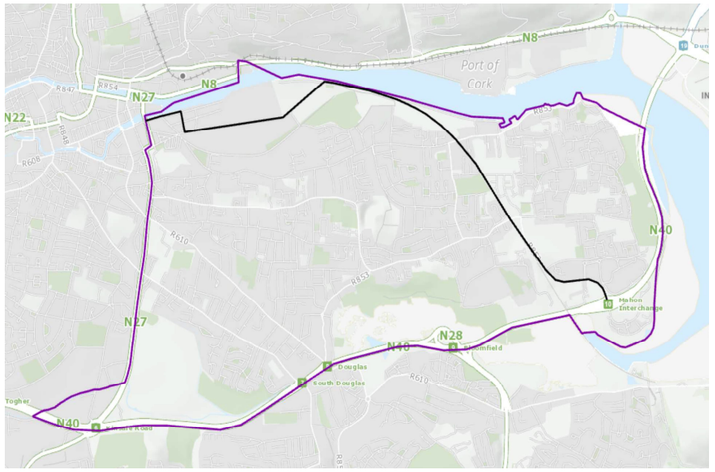
Outcome: Taken forward to MCA

Option 17



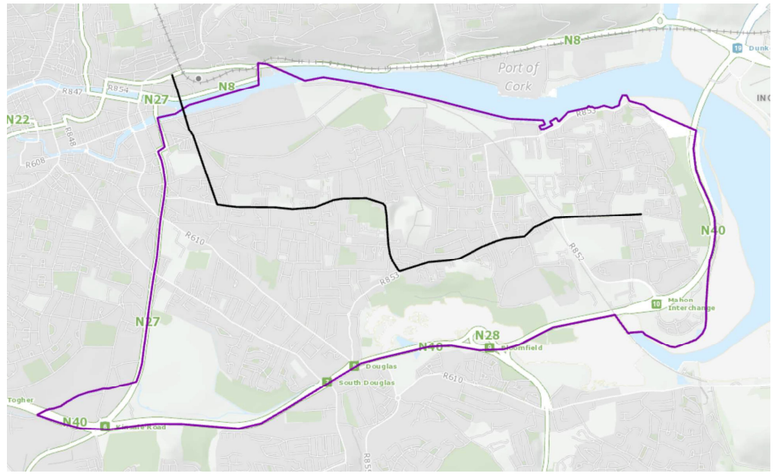
Outcome: Taken forward to MCA

Option 14



Outcome: Taken forward to MCA

Option 16



Outcome: Ruled Out

4.6.3 Sub-Area 3: Area Options Formation

Four core spine routes, running west to east though Sub-Area 3 as outlined in Figure 4.10. These were the initial geometrically feasible options (prior to further assessment). These were identified as follows:

- Core Spine Route 1 – Yellow Route;
- Core Spine Route 2 – Pink Route;
- Core Spine Route 3 – Brown Route; and
- Core Spine Route 4 – Green Route.

Each of these core spines routes could serve a Strategic Park and Ride facility for the N22 on the western extent of each route.

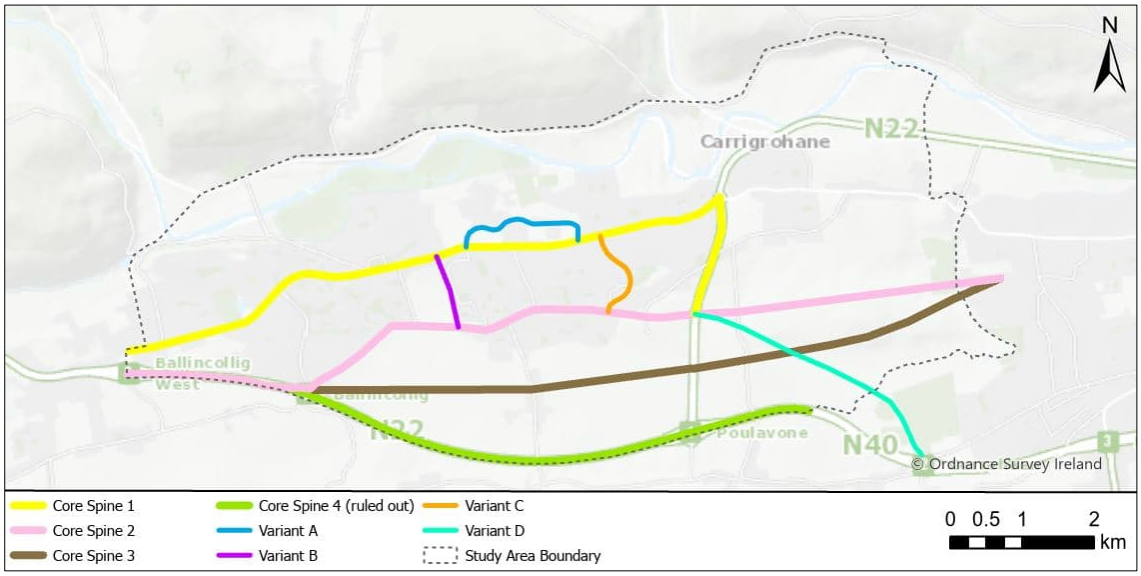


Figure 4.10 : Sub-Area 3 Core Spines and Variant (connecting) Spines for Area Options

4.6.3.1 Summary of Area Options Formation for Sub-Area 3

Following the sifting exercise of potential sections within each sub-area to be brought forward for further consideration, geometrically feasible Area Options were identified for each sub-area. These geometrically feasible Area Options were based on a high-level assessment and assessment of the LRT design standards.

Core Spines were identified on the Area Options, with associated variants of each Core Spine driven by inclusion of particular sections. The Core Spines formed the basis of the options that were carried forward for further assessment through MCA.

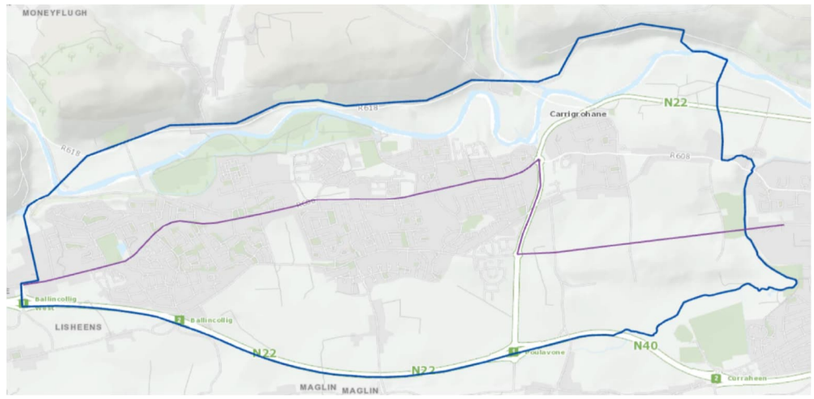
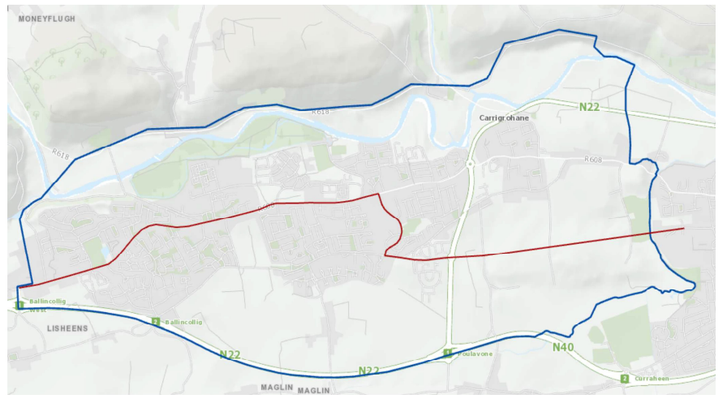
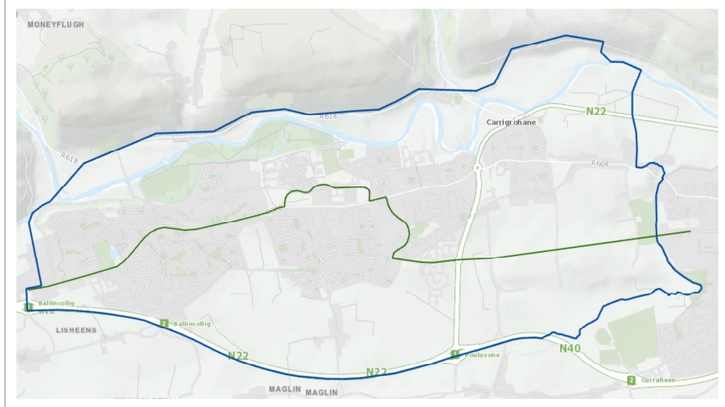
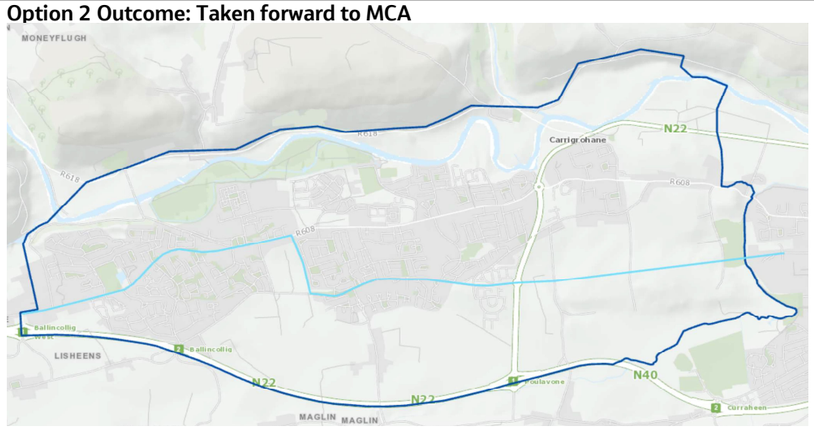
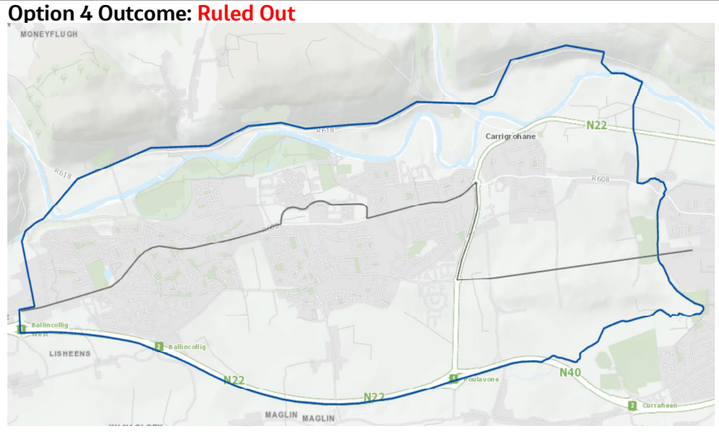
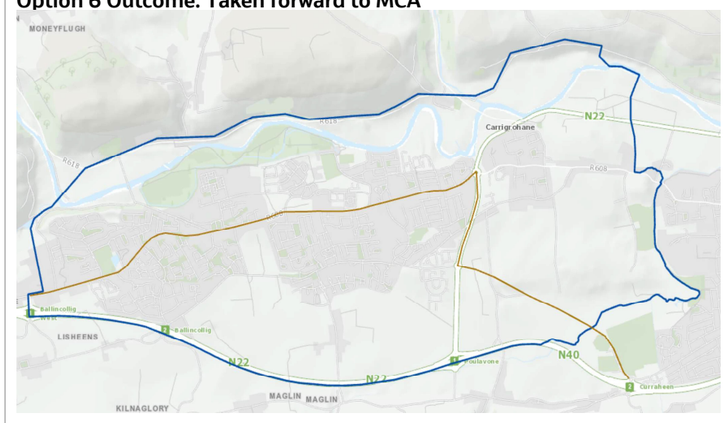
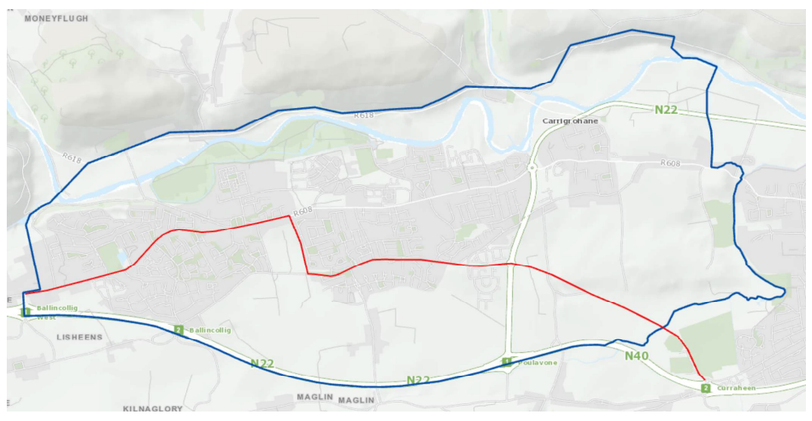
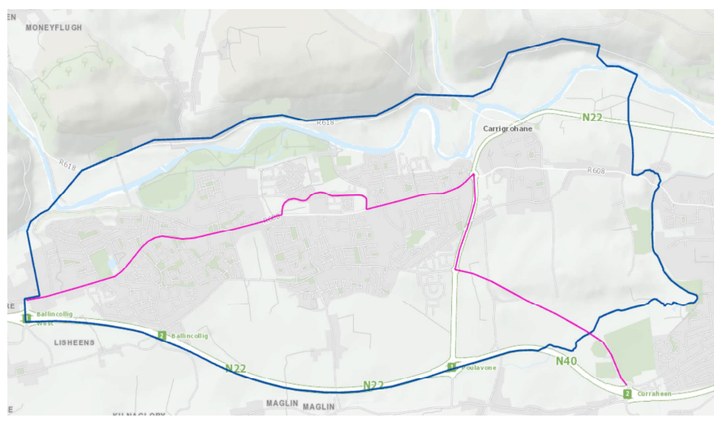
For Sub-Area 3 there were 22 options identified. The list of Area Options are shown in Table 4.10. Following a qualitative review, 14 options were carried forward from Sub-Area 3 formation to the MCA stage with the following eight options screened out:

- Option 4;
- Option 5;

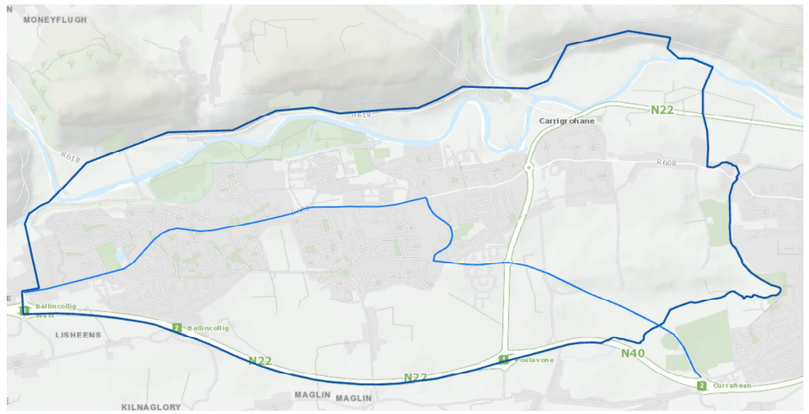
- Option 9;
- Option 10;
- Option 19;
- Option 20;
- Option 21; and
- Option 22.

These options were screened out as they did not deliver on the high-level objectives of the Proposed Scheme, presented significant engineering challenges or limited connectivity to carry across to Sub-Area 1 and were more convoluted routes (resulting in less competitive journey times).

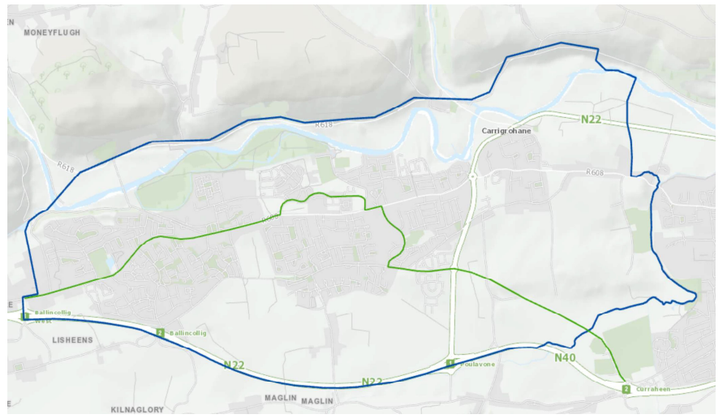
Table 4.10 Sub-Area 3 Corridor Options (derived from formation maps)

Option 1 Outcome: Taken forward to MCA 	**Option 3 Outcome: Taken forward to MCA** 	**Option 5 Outcome: Ruled Out** 
Option 2 Outcome: Taken forward to MCA 	**Option 4 Outcome: Ruled Out** 	**Option 6 Outcome: Taken forward to MCA** 
Option 7 Outcome: Taken forward to MCA 	**Option 9 Outcome: Ruled Out** 	**Option 11 Outcome: Taken forward to MCA** 

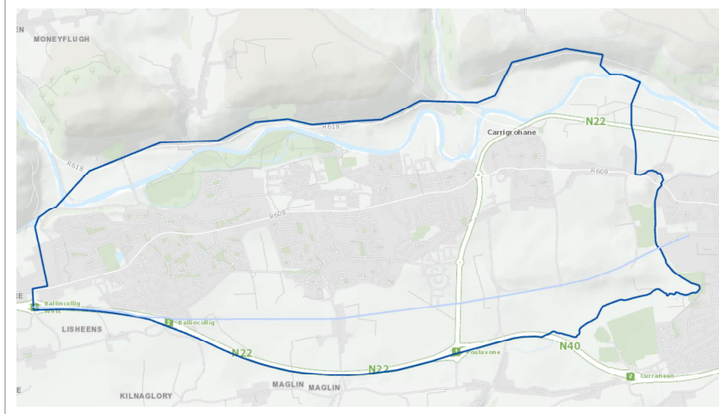
Option 8 Outcome: Taken forward to MCA



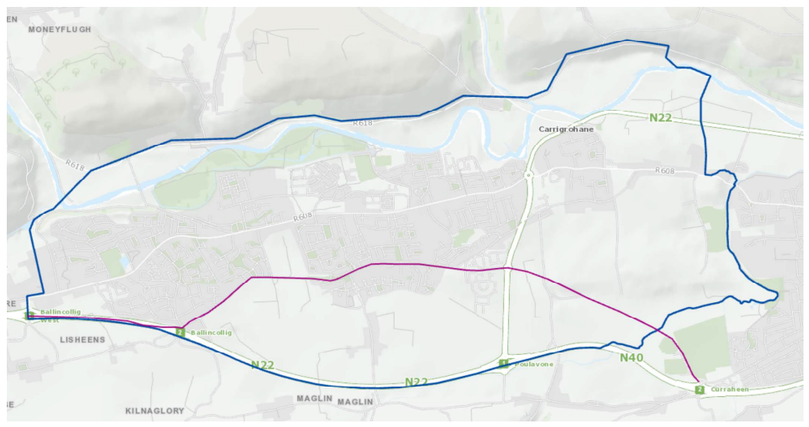
Option 10 Outcome: Ruled Out



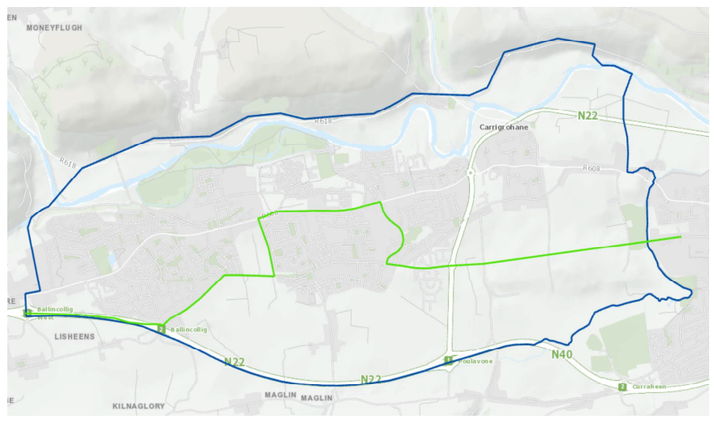
Option 12 Outcome: Taken forward to MCA



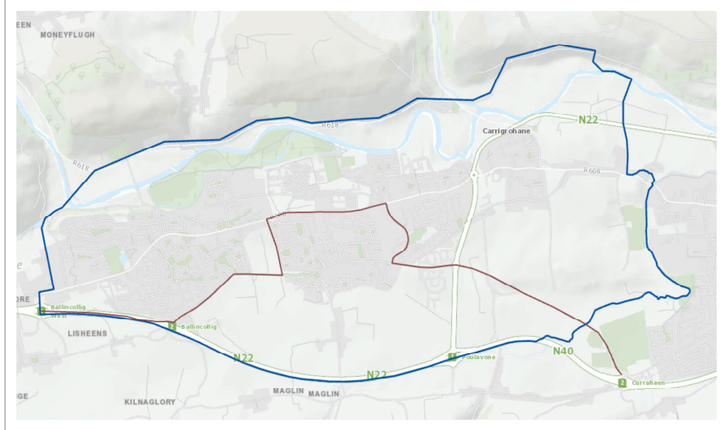
Option 13 Outcome: Taken forward to MCA



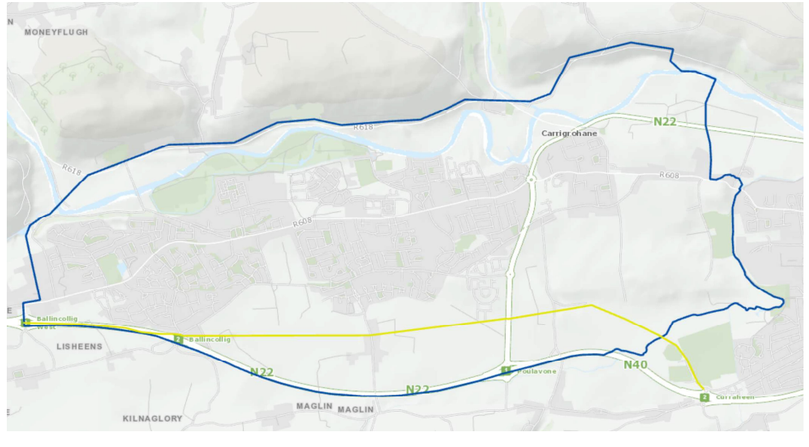
Option 15 Outcome: Taken forward to MCA



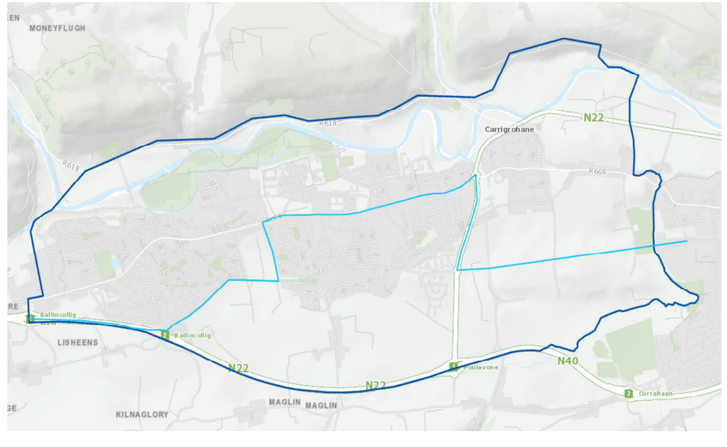
Option 17 Outcome: Taken forward to MCA



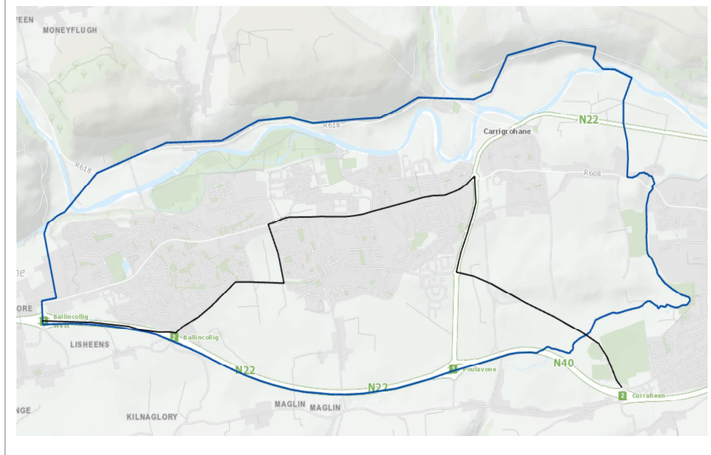
Option 14 Outcome: Taken forward to MCA



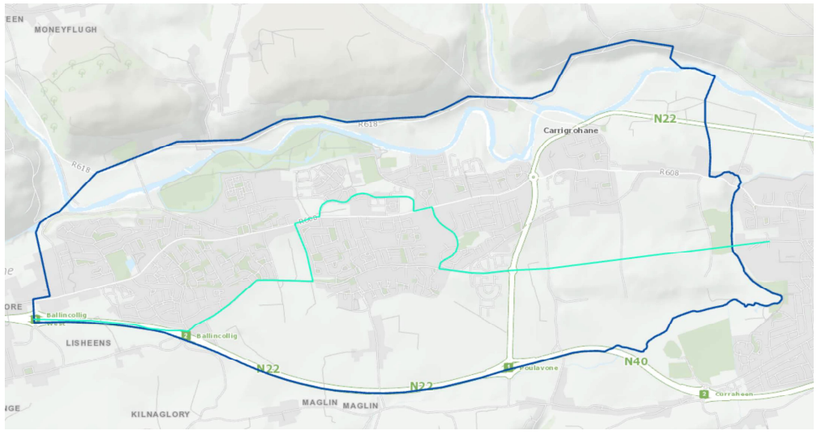
Option 16 Outcome: Taken forward to MCA



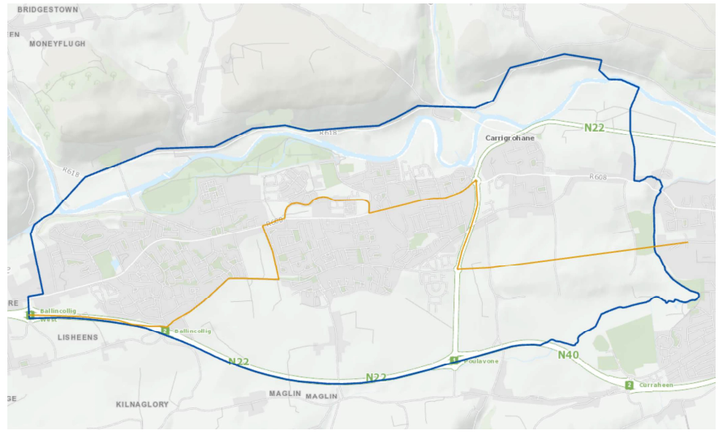
Option 18 Outcome: Taken forward to MCA



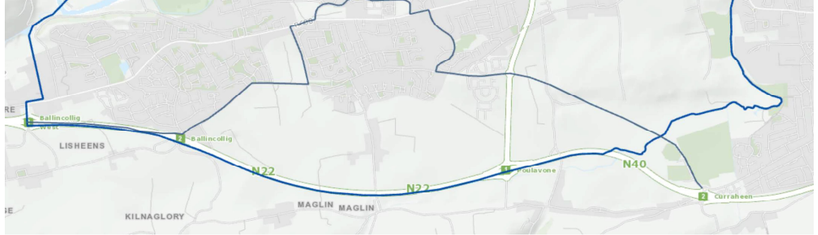
Option 19 Outcome: Ruled Out



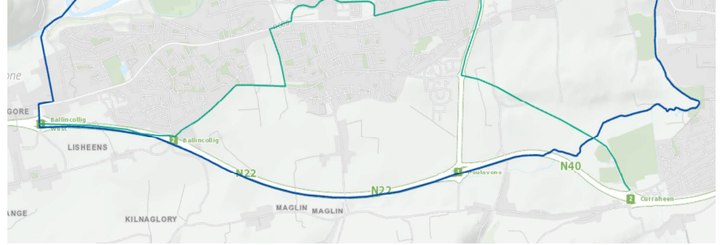
Option 21 Outcome: Ruled Out



Option 20 Outcome: Ruled Out



Option 22 Outcome: Ruled Out



4.7 Area Options Formation (Sub-Areas 1-3) Summary

This chapter sets out the purpose of the Step A Spider Web Preliminary Assessment, which was to determine feasible and practicable area sections that could accommodate the Proposed Scheme and inform the development of a long-list of Area Options.

The steps that were adopted in the Spider Web sifting included the identification of all feasible and practical route sections and suitability assessments for the Proposed Scheme in terms of engineering and space-proofing, gradient, environmental considerations, and land use and transport planning considerations. The Spider Web sifting process and assessment was underpinned by the Cork LRT Environmental Constraints Report and its associated appendices.

The sifting exercise undertaken as part of the Spider Web process resulted in the identification of feasible and practicable Area Sections that could accommodate the Proposed Scheme for the three Sub-Areas: 184 sections for Area 1, 75 sections for Sub-Area 2 and 35 sections for Sub-Area 3.

These route sections were considered as part of the Area Option development process and combined to form multiple alignment options within each of the three Sub-Areas.

Having established the potential sections within each study area that were brought forward for further consideration, geometrically feasible area options were identified for each study area. These geometrically feasible area options were based on a high-level assessment and assessment of the LRT design standards.

In particular, consideration was given to potential demand (existing and future) based on indicative stop locations, proximity to key trip attractors, integration with existing and future Public Transport, and the directness of routes. As with the Spider Web Preliminary Assessment, further consideration was given to the environmental constraints with constraints avoided where possible.

In addition to the geometrically feasible area options being assessed on their individual merits against the objectives, in some instances, area options were screened relative to each other allowing some area options to be ruled out if similar, more suitable alternatives existed.

Finally, consideration was given to the interaction of options between study area sections to ensure that all suitable connections between study areas were considered at the Step B Area Option MCA Stage.

The summary of options identified for each study area were as follows:

1. For Sub-Area 1 there were 28 options identified. Following a qualitative review, 10 options were carried forward from the Sub-Area 1 formation to the MCA stage;
2. For Sub-Area 2 there were 17 options identified. Following a qualitative review, 15 options were carried forward from the Sub-Area 2 formation to the MCA stage; and
3. For Sub-Area 3, there were 22 options identified. Following a qualitative review, 14 options were carried forward from the Sub-Area 3 formation to the MCA stage.

5 Step B: Multi-Criteria Analysis

5.1 Introduction

This chapter sets out the design development process (including the assessment and MCA) that was undertaken during Step B. Following the conclusion of the Spiders Web (Step A) assessment and identification of the long list of Area Options within each of the Study Areas, the primary focus of Step B was to identify End-to-End Route Options (ETE) through the application of the MCA. The outcomes of Step B were carried forward for further design development as well as the application of a more detailed MCA at Step C. The assessment approach including decisions points for Step B is outlined in Figure 5.1.

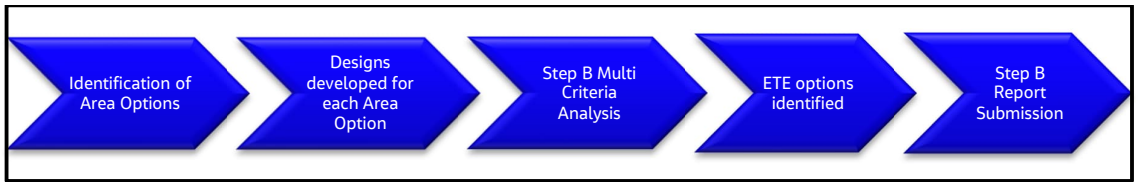


Figure 5.1: Flow chart of key decision points throughout Step B

5.2 Step A: Spider Web Preliminary Assessment Outcomes

The outcome of Step A, the Spider Web Preliminary Assessment process, was used to determine feasible and practicable route sections that could accommodate the Proposed Scheme and inform the development of a long list of Area Options. The analysis from the Spider Web Area Formation brought forward 39 out of 67 potential area options. This is broken down into 10 out of 28 options for Area 1, 15 out of 17 Options for Area 2, and 14 out of 22 options for Area 3, as shown in Figure 5.2.

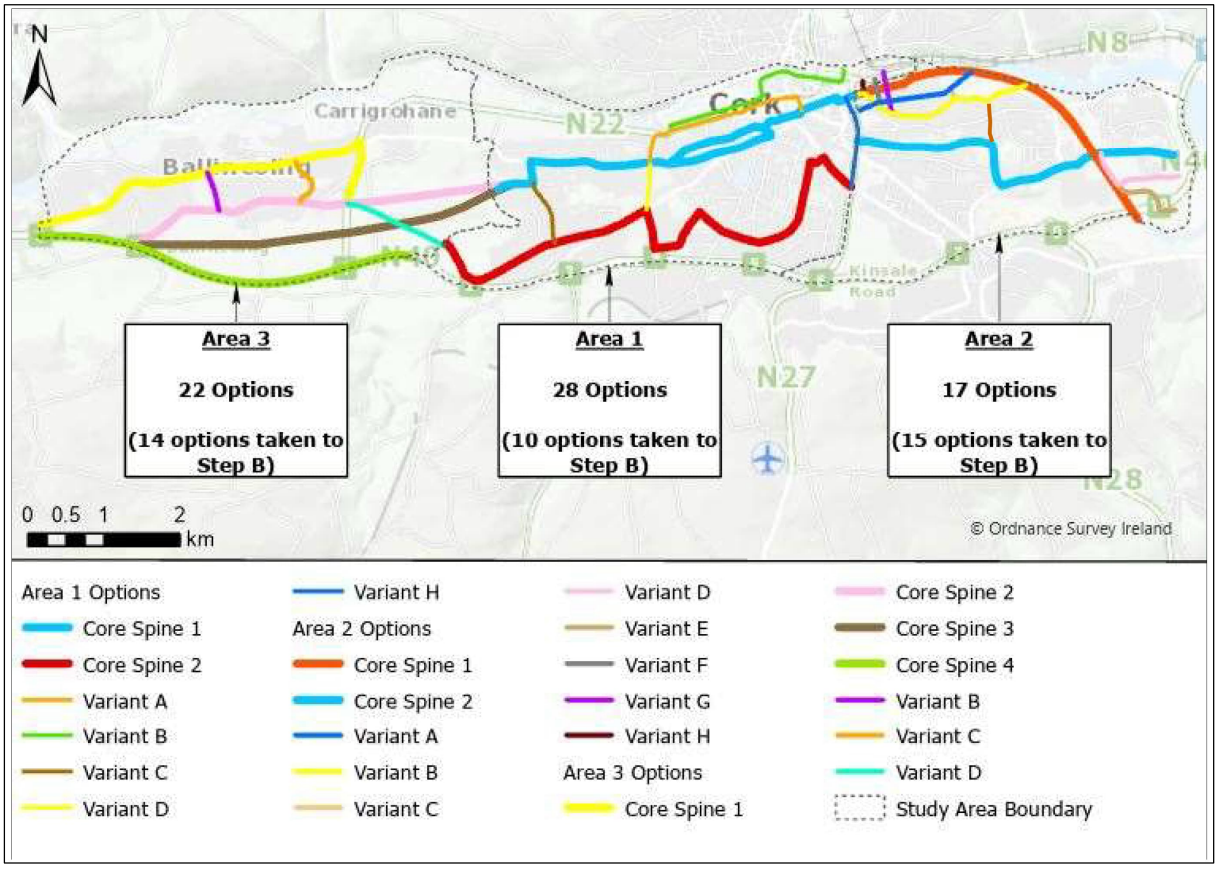


Figure 5.2: Spider Web Areas Formation Summary

5.3 Design Development during Step B

The Area Options which emerged from Step A, were progressed to Step B MCA. To underpin the Step B MCA process, designs for all area options were developed to enable a more detailed understanding of their feasibility, whilst also providing a clearer indication of potential impacts associated with each option.

During the initial design development phase of Step B, each sub-area was reviewed. The outcomes of Step A in relation to Sub-area 3 and Sub-area 2 remained unchanged. However, the Step A outcomes for Sub-area 1 were further refined.

As shown in Figure 5.3, sections of the red core spine associated with Sub-Area 1, were ruled out due to convoluted routing, associated slow and unattractive journey times to achieve a mode shift from private cars, low levels of catchment, and lack of connectivity to the core city centre. This phase of the design development resulted in a reduction of the 10 area options shortlisted for Sub-Area 1, to seven Sub-Area options to be taken forward to the Step B MCA.

Figure 5.3 identifies the sections of the red core spine in Sub-area 1 that were not taken forward to the Step B MCA.

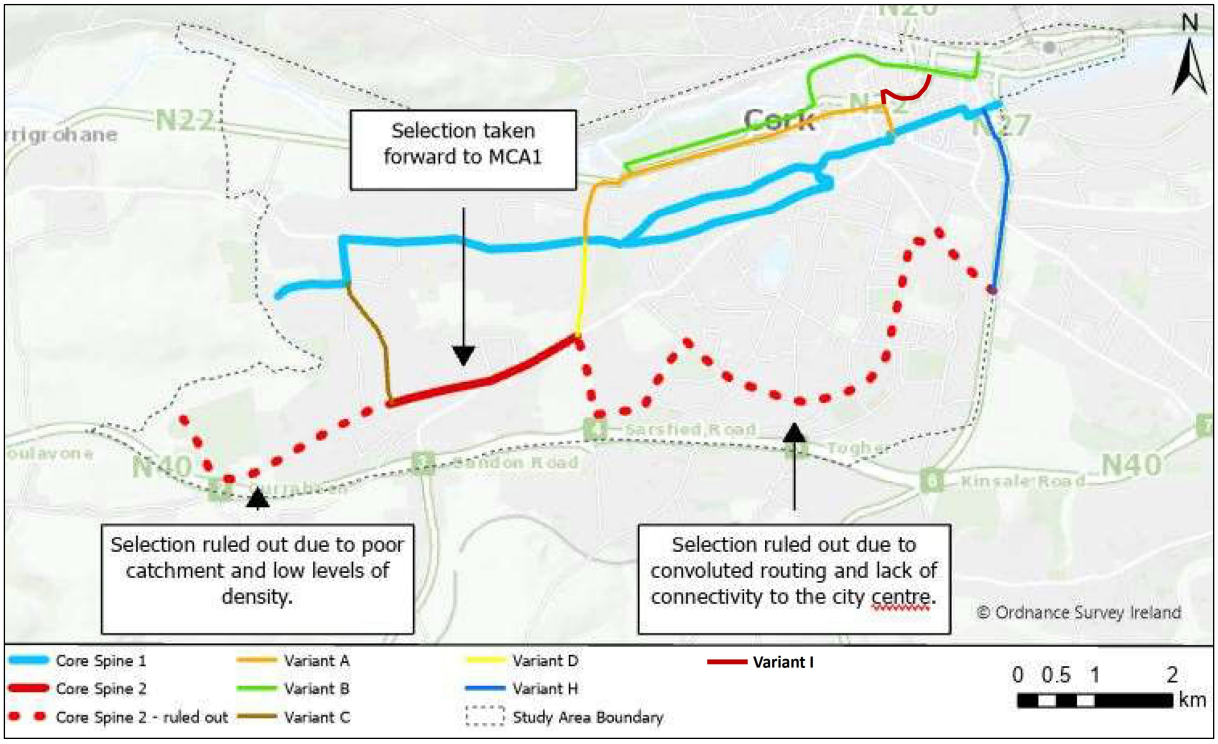


Figure 5.3: Sections of Red Core Spine in Area 1 not taken to MCA

Designs were progressed for the remainder of the options in each area and were carried through to the Step B MCA are as follows:

- Sub-Area 1: 7 Options;
- Sub-Area 2: 15 Options; and
- Sub-Area 3: 14 Options.

The Step B MCA was used to analyse the 36 area route options outlined above which were further refined through design development from the previous stage (Step A), with each area route option analysed under set criteria across all three Sub-Areas.

The design development included a typical cross section which could be from 11.5m to 21.5m, which allowed space proofing of each route and the implications it had in terms of land-take, level segregation and cycle provision. Also, indicative stops were provided for all routes. Additionally, potential building demolition, impact on boundaries and landscape and impact on junctions were outlined on the Step B designs for each area.

Each route option for the Step B MCA was assessed on criteria outlined in the "Common Appraisal Framework (CAF) for Transport Projects and Programmes" guidelines (DoT 2020).

5.4 Step B Methodology

As outlined in section 3.4.2, to underpin the Step B MCA process, designs for all Area Route Options were developed to enable a more detailed assessment of their feasibility, whilst also providing a clearer indication of potential impacts associated with each option. The designs for each option provided the primary reference tool for the Step B MCA process.

In line with the established methodology as outlined in Chapter 3, an appreciation of constraints and opportunities within the study area as well as the defined Proposed Scheme objectives, informed the establishment of project-specific options assessment criteria.

The Step B MCA assessment compared area options against each other within each of the three study areas. The scoring was founded on professional judgement and expertise in respect of the items to be qualitatively evaluated, and that comprehensively assessed the key relevant criteria in accordance with industry good practice.

For the Step B MCA the CAF criteria "Physical Activity" was not included as it would not be a key differentiator on the assessment of the Area Options. "Physical Activity" relates to the potential health benefits derived from the increase in active modes. For this study "Physical Activity" assessed cycle facilities available around each option and their proposed stops, it also looked at the space available for cycle tracks along each route option and the associated potential uplift in cyclists. This primary criteria was used in Step C MCA.

The assessment compared the relevant area options, identifying and summarising the comparative merits and disadvantages of each alternative under all the applicable criteria and sub-criteria identified in

Table 5.1.

To ensure the Step B MCA was accurately measured and that each route option was comparable, each of the primary criteria set out was broken down into sub-criteria. The sub-criteria outlined in Chapter 3 is shown below.

Table 5.1: Summary of the Five Appraisal Criteria and related Sub-Criteria

Assessment Criteria	Assessment Sub-Criteria	Approach
1. Economy	1.a. Option Cost Estimate	Direct and indirect costs – high level cost estimate, level of detail will be equivalent for each area option
	1.b. Transport Reliability	Qualitative Assessment to assess transport service reliability. Based on level of segregation
	1.c. Journey Time	Assessment of indicative journey times for each area option including dwell times at stops etc
	1.d. Catchment Transport Demand	GIS Analysis – 500m and 1km Catchment Analysis – Population and employment per km
2. Integration	2.a. Land Use Policy Integration	Compatibility with existing and future land use

	2.b. Public Transport Integration	Compatibility with existing and future PT network
	2.c. Integration with Other Modes	Compatibility with existing walking, cycling, and traffic
3. Accessibility & Social Inclusion	3.a. Key Trip Attractors	Ability to serve key trip attractors
	3.b. Deprived Geographic Areas (social inclusion)	GIS analysis to Pobal, CSO
4. Environment	4.a. Material and Cultural Aspects (Archaeology, Architectural and Cultural Heritage)	Based on comparative (quantitative and qualitative) assessment of direct impacts and their likely effects.
	4.b Biodiversity	Comparative assessment based on the data collections in relation to biodiversity
	4.c Landscape and Visual	Comparative assessment based on the data collection in relation to Landscape and Visual Impact Assessment (LVIA)
	4.d. Population	Comparative assessment based on the data collection across the areas and locations of importance to people and communities
5. Safety	Road interfaces	Level of segregation, Interface with roads/junctions, collision data

The scoring five-point scale was coloured coded, with options showing significant advantages over other options graded dark green, significant disadvantages over other options graded red, orange and light green being adopted for some advantages/disadvantages and yellow being used for options which typically delivered comparable results to all or the majority of other options.

The scoring applied in this MCA analysis was based on the assessment rule – '*an option is only scored with significant advantages (dark green) if an option with significant disadvantages (red) can also be identified*'.

5.5 Step B MCA

Table 5.2 shows the total number of options identified during the Step A Spider Web process and subsequently how many options were brought forward to Step B for the MCA assessment against each of the Study Areas (1-3).

Table 5.2: Total Number of Options Identified During the Step A Spider Web Process

	STEP A	STEP B	
Sub-Area	**Total Number of Options identified by Spider Web**	**Number of Options brought forward (sifted) for MCA**	**Specific Option numbers (sifted from Spider Web Long List)**
1	28 Options	7 Options	1, 2, 3, 9, 12, 17, 18
2	17 Options	15 Options	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 17
3	22 Options	14 Options	1, 2, 3, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18
Total	**67 Options**	**36 Options**	

It is important to note, at this Step B stage the design configurations shown below in sections 5.5.1, 5.5.3, and 5.5.4 were indicative and were subject to further development at Step C. Any route option which made it into Step C was subject to further refinement following a more detailed Multi Criteria Assessment.

5.5.1 Sub-Area 1: Step B MCA Summary

Table 5.3 to Table 5.10 show the summary and overall assessment outcome given to each individual option for Sub-Area 1. This section also highlights the options that were recommended for the next 'end-to-end' option stage. Chapter 6 discusses each of these 'end-to-end' options in more detail.

Table 5.3: Sub-Area 1 MCA Summary Tables – Option 1

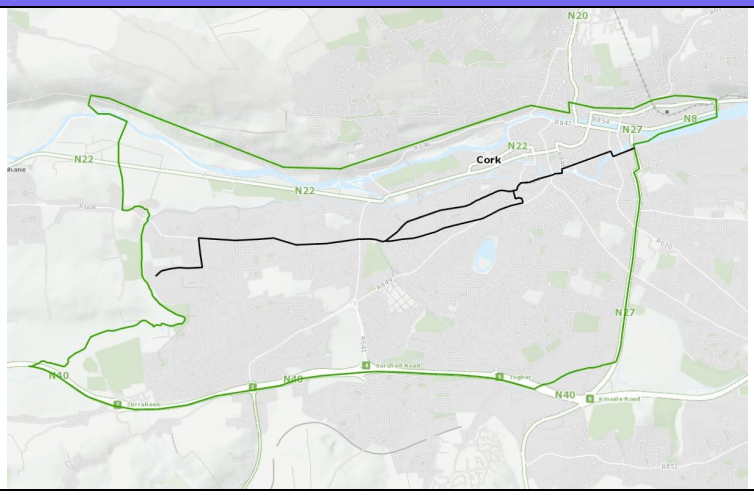
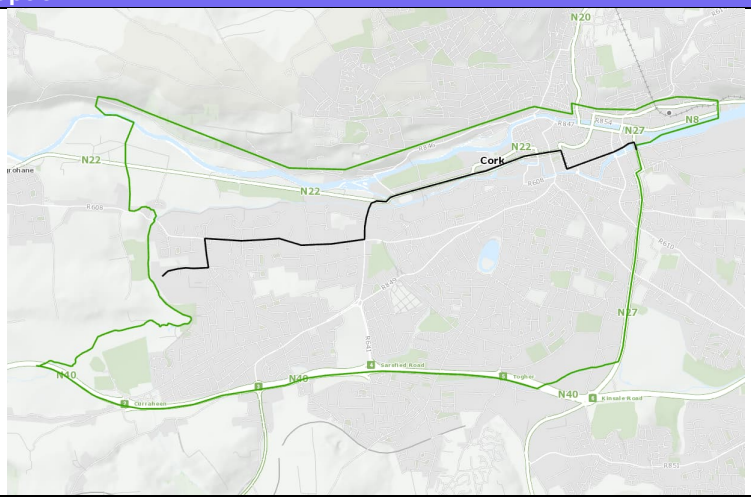
Option 1		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 1 presents significant challenges to accommodate an LRT system. This is due partly to the alignment following a number of narrow streets with tight radii. Bandon Rd, Noonan Rd, Gregg Rd, Gillabbey St & Bishop St have 6 separate 25m radius curves within 400m of proposed track, which will require higher ongoing maintenance costs. This sub-area option also seeks to introduce a single-track loop, which will attract higher Option Cost Estimates with potentially lower catchment, leading to a poor performance on Economy and Accessibility. This sub-area option also requires the construction of a new bridge at Sullivan's Quay to connect to Grand Parade. In terms of Integration, this option also performs less well when compared to other options, with the single-track loop playing a factor reducing integration to the existing public transport network, with no existing routes operating along Magazine Road, and performing less well due to integration with surrounding land use policy. The environment for Option 1 contains narrow, mature, densely plotted residential streets for its entire length – with multiple private entrances, very narrow footpaths and in some instances mature boundary walls and front gardens . The route passes a large number of residential and commercial properties, with the potential to cause significant disruption, especially during construction. Option 1 is routed immediately next to the landmark St Fin Barre's Cathedral, which makes an important contribution to the townscape character, is a Protected Structure of International importance and a Recorded Monument. There is potential that the route would impact on the associated graveyard which is also a Recorded Monument and has the potential to impact the Protected Linear Vew from South Mall across to St Fin Barre's Cathedral. A single track would struggle to integrate comfortably, underpinning a comparatively poor performance in the environment criteria. On Safety Option 1 performs comparably poorly due to the scale of the single-track loop, increasing impact and interface with the number of junctions.		

Table 5.4: Sub-Area 1 MCA Summary Tables–- Option 2

Option 2		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal

Option 2 performs well with advantages identified for the Economy criteria as it is likely to attract the least Option Cost Estimate comparative to other options and does not require significant supporting structures to deliver the route, with all sections proposing to utilise existing carriageway. Whilst Option 2 integrates better with the Public Transport network than Option 1, it still scores less well overall on Integration criteria due to its less favourable integration with land use policy. Option 2 serves less areas of social deprivation comparable to other options and is scored down on accessibility, however Option 2 directly serves University College Cork which is a significant Key Trip Attractor within the City Centre. Option 2 for Environment has been assessed has having 'some advantages' overall when compared against other options in Sub-Area 1, although it is routed within Cork City's historic core which has a very high archaeological potential which is similar for all route options in Sub-Area 1. Further consultation, design and assessment at Step C will provide further detail. Option 2 has been assessed by Biodiversity, Landscape and Population as having 'some advantages' compared to other options due to utilising mostly existing carriageway and hardstanding. Option 2 interfaces with a higher number of junctions on the network and thus performs less favourable on Safety criteria.

Table 5.5: Sub-Area 1 MCA Summary Tables–- Option 3

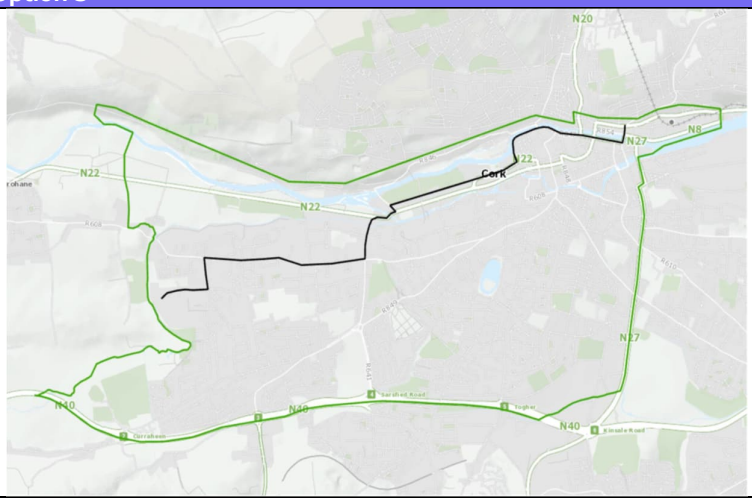
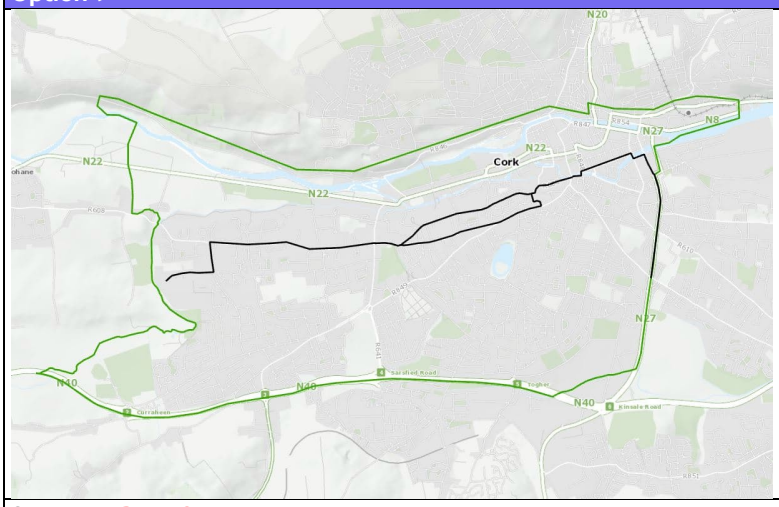
Option 3		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 3 performs comparably well on Economy with advantages due to its route length and competitive journey times. However, the alignment for Option 3 presents significant challenges to accommodate an LRT system due to its geometric constraints, resulting in significant disadvantages on Integration. With particular emphasis on Grenville Place, this option would require significant interventions and supporting structure over the River Lee. Option 3 has some disadvantages to other option in Accessibility, serving on 3 out of 26 deprived areas. Option 3 has significant disadvantages comparable to other options, due to land-take, its disruption of existing residential property, its significant disadvantages for Biodiversity, Landscape and Visual and Material Aspects when compared to other route options. Option 3 would also avoid the core of the medieval city. Option 3 performs comparably well on Safety due to its proposed off-carriageway sections of segregation along the Quay adjacent to the River Lee.		

Table 5.6: Sub-Area 1 MCA Summary Tables–- Option 9

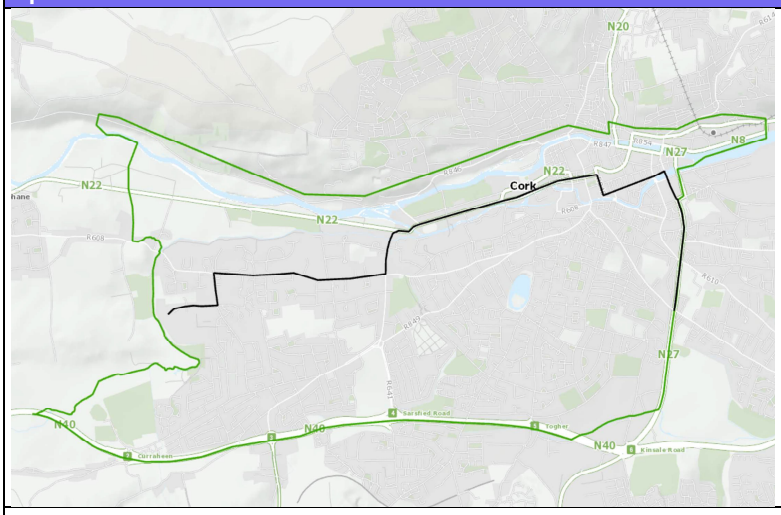
Option 9		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 9 presents significant challenges to accommodate an LRT system. This is due partly to the alignment following a number of narrow streets with tight radii. Bandon Rd, Noonan Rd, Gregg Rd, Gillabbey St & Bishop St have six separate 25m radius curves within 400m of proposed track, which will require higher ongoing maintenance costs. This area option also seeks to introduce a single-track loop, which will attract higher capital costs with potentially lower catchment, leading to a poor performance on Economy and Accessibility. This area option also requires the construction of a new bridge at Sullivan's Quay to connect to Grand Parade. In terms of Integration, this option also performs less well when compared to other options, with the single-track loop playing a factor reducing integration to the existing public transport network, with no existing routes operating along Magazine Road, and performing less well due to integration with surrounding land use policy.

The receiving environment for Option 9 contains narrow, mature, densely plotted residential streets for its entire length – with multiple private entrances, very narrow footpaths and in some instances mature boundary walls and front gardens, even a single track would struggle to integrate comfortably. Option 9 would have significant disadvantages over other route options for Population and Material and Cultural Aspects as it passes a large number of residential and commercial properties and has the potential to impact the grounds of St. Fin Barre's Cathedral and its graveyard. On Safety Option 9 performs comparably poorly due to the scale of the single-track loop, increasing impact and interface with the number of junctions.

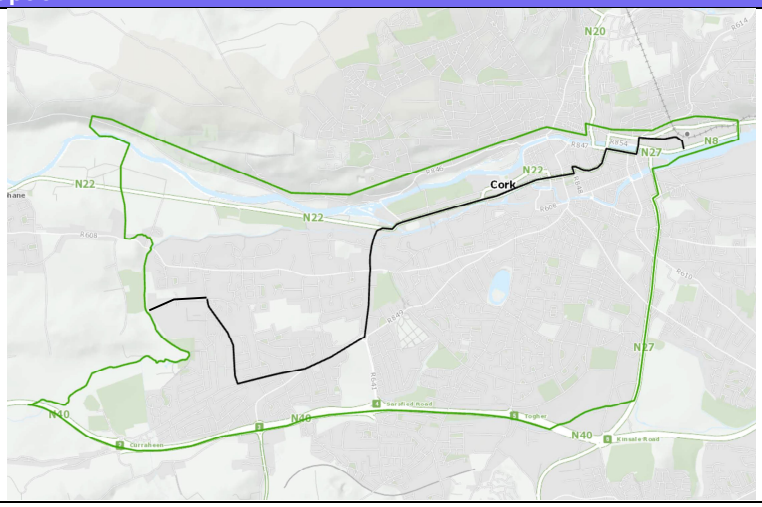
Table 5.7: Sub-Area 1 MCA Summary Tables–- Option 12

Option 12		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal

Option 12 performs comparably well with advantages identified for the Economy criteria and is likely to attract lower Option Cost Estimate comparative to other options. This option does not require significant supporting structures to deliver the route, with all sections proposing to utilise existing carriageway. Option 12 serves less areas of social deprivation comparable to other options and is scored down on accessibility, Whilst Option 12 integrates better with the Public Transport network than Option 1, it still scores less well overall on Integration criteria due to its less favourable integration with land use policy. This Option has overall been rated as having some disadvantages over other options for Environment, in particular for Landscape and Visual and Material and Cultural Aspects. However, it is noted that Population and Biodiversity scored this route with having some advantages over others as the route will mostly remain on existing road/hard standing. When compared to other options in sub-area 1 across all criteria, Option 12 still ranks well, particularly with utilisation of all carriageways running and connection along the N27 and warrants further assessment at Step C.

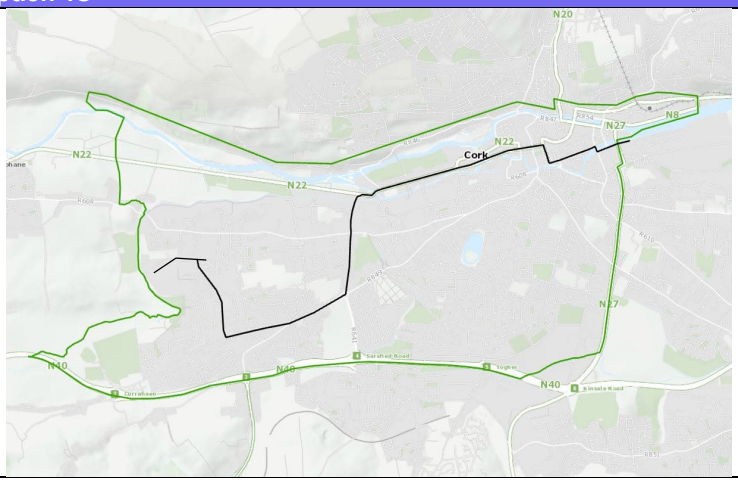
Table 5.8: Sub-Area 1 MCA Summary Tables–- Option 17

Option 17		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal

Primarily due to its length, Option 17 has some disadvantages on the Economy criteria, also leading to longer journey times. However, Option 17 performs well with advantages identified for Integration and Accessibility criteria, due to the key trip attractors that this option serves i.e. Wilton Shopping Centre and Cork University Hospital and the size of the catchment area being served. Along with Option 18, this option also serves the greatest catchment when compared to other options. Option 17 will have the opportunity to connect directly to Kent Station via St Patrick Street. Overall Option 17 has some advantages over other route options for Environment. This route has significant advantages when compared against other route options for Population and has some advantages when compared against other route options for Biodiversity and Landscape and Visual as this option utilises mostly existing carriageway and hardstanding resulting in less potential impact to habitat and Cork City's Area of High Landscape Value. Safety is comparable across all options. Option 17 interfaces with a high number of junctions on the network and thus performs less favourable on Safety criteria. It should be noted that the junction of Washington Street and St Patrick Street may present some geometric challenges in relation to the required track radius for LRT, this will be assessed in further detail should this option be carried forward.

Table 5.9: Sub-Area 1 MCA Summary Tables–- Option 18

Option 18		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal		
Similar to Option 17, Option 18 has some disadvantages on the Economy criteria as a result of its longer route length, also leading to longer journey times. Option 18 performs well with advantages identified for Integration and Accessibility criteria, due to the key trip attractors that this option serves i.e. Wilton Shopping Centre and Cork University Hospital and the size of the catchment area being served. Along with Option 17, this option also serves the greatest catchment when compared to other options. Option 18 will have the opportunity to connect indirectly to Kent Station via a proposed pedestrian footbridge. Option 18 has been rated as having significant advantages when compared against other options in Sub-Area 1 for Environment. This Option has significant advantages over other options for Biodiversity, Landscape and Visual and Population as this option is less likely to result in the loss of existing trees along the route and utilises mostly existing carriageway and hardstanding. Option 18 interfaces with a high number of junctions on the network and thus performs less favourable on Safety criteria.		

The Table 5.10 shows a summary of outcomes of the MCA on the Sub-Area 1 Options:

Table 5.10: Sub-Area 1 MCA Summary

Study Sub-Area 1 Options	1	2	3	9	12	17	18
Economy							
Integration							
Accessibility & Social Inclusion							
Environment							
Safety							
Preferred Options Recommended for Next Stage	***No***	***YES***	***No***	***No***	***YES***	***YES***	***YES***

5.5.2 Sub-Area 1 Step B Summary of MCA Outcomes

The Preferred area options recommended for Sub-Area 1 offer a range of routing variations and design flexibility for ETE design development moving to into Step C. The Preferred area options recommended to be incorporated within proposed End-to-End options from Sub-Area 1 were as follows:

- Option 2 – utilising Model Farm Road, this presents the scheme with an option with high connectivity to the Docklands via Grand Parade;

- Option 12 – utilising Model Farm Road, this presents the scheme with an option utilising the N27, to connect to Boreenmanna Road;
- Option 17 – utilising Curraheen Road, this option presents the scheme with high connectivity to link with Kent Station via Patrick Street; and
- Option 18 – utilising Curraheen Road, this option presents the scheme an option with high connectivity to the Docklands via Grand Parade.

5.5.3 Sub-Area 2 Step B MCA Summary

Table 5.11 to Table 5.26 show the summary and overall assessment outcome given to each individual option for Sub-Area 2. This section also highlights the options that were recommended for the next 'end-to-end' option stage. Chapter 6 discusses the formation of each of these 'end-to-end' options in more detail.

Table 5.11: Sub-Area 2 MCA Summary Tables–- Option 1

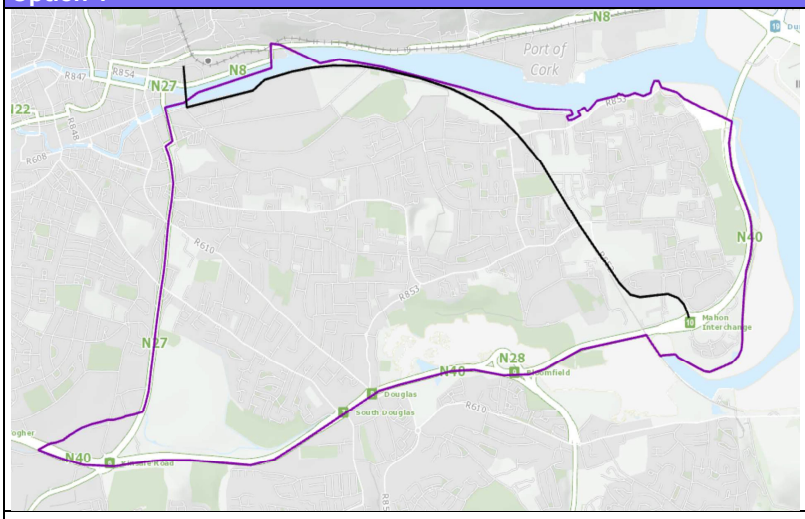
Option 1		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 1 performs well with advantages identified for Economy and is likely to attract lower capital cost comparative to other options, with a comparably shorter route length and optimal journey time. Option 1 performs comparably well on Safety, primarily due to levels of segregation from on-carriageway running. Option 1 is favourable comparable to other options when it comes to Integration, Accessibility, integrating well with active modes and serving 6 out of 7 main trip attractors. Environment overall rated Option 1 as having some disadvantages over other route option in Area 2 as it is routed along the Greenway with the potential impact to habitat and a public open space amenity. However, this area option has been ruled out in favour of option 3, due to the one sided catchment area in the south docklands, when compared to Centre Park Road used in Option 3, which has a two sided catchment area. Option 3 follows a similar route to Option 1 but has higher integration with the existing network.		

Table 5.12: Sub-Area 2 MCA Summary Tables–- Option 2

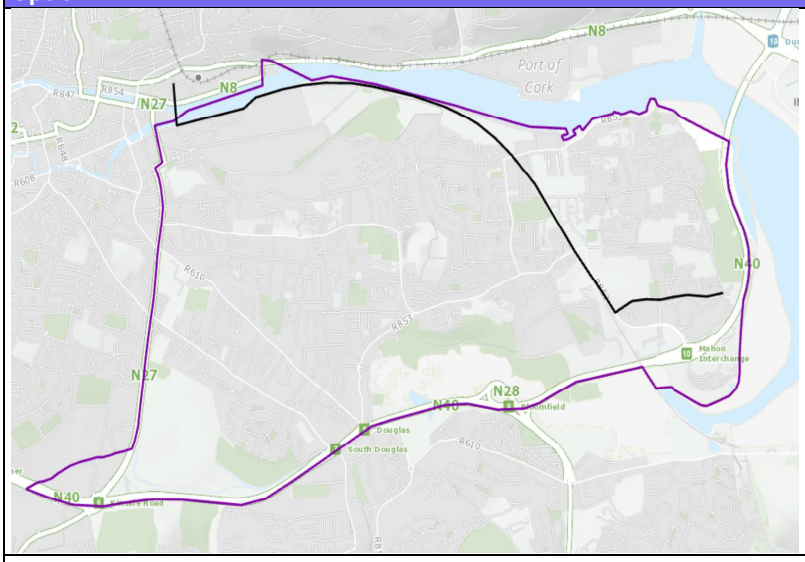
Option 2		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 2 performs well with advantages identified for Economy and is likely to attract lower Option Cost Estimate comparative to other options. Option 2 performs comparably well on Safety, primarily due to levels of segregation from on-carriageway running. Option 2 is favourable when compared to other options when it comes to Integration, Accessibility, integrating well with active modes and serving 6 out of 7 main trip attractors. Environment overall rated Option 2 as having some disadvantages over other route option in Area 2 as it is routed along the Greenway with the potential impact to habitat and a public open space amenity. This option has been ruled out in favour of option 3, due to the one-sided catchment area in the south docklands, when compared to Centre Park Road used in Option 3, which has a two sided catchment area. As with Option 1 and Option 2, Option 3 follows a similar route to Option 2 but has higher integration with the existing network and connects directly with Mahon Shopping Centre.		

Table 5.13: Sub-Area 2 MCA Summary Tables–- Option 3

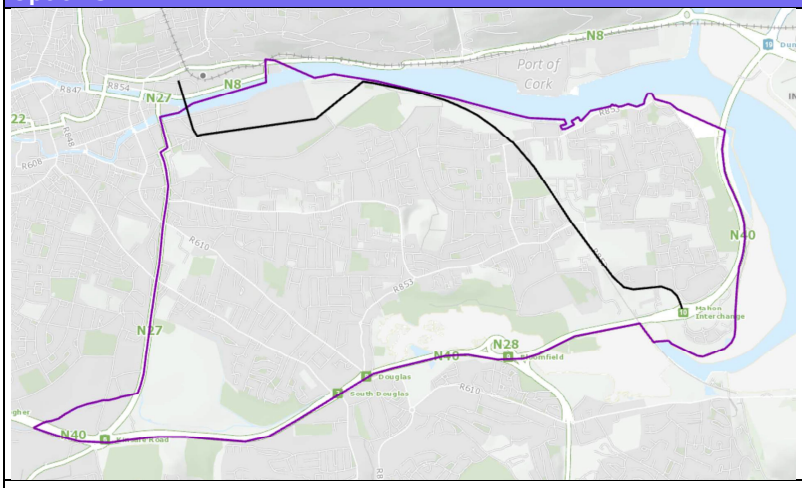
Option 3		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- end to end Option Appraisal		
Option 3 performs well with advantages identified for Economy and is likely to attract lower capital cost comparative to other options with a comparably shorter route length and journey time. Option 3 also performs well on Environment as having some advantages over other options due to reduced impact on Archaeological Architecture and Cultural Heritage. Option 3 is favourable comparable to other options when it comes to Integration and Accessibility, integrating well with active modes and serving 6 out of 7 main trip attractors and serving a higher catchment compared to Options 1 and 2. This option provides a direct connection to Kent Train Station via a new light rail bridge, connecting to Mahon Point, and will also penetrate through the Docklands, serving regeneration on these development lands. Safety of Option 3 is comparable to other options.		

Table 5.14: Sub-Area 2 MCA Summary Tables–- Option 4

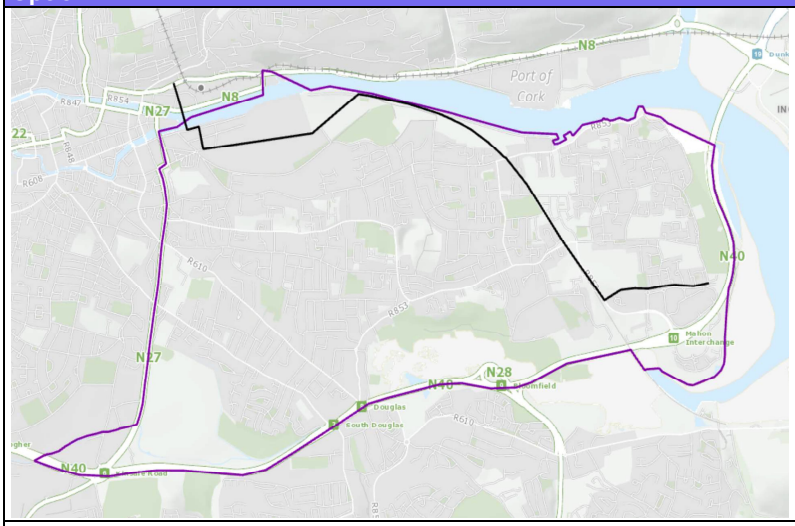
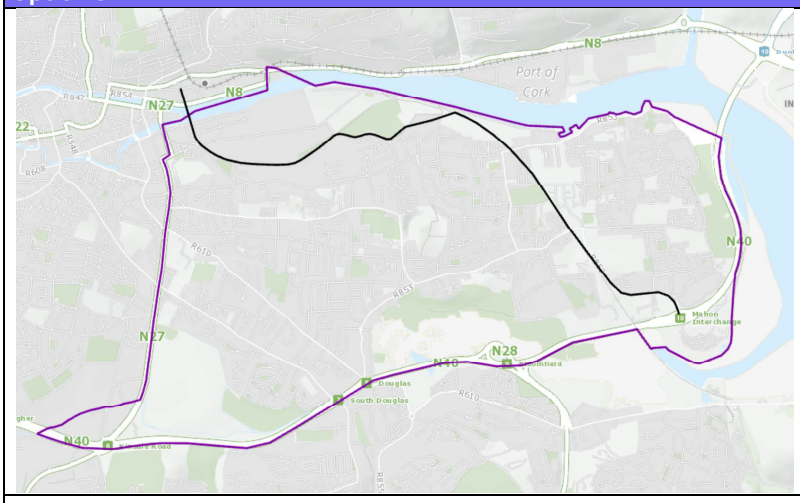
Option 4		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Despite a slightly longer route length Option 4 performs well on Economy and is comparative to Option 3. Option 4 is favourable comparable to other options when it comes to Integration and Accessibility, integrating well with active modes and serving 6 out of 7 main trip attractors and serving a higher catchment compared to Options 1 and 2. Option 4 also performs well on Environment as having some advantages over other options due to reduced impact on Archaeological Architecture and Cultural Heritage. However, when compared to Option 3, Option 4 provides no direct connection to Mahon Point and has been ruled out in favour of Option 3. Safety of Option 4 is comparable to other options.		

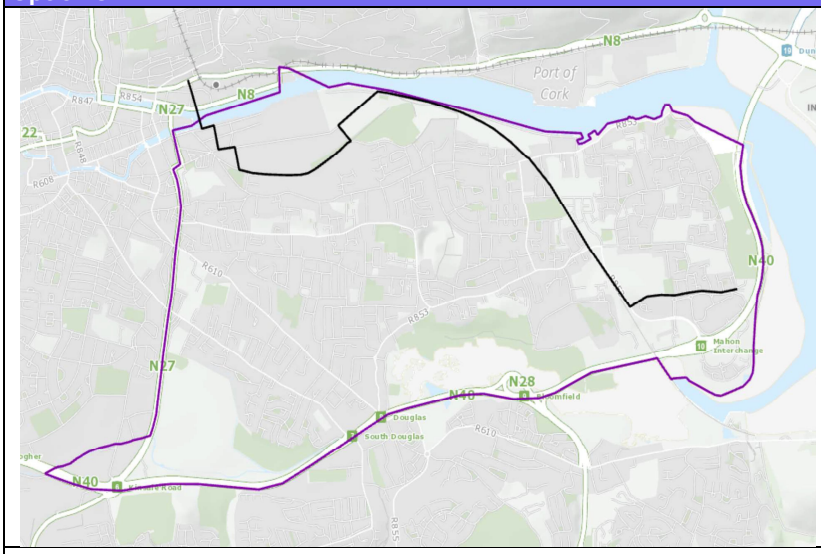
Table 5.15: Sub-Area 2 MCA Summary Tables–- Option 5

Option 5		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 5 performs well on Economy compared to other options, and also performs comparably well on Integration and Accessibility, integrating well with active modes and serving 6 out of 7 main trip attractors and serving a higher catchment compared to Options 1 and 2.However, Option 5 performs less well on the Environment criteria, with some disadvantages in relation to Landscape and Visual and Population as Option 5 is routed through Cork City High Value Landscape for approximately 1.6km, Landscape Preservation Zone for approximately 200m and the Greenway which is a designated public open space. Option 5 is comparable to other options on the Safety criteria.

Table 5.16: Sub-Area 2 MCA Summary Tables–- Option 6

Option 6		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 6 performs less well when compared to the other options on Economy, due to being the second longest route option, and comparatively slower journey times. This option performs well in terms of Integration and Accessibility, with increased catchment but is comparable to other options in Safety. With respect to the Environment criteria, this option has some disadvantages when compared against other route options for Landscape and Visual and Population as the route passes through Cork City High Value Landscape for approximately 1.6km and is routed on approximately 1.1km of land designated as public open space. This option has been ruled out in favour of Option 3.

Table 5.17: Sub-Area 2 MCA Summary Tables–- Option 7

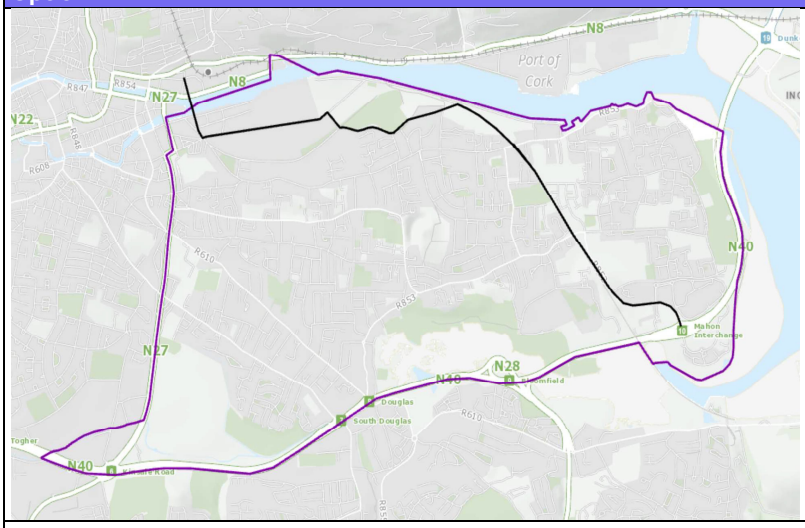
Option 7		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 7 has some advantages compared to other options on Integration, with a direct connection to Kent Station (via a new bridge) and Mahon Point, but performs less well on both Economy and Environment, as it provides comparatively poorer journey time than other options and has some disadvantages compared to other route options for Landscape and Visual and Population as it is routed through Cork City High Value Landscape for approximately 1.6km, a Landscape Preservation zone for approximately 200m and is routed through a section of land designated as public open space. With regards to Accessibility Option 7 performs well serving six out of seven main trip attractors in the area. Option 7 is comparable to other options on the Safety criteria Option 7 has been ruled out in favour of Option 3.		

Table 5.18: Sub-Area 2 MCA Summary Tables–- Option 8

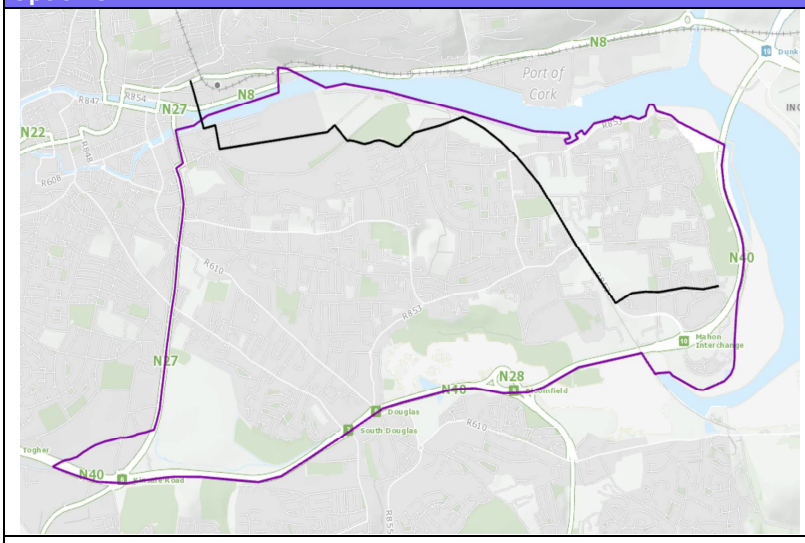
Option 8		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 8 has some advantages compared to other options on Integration, with a direct connection to Kent Station (via a new bridge) and Mahon Point, but performs less well on both Economy and Environment, as it provides comparatively poorer journey time than other options and has some disadvantages compared to other route options for Landscape and Visual and Population as it is routed through Cork City High Value Landscape for approximately 1.6km, a Landscape Preservation zone for approximately 200m and is routed through a section of land designated as public open space. With regards to Accessibility Option 8 performs well serving 6 out of 7 main trip attractors in the area., Option 8 is comparable to other options on the Safety criteria Option 8 has been ruled out in favour of Option 3.		

Table 5.19: Sub-Area 2 MCA Summary Tables–- Option 9

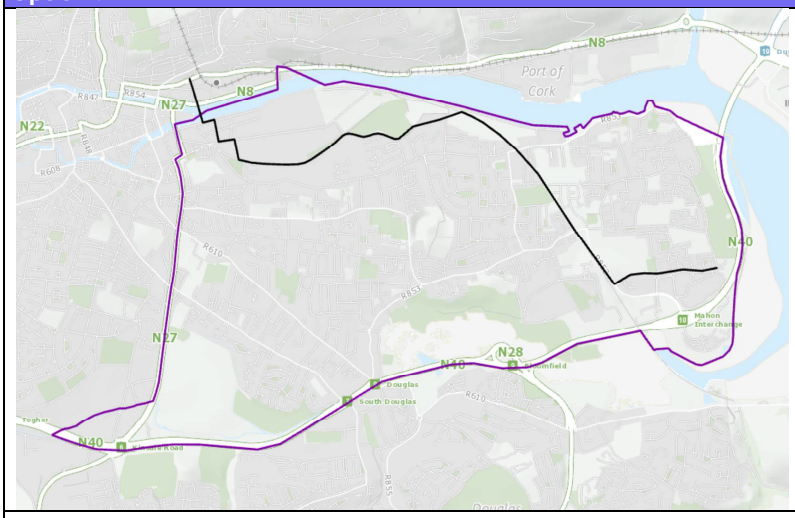
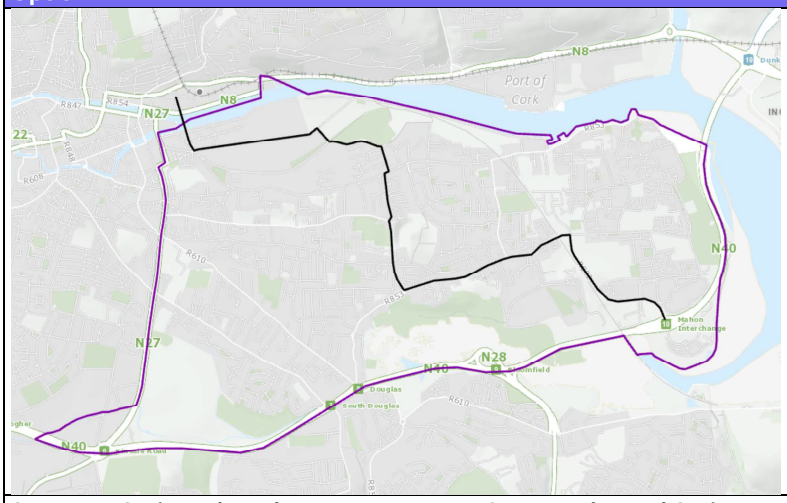
Option 9		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 9 performs poorly on Economy when compared to the other options, due to being the second longest route option, with comparatively slower journey times. However, Option 9 performs comparatively better than some other options on Integration due to its public transport integration and integration with other modes. With respect to the Environment criteria, this option has some disadvantages over other route options for Landscape and Visual and Population as it is routed through Cork City High Value Landscape and is routed along the Greenway which is designated as a public open space. With regards to Accessibility Option 9 performs well as it hits a high number of key trip attractors. Safety is comparable to other options. However, Option 9 has been ruled out in favour of Option 3.		

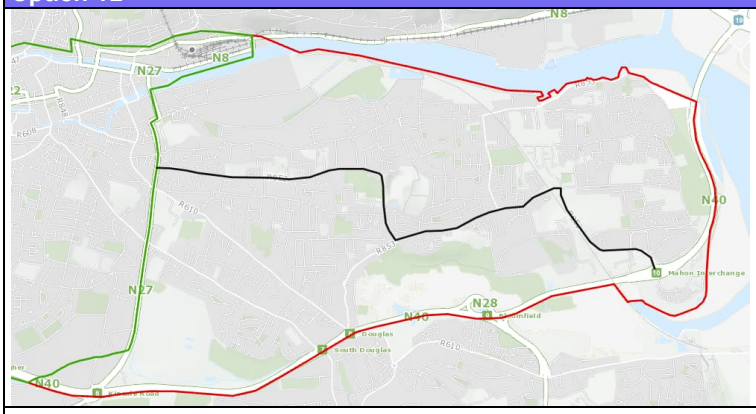
Table 5.20: Sub-Area 2 MCA Summary Tables–- Option 11

Option 11		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: Option selected to progress to Next Step–- end to end Option Appraisal

Option 11 presents an alternative route to the Greenway through Sub-Area 2, being the only option that utilises Church Yard Lane. This option preforms well in the Integration and Environmental criteria and has significant advantages when compared against other route options for Material and Cultural Aspects and Landscape and Visual as it avoids the Greenway despite some increased residential impacts. The option has some advantages to other options in terms of Accessibility. However, Option11 has significant disadvantages by comparison to other options in Economy, this is primarily due to the length of the option and the journey time associated with the longer route. Some road regrading/important engineering works may be required to facilitate the construction of the route, due to challenges with respect to ground levels and physical building constraints. Mitigation may be required following further investigation and assessment. This option performs comparatively less well on Safety due to increased number of junctions and proposed on-carriageway running.

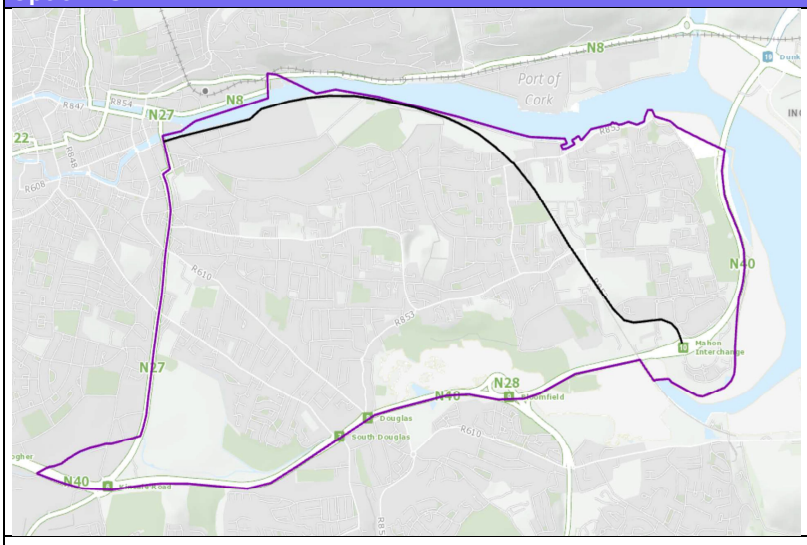
Table 5.21: Sub-Area 2 MCA Summary Tables – Option 12

Option 12		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: Option selected to progress to Next Step–- end to end Option Appraisal

Similar to Option 11, Option 12 presents another alternative option to the Greenway and utilises existing carriageway linking from the N27 but does not connect directly with Kent Station or the docklands which are two key trip attractors. For Environment Option 12 has some disadvantages when compared to other options due to the increased residential impacts, it avoids the Greenway but has disadvantages for Material and Cultural Aspects over other routes as it has the most direct impacts on architectural heritage constraints. The option performs well in terms of Integration, but again has some disadvantages in relation to accessibility, serving only 4.5 out of 7 key trip attractors in the area. Option 12 has significant disadvantages by comparison to other options in Economy, this is primarily due to the length of the option and the journey time associated with the route. This option performs comparatively less well on Safety due to increased number of junctions and proposed on-carriageway running. However, this option provides an alternative to options that utilise either the Greenway and Church Yard Lane connections and will be brought forward for further assessment.

Table 5.22: Sub-Area 2 MCA Summary Tables – Option 13

Option 13		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 13 performs very well under the criteria of Economy due to its associated length and cost and simplified alignment. It has some disadvantages on Integration as is has poor compatibility with existing and future land use and future transport networks. Option 13 performs well under accessibility as it hits a high number of key trip attractors when compared to other options. Option 13 has disadvantages in relation to Environment with emphasis on material and cultural aspects related to its alignment on the Greenway. Safety performs positively compared to other options due to the number of junctions being affected and the level of segregation achievable. Option 14 has been brought forward over Option 13 due to the catchment size being served in the docklands, as Option 13 runs along the River Lee it will fail to directly serve the catchment with the centre and south of the centre which Option 14 will serve. Option 13 has been ruled out in favour of Option 3.

Table 5.23: Sub-Area 2 MCA Summary Tables – Option 14

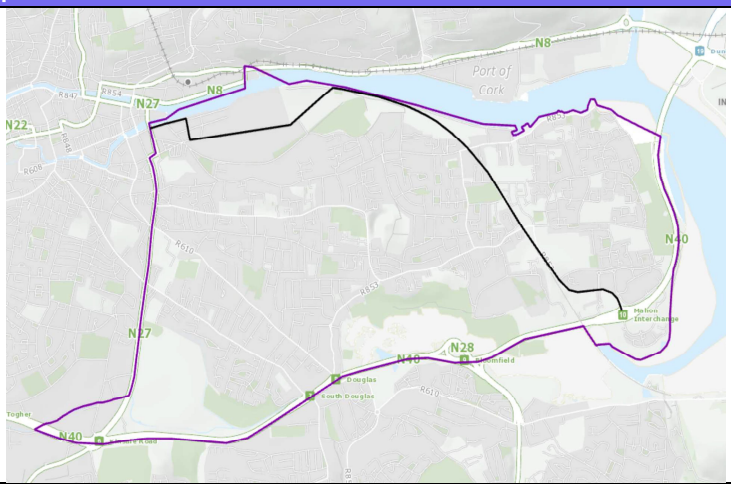
Option 14		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal		
Option 14 performs well under the criteria of Economy due to its associated length and cost. It has a negative score in integration as is has poor compatibility with existing and future land use and has poor compatibility with existing and future transport networks. Option 14 performs well under accessibility as it hits a high number of key trip attractors when compared to other options. Option 14 has disadvantages in relation to Environment with emphasis on landscape and visual due to its alignment on the Greenway. Safety is comparable to other options due to the number of junctions being affected and the level of segregation achievable. Option 14 has been brought forward over Option 15 due to the simplified alignment which exits the docklands.		

Table 5.24: Sub-Area 2 MCA Summary Tables – Option 15

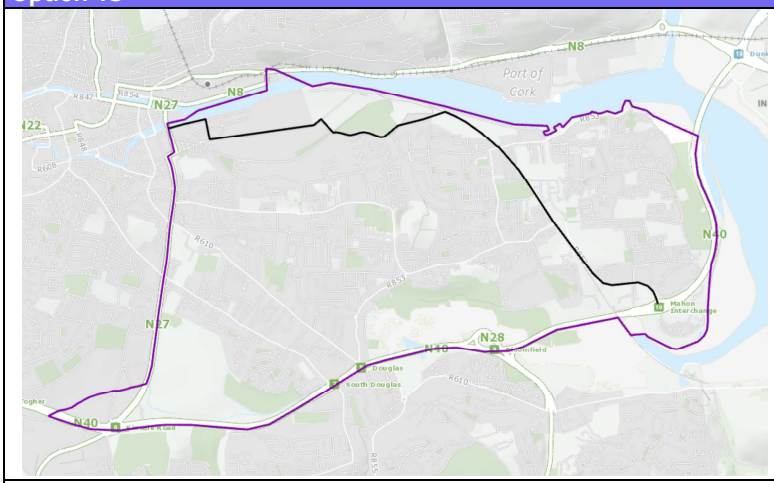
Option 15		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 15 has advantages over other options under the criteria of Economy due to its associated length and cost. Option 15 however has some disadvantages in Integration as it has poor compatibility with existing and future land use and has poor compatibility with existing and future transport networks. Option 15 performs well under Accessibility as it hits a high number of key trip attractors when compared to other options. Option 15 has disadvantages in relation to Environment with emphasis on landscape and visual due to its alignment on the Greenway. Safety is comparable to other options due to the number of junctions being affected and the level of segregation achievable.		

Table 5.25: Sub-Area 2 MCA Summary Tables – Option 17

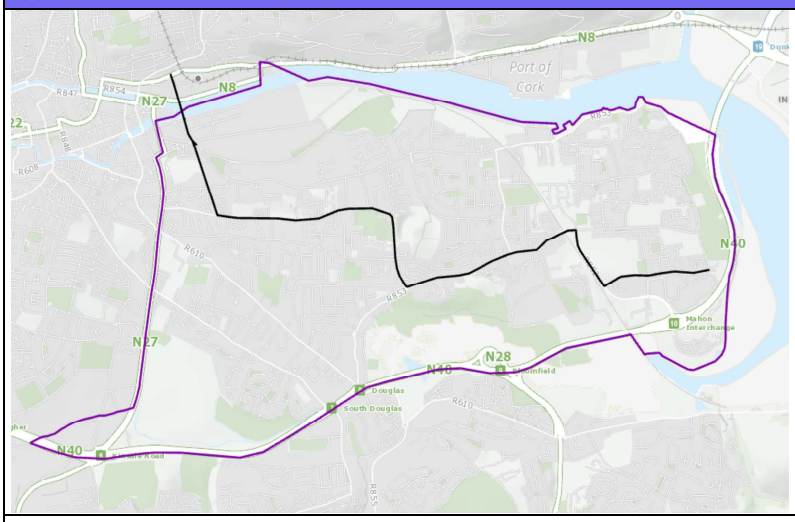
Option 17		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
As one of the longer routes in Sub-Area 2, Option 17 has significant disadvantages on both the Economy and Environment criteria. Option 17 has significant disadvantages for Material and Cultural Aspects and Population as it has the most direct impacts on architectural heritage constraints and this option has a greater number of visual residential receptors at the eastern end than other options. The Option Cost Estimate of the option is also much higher due to the land-take. This option scores poorly in Accessibility as it serves a low amount of key trip attractors. This option performs comparatively less well on Safety due to increased number of junctions and proposed on-carriageway running. Option 17 has been ruled out in favour of Options 11 & 12.		

Table 5.26 shows a summary of outcomes of the MCA on the Sub-Area 2 Options:

Table 5.26: Sub-Area 2 MCA Summary

Study Sub-Area 2 Options	1	2	3	4	5	6	7	8	9	11	12	13	14	15	17
Economy															
Integration															
Accessibility & Social Inclusion															
Environment															
Safety															
Preferred Options Recommended for Next Stage	No	No	YES	No	No	No	No	No	No	YES	YES	No	Yes	No	No

5.5.4 Sub-Area 2 Summary of MCA outcomes

The Preferred area options recommended for Sub-Area 2 offer a range of routing variations and design flexibility for End-to-End design development moving into Step C. The Preferred area options recommended to be incorporated within proposed ETE Route Options from Sub-Area 2 were:

- Option 3 – connecting via a new light rail bridge from Kent Station and utilising Centre Park Road, this presents the scheme with an option to connect to Mahon Point using the Greenway and thus accommodates full priority infrastructure for LRT;

- Option 11 – connecting via a new bridge from Kent Station and utilising Church Yard Lane, this presents the scheme with an option to connect to Mahon Point using Boreenmanna Road using shared running, but with higher levels of catchment attributed to this route;
- Option 12 – connecting from the N27, this presents the scheme with an option to connect to Boreenmanna Road to Mahon Point, utilising existing highway infrastructure for shared running; and
- Option 14 – connecting via Grand Parade and utilising Centre Park Road, this presents the scheme with an option to connect to Mahon Point using the Greenway and thus accommodates full priority infrastructure for LRT.

5.5.5 Sub-Area 3 Step B MCA Summary

Table 5.27 to Table 5.41 show the summary and overall assessment outcome given to each individual option for Sub-Area 3. This section also highlights the options that were recommended for the next 'end-to-end' option stage. Chapter 6 discusses the formation of each of these 'end-to-end' options in more detail.

Table 5.27: Sub-Area 3 MCA Summary Tables – Option 1

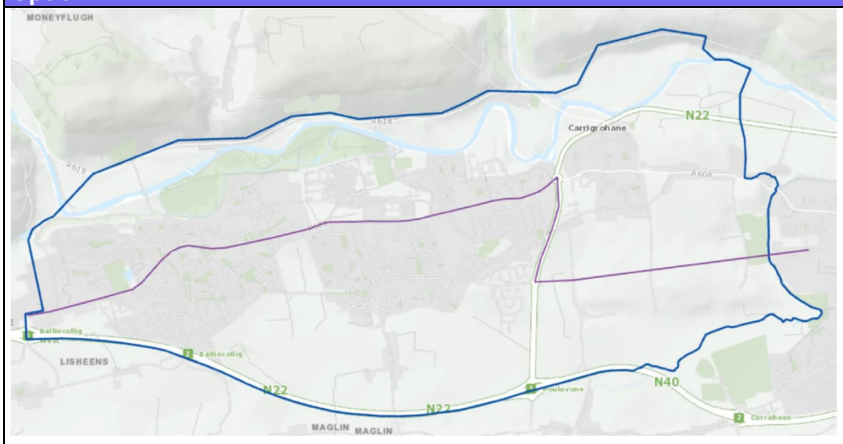
Option 1		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 1 preforms very well against the Integration criteria as it will travel through the Ballincollig town centre and will therefore have good compatibility with existing walking, cycling and traffic. Due to the convoluted alignment of Option 1 Economy scores very poorly due to the length of the option and cost associated with it. Accessibility criteria scores very positively as it serves a number of key trip attractors. Safety also preforms poorly against other options in Sub-Area 3 as Option 1 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 1 is comparable to a lot of options in Sub-Area 3, this is evident across all four criteria used in the MCA. This option also provides an optimal connection to Sub-Area 1 with the eastern extent of this option section travelling east towards Munster Technology University. Due to its alignment on the N22 and cost, the option has not been brought forward.		

Table 5.28: Sub-Area 3 MCA Summary Tables – Option 2

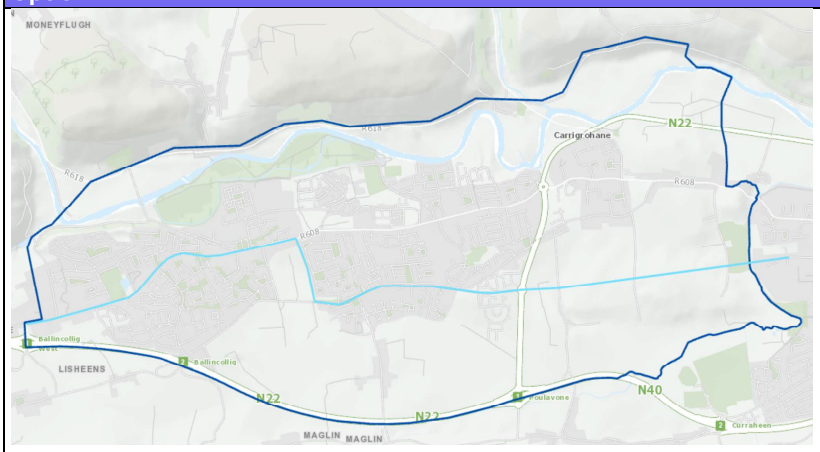
Option 2		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal		
Option 2 has some advantages under the Safety and the Accessibility criteria and picks up a higher number of trip attractors and will be able to achieve a high level of segregation. This option performs poorly on Economy due to its alignment, length and cost associated with these. Integration has scored positively as Option 2 is compatible with existing and future land use and is also compatible with the future transport network. Environment for Option 2 is comparable to a lot of options in Sub-Area 3, this is due to it scoring well on Material and Cultural aspects but scoring negatively against Landscape and Visual and population. This option also provides an optimal connection to Sub-Area 1 with the eastern extent of this option section travelling east towards Munster Technology University and has therefore been brought forward.		

Table 5.29: Sub-Area 3 MCA Summary Tables – Option 3

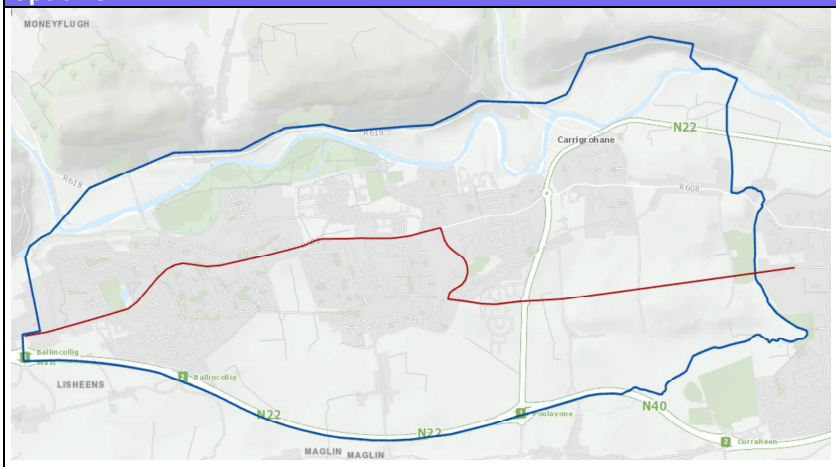
Option 3		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal		
Option 3 preforms very well against the Integration criteria as it will travel through the Ballincollig town centre and will therefore have good compatibility with existing walking, cycling and traffic. Due to the convoluted alignment of Option 3 Economy scores poorly due to the length of the option and cost associated with it. Accessibility criteria scores very positively as it serves a number of key trip attractors. Safety also preforms poorly against other options in Sub-Area 3 as Option 3 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 3 is comparable to a lot of options in Sub-Area 3, this is evident across all four criteria used in the MCA. This option also provides optimal connection to Sub-Area 1 with the eastern extent of this option section travelling east towards Munster Technology University and has been brought forward.		

Table 5.30: Sub-Area 3 MCA Summary Tables – Option 6

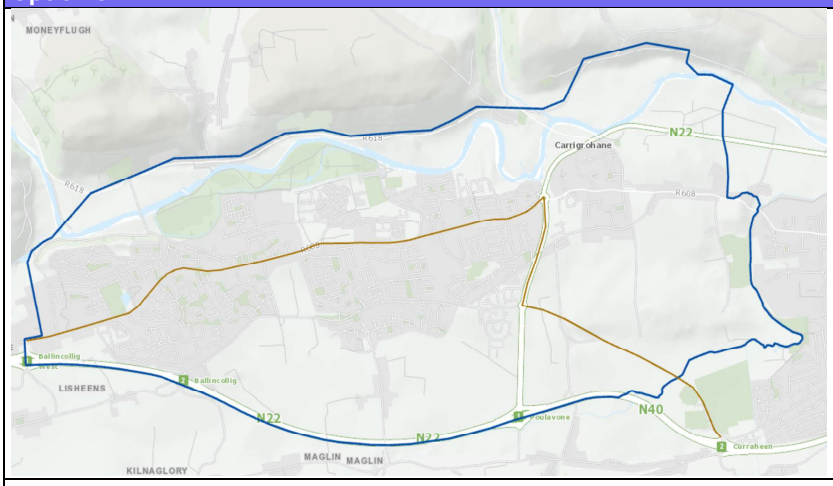
Option 6		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 6 preforms well against the Integration criteria as it will travel through the Ballincollig town centre and will therefore have good compatibility with existing walking, cycling and traffic. Due to the convoluted alignment of Option 6 Economy scores very poorly due to the length of the option and cost associated with it. Accessibility criteria scores positively as it serves a number of deprived areas and key trip attractors. Safety also preforms poorly against other options in Sub-Area 3 as Option 6 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 6 is comparable to a lot of options in Sub-Area 3, this is evident across all four criteria used in the MCA. This option also provides a sub-optimal connection to Sub-Area 1 with the eastern extent of this option section travelling south towards an area of low density.		

Table 5.31: Sub-Area 3 MCA Summary Tables – Option 7

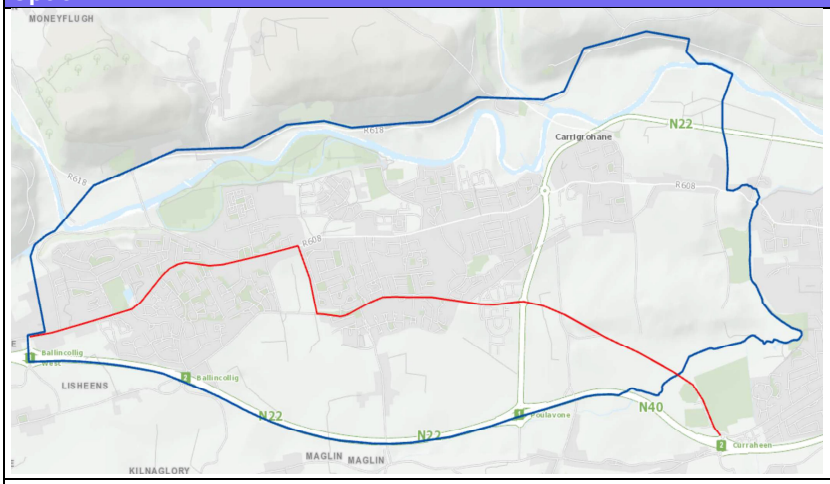
Option 7		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 7 has some advantages under the Safety and the Accessibility criteria and picks up a higher number of trip attractors and will be able to achieve a high level of segregation. This option performs poorly on Economy due to its alignment, length and cost associated with these. Integration has also scored poorly as Option 7 is not compatible with existing and future land use and also not being compatible with the future transport network. Environment for Option 7 is comparable to a lot of options in Sub-Area 3, this is due to it scoring well on Material and Cultural aspects but scoring negatively against Landscape and Visual.		

Table 5.32: Sub-Area 3 MCA Summary Tables – Option 8

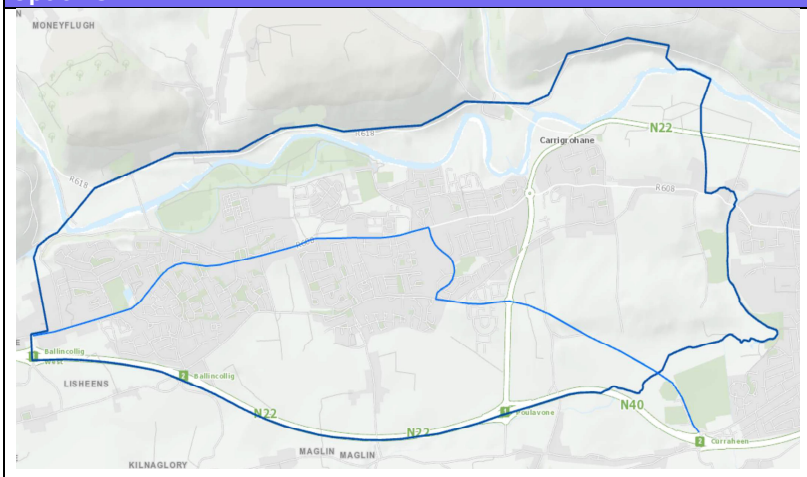
Option 8		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 8 has some advantages on Accessibility and Integration criteria and picks up a higher number of trip attractors. This option performs poorly on Economy and Safety when compared to other options. This is due to the length, longer journey time, convoluted alignment of the option, and high number of junctions affected. Environment for Option 8 is comparable to a lot of options in Sub-Area 3, this is due to each sub-criteria within Environment having a comparative alterative on other options.		

Table 5.33: Sub-Area 3 MCA Summary Tables – Option 11

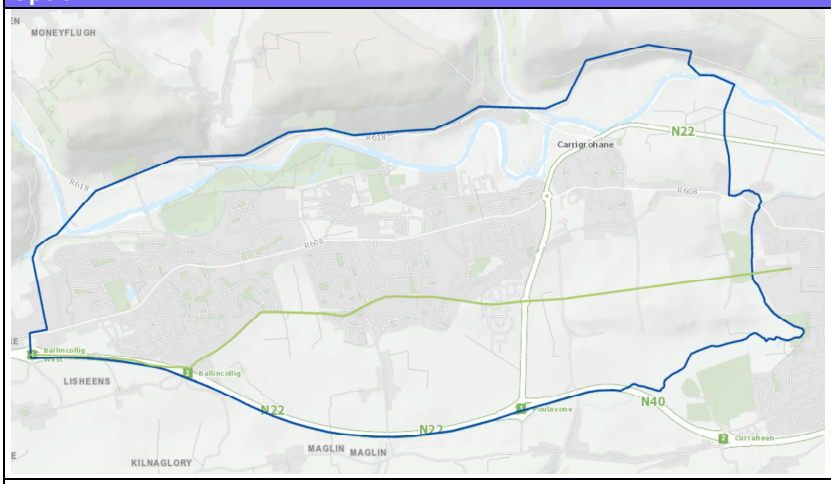
Option 11		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: Option selected to progress to Next Step–- ETE Route Option Appraisal		
Option 11 performs well on Economy and Safety as it affects a low number of junctions and would likely attract a lower capital cost compared to other options due to its length and alignment. Option 11 also has a positive performance in Integration as it has a good compatibility with existing and future land use and also has a good compatibility with existing walking, cycling and traffic. Environment for Option 11 is comparable to a lot of options in Sub-Area 3, this is due to is scoring very well on Material and Cultural aspects but scoring negatively against Landscape and Visual and Population.		

Table 5.34: Sub-Area 3 MCA Summary Tables – Option 12

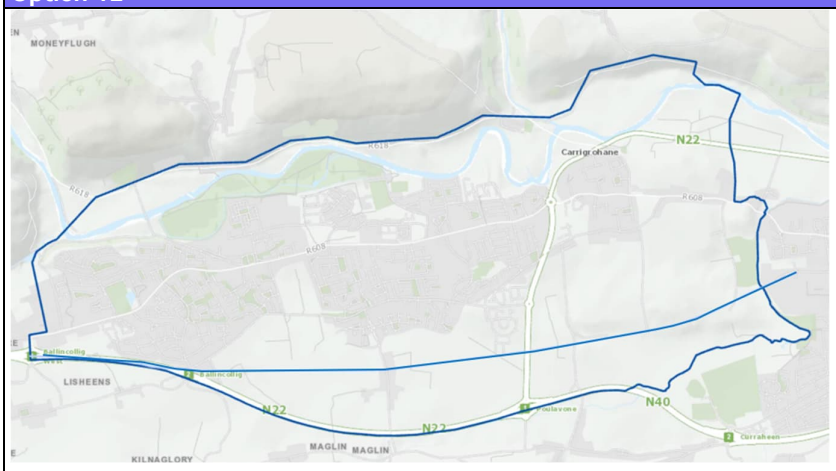
Option 12		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 12 performs well on Economy and Safety as it affects a low number of junctions and would likely attract a lower Option Cost Estimate compared to other options due to its length and alignment. However, Option 12 seeks an alignment through rural lands south of the Ballincollig, and thus has significant disadvantages identified for Integration and Accessibility as there little to no compatibility with existing and future land use and will fail to serve any key trip attractors. Environment for Option 12 has also scored poorly as it will have a negative visual impact on surrounding environment, it will cause severance of agricultural land.		

Table 5.35: Sub-Area 3 MCA Summary Tables – Option 13

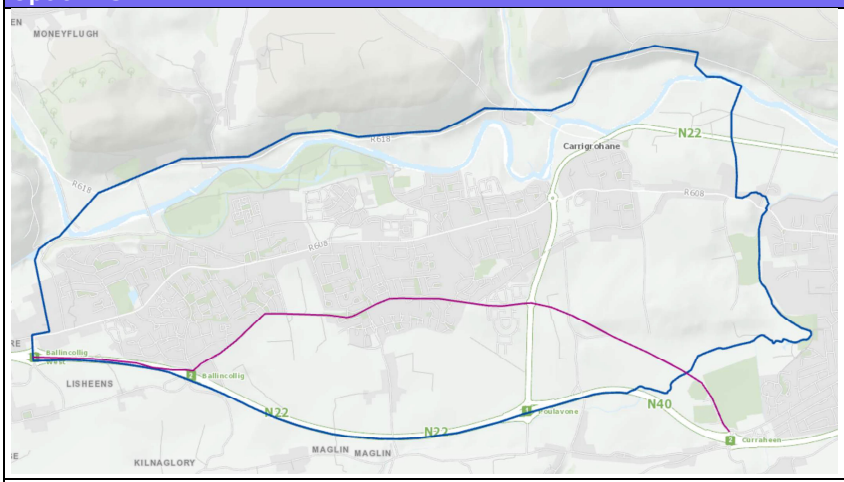
Option 13		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 13 performs well on Economy and Safety as it affects a low number of junctions and would likely attract a lower capital cost compared to other options due to its length and alignment. For this option, Integration, Accessibility perform poorly when compared to other options. Option 13 seeks an alignment south of the Ballincollig, and thus has some disadvantages identified for Integration and Accessibility as there is minimal compatibility with existing and future land use and will only serve one key trip attractors. Option 13 scores well for Environment, it will have minimal impact on material and cultural aspects along the alignment, will have small visual impact when compared to other options and won't affect a high number of residential properties. Option 13 was ruled out in favour of Option 11 due to its connecting point into Sub-Area 1.		

Table 5.36: Sub-Area 3 MCA Summary Tables – Option 14

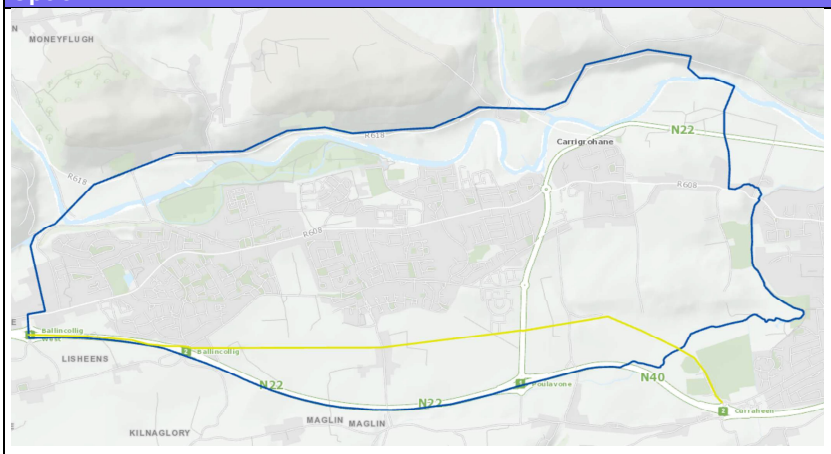
Option 14		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 14 performs well on Economy and Safety as it affects a low number of junctions and would likely attract a lower Option Cost Estimate compared to other options due to its length and alignment. However, Option 14 seeks an alignment through rural lands south of the Ballincollig, and thus has significant disadvantages identified for Integration and Accessibility as there little to no compatibility with existing and future land use and will fail to serve any key trip attractors. Environment for Option 14 has also scored poorly as it will have a negative visual impact on surrounding environment, it will cause severance of agricultural land and there will be a greater number of residential properties affected.		

Table 5.37: Sub-Area 3 MCA Summary Tables – Option 15

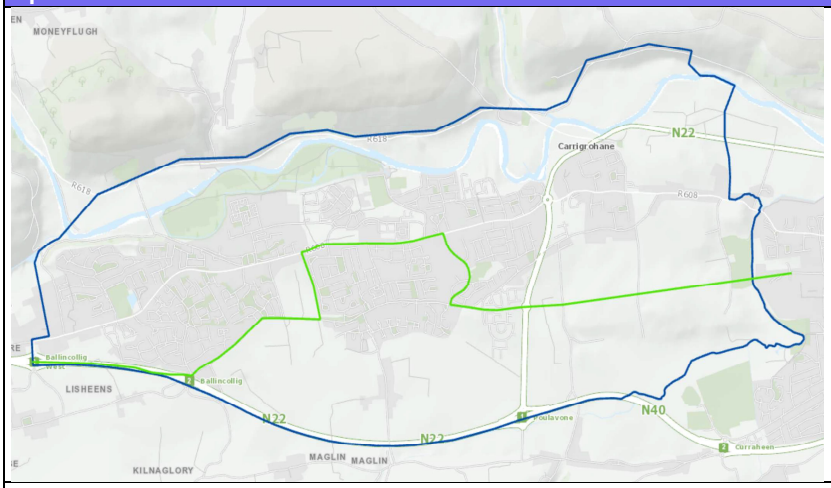
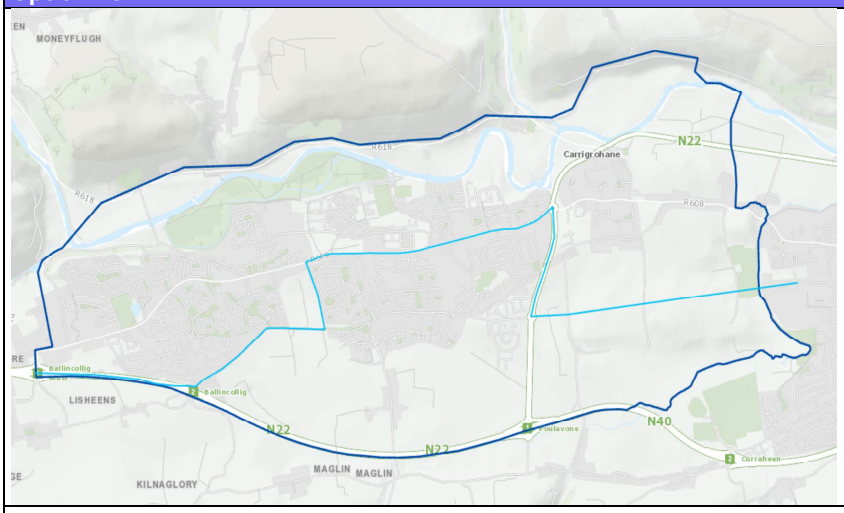
Option 15		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 15 preforms very well against the Integration criteria as it will travel through the Ballincollig town centre, has very strong compatibility with existing and future land use and will therefore have good compatibility with existing walking, cycling and traffic. However, due to its alignment, length and cost associated with these Economy has scored poorly. Safety preforms poorly against other options in Sub-Area 3 as Option 15 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 15 has also scored poorly as it will have a negative visual impact on surrounding environment, it will cause disruption to local communities and cause severance of agricultural land.		

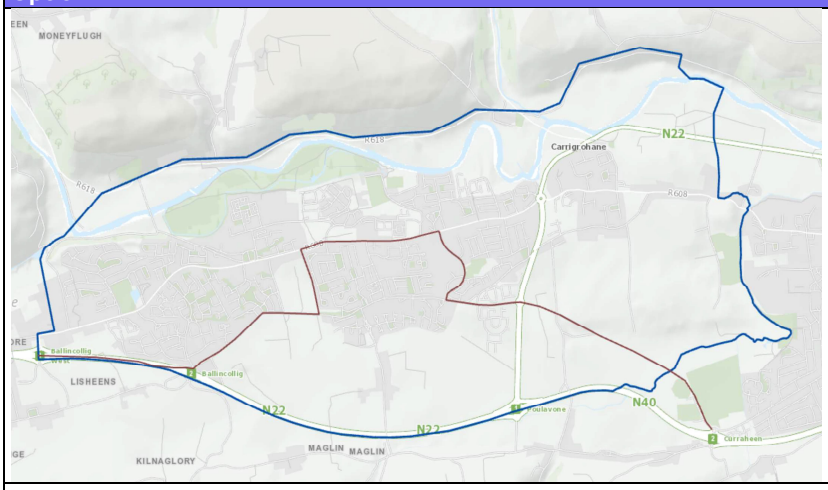
Table 5.38: Sub-Area 3 MCA Summary Tables – Option 16

Option 16		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 16 preforms very well against the Integration criteria as it will travel through the Ballincollig town centre, has very strong compatibility with existing and future land use and will therefore have good compatibility with existing walking, cycling and traffic. However, due to its alignment, length and cost associated with these Economy has scored poorly. Safety also preforms poorly against other options in Sub-Area 3 as Option 16 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 16 has also scored poorly as it will have a negative visual impact on surrounding environment, it will cause disruption to local communities and cause severance of agricultural land.

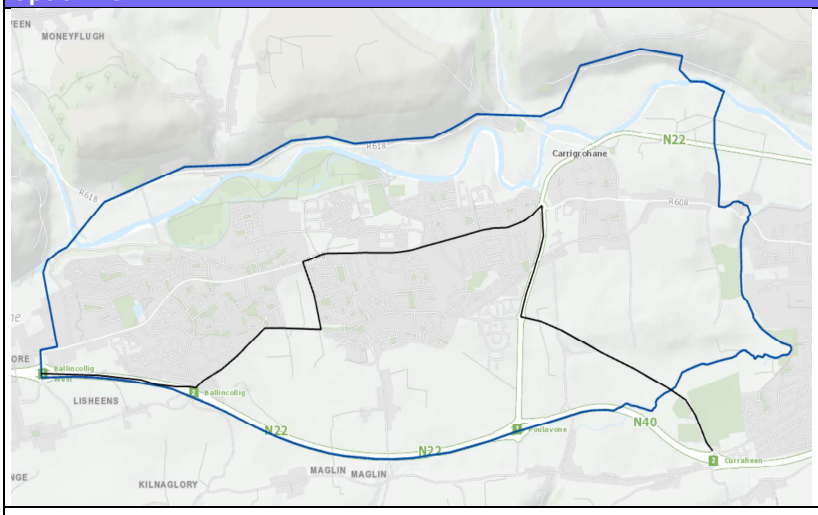
Table 5.39: Sub-Area 3 MCA Summary Tables – Option 17

Option 17		
	Economy	
	Integration	
	Accessibility	
	Environment	
	Safety	

Summary: RULE OUT

Option 17 preforms well against the Integration criteria as it will travel through the Ballincollig town centre and will have good compatibility with existing walking, cycling and traffic. Due to the convoluted alignment of Option 17 Economy scores poorly due to the length of the option and cost associated with it. Safety also preforms poorly against other options in Sub-Area 3 as Option 17 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 17 is comparable to a lot of the early options in Sub-Area 3, this is evident across all four criteria used in the MCA. This option also provides a sub-optimal connection to Sub-Area 1 with the eastern extent of this option section travelling south towards an area of low density.

Table 5.40: Sub-Area 3 MCA Summary Tables – Option 18

Option 18		
	**Economy**	
	Integration	
	Accessibility	
	Environment	
	Safety	
Summary: RULE OUT		
Option 18 preforms well against the Integration criteria as it will travel through the Ballincollig town centre and will therefore have good compatibility with existing walking, cycling and traffic. Due to the convoluted alignment of Option 18 Economy scores poorly due to the length of the option and cost associated with it. Safety also preforms poorly against other options in Sub-Area 3 as Option 18 affects a high number of junctions along the route and only gives a medium level of segregation. Environment for Option 18 is comparable to a lot of the early options in Sub-Area 3, this is evident across all four criteria used in the MCA. This option also provides a sub-optimal connection to Sub-Area 1 with the eastern extent of this option section travelling south towards an area of low density.		

The Table 5.41 shows a summary of outcomes of the MCA on the Sub-Area 3 Options:

Table 5.41: Sub-Area 3 MCA Summary

Study Sub-Area 3 Options	1	2	3	6	7	8	11	12	13	14	15	16	17	18
Economy														
Integration														
Accessibility & Social Inclusion														
Environment														
Safety														
Preferred Options Recommended for Next Stage	No	YES	YES	No	No	No	Yes	No	No	No	No	No	No	No

5.5.6 Sub-Area 3 Summary of MCA outcomes

The Preferred Area Options recommended for Sub-Area 3 offer a range of routing variations and design flexibility for End-to-End design development moving to into Step C. The Preferred Area Options recommended to be incorporated within proposed ETE Route Options from Sub-Area 3 are:

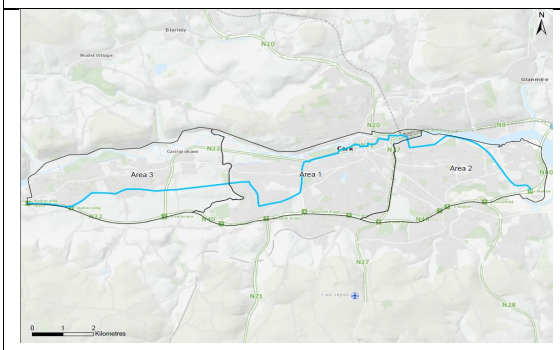
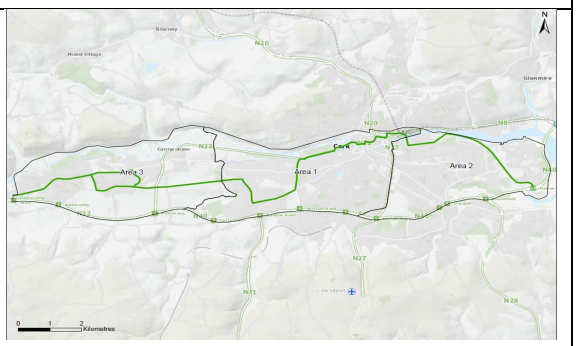
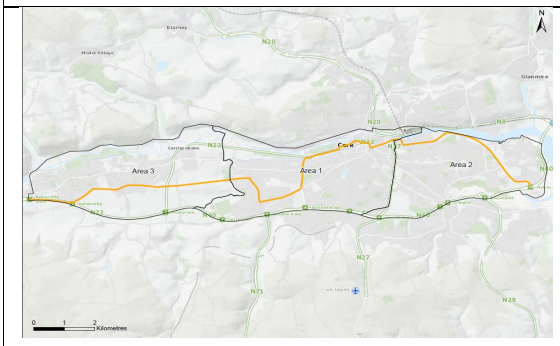
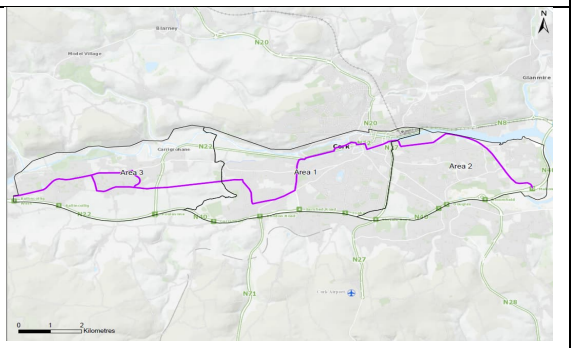
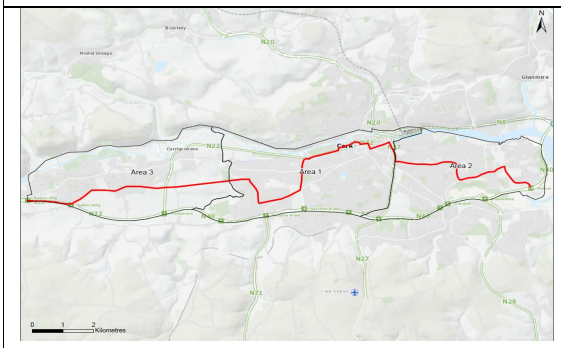
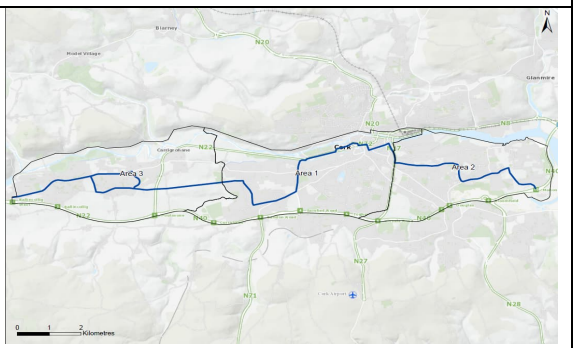
- Option 2 – connecting with the town centre of Ballincollig, this presents the scheme with an option to connect to Carriganarra Road via Flynn Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT;

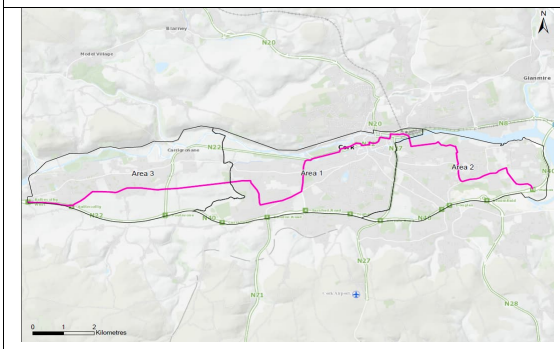
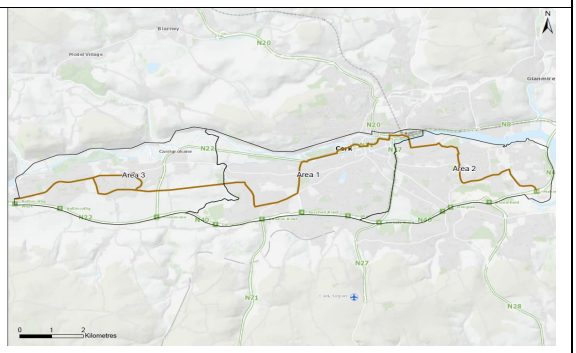
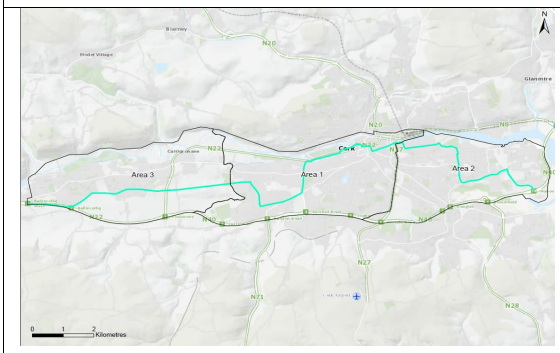
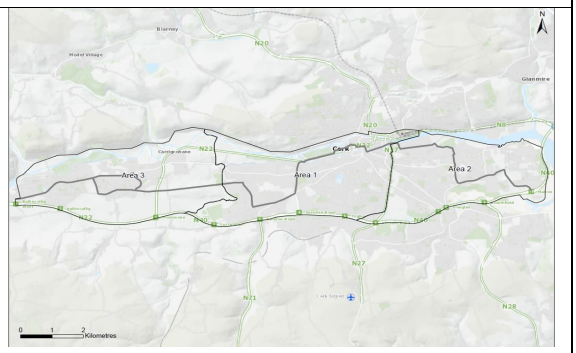
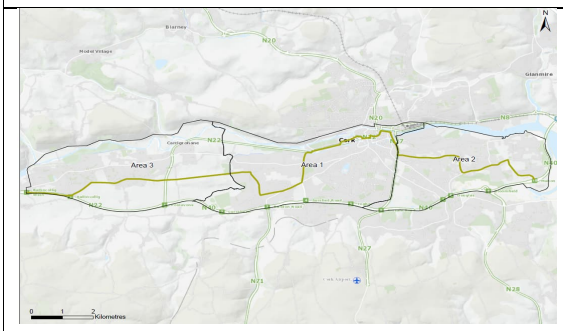
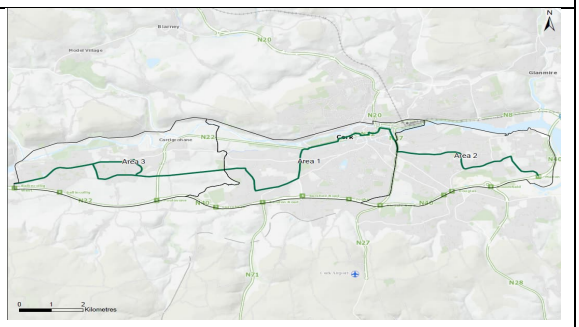
- Option 3 – connecting with the town centre of Ballincollig, this presents the scheme with an option to connect to Carriganarra Road via Leo Murphy Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT; and
- Option 11 – linking with strategic traffic corridor on the N22, this option runs south of the town centre of Ballincollig, along Castle Road and Carriganarra Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT.

5.6 Step B Area Options Combined (ETE Route Options)

The combination of the preferred area options from Sub-Area 1-3 led to the identification of full ETE Route Options for the scheme. In total, 12 ETE Route Options from Step B have been identified for the scheme. These 12 ETE Route Options have been combined on a single map and are presented in Table 5.42.

Table 5.42 - ETE Route Options (following Step B MCA Assessment Process)

ETE Option 1	**ETE Option 2**
	
ETE Option 3	**ETE Option 4**
	
ETE Option 5	**ETE Option 6**
	

ETE Option 7	ETE Option 8
	
ETE Option 9	**ETE Option 10**
	
ETE Option 11	**ETE Option 12**
	

As shown in Table 5.42, the Step B route Options have in common a number of sections along the route, primarily in Sub-Area 1. The Step B ETE Route Options shown above were then subject to further design development and refinement prior to Step C. This process is outlined in Chapter 6: End-to-End Route Options.

6 End-to-End Route Options

This chapter outlines the ETE Route Options for the scheme. The combination of the preferred area options from Sub-Area 1-3 led to the identification of full ETE Route Options for the scheme. In total, 12 ETE Route Options from Step B have been identified for the scheme. These ETE Route Options will be assessed through MCA at Step C (included within chapter 10 of this report) to identify the EPR, which will be taken to public consultation at Stage 2 of the Proposed Scheme.

Following completion of the Step B MCA, a number of options for each Sub-Area 1-3 were recommended. The options recommended per sub-area are summarised in Table 6.1.

Table 6.1: Summary of Shortlisted Options from Step B

Sub-Area 1 Options Recommended	
Option 2	Utilising Model Farm Road, this presents the scheme with an option with high connectivity to the Docklands via Grand Parade.
Option 12	Utilising Model Farm Road, this presents the scheme with an option utilising the N27, to connect to Boreenmanna Road.
Option 17	Utilising Curraheen Road, this option presents the scheme with high connectivity to link with Kent Station via Patrick Street.
Option 18	Utilising Curraheen Road, this option presents the scheme an option with high connectivity to the Docklands via Grand Parade.
Sub-Area 2 Options Recommended	
Option 3	Connecting via a new bridge from Kent Station or via one of the existing bridges from South Mal presents the scheme with an option to connect to Mahon Point using the Greenway and thus accommodates full priority infrastructure for LRT.
Option 11	Connecting via a new bridge from Kent Station or via one of the existing bridges from South Mal presents the scheme with an option to connect to Mahon Point using Boreenmanna Road using shared running, but with higher levels of catchment attributed to this route.
Option 12	Connecting from the N27, this presents the scheme with an option to connect to Boreenmanna Road to Mahon Point, utilising existing highway infrastructure for shared running.
Option 14	Connecting via Grand Parade and utilising Centre Park Road, this presents the scheme with an option to connect to Mahon Point using the Greenway and thus accommodates full priority infrastructure for LRT.
Sub-Area 3 Options Recommended	
Option 2	Connecting with the town centre of Ballincollig, this presents the scheme with an option to connect to Carriganarra Road via Flynn Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT.
Option 3	Connecting with the town centre of Ballincollig, this presents the scheme with an option to connect to Carriganarra Road via Leo Murphy Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT.
Option 11	Linking with strategic traffic corridor on the N22, this option runs south of the town centre of Ballincollig, along Castle Road and Carriganarra Road, prior to connecting to Killumney Road Roundabout to a section of full priority infrastructure for LRT.

The options per sub-area, as summarised in Table 6.1, were then combined to present 12 draft ETE Route Options.

6.1 Further Design Development

To underpin the Step C MCA process, Step C designs for all area options were developed, reviewed and optimised, to enable a more detailed understanding of their feasibility, whilst also providing a clearer indication of potential impacts associated with each ETE Route Option.

Following initial design development during Step C, a number of constraints and challenges were identified within each sub-area. The project team visited these locations to undertake a more detailed on-site survey. This exercise then identified opportunities to optimise some elements of the ETE Route Options. These are optimisations summarised as follows:

- Sub-Area 1: Utilisation of St Patrick's Bridge & MacCurtain Street from St Patrick Street, preferred over Merchant's Quay;
- Sub-Area 2: Utilisation of Kennedy Quay to connect to LRT and active travel bridge to Kent Station, preferred over Centre Park Road; and
- Sub-Area 3: Reduction of extents of LRT infrastructure in Ballincollig, also introducing the variation of a one-way loop, linking with Ballincollig town centre.

6.1.1 Sub-Area 1 Optimisations

The constraints and challenges for Sub-Area 1 related mostly to operational and engineering improvements, with some existing flood risks on the proposed alignment along Merchants Quay.

Upon review of the proposed alignment in Sub-Area 1, it was considered that a route connecting to St Patrick Street Bridge, then connecting to MacCurtain Street, provided the Proposed Scheme with a more optimised alignment.

This new alignment brings operational benefits with less turns in the track, lending better to LRT operations in relation to day-to-day running costs, journey time efficiencies and future ongoing maintenance costs. The alignment also produces enhanced journey times as the Luas would be able to achieve and maintain higher speeds across this section. From modelling analysis completed in which the optimised section was compared, it also produces higher levels of patronage and catchment to the north of the River Lee.

The optimised alignment also mitigates against any flood risk potential that may be associated with Merchants Quay, which is currently zoned as a higher risk area. The constructability of this optimised route would also mitigate temporary traffic management, with more manageable routes and ensuring access is maintained to the existing bus station for commuters and bus operations. The sub-Area 1 optimisation is shown in Figure 6.1:

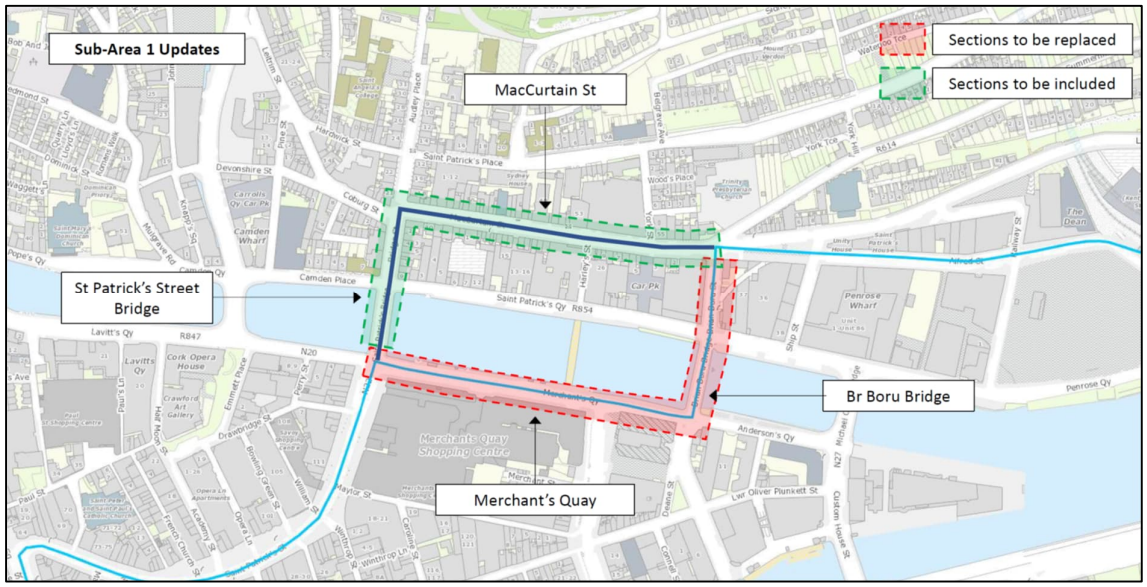


Figure 6.1: Sub-Area 1 Design Development Optimisations

6.1.2 Sub-area 2 Optimisations

The constraints and challenges for Sub-Area 2 related mostly to enhancing connections between Kent Station and the Docklands. Operational and engineering improvements.

Following a review of the proposed alignment in Sub-Area 2, a number of minor alterations were made to ensure better connectivity to Kent Station. A direct 125m bridge, to cater for LRT movements and active travel, with an improved desire line linking with strategically positioned Luas Stops will ensure more direct and efficient connections for commuters between Kennedy Quay and Kent Station for those options that do not transverse the bridge to Kent Station.

For Options that do not connect directly, the proposed bridge will form an active travel bridge only. The alignment of this bridge in both forms has been revised to link with Kennedy Quay and Furlong Street.

A short section of track along Victoria Road has been replaced by an extension into Kennedy Quay, to connect with the active travel bridge in both direct and indirect options, reducing walking distances for commuters.

This extension into Kennedy Quay will also act as a much-needed regeneration catalyst for the docklands, generating new footfall along the river front. When modelled there is no negative impact on run times with this optimisation. The Sub-Area 2 optimisation is shown in Figure 6.2:

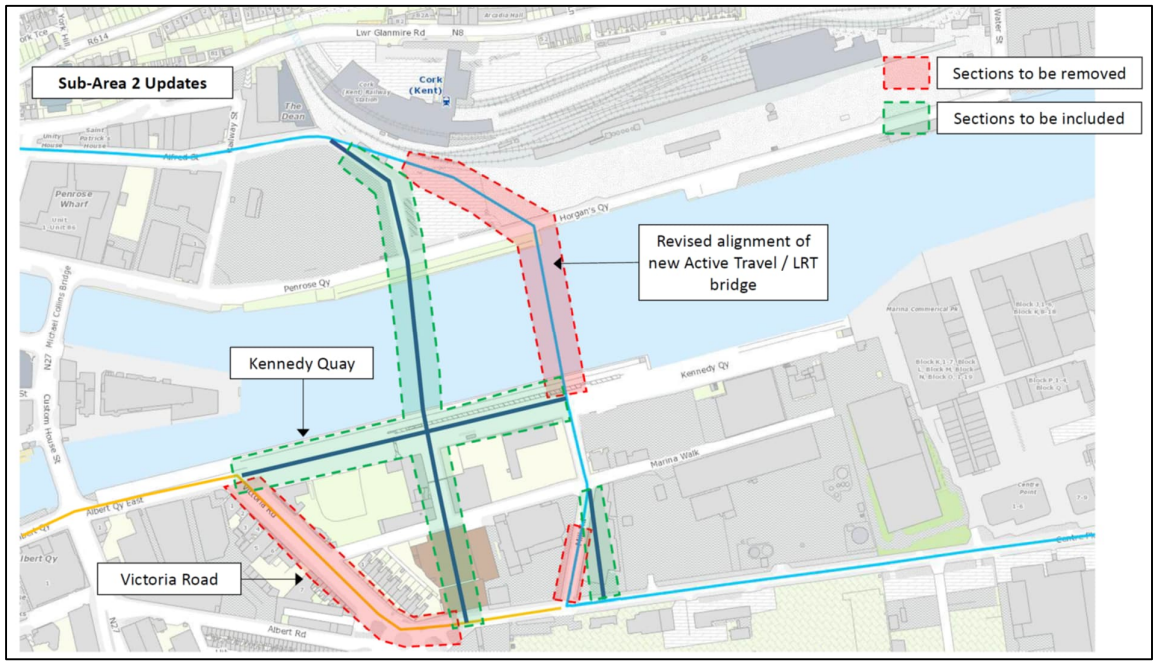


Figure 6.2: Sub-Area 2 Design Development Optimisations

6.1.3 Sub-Area 3 Optimisations

Similar to Sub-Area 1 and 2, a review was conducted of the proposed alignment in Sub-Area 3 identifying, a number of constraints and challenges. For Sub-Area 3 these related to lower levels of catchment at the western end of Ballincollig as well as some geometrical constraints within the cross-section of the town centre.

Following some analysis on the level of patronage and potential catchment, it was determined that the alignment did not gain much benefit in reaching all the way to western extents of the N22. The alignment was therefore reduced, instead focusing on the town centre area as both the start and end point of the Proposed Scheme, saving on the need for over 3km of LRT infrastructure.

As a solution to address some of the geometric constraints in the town centre of Ballincollig, as well to bring improvements to the overall operation through infrastructure efficiencies, the possibility of a single-track loop was introduced on Carrigrohane Road in the town centre of Ballincollig.

Whilst achieving catchment to both the northern and southern part of Ballincollig, this optimisation also maintains access to the town centre for other modes such as bus, general traffic and cyclists. The Sub-Area 2 optimisation is shown in Figure 6.3:

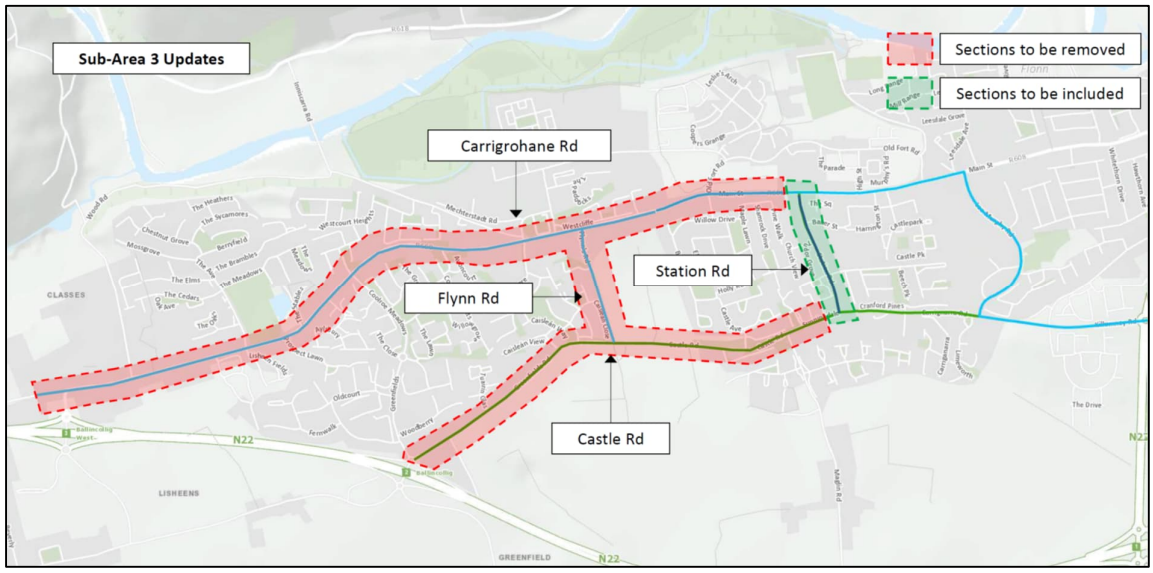


Figure 6.3: Sub-Area 3 Design Development Optimisations

6.2 End–to–End (ETE) Route Options

6.2.1 Option Development Process

Following the recommendations from the Step B MCA analysis and completion of some further design development, 12 ETE Route Options were developed for further assessment and consideration at Step C. The combination of these area options was reviewed to ensure that they presented the ETE Route Options with optimal connectivity, enhanced catchment and consideration of mitigating constraints, including potential environmental impacts.

Step C also assessed the common elements required for operation of the LRT system, such as the provision of a maintenance depot and associated stabling, as well as the provision of Park and Ride facilities and a mobility hub to help cater for appropriate access and modal shift for the Proposed Scheme.

It should also be noted that the proposals along the Greenway are based on extensive use of single track with potential for passing loops at some of the stops. The single-track proposals are primarily to limit the cross-sectional impact on the Greenway, its existing utilities (two pumped water sewage pipes and one gas main), the protected arched bridges, and its use as pedestrian and cycle route and the natural habitat.

Operational consequences of the single-track running have been assessed in detail in the Step C design and are likely to result in a capped tram frequency of between 6 and 8 trams per hour. However, it is envisaged that this will be of sufficient capacity to cover the forecast demand along the Mahon section of the line.

The final12 ETE Route Options for the Step C MCA are shown in Figure 6.4. Each ETE Route Option design is presented in detail in Volume 2: Drawings Part A – ETE Route Option Drawings of this report.

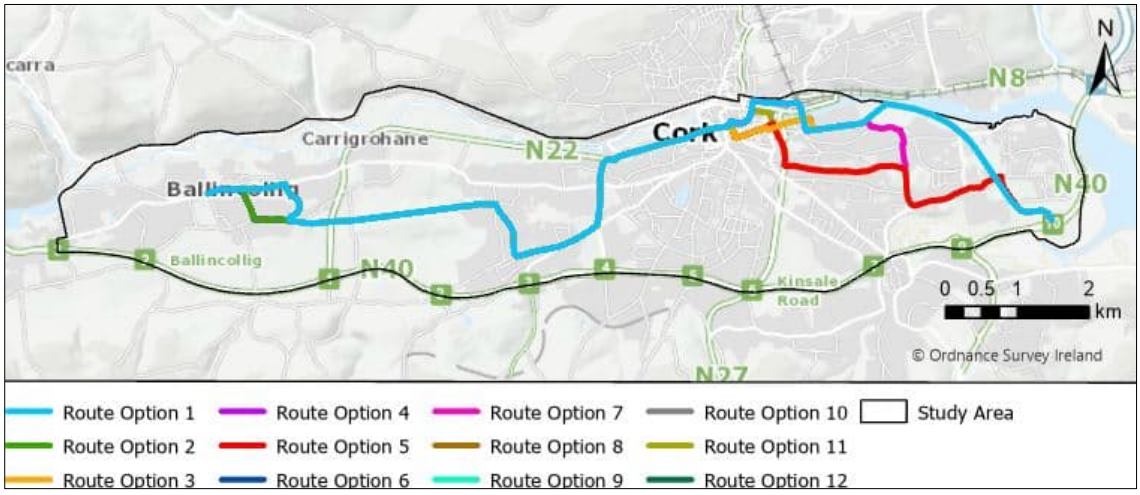
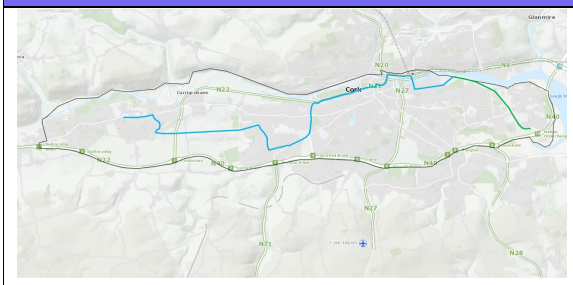
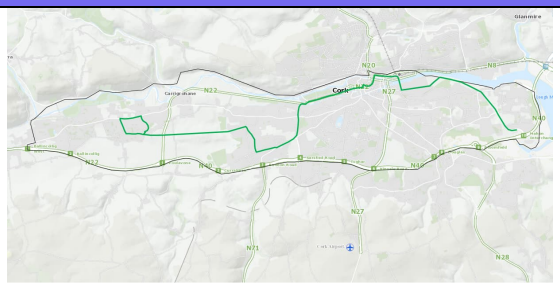


Figure 6.4: Final 12 End-to-End Options Combined

Table 6.2: Individual ETE Route Options 1 – 2

ETE Route Option 1	ETE Route Option 2
	
Sub-Area 3	**Sub-Area 3**
The ETE Route Option begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22. It passes perpendicular through the N22. It then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The ETE Route Option in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road the track goes from dual to single track. The alignment which will bring passengers into Sub-Area 3 (single track) will continue on Carriganarra Road until it reaches Station Road. Here it will divert up Station Road and proceed up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continues through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment will turn down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It will pass perpendicular through the N22. It then proceeds through the agricultural farmlands until it reaches Munster Technology University.

ETE Route Option 1	ETE Route Option 2
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route options travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction this route option then follows St Patrick's Street, crossing north of the River Lee via the existing Patrick's Bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment then interchanges directly with Kent Station. A new proposed LRT bridge would link the Proposed Scheme across the River Lee to Kennedy Quay, accessing Furlong Street and Centre Park Road.	From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction this route option then follows St Patrick's Street, crossing north of the River Lee via the existing Patrick's Bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment then interchanges directly with Kent Station. A new proposed LRT bridge links the route across the River Lee to Kennedy Quay, accessing Furlong Street and Centre Park Road.
Sub-Area 2	**Sub-Area 2**
The route in Sub-Area 2 begins from the bridge connection from Kent Station and travels on Furlong Street linking up with Centre Park Road. The route then travels along Centre Park Road until it reaches the Marina. From the Marina, the option follows the existing Greenway (Orange Circle) for the majority of the Sub-Area 2 route. The route exits the Greenway at the CSPCA carpark which is located at the south end of Sub-Area 2. It then continues to follow the R852 before reaching its terminus.	The route in Sub-Area 2 begins from the bridge connection from Kent Station and travels on Furlong Street linking up with Centre Park Road. The route travels along Centre Park Road until it reaches the Marina. From the Marina, the route follows the existing Greenway (Orange Circle) for the majority of the Sub-Area 2 route. The route exits the Greenway at the CSPCA carpark which is located at the south end of Sub-Area 2. It then continues to follow the R852 before reaching its terminus.

Table 6.3: Individual ETE Route Options 3–– 4

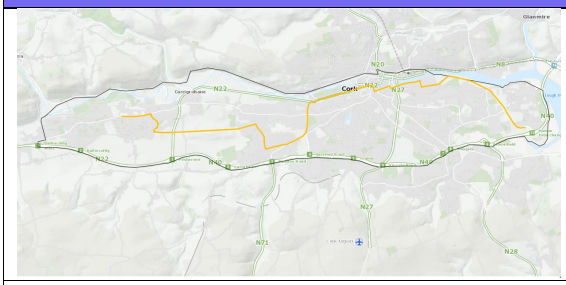
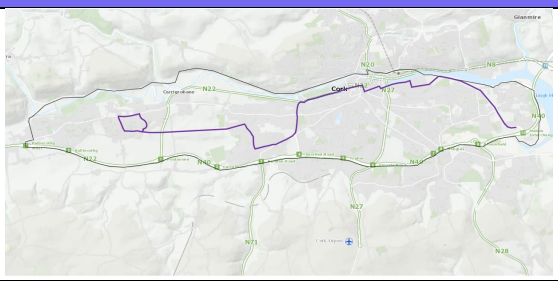
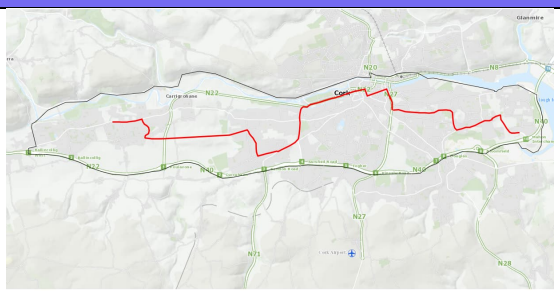
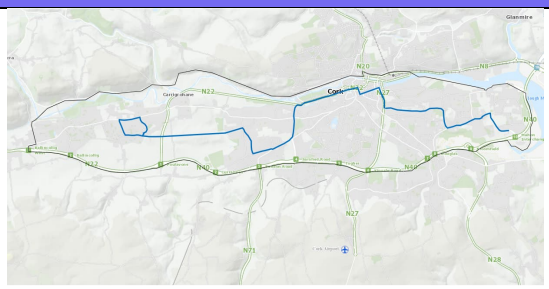
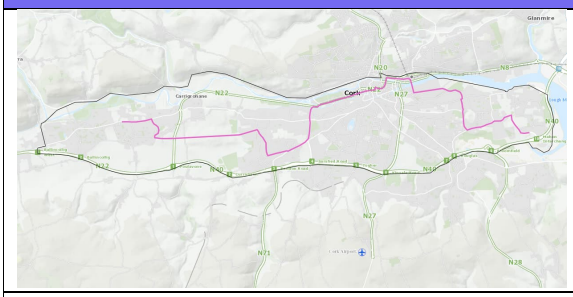
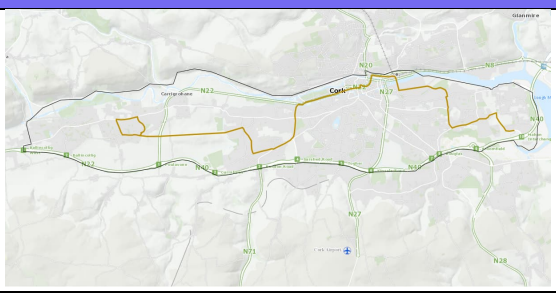
ETE Route Option 3	ETE Route Option 4
	
Sub-Area 3	**Sub-Area 3**
The ETE Route Option begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22. It then passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The ETE Route Option in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road, the track goes from dual to single track. The alignment brings passengers into Sub-Area 3 (single track) and continues on Carriganarra Road until it reaches Station Road. Here it diverts up Station Road and proceeds up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continues through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment turns down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It then passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, this route then follows the Grand Parade and South Mall which heads east towards Sub-Area 2. The route then diverts right over Parnell Bridge. Once the alignment is over the bridge it diverts left and continues down MacSweeney and Albert Quay until it reaches Kennedy Quay Sub-Area 2.	From Munster Technology University, this route travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follows the Grand Parade and South Mall, which heads east towards Sub-Area 2. The route then diverts right over Parnell Bridge. Once the alignment is over the bridge it will divert left and continue down MacSweeney and Albert Quay until it reaches Kennedy Quay Sub-Area 2.
Sub-Area 2	**Sub-Area 2**
The route in Sub-Area 2 begins from Kennedy Quay and travels on Mill Road linking with Center Park Road. The route then travels along Centre Park Road until reaches the Marina. From the Marina, the option follows the existing Greenway (Yellow Circle) for the majority of the Sub-Area 2 option. The option exits the Greenway at the CSPCA carpark which is located at the south end of Sub-Area 2. It then continues to follow the R852 before reaching its terminus	The route in Sub-Area 2 begins from Kennedy Quay and travels on Mill Road linking with Center Park Road. The route then travels along Centre Park Road until it reaches the Marina. From the Marina, the option follows the existing Greenway (Yellow Circle) for the majority of the Sub-Area 2 option. The option exits the Greenway at the CSPCA carpark which is located at the south end of Sub-Area 2. It then continues to follow the R852 before reaching its terminal.

Table 6.4: Individual ETE Route Options 5–– 6

ETE Route Option 5	ETE Route Option 6
	
Sub-Area 3	**Sub-Area 3**
The LRT alignment begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22. It then passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The LRT alignment in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road the track goes from dual to single track. The alignment brings passengers into Sub-Area 3 (single track) and continues on Carriganarra Road until it reaches Station Road. Here it diverts up Station Road and proceeds up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continues through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment turns down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route options travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follow the Grand Parade and South Mall, which heads east towards Sub-Area 2. The route continues east passing Lapp's Quay until it reaches Clontarf St. The route diverts south down Clontarf St and continues on the South Link Road until it reaches the junction between South Link Road and Boreenmanna Road.	From Munster Technology University, this route travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follows the Grand Parade and South Mall which heads east towards Sub-Area 2. The route continues east passing Lapp's Quay until it reaches Clontarf St. The route diverts south down Clontarf St and continues on the South Link Road until it reaches the junction between South Link Road and Boreenmanna Road.

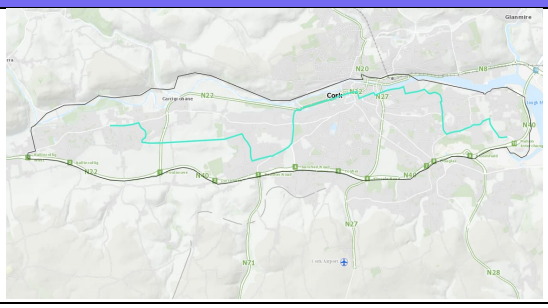
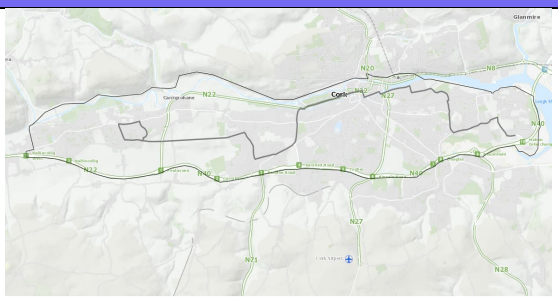
ETE Route Option 5	ETE Route Option 6
Sub-Area 2	**Sub-Area 2**
The option begins where Boreenmanna Road intersects with the South City Link Road. The route continues to travel East along Boreenmanna Road until it reaches Churchyard Ln where it travels south along R852. The option then travels south on Churchyard Ln before it diverts East and travels along Skehard Road. it then follows Skehard Road until it crosses over the existing Greenway. At this point it diverts south onto the R852 which it follows until its terminus.	The option begins where Boreenmanna Road intersects with the South City Link Road. The option continues to travel east along Boreenmanna Road until it reaches Churchyard Ln where it then proceeds south. The route then travels south on Churchyard Ln before it diverts east and travels along Skehard Road. The option follows Skehard Roaduntil it crosses over the existing Greenway At this point it diverts south onto the R852 which it follows until its terminus

Table 6.5: Individual ETE Route Options 7–– 8

ETE Route Option 7	ETE Route Option 8
	
Sub-Area 3	**Sub-Area 3**
The ETE Route Option begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22and passes perpendicular through the N22. The ETE Route Option then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The ETE Route Option in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road the track goes from dual to single track. The alignment brings passengers into Sub-Area 3 (single track) and continues on Carriganarra Road until it reaches Station Road. Here it will divert up Station Road and proceeds up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continue through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment turns down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It passes perpendicular through the N22. The ETE Route Option then proceeds through the agricultural farmlands until it reaches Munster Technology University.

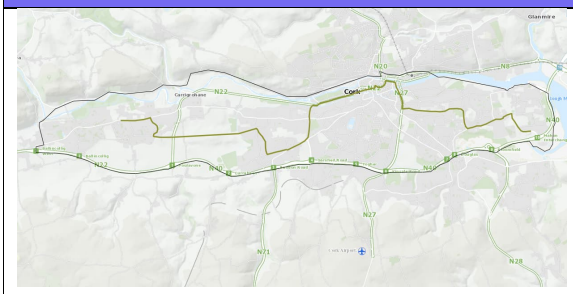
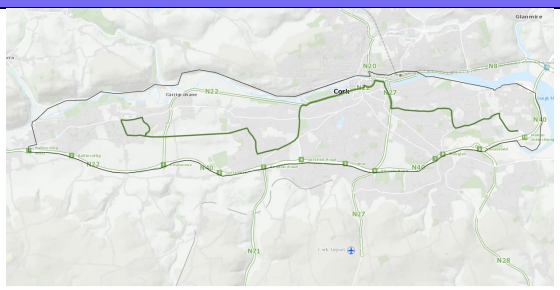
ETE Route Option 7	ETE Route Option 8
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction it then follows St Patrick's Street, crossing north of the River Lee via the existing St Patrick's Street bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment then interchanges directly with Kent Station. A new proposed LRT bridge links the route across the River Lee to Kennedy Quay, accessing Furlong Street and Centre Park Road.	From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follows St Patrick's Street, crossing north of the River Lee via the existing St Patrick's Street bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment would then interchange directly with Kent Station. A new proposed LRT bridge links the route across the River Lee to Kennedy Quay, accessing Furlong Street and Centre Park Road.
Sub-Area 2	**Sub-Area 2**
The route in Sub-Area 2 begins from the bridge connection from Kent Station and will travel on Furlong Street linking up with Centre Park Road. The route travels along Centre Park Road until it reaches Marque Road which it travels for a short distance until it reaches Monahan Road and travels in a southeast direction (Orange Circle). It then diverts south onto Maryville Ln until it reaches Blackrock Road before moving to access Churchyard Ln. The route travels south on Churchyard Ln before it diverts East and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway. At this point it diverts south onto the R852 which it follows until its terminus.	The route in Sub-Area 2 begins from the bridge connection from Kent Station and will travel on Furlong Street linking up with Centre Park Road. The route travels along Centre Park Road until it reaches Marque Road which it travels for a short distance until it reaches Monahan Road and travels in a southeast direction (Orange Circle). It then diverts south onto Maryville Ln until it reaches Blackrock Road before moving to access Churchyard Ln.. The route travels south on Churchyard Ln before it diverts East and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway. At this point it diverts south onto the R852 which it follows until its terminus.

Table 6.6: Individual ETE Route Options 9–- 10

ETE Route Option 9	ETE Route Option 10
	
Sub-Area 3	**Sub-Area 3**
The ETE Route Option begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22. It then passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The ETE Route Option in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road the track goes from dual to single track. The alignment brings passengers into Sub-Area 3 (single track) and continues on Carriganarra Road until it reaches Station Road. Here it diverts up Station Road and proceeds up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continues through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment turns down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It passes perpendicular through the N22. The route proceeds through the agricultural farmlands until it reaches Munster Technology University.
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follows the Grand Parade and South Mall, which heads east towards Sub-Area 2. The route diverts right over Parnell Place bridge, once the alignment is over the bridge it then diverts left and continues down MacSwiney and Albert Quay until it reaches Kennedy Quay Sub-Area 2.	From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction, it then follows the Grand Parade and South Mall, which heads east towards Sub-Area 2. The route diverts right over Parnell Place bridge, once the alignment is over the bridge it then diverts left and continues down MacSwiney and Albert Quay until it reaches Kennedy Quay Sub-Area 2.

ETE Route Option 9	ETE Route Option 10
Sub-Area 2	**Sub-Area 2**
The route in Sub-Area 2 begins from Kennedy Quay and travels on Mill Road linking with Centre Park Road. The routethen travels along Centre Park Road until it reaches Marque Road. It then travels for a short distance until it reaches Monahan Road where it travels in a southeast direction (Orange Circle). The route then diverts south onto Maryville Ln until it reaches Blackrock Road. The route uses Blackrock Road as a staggered junction which is used to access Churchyard Ln. The route travels south on Churchyard Ln before it diverts east and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway At this point it diverts south onto the R852 which it follows until its terminus.	The route in Sub-Area 2 begins from Kennedy Quay and travels on Mill Road linking with Centre Park Road. The route then travels along Centre Park Road until it reaches Marque Road. It then travels for a short distance until it reaches Monahan Road where it travels in a southeast direction (Orange Circle). The route then diverts south onto Maryville Ln until it reaches Blackrock Road. The route uses Blackrock Road as a staggered junction which is used to access Churchyard Ln. The route travels south on Churchyard Ln before it diverts east and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway. At this point it will divert south onto the R852 which it follows until its terminus.

Table 6.7: Individual ETE Route Options 11–– 12

ETE Route Option 11	ETE Route Option 12
	
Sub-Area 3	**Sub-Area 3**
The ETE Route Option begins just outside Ballincollig Town Centre on the R608 Road. On the R608 the alignment passes through the Town Centre on Main Street until it reaches Leo Murphy Link Road. The alignment diverts down the Leo Murphy link road until it reaches the Link Road to the south. On the Link Road the alignment proceeds east towards the N22. It then passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.	The ETE Route Option in Sub-Area 3 is made up of a single and dual track alignment. Starting at the junction between the Link Road and Leo Murphy Link Road the track goes from dual to single track. The alignment brings passengers into Sub-Area 3 (single track) and continues on Carriganarra Road until it reaches Station Road. Here it diverts up Station Road and proceed up to the Main Street of Ballincollig Town Centre. The alignment turns right onto Main Street and continues through the town centre until it reaches the junction to turn for Leo Murphy Road. At the junction the single track alignment turns down Leo Murphy Link Road until it can link back up the with the dual track alignment on the Link Road. On the Link Road the alignment (dual track) proceeds east towards the N22. It passes perpendicular through the N22. The route then proceeds through the agricultural farmlands until it reaches Munster Technology University.

ETE Route Option 11	ETE Route Option 12
Sub-Area 1	**Sub-Area 1**
From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction this route option then follows St. Patrick's Street until it reaches Merchants Quay. The route travels down Merchants Quay and Anderson's Quay until it reaches the N27. The route diverts south down the N27 and the South Link Road until it reaches the junction between South Link Road and Boreenmanna Road.	From Munster Technology University, this route option travels south along Melbourn Road. It then proceeds along Curraheen Road and Bishopstown Road and passes along the frontage of the Cork University Hospital and Wilton Shopping Centre. From the Wilton Roundabout the route travels north up Wilton Road and then east along the N22 towards the City Centre along Western Road. At the Grand Parade junction this route option then follows St. Patrick's Street until it reaches Merchants Quay. The route travels down Merchants Quay and Anderson's Quay until it reaches the N27. The route diverts south down the N27 and the South Link Road until it reaches the junction between South Link Road and Boreenmanna Road.
Sub-Area 2	**Sub-Area 2**
The option begins where Boreenmanna Road intersects with the South City Link Road. The route continues to travel east along Boreenmanna Road until it reaches Churchyard Ln where it proceeds south. The option will travel south on Churchyard Ln before it diverts East and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway. At this point it will divert south onto the R852 which it follows until its terminus.	The option begins where Boreenmanna Road intersects with the South City Link Road. The route continues to travel east along Boreenmanna Road until it reaches Churchyard Ln where it proceeds south. The option travels south on Churchyard Ln before it diverts East and travels along Skehard Road. The option follows Skehard Road until it crosses over the existing Greenway. At this point it diverts south onto the R852 which it follows until its terminus.

7 Cost Estimate

7.1 Introduction

Following the completion of the Step C design drawings and associated cross-sections, an Option Cost Estimate and Operations & Maintenance (O&M) estimate was carried out for the 12 ETE Route Options. Both cost estimates provided a key input to the economic appraisal process and allowed the calculation of a BCR, to ascertain value for money and comparison across route options.

The Options Cost estimate includes the cost of designing and constructing a LRT scheme to provide a high-speed, high-capacity, high-frequency public transport link from Ballincollig to Mahon point along the 12 ETE Route Options. The Option Cost Estimate includes railway control and power systems, electric power and plant, permanent way, operational telecommunication systems, building works, depot facilities, civil engineering and infrastructure works, enabling works, rolling stock, land acquisition and injurious affection costs.

Based on Jacobs standard estimating procedures the estimate has been classed as a Class 4 estimate. This is reflective of the maturity and quality of information on which the estimate is based. Class 4 estimates are considered to have an accuracy range of -30% to +40%. The estimate should be carefully considered in conjunction with the detailed list of qualifications, assumptions and exclusions included within Volume 4 – Cost Estimate Part B – ETE Cost Estimate.

An Operations & Maintenance (O&M) Cost estimate was also carried out for operating and maintaining the necessary trams, signals, vehicle equipment, stops and facilities to enable a reliable future proofed mode of sustainable transport for the city. The O&M estimate is detailed further in section 8.7 of this report.

7.2 Basis of Option Cost Estimate

The Options Cost estimate for the Luas Cork works has been developed using parametric estimating methods. Quantities have been quantified in accordance with the Rail Method of Measurement – Order of Cost Estimating, Cost Planning and Detailed Measurement of Rail Infrastructure Works – Volume 1, 1st Ed. ("RMM1") published in July 2018. Where items of work could not be quantified, either a percentage or sum allowance was included based on data from other projects or on the Estimator's professional judgement. Buildings and Property have been quantified and itemised in accordance with Group Element 1.06 of RMM1 based on Group Element Unit of gross internal floor area ("GIFA") with the cost estimated on a unit cost basis.

All costs have been based at 2Q 2022 to align with the completion of the ETE Route Option Design, and have been factored to consider geographical location in accordance with published cost data from the RICS' Building Cost Information Service (BCIS). The estimated rates have also been benchmarked against past project data where available, and projects of a similar scale such as Luas Finglas, and have been found to be comparable. The full Cost Estimate for ETE Route Options 1-12 is included in Volume 4: Cost Estimate: Part B – ETE Cost Estimates.

7.3 Programme

To inform the cost estimate it has been assumed that the works are anticipated to start in 2nd quarter 2030 with a programme duration of 5 years.

7.4 Inflation

The estimate includes an allowance for inflation. This has been calculated from the base date of pricing (2Q 2022) to the midpoint of construction (4Q 2032). Inflation has been estimated based on the BCIS Civil Engineering Tender Price Index up to 2Q 2027 as no further forecasts are available beyond this date. An inflation rate of 3.5% per annum has been included from 3Q 2027 to 4Q 2032.

7.5 Risk

The Contingency for the main route, depot and land acquisition was calculated using the NTA's Contingency Calculator. Based on the Phase 2 Non-standard work classification the contingency percentage applied to the above estimated costs is 59%. A 20% contingency has been allowed for rolling stock as it is a proprietary product. The 20% contingency included is in line with discussions with TII regarding their experience in procuring rolling stock.

It is anticipated that the level of risk will decrease in line with scope and design maturity as the Proposed Scheme moves to the next stage of design development.

7.6 Option Cost Estimate Summary

A cost estimate summary of the 12 ETE Route Options is outlined in Table 7.1. A more detailed breakdown is shown in Table 7.2.

Table 7.1: Summary of Option Cost Estimates for ETE Route Options 1-12

	Light Rail Works		
	Main Route (€m)	**Depot (€m)**	**Total (Light Rail +Depot) (€m)**
Option 1	€ 1,775	€ 248	€ 2,022
Option 2	€ 1,804	€ 248	€ 2,052
Option 3	€ 1,664	€ 248	€ 1,912
Option 4	€ 1,701	€ 248	€ 1,949
Option 5	€ 1,657	€ 248	€ 1,905
Option 6	€ 1,695	€ 248	€ 1,943
Option 7	€ 1,886	€ 248	€ 2,134
Option 8	€ 1,924	€ 248	€ 2,172
Option 9	€ 1,786	€ 248	€ 2,034
Option 10	€ 1,825	€ 248	€ 2,073
Option 11	€ 1,659	€ 248	€ 1,907
Option 12	€ 1,697	€ 248	€ 1,945

Table 7.2: Detailed Summary of Cost Estimate for ETE Route Options 1-12

Ref	Description		Light Rail Works												Depot	
			OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5	OPTION 6	OPTION 7	OPTION 8	OPTION 9	OPTION 10	OPTION 11	OPTION 12	m2	7,529
	Km		17.31	18.32	17.04	18.04	17.44	18.45	18.06	19.06	17.78	18.79	17.58	18.59	Km	5.4
	Construction Works (Including Preliminaries and Traffic Management)		€555,685,412	€567,346,673	€519,974,044	€534,382,341	€517,476,729	€532,058,409	€594,002,211	€608,837,787	€562,113,637	€576,998,977	€518,153,399	€533,012,501		€87,284,729
	Land Acquisition and Injurious Affection Costs		€8,907,748	€7,155,048	€4,774,748	€3,012,048	€4,903,350	€3,255,150	€10,291,050	€8,528,350	€6,032,850	€4,387,150	€5,011,650	€3,264,950		n/a
	Rolling Stock		€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000	€103,500,000		n/a
	Project / Design Team and Other Project Costs	25%	€138,921,353	€141,836,669	€129,993,511	€133,595,584	€129,369,182	€133,014,602	€148,500,553	€152,209,446	€140,528,409	€144,249,744	€129,538,350	€133,253,125	25%	€21,821,181
	Design Risk / Contingency															
	Construction Works & Land	59%	€415,073,562	€422,639,650	€386,297,959	€395,884,084	€384,532,064	€394,313,615	€444,148,350	€454,049,595	€418,118,189	€428,125,164	€385,095,005	€395,023,040	59%	€64,372,487
	Rolling Stock	20%	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000	€20,700,000		n/a
	Inflation															
	Inflation from 2Q2022 to 2Q2030	31%	€385,264,303	€391,585,192	€361,224,481	€369,232,958	€359,749,211	€367,920,951	€409,554,071	€417,825,805	€387,807,856	€396,167,921	€360,219,505	€368,513,621	31%	€53,778,303
	Inflation from 2Q2030 to 4Q2032	9%	€146,524,714	€148,928,691	€137,381,827	€140,427,631	€136,820,748	€139,928,645	€155,762,661	€158,908,588	€147,492,085	€150,671,606	€136,999,612	€140,154,051	9%	€20,453,103
	Total Cost Including Inflation (Ex VAT)		**€1,774,577,092**	**€1,803,691,923**	**€1,663,846,570**	**€1,700,734,646**	**€1,657,051,284**	**€1,694,691,372**	**€1,886,458,896**	**€1,924,559,571**	**€1,786,293,026**	**€1,824,800,562**	**€1,659,217,521**	**€1,697,421,288**		**€247,709,803**
	Cost/km		**€102,517,452**	**€98,454,799**	**€97,643,578**	**€94,275,756**	**€95,014,408**	**€91,853,191**	**€104,455,088**	**€100,973,745**	**€100,466,424**	**€97,115,517**	**€94,380,974**	**€91,308,300**		

7.7 Operations & Maintenance Cost

The cost of running each of the 12 ETE Route Options (including staff costs, energy) and maintaining each of the route options (both infrastructure and rolling stock) has been estimated. The purpose of estimating the Operations & Maintenance (O&M) cost is primarily to feed into BCR calculations as part of this assessment, in order to provide more rigorous and robust BCRs that include both Capital and O&M costs.

To inform the O&M cost estimate a review of the existing Dublin Luas system was used to calculate an average O&M cost per operated vehicle-kilometres. Annual figures for the year 2019 were extracted from the NTA 2020 Bus & Rail statistics bulletin: https://www.nationaltransport.ie/wp-content/uploads/2021/10/NTA-PSO-Bus-and-Rail-Statistics-2020.pdf

- 2019 Passengers Revenue: 81.0m€;
- 2019 Annual DSP Free Travel Scheme Funding: 3.9m€;
- 2019 Annual LRT veh.km operated: 4.4m; and
- Luas did not receive PSO funding from the Authority in 2019 and returned a surplus of 15.31m€.

The bulletin states that Luas returned a surplus of 15.31m€ in 2019, so the total annual operating costs are estimating at 69.59m€ (81.0+3.9-15.31), or 15.8€/km once divided by the 4.4m veh.km operated in 2019.

It has been assumed that the proposed Luas Cork scheme would operate with a 5min frequency in each direction, 12h a day, 365 days a year, over 18km. These assumptions add up to 1.9m veh.km per year. Using the 2019 Dublin Luas operating cost ratio, the Luas Cork scheme would cost 29.9m€ (€2019) annually to operate. Converted to €2011 for consistency (29.1m€) and multiplied by 60 years, total O&M cost is estimated at €1,747,021,095 (€2011).

8 Transport Modelling

8.1 Introduction

This chapter provides a summary of the transport modelling work undertaken for the 12 ETE Route Options during Step C and details the results of each, forecasting for the potential transport demand. This chapter also details the following elements of the modelling process:

- The South Western Regional Model (SWRM);
- The 2020 base year scenario development and validation;
- The Forecasted Do Minimum scenario;
- The Forecasted Do Something scenarios; and
- Modelling results.

A detailed modelling Transport Modelling Report (TMR) has been developed and appended to this report in Volume 5: Transport Assessment: Part A - Transport Modelling Report. This provides more granularity and details on the modelling process and should be consulted for a more comprehensive presentation of the work completed on the analysis of the 12 ETE Route Options.

8.2 The South Western Regional Model (SWRM)

The South Western Regional Model (SWRM) is a strategic, multi-modal model capable of modelling all surface-based forms of transport (Car, Bus, Rail, Light Rail/Metro, walking and cycling). The SWRM has a calibrated base year of 2016 built on census and National Household Survey data.

The SWRM is one of the five large-scale regional transport models that sit within the NTA's Regional Modelling System. This system comprises the National Demand Forecasting Model, the detailed multi-modal regional transport models and a suite of Appraisal Modules. Collectively, the models cover the entire national transport network of Ireland, with the five regional models focussed on the travel-to-work areas of the major population centres; and in the case of the SWRM focused on Cork.

These strategic models are designed to be used in the assessment of both transport policies and schemes that have a local, regional and national impact, and they facilitate the assessment of proposed transport schemes at both macro and micro level, and throughout the different scheme development phases. Based on the characteristics of the proposed Luas Cork it was therefore considered appropriate to undertake the transport modelling assessment utilising the SWRM.

Five different time periods are represented in the SWRM. The five time periods are: Morning peak (AM) – 07:00-10:00; Lunch Time (LT) – 10:00-13:00; School Run (SR) – 13:00-16:00; Evening Peak (PM) – 16:00-19:00; Off-Peak (OP) – 19:00-07:00.

More details on the NTA Regional Modelling System are publicly available on the NTA website: https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/.

8.3 2020 Base Year Model Development

The 2016 calibrated base year has been updated to a more recent 2020 base year (pre-covid). Any recent change to the transport network likely to impact the assessment of the scheme is included into the modelling, to improve its accuracy. While the SWRM covers the full extent of Cork and Kerry counties, the 2020 base year scenario modifications are focused on Cork City, in the vicinity of the Proposed Scheme route options.

The 2020 base model has been developed using the assumption that pre-pandemic service levels and demand volumes should continue to be used for appraisals until updated guidance is published. Further modelling work that will be required as the proposals develop will draw on any specific guidance offered by the NTA/TII or others on handling medium and longer-term impacts on travel volumes and demand. This will include any specific post-COVID scenarios and the use of sensitivity analysis to consider forecast transport demand and wider benefit delivery.

The road network was compared against a recently developed network for the South Quays Public Transport Improvement Scheme on Cork South Quay. In addition to this, a manual review of all the key junctions in the City Centre and within the Proposed Scheme study area was undertaken to ensure they are up to date. More details on the road network modifications can be found in the Traffic Model report.

The calibrated 2016 Public Transport network was used to set up the 2020 base model. More recent public transport service data, representing 2019 supply network, were compared to the calibrated 2016 PT lines. Only minor adjustments were made to the coding (e.g. introduction of Bus Éireann route 213: Black Ash P&R to St. Patrick Street).

8.4 Forecast Year Modelling – Do Minimum

8.4.1 Land Use and Demand

The opening year for the scheme is assumed to be 2035 and 2050 (opening year +15 years) the future design year. This section summarises the future development assumptions for the Study Area, as detailed in the Cork City and Cork County Development plans. These plans provide the basis of the projected 2035 population and employment for the Study Area as used in the SWRM and based on demographic forecasts prepared by the National Transport Authority in conjunction with the Cork City and County planning departments.

Table 8.1 provides a high-level comparison between the 2016, 2035 and 2050 population totals; the 2035 year represents the opening year for the Proposed Scheme and has been interpolated by the NTA from the 2040 NTA reference case.

Table 8.1: 2016, 2035 and 2050 Population for different geographical areas – source NTA (from planning data sheets)

	2016	2035	Difference 2016-2035 (%growth)	2050	Difference 2016-2050 (%growth)
Ireland	4,761,865	5,545,490	+783,625 (+16%)	6,164,141	+1,402,276 (+29%)
Cork County	541,856	648,746	+106,890 (+20%)	733,733	+191,877 (+35%)
Cork Metropolitan	305,406	399,991	+94,585 (+31%)	475,442	+170,036 (+56%)
Cork City	130,644	182,890	+52,246 (+40%)	223,298	+92,654 (+71%)

Based on the NTAs planning data sheets, CMA population is forecasted to grow by approximately 94,585 (+31%) and approximately 52,246 (+40%) for Cork City between 2016 and 2035. The most considerable increases in population are forecast for the South Ballincollig and City Docklands areas which see increases of 8,500 and 11,500 people respectively.

Table 8.2 provides a comparison between the 2016, 2035 and 2050 total employment, broken down by geographical areas.

Table 8.2: 2016, 2035 and 2050 Employment for Different Geographical Areas – NTA (from planning data sheets)

	2016	2035	Difference 2016-2035 (%growth)	2050	Difference 2016-2050 (%growth)
Ireland	2,006,641	2,344,414	+337,773 (+17%)	2,611,476	+604,835 (+30%)
Cork County	229,919	276,499	+46,580 (+20%)	313,398	+83,479 (+36%)
Cork Metropolitan	130,220	171,683	+41,463 (+32%)	204,635	+74,415 (+57%)
Cork City	52,786	75,350	+22,564 (+43%)	92,680	+39,894 (+76%)

A significant employment increase is forecast for Cork City, with approximately 23,000 additional jobs (+43%) predicted to be in place by 2035 (compared to the 17% national average employment increase). A significant proportion would also be located in the Docklands, Tivoli and South Ballincollig.

8.4.2 Transport Schemes

Future year forecasts for the Proposed scheme requires a definition of the expected transport provision in the area in advance of delivery of the proposed Luas Cork scheme. The core Do Minimum scenario defines the transport network in the absence of the proposed Luas Cork Scheme and is predominantly based on the Proposed Scheme identified in the Cork Metropolitan Area Transport Strategy (CMATS) published in February 2020 and the NDP 2021-2030, which outlines up the Government's investment priorities and strategy on delivering infrastructure projects in the coming decade.

8.4.2.1 Do Minimum Scheme Definition

This section outlines the transport schemes to be included as part of the Do Minimum scenario for the opening year (2035). The Proposed Scheme opening year (2035) will be based on the investment priorities contained within the NDP (2021-2030) and includes the following:

- M28 Cork-Ringaskiddy – Road scheme;
- Dunkettle Interchange – Road scheme;
- Southern Distributor Road – Road scheme;
- Northern Distributor Road – Road scheme;
- Pedestrianisation of Cork City – Active Modes scheme;
- Cycle Plan – Active Modes scheme;
- Bus Connects – Public Transport scheme; and
- Suburban Rail development plan–- Public Transport scheme.

8.4.2.2 Other elements

Large transport schemes are not the only aspects of the transport network that are likely to change in the coming years. Other elements can be captured in the transport modelling such as:

a) Traffic management: 50% car parking capacity reduction between 2016 and 2035 in City Centre;

b) Traffic management: Road Speed reduction and circulation plan on Cork island;

c) Integrated fares system; and

d) Behaviour change (increased proportion of cyclists, home-working etc.): To be considered as sensitivity tests.

8.5 Forecast Year modelling – Do Something scenarios

The 12 ETE Route Options identified were modelled, and the purpose of this section is to describe how the options are represented in the SWRM and the modelling assumptions made. Do Something refers to the scenarios that include a version of the Luas Cork scheme, as opposed to the Do Minimum scenario that doesn't include the Luas Cork scheme.

8.5.1 Highway modelling

The impacts of the Proposed Schemes ETE Route Options on road capacities and traffic were not considered at this stage. All local accesses to modelled traffic zones are retained from the Do Minimum. As the Proposed Scheme design develops, there may be a number of changes to the way the highway network operates as a result of the introduction of on-street running of the Luas Cork system and how the system interfaces with the roadway, particularly at major junctions.

While some highway capacities may be lost with the introduction of the Luas Cork System, mitigation measures may be possible to retain some capacity on the wider network, through reconfiguration and expansion targeted areas on the network, such as pinch points for vehicular traffic and through careful configuration of junction geometry and signal timings both on-line and off-line routes. Therefore, at this stage no traffic management systems have been designed and coded in the Do Something models.

8.5.2 Public Transport modelling

8.5.2.1 LRT network coding

The proposed stop locations on the 12 ETE Route Options were defined as part of the Step B – development of area options and are considered an input to the transport demand modelling. A list of Luas stops with coordinates (in Irish Grid TM65 referential) and a list of Luas links has been defined. Finally, using GIS software, stop-to-stop actual distances were calculated (not crow-fly distances).

8.5.2.2 Luas journey times

From an operational speed perspective, the Luas route options has been split in 3 categories, depending on the level of segregation, and mixing with the other modes. Average Luas speeds on each of the 3 categories has been derived from existing Dublin Luas operating speeds and are:

- Mixed on-street–- Several junctions & mixed with car, walk & cycle – 12.0kph;
- Segregated on-street–- Segregated from the traffic with some junction crossing – 19.0kph; and
- Off street–- Fully segregated–- No junction crossing for the entire section – 25.0kph

8.5.2.3 Fares

It has been assumed that an integrated fare system across all Public Service Operators (PSO) will be in place in Cork City by the time the Luas Cork scheme is operational. The integrated fare system utilised in the modelling comprises of two flat fare rates based on distance (short and long).

8.5.2.4 Other Public Transport Modes

It has been assumed, at this stage in the development that the introduction of the Luas Cork Scheme does not have any impact on the operation of the public transport network, apart on a limited number of urban bus routes that directly overlap and compete. While the Proposed Scheme may serve Kent station (directly or indirectly depending on the ETE Route Option), the operation will not impact on mainline heavy rail services which will be expected to remain unchanged.

The current assumption for the Do Something tests is that bus services that directly compete with the Proposed Scheme would be amended. Overall, 6 urban bus routes have been adapted following two key principles: Remove or reduce frequencies where buses and trams run on the same section and extend bus routes to act as feeders to the Luas Cork Scheme where relevant and would enhance the catchment of the integrated Public Transport network.

8.5.3 Other model components

8.5.3.1 Active Modes

Walking and Cycling are included in the SWRM as separate modes and assigned on specific networks. The potential impact that the Luas Cork Scheme will have on active modes hasn't been coded and the same active modes networks is in place in both the Do Minimum and the Do Something scenarios. At this early stage of the development of the Luas Cork Scheme, there isn't enough information available to represent the modifications brought by the Luas system on active modes in the SWRM.

8.5.3.2 Park & Ride (P&R)

Park & Ride sites were identified and assessed following the establishment of the 12 End-to-End options. There are two P&R sites which have been defined and form part of the End-to-End assessment. These sites have been coded into the model utilising the P&R forecast method developed by the NTA during the development of their Regional Modelling System. The sites and relative car parking capacities are:

1. P&R Site 1: Greenfield site (adjacent to the N22) connecting to the Killumney Road Roundabout; and
2. P&R Site 2: Site North of Mahon Link Road, between City Gate and Mahon Point Shopping Centre.

8.6 Transport Modelling results

Each of the 12 End-to-End options has been coded and run in the SWRM. Mode shares in the Cork Metropolitan Area are represented in Figure 8.1Figure 8.1. A shift from car to PT and Active Modes (-9.6 percentage points) occurs between 2016 and 2035 (Do Minimum), due to the introduction of the Bus Connects scheme, the reduction in parking spaces in the city centre, and the implementation of active modes schemes (Cork cycle plan, pedestrianisation). Car mode share is reduced by a further 2.2 percentage points between 2035 and 2050 (Do Minimum), as increasing traffic congestion makes sustainable modes a more attractive option.

Car mode share goes down by 0.2 percentage points between Do Minimum and Do Something (both 2035 and 2050), while PT goes up by 0.9 percentage points in 2035 and 1.1 percentage point in 2050, due to the introduction of the Proposed Scheme. ETE Route Option 1 has been selected from the Transport Modelling report to demonstrate an example of the profile transport modelling results as shown in Figure 8.1Figure 8.1 to Figure 8.3Figure 8.3. The full set of results for ETE Route Options 1-12 are included within the full Transport Modelling Report in Volume 5: Transport Assessments, Part A: Transport Modelling Report.

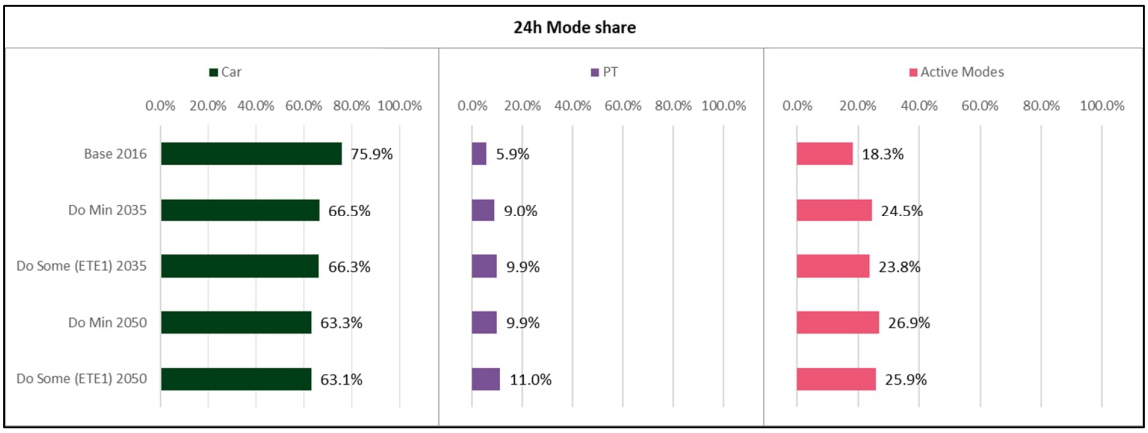


Figure 8.1: 24h Mode Shares in Cork Metropolitan Area

Figure 8.2Figure 8.2 and Figure 8.3Figure 8.3 are LRT opening year line (or load) profiles for the AM peak hour, in each direction, for one of the options (ETE1). Kent station is the busiest station in the morning, with over 400 boardings per hour in each direction. Cork IT, UCC and Marquee St Road (Docklands) stations have a significant amount of alightings in the AM.

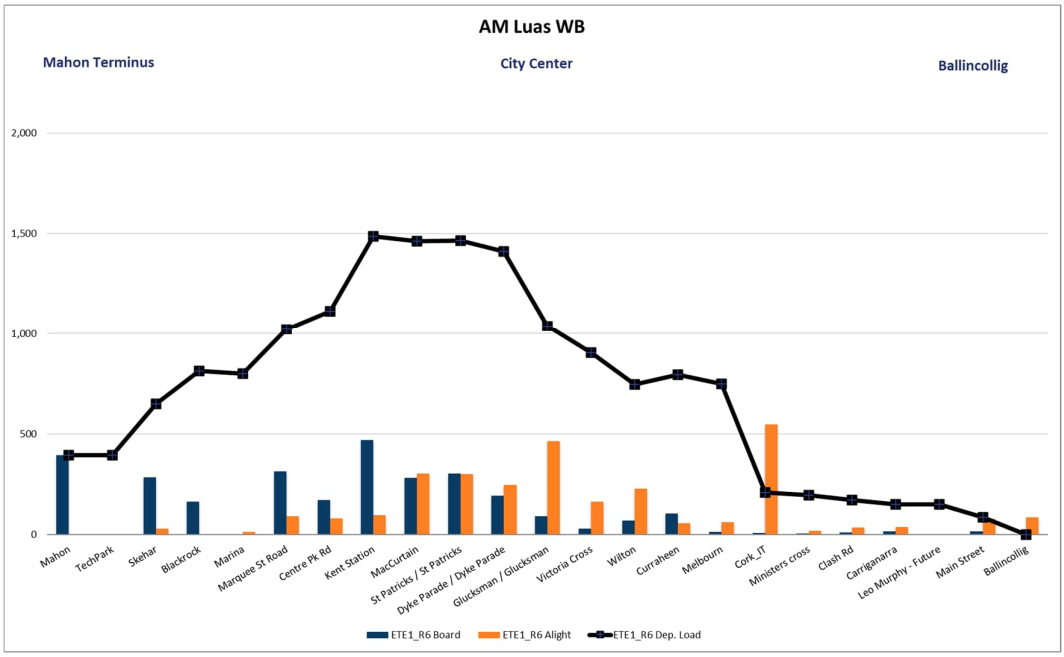


Figure 8.2: LRT Line Profile Westbound– 2035 AM peak hour (End-to-End option 1)

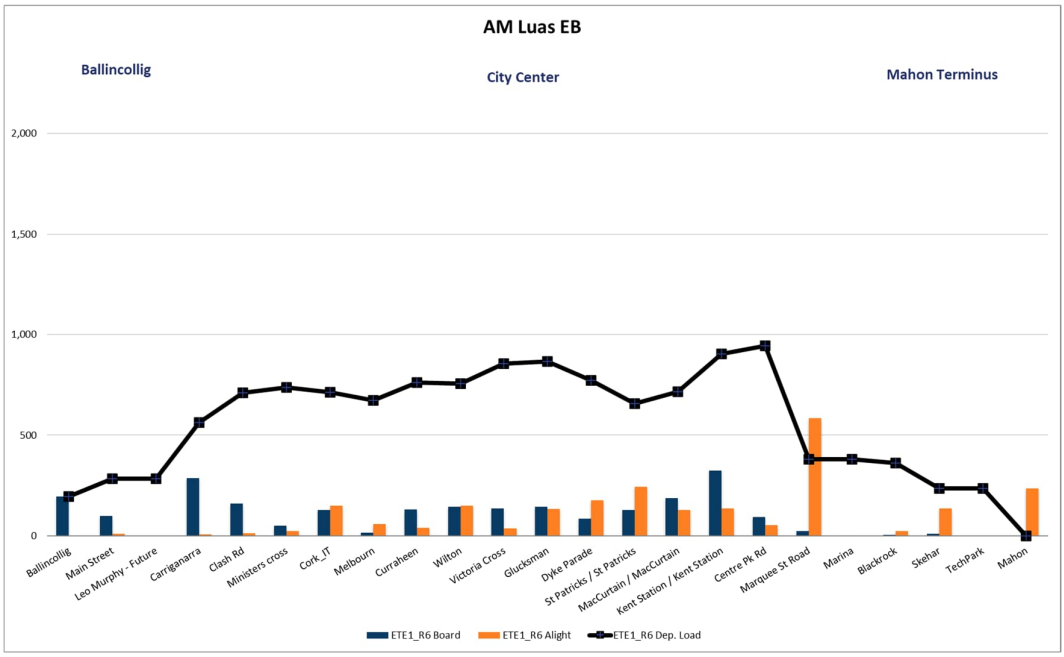


Figure 8.3: LRT line profile Eastbound– 2035 AM peak hour (End-to-End option 1)

From the model runs; other indicators have been extracted to compare the 12 ETE Route Options and feed into the Step C Multi Criteria Assessment (MCA). The transport modelling undertaken provides information on the following:

- LRT Journey Times;
- LRT patronage: daily and annual demand, peak flows; and
- Transfers between LRT and other PT modes (Bus & Rail).

Table 8.3 summarises these indicators.

Table 8.3: 2035 Modelling Results Summary Table

ETE	End-to-end journey times (min)	24h Luas Boardings	Annual Luas Boardings	Peak flow (pass/h)	24h modelled transfers between Bus & Luas	24h modelled transfers between Rail & Luas
1	53.5	49,041	16,387,478	1,486	13,482	6,181
2	52.5	48,593	16,238,599	1,483	13,270	6,173
3	51.4	47,933	16,071,127	1,568	14,884	4,685
4	50.4	47,486	15,921,926	1,567	14,675	4,679
5	56.2	46,304	15,556,357	2,084	13,804	2,750
6	55.2	45,815	15,395,429	2,078	13,585	2,739
7	58.3	52,460	17,494,747	2,135	13,708	6,338
8	57.3	51,978	17,337,512	2,194	13,490	6,332
9	56.3	50,933	17,040,463	2,230	14,960	4,838
10	55.3	50,480	16,890,438	2,229	14,767	4,829
11	58.9	45,555	15,317,771	1,950	13,435	2,830
12	57.9	45,108	15,167,258	1,944	13,218	2,817

The modelling results extracted from the SWRM allow a fair comparison of the options, representing design differences and estimating their impacts on the transport system. The End-to-End journey times vary from 50.4min for the more direct route using the Greenway and 58.9min for a more circuitous ETE Route Option 11. Total modelled daily boardings range between 45,108 passengers and 52,460 passengers. All these indicators, taken separately, give different options ranking. Of the 12 ETE Route Options, those highlighted in 'green' have been assessed as having the optimal modelling outcome across the summary of results.

8.7 Benefits Costs Ratio (BCR)

In addition to the forecast demand modelling other outputs from the modelling of the 12 ETE Route Options are used as inputs to calculate the benefits as part of the economic appraisal undertaken. They were inputted into the Transport Users Benefit Appraisal (TUBA) software, comparing Do Minimum and Do Something scenarios for the two modelled forecasted years (2035 and 2050), to calculate and determine the benefits over the 60 years appraisal period.

The Common Appraisal Framework (CAF – October 2021 revision) states that *"A quantification of the benefits and costs over time should be brought back to present values and a 2011 base year"* . The estimated capital costs for the 12 ETE Route Options have therefore been converted in €2011 values. Operations & Maintenance costs were also estimated, based on Dublin Luas system costs. Both benefits and costs were converted to Net Present Values, using the discount rates provided by the PSC.

Table 8.4: BCR Results Summary Table

ETE	Option Cost Estimate (€2032) Incl. Rolling Stock & Depot (€m)	Option Cost Estimate (€2011) Incl. Rolling Stock & Depot (€m)	Operation & Maintenance Costs for 60y (€2011) (€m)	Present Value Option Cost Estimates (€2011) (€m)	Present Value O&M Costs (€2011) (€m)	Total Present Value Costs (€2011) (€m)	Total Present Value Benefits (€2011) (€m)	BCR
1	€ 1,886	€ 1,290	€ 1,747	€ 640	€ 337	€ 977	€ 942	0.96
2	€ 1,915	€ 1,309	€ 1,747	€ 649	€ 337	€ 986	€ 915	0.93
3	€ 1,784	€ 1,219	€ 1,747	€ 605	€ 337	€ 942	€ 943	1.00
4	€ 1,820	€ 1,243	€ 1,747	€ 617	€ 337	€ 954	€ 938	0.98
5	€ 1,778	€ 1,215	€ 1,747	€ 603	€ 337	€ 940	€ 667	0.71
6	€ 1,814	€ 1,239	€ 1,747	€ 615	€ 337	€ 952	€ 641	0.67
7	€ 1,990	€ 1,361	€ 1,747	€ 676	€ 337	€ 1,013	€ 1,021	1.01
8	€ 2,028	€ 1,386	€ 1,747	€ 688	€ 337	€ 1,025	€ 991	0.97
9	€ 1,899	€ 1,297	€ 1,747	€ 644	€ 337	€ 981	€ 1,028	1.05
10	€ 1,936	€ 1,322	€ 1,747	€ 656	€ 337	€ 993	€ 999	1.00
11	€ 1,780	€ 1,216	€ 1,747	€ 604	€ 337	€ 941	€ 599	0.64
12	€ 1,817	€ 1,241	€ 1,747	€ 616	€ 337	€ 953	€ 596	0.63

The calculated BCRs range between 0.63 and 1.05, with ETE Route Options 3, 7, 9 & 10 (highlighted in green) being the best performing options, and options 11 and 12 preforming the worst. While the present value costs are within a narrow range (€ 941,281,228 - € 1026,496,423), the present value benefits are more widely spread (€ 595,377,000 - € 1,027,836,000). The BCR differences among options are more due to benefit differences rather than cost differences. Options with the lowest BCRs (11 & 12) also have the slowest alignments, highlighting the link between speed and benefits, which are related to journey times savings.

8.8 Conclusion of Transport Modelling

The Cork LRT feasibility study has used the NTA SWRM to estimate how the different alignment options would impact the transport system in the future. This Strategic Regional Transport Model has been adapted for this study, drawing in expectations of future year growth drivers from the NTA and expected transport network improvements, in part developed to support the forecast growth in demand.

Modelling work completed on this project yield several Key Performance Indicators for the Step C MCA. The consistency applied in the coding of the different 12 ETE Route Options and performance of model across the different ETE Route Option geographies allow a fair comparison, which is essential for identifying the EPR option as part of the Step C MCA and, in due course, into more detailed design work and furthermore detailed modelling work.

Whilst the overall mode shares and scheme costs are similar across the options, certain indicators such as LRT boardings, journey times, transfer to other modes, and economic benefits differ more significantly from one option to another. The transport modelling provides quantified information to measure these differences. It emerges from that work that a certain set of options perform better than other on key indicators (LRT boardings, BCR): 7-8 and 9-10.

9 Step C Multi Criteria Assessment (MCA)

9.1 Introduction

As outlined in earlier chapters, the completion of the Step B MCA and subsequent design development process identified 12 ETE Route Options for the Proposed Scheme. As part of Step C, the 12 ETE Route Options underwent a detailed MCA process. The MCA methodology for Step C is line with the criteria outlined in the "Common Appraisal Framework (CAF) for Transport Projects and Programmes" guidelines and as detailed within the MCA Methodology in Chapter 3. The overall aim for the Step C MCA was to identify an EPR for the Proposed scheme. Table 9.1 presents all criteria and sub-criteria used for the Step C MCA.

Table 9.1: End-to-End MCA Assessment Criteria and Sub-Criteria

Assessment Criteria	Assessment Sub-Criteria	Approach
1. Economy	a. Benefit Cost Ratio (TUBA, Capex and O&M costs)	Comparative cost benefit analysis for each End-to-End option.
	b. Patronage (outputs from SWRM)	Passenger demand figures from model runs.
	c Journey Time	Assessment of indicative journey times for each End-to-End option including dwell times at stops etc.
2. Integration	2.a. Land Use Policy, Residential Population and Employment Catchments	Integration with existing residential, educational & leisure uses in this established area.
	2.b. Bus Network Integration	24h modelled transfers between LRT and Bus.
	2.c. Rail Integration	24h modelled transfers between LRT and Rail.
	2.d Traffic Network Integration	Sum of road traffic (2035 AM peak hour) at junctions on the LRT alignment.
	2.e Active Modes (Cyclist & Pedestrians)	Compatibility with existing walking, cycling, and traffic.
3. Accessibility & Social Inclusion	3.a. Key Trip Attractors	Ability to serve key trip attractors.
	3.b. Deprived Geographic Areas (social inclusion)	Deprivation Index from Trinity College Dublin, based on 2016 Census Data.
4. Environment	4.a. Population and Human Health	Comparative assessment based on the data collection for population and human health to include a review of sensitive receptors on the corridor;144evesoo sites; radiation and stray currents.
	4.b Biodiversity	Comparative assessment based on the data collection/review, site walkovers in relation to biodiversity, to include a review of designated sites & other protected sites, habitats, treelines, birds, mammals, bats and potential new habitats.
	4.c. Soils, Geology & Groundwater	Comparative assessment based on the data collection/review for soils, geology and groundwater to include a review of the contaminated land, soil resources assessment to include soil sealing, soil compaction, soil erosion, organic matter.
	4.d. Hydrology and Flood Risk	Comparative assessment based on the data collection/review for hydrology; water quality; hydromorphology; designated sites and flood risk.

Assessment Criteria	Assessment Sub-Criteria	Approach
	4.e. Air Quality and Climate	Comparative assessment of the ETE Route Options for air quality to include a review of sensitive receptors along the corridor for the construction and operational phases of the Proposed Scheme. Comparative assessment of the ETE Route Options for climate to include a review of the latest EPA GHG emissions data and a review of ETE Route Options for the construction and operational phases.
	4.f. Noise & Vibration	Comparative assessment of the ETE Route Options for noise & vibration. To include a review of noise sensitive receptors, vibration sensitive receptors and impacts to sensitive land use/archaeological/cultural heritage receptors.
	4.g. Landscape and Visual	Comparative summary assessment based on the Landscape walkovers and focussed on the key differences in the likely significant effects on the landscape character, designated landscapes as well as visual receptors between the options.
	5.h. Archaeological, Architectural and Cultural Heritage	Comparative assessment of the ETE Route Options based on a review of data and the findings of Step B Archaeological, Architectural and Cultural Heritage report.
5. Safety	5.a. Road interfaces	Level of segregation, Interface with roads and junctions.
	5.b. Cycle and Pedestrian	Level of segregation and priority.
6. Physical Activity	6.a. Infrastructure Upgrades	New infrastructure, is it a loss or gain, Overall benefit/disbenefit.
	6.b. Space availability for Cycle Facilities	Number of Luas stops with expected space availability to support Luas Cycle + Ride.

For the Step C MCA Physical Activity (previously excluded from the Step B process) was included. "Physical Activity" relates to the potential health benefits derived from the increase in active modes. For this study "Physical Activity" assessed cycle facilities available around each option and their proposed stops, it also looked at the space available for cycle tracks along each route and the associated potential uplift in cyclists.

9.2 Economy

The Economy criteria is the first of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- BCR;
- Patronage; and
- Journey Time.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.2.1 BCRs

This economy criteria expresses the economic viability of the project through the development of a BCR. In general terms where a ETE Route Option has a BCR of over '1' it provides a positive return to the economy. The Present Value of Benefits (PVB) and the Present Value of Costs (PVC) are the two sub-parameters necessary for the calculation of the BCR, referring to the relationship between the provided benefits of a new project and the cost for implementing it (constructing and operating in the case of Luas Cork).

Each of the ETE Route Options had a range of benefits that formed key components of the assessment that included travel time savings, vehicle operation costs, monetised benefits of reductions in pollutant emissions and monetised benefits of improved safety for the travelling public.

For the ETE Route Options Cost Estimate, construction costs (including land acquisition), operational and maintenance costs were included. All costs and benefits have been discounted to net present values to reflect the profile of costs and benefits over time. This common approach also allows comparison between different projects.

9.2.1.1 Option Cost Estimate

As part of the Step C process the Option Cost Estimates formed an important component of the comparative BCR assessment. Option Cost Estimate refers to the construction of each ETE Route Option.

To achieve a like for like cost comparison across each of the ETE Route options, local and national market rates, historical cost data and other information on costing was used as the source to complete this analysis, refer to Chapter 8 – Cost Estimation. The below factors were used to determine the cost estimate:

- Track Work;
- Stops;
- Structures;
- Roadworks;
- Traction Power / Overhead line equipment (OHLE);
- Power & Systems;
- Installation of all necessary electronical communication, controls and signalling systems at stops;
- Hardscaping;
- Full Depth and Central Control Room;
- Park & Ride;
- Utility Diversions;
- Property & Land Acquisition; and
- Indirect Costs.

9.2.1.2 Operation & Maintenance Cost

The Operation and Maintenance cost was estimated, as detailed in chapter 8, to be included in the BCR calculations.

9.2.1.3 Benefits

The benefits for each ETE Route Options were utilised to capture the expected PVB of providing the scheme to the local community, regional beneficiaries and state. Most benefits attained will be to those living in the immediate vicinity of the proposed route alignment, taking the form of improved transport opportunity and travel time benefits.

9.2.1.4 BCR MCA Summary

The BCR expresses the economic viability of each ETE Route Option. In general terms where a ETE Route Options has a BCR of over one it provides a positive return to the economy.

Table 9.2: End-to-End Options BCR Comparative Assessment

ETE Route Option	Sub-Criteria: Benefit Cost Ratio	
	BCR	Assessment Outcome
1	0.96	
2	0.93	
3	1.00	
4	0.98	
5	0.71	
6	0.67	
7	1.01	
8	0.97	
9	1.05	
10	1.01	
11	0.64	
12	0.63	

Table 9.2 illustrates the comparative scoring against each of the 12 ETE Route Options. From the table it is shown that Options 1 – 4 and 7 – 10 have higher BCR compared to the other options. As detailed in Section 8.7, higher BCRs are mostly due to higher present value benefits rather than lower present value costs.

9.2.2 Patronage (Outputs from SWRM)

The NTA's Southwestern Regional Model (SWRM) take account of multiple factors which influences public transport usage along each ETE Route Option. The SWRM accounts for stop location, competition or integration with other modes and other public transport services, connectivity to desired destinations and journey time. The patronage criteria assessed each ETE Route Option, in terms of how many passengers each route option will attract to use the Proposed Scheme.

Patronage (Outputs from SWRM) expresses modelled Luas boardings in a 24hr period, annual boardings, and hourly peak line flows.

Table 9.3: End-to-End Options 2035 Patronage Comparative Assessment

ETE Route Option	Sub-Criteria: Patronage			
	Daily Boardings	Annual Boardings	Hourly Peak Flows	Assessment Outcome
1	49,000	16.39m	1490	
2	48,600	16.24m	1480	
3	47,900	16.07m	1570	
4	47,500	15.92m	1570	
5	46,300	15.56m	2080	
6	45,800	15.54m	2080	
7	52,500	17.49m	2140	

ETE Route Option	Sub-Criteria: Patronage			
	Daily Boardings	Annual Boardings	Hourly Peak Flows	Assessment Outcome
8	52,000	17.34m	2190	
9	50,900	17.04m	2230	
10	50,500	16.89m	2230	
11	45,600	15.32m	1950	
12	45,100	15.17m	1940	

Table 9.3 illustrates the comparative scoring against each of the 12 ETE Route Options. From the table it is shown that Options 7, 8, 9 and 10 have some advantages in patronage when compared to the other options. As outlined above the Patronage criteria assessed a number of factors including 24h boardings, annual boarding and hourly peak flows. Each of these factors were assessed together to give an overall for each option. Options 7, 8, 9, and 10 predict 24hr boardings between 52,500 to 50,500, annual boardings between 17.5 million to 16.9 million, and hourly peak flows of between 2,230 and 2,140. As a reference for annual boardings in the opening year (2035), when compared to the Luas Dublin opening year (2005), which opened with 39,000 annual boardings on the Green Line and 41,000 on the Red Line.

9.2.3 Journey Time

An additional parameter contributing to the economy criteria is the journey time. Journey Time expresses the modelled ETE journey times for each option. This sub-criteria complements the economic benefits sourced from the SWRM / TUBA and provides a good indicator of the potential quality of service offered by each option.

Each alignment has a different end to end runtime between Ballincollig and Mahon. The differentiating factors affecting the runtime are the length of the route, the interaction with the road network (crossing points, shared, off-street and on-street segregated tracks) and the directness of the alignment.

Table 9.4: ETE Route Options Runtime Comparative Assessment

ETE Route Option	Sub-Criteria: Journey Time (JT)	
	JT Mins	Assessment Outcome
1	54	
2	53	
3	51	
4	50	
5	56	
6	55	
7	58	
8	57	
9	56	
10	55	
11	59	
12	58	

Table 9.4 illustrates the comparative scoring for runtime against each of the 12 ETE Route Options as well as the calculated run times for each option. From the table it is shown that Options 1–- 6 and 9–- 10 have some

advantage across the 12 ETE Route Options. These options achieve a runtime under 56 minutes. Options 7, 8, 11 and12 fail to achieve this runtime as they achieve a journey time of 57 minutes or above and are therefore considered to have some disadvantages by comparison. The main reason Options 7, 8, 11 and 12 have a higher journey time is due to the length of the ETE Route Options alignment and the increased number of tight radius turns associated which each option.

9.2.4 Economy Summary

Table 9.5 presents a summary of the scoring across the 12 ETE Route Options for Economy.

Table 9.5: Economy MCA Assessment Summary

Economy Summary	ETE Route Option											
Sub-Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
BCR												
Patronage												
Journey time												
Assessment Summary												

As Option 1 – 4 and 7 – 10 have been scored as the having some advantages for the summary of the primary Economy criteria when compared to the other ETE Route Options.

Options 5, 6, 11, and 12 have been scored as having some disadvantages under this Primary Economy criteria due to performing less well across the sub-criteria.

9.3 Integration

The Integration criteria is the second of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- Land Use Policy, Residential Population and Employment Catchment;
- Public Transport (bus and rail); and
- Integration with other key Modes.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.3.1 Land Use Policy, Residential Population and Employment Catchment

The Land Use Policy, Residential Population and Employment Catchment sub-criteria seeks to evaluate all the policies and guidelines on a local, regional and national level basis. This report considered a thorough review of policies and guidelines with reference to Luas Cork relative to each ETE Route Option, reviewing the Proposed Scheme and it associated objectives against policy documents such as:

- Regional Spatial and Economic Strategy for the Southern Region (RSES) 2020;
- Cork Metropolitan Area Transport Strategy 2040 (CMATS);

- Metropolitan Area Strategic Plan (MASP);
- Cork County Development Plan 2022-2028; and
- Cork City Development Plan 2022-2028.

As part of the assessment for this sub-criteria, and in addition to the review of relevant land use policy, residential population and employment catchment relative to each ETE Route Option were also assessed.

Table 9.6 shows the assessment outcome for this sub-criteria, including a comparison of the population catchment within a 15-minute walk of the Luas Stop locations, the average population density per km for each ETE Route Option and the employment catchment within a 15-minute walking distance of the Luas Stop locations for each ETE Route Option.

Table 9.6: Land Use Policy, Residential Population and Employment Catchment Assessment Outcome

Sub-Criteria: Residential Population and Employment Catchment				
ETE Route Options	**Alignment with Land Use Policy**	**Residential density in catchment areas along route**	**Employment in 15 minute walking catchment around stop locations**	**Sub-Criteria Assessment Outcome**
1		2,917 people/km2	31,928 jobs	
2		2,893 people/km2	30,926 jobs	
3		2,894 people/km2	29,314 jobs	
4		2,844 people/km2	29,441 jobs	
5		2,934 people/km2	33,654 jobs	
6		2,912 people/km2	32,652 jobs	
7		2,876 people/km2	33,868 jobs	
8		2,852 people/km2	32,866 jobs	
9		2,835 people/km2	32,368 jobs	
10		2,806 people/km2	31,381 jobs	
11		2,981 people/km2	35,182 jobs	
12		2,959 people/km2	34,153 jobs	

As shown in Table 9.6, ETE Route Options 1 and 5-12 were considered to have some advantages within the assessment outcome when compared to ETE Route Options 2 – 4. Despite ETE Route Options, 5 & 6 and 11 & 12 not aligning as well with Land Use Policy, they have the greatest catchment of employment. ETE Options 1 and 7 – 10 have a better alignment with land use policy and also some advantage of employment catchment when compared to ETE Route Options 2 – 4. All ETE Route Options have comparable residential catchment along their respective route alignments.

9.3.2 Bus Network Integration

This sub-criteria assesses the extent that the Proposed Scheme is compatible with the bus network through the metric of 'modelled transfers'. The current bus network in the city centre provides many bus services for the greater Cork area and includes services along the majority of the Proposed Scheme alignments. The National Transport Authority is planning to further enhance the existing bus network and is developing plans

to introduce 12 new Sustainable Transport Corridors, including approximately 93 km of bus lane / bus priority and 112 km of cycle facilities (one direction) delivering 56 km of the cycle network across the city.

The ETE Route Options comparison for the Bus Network Integration criteria was completed using the NTA South Western Regional Model tool to calculate the number of modelled transfers between bus and the Proposed Scheme. Table 9.7 shows a comparison of ETE Route Options' number of 24 hour transfers between the two modes.

Table 9.7: Bus Network Integration Assessment Outcome

ETE Route Option	Sub-Criteria: Bus Network Integration	
	24Hr Transfers Between Bus and Luas Cork	Assessment Outcome
1	13500	
2	13300	
3	14900	
4	14700	
5	13800	
6	13600	
7	13700	
8	13500	
9	15000	
10	14800	
11	13400	
12	13200	

As shown in Table 9.7, it was assessed that Options 3, 4, 9 and 10 had some advantages compared to other options. This showed that options which serve South Mall in the city centre and also the Docklands area were the highest performing.

9.3.3 Rail Network Integration

This sub-criteria assesses the extent that the Proposed Scheme is compatible with the rail network through the metric of 'modelled transfers'. The ETE Route Options comparison for the Rail Network Integration criteria was completed using the NTA South Western Regional Model tool to calculate the number of modelled transfers between rail and the Proposed Scheme. Rail Integration expresses modelled transfer between existing Rail and Luas Cork. Table 9.8 shows a comparison of ETE Route Options' number of 24 hour transfers between the two modes.

Table 9.8: End-to-End Options Rail Integration Assessment Criteria

ETE Route Option	Sub-Criteria: Rail Network Integration	
	24Hr Transfers Between Rail and Luas Cork	Assessment Outcome
1	6,200	
2	6,200	
3	4,700	
4	4,700	

5	2,800	
6	2,700	
7	6,300	
8	6,300	
9	4,800	
10	4,800	
11	2,800	
12	2,800	

As shown in Table 9.8 ETE Route Options 1 – 4 and 7–- 10 had some advantages when compared to the other options. ETE Route Options 1, 2, 7 and 8 directly serve Kent Station and as a result provide the highest number of transfers between Rail and the Proposed Scheme. ETE Route Options 3, 4, 9 and 10 which serve Kennedy Quay (Docklands) also provide a higher level of transfers, primarily as a result of the proposed active travel bridge in these options which proposes to link Kennedy Quay to Kent Station.

9.3.4 Traffic Network Integration

The surrounding road network is a sub-criteria that is expected to be broadly affected by all 12 ETE Route Options, since they all have a series of commons sections from Ballincollig to Mahon. Traffic Network Integration expresses the sum of traffic during 2035 AM peak hour at junctions on the ETE Route Option alignments and the number of road traffic junctions on each alignment. The options comparison for the Traffic Network Integration criteria was completed using the NTA SWRM tool. Further details on the modelling work and outputs extractions can be found in the Transport Modelling Report.

Table 9.9: End-to-End Options Traffic Network Integration Assessment Criteria

Sub-Criteria: Traffic Network Integration			
ETE Route Options	**The sum of AM peak hour traffic crossing the LRT**	**Number of road traffic junctions along the alignment**	**Assessment Outcome**
1	75,500 pcu/h	71	
2	78,100 pcu/h	73	
3	92,000 pcu/h	75	
4	94,600 pcu/h	77	
5	111,700 pcu/h	87	
6	114,200 pcu/h	89	
7	91,100 pcu/h	84	
8	75,500 pcu/h	71	
9	107,500 pcu/h	86	
10	110,300 pcu/h	90	
11	98,300 pcu/h	87	
12	100,900 pcu/h	89	

To compare each ETE Route Option the number of Passenger Car Units Per Hour (pcu/h) crossing the Luas was modelled. It was found that ETE Route Options 1 and 2 had signification advantages compared to other

options. This is primarily as a result of having a very low impact on road traffic due to higher levels of segregation with proposed utilisation of the Greenway and St Patrick Street in the City Centre. When modelled ETE Route Options 1 and 2 had less than 80,000 pcu/h crossing the LRT alignment, this is a significant advantage over options 5, 6, 9 and 10 which have over 101,000 pcu/h crossing their LRT alignment.

9.3.5 Active Modes (Cyclist & Pedestrians)

The Active modes (Cyclist and Pedestrians) sub-criteria assesses compatibility with the existing walking and cycling network. The ETE Route Options retain the accessibility and functionality of the footways, and where possible would propose to enhance provision for both pedestrians and cyclists. Pedestrians would be able to continue to utilise the footways adjacent to most road links in the vicinity of the Proposed Scheme, with limited impediment and would therefore have good connectivity to access proposed Luas routes and stops. Table 9.10 shows the MCA assessment outcome for Active Modes (Cyclist and Pedestrian).

Table 9.10: End-to-End Options Active Modes Comparative Assessment

Sub-Criteria: Active Modes (Cyclist and Pedestrian)												
ETE Route Options	1	2	3	4	5	6	7	8	9	10	11	12
Assessment Outcome												

As the proposed alignment for each ETE Route Option includes an upgraded cycle and walking facility where possible, the assessment of options was focused on areas where existing active travel facilities were affected by the proposed alignment.

In this case Options 1, 2, 3 and 4 are considered to have disadvantages when compared to the other options. The reason for this is driven by the required configuration of the Greenway cross-section, to accommodate the Proposed Scheme. All other ETE Route Options retain the use of the Greenway in its current configuration whilst also adding additional infrastructure for Active Modes across the Luas Cork network.

9.3.6 Integration Summary

Table 9.11 presents a summary of the scoring across the 12 ETE Route Options for Integration, summarising the scoring from the Land Use Policy, Residential Population and Employment Catchment, Bus Network Integration, Rail Integration, Traffic Network Integration, and Active Modes sub-criteria. The summary colour indicated is from a collective assessment of each criteria for each option.

Table 9.11: Integration MCA Assessment Summary

Integration Summary	ETE Route Options											
Sub-Criteria	1	2	3	4	5	6	7	8	9	10	11	12
Land Use Policy, Residential Population & Employment Catchment												
Bus Network Integration												
Rail Integration												

Traffic Network Integration												
Active Modes (Cyclist & Pedestrian)												
Assessment Summary												

As shown in Table 9.11, ETE Route Options 1, 3 & 4, and 7 – 10 are considered to have some advantages compared to ETE Route Options 2, 5 & 6 and 11 & 12. Traffic Network Integration was the only sub-criteria under Integration where significant advantages (and disadvantages) could be identified. However, it should also be noted that ETE Route Options 5 & 6 and 9 – 12 are also some of the longest options in terms of proposed track length and as a result will likely impact on a greater number of PCUs conflicting or crossing the Proposed Scheme alignment.

9.4 Accessibility & Social Inclusion

The Accessibility and Social Inclusion criteria is the third of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- Key Trip Attractors; and
- Deprived Geographical Area.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.4.1 Key Trip Attractors

The sub-criteria assessed the ability of the Proposed Scheme to serve Key Trip Attractors. The Step C MCA included an evaluation of the number of trips to key city centre trip attractors along each ETE Route Option over a 24-hour period. Table 9.12Table 9.12 indicates the modelled figure of the 24hr trips to or from the key trip attractors along each ETE Route Option.

Table 9.12: End-to-End Options 24hr Key Trip Attractors Assessment Criteria

Sub-Criteria: Key Trip Attractors		
ETE Route Options	**24hr trips to or from key attractors**	**Assessment Outcome**
1	32,600	
2	32,300	
3	32,700	
4	32,400	
5	31,900	
6	31,500	
7	34,300	
8	33,900	
9	34,200	

10	33,900	
11	31,400	
12	31,100	

As outlined in Table 9.12, ETE Route Options 7 – 10 were assessed to have some advantages compared to other options. This showed that online ETE Route Options which serve the city centre, Kent Station (directly and indirectly), South Mall and the alignments using Churchyard Lane were the highest performing.

9.4.2 Deprived Geographic Areas

This sub-criteria utilised GIS analysis of the Deprivation Index based on the 2016 Census Data. The meaning of the index is that a low value shows lower levels of deprivation. The values used for the MCA are rescaled such that the least deprived area within Cork City Council would have a score of 0 and the most deprived area within Cork City Council would have a score of 100 (10% of outliers on either end are removed). The scores do not take into account the total quantity of deprived people, rather it measures the average deprivation of people in the catchment area from the ETE Route Option. Table 9.13 shows the range of Deprived Geographic Areas for the 12 ETE Route Options, based on GIS analysis of the deprivation index.

Table 9.13: End-to-End Options Deprived Geographic Areas Levels of Deprivation

Sub-Criteria: Deprived Geographic Areas												
ETE Route Options	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Deprivation Index	43.7	43.9	43.5	43.3	39.4	41.5	41.5	41.5	40.8	40.8	40	40
Assessment Outcome												

As shown in Table 9.13, all 12 ETE Route Options scored between 39.4 – 43.7 on the Deprivation Index. It was assessed that due to this small margin that all ETE Route Options were comparable within this sub-criteria.

9.4.3 Accessibility and Social Inclusion Summary

Table 9.14 presents a summary of the assessment across the 12 ETE Route Options for Accessibility and Social Inclusion, summarising the assessment from the sub-criteria, Key Trip Attractors and deprived Geographic Areas. The assessment summary indicated is from a collective assessment of each criteria for each option.

Table 9.14: Accessibility and Social Inclusion MCA Assessment Summary

Accessibility & Social Inclusion	ETE Route Options											
Sub-Criteria	1	2	3	4	5	6	7	8	9	10	11	12
Key Trip Attractors												
Deprived Geographic Areas												
Assessment Summary												

As show in Table 9.14 Options 7, 8, 9 and 10 are considered to have some advantages across the criteria compared to other options, with the Key Trip Attractors being the main differentiator. All options were comparable across Deprived Geographical Areas.

9.5 Environment

The Environment criteria is the fourth of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- Population and Human Health;
- Biodiversity;
- Soils, Geology & Groundwater;
- Hydrology & Flood Risk;
- Air Quality and Climate;
- Noise and Vibration;
- Landscape & Visual; and
- Archaeological, Architectural and Cultural Heritage.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.5.1 A EIAR reviewed for the Methodology

Section 3.6.1 Option Selection – Step C: End-to-End Option Selection provides detail on the Step C methodology. Further details in relation to the Environmental methodology at Step C can be found in Section 3.10 Environment.

Details on the environmental assessment, methodology and the relevant constraints for each sub-criteria are presented in the Environmental Appraisal Report which can be found in Volume 6- Environmental Appraisal Report & Associated Appendices of this OSR. The findings within each assessment chapter are relevant to that chapter and form one part of the overall Option Selection Report process that was used to assess the selection of the EPR Corridor.

Please refer to Volume 2: Drawings – Part B – Environmental Drawings of this OSR for Figures.

9.5.2 Sub-Criteria: Population and Human Health

The natural and built environment can undergo positive and negative changes as a result of the environmental impacts associated with the construction and operation of new infrastructure projects. This is particularly the case for transport infrastructure projects where construction phase environmental impacts can negatively impact populations and human health as a result of construction activities, while operational phase environmental impacts can positively impact populations and human health through societal benefits by way of the provision and promotion of more effective, efficient and sustainable transport options.

9.5.2.1 Methodology

The Study Area for the environmental appraisal of ETE Route Options as related to population and human health comprises of a 100 m buffer either side of the centreline of each ETE Route Option. The appraisal method for the assessment of ETE Route Options for the Cork LRT relative to population and human health

used professional judgement in cognisance with the relevant guidelines, policies, and data / information sources.

This appraisal considers the following aspect themes:

- Community/ Commercial Amenity (i.e., the perceived character or attractiveness of an area or the way people use community facilities and recreational resources in a locality);
- Major Accidents / Seveso Sites; and
- Electromagnetic Currents.

Changes in demographics, traffic and transport and future land use as a result of the proposed ETE Route Options are discussed under the 'Economy', 'Safety' and 'Integration' sections of the OSR report and are not replicated here to avoid duplication.

Similarly, changes related to landscape amenity, principally visually impacts, and changes in emissions / pollutants within the environment which may affect human health (i.e. air, noise, contaminated land, flooding, etc.) are considered and assessed under each of the specific related topic aspects (i.e. Landscape and Visual, Air Quality and Climate, Noise and Vibration, Soils, Geology and Groundwater, Hydrology and Flood Risk) and are not replicated here to avoid duplication.

9.5.2.2 Existing Environment

Cork is Ireland's second city and plays a key role in driving the economic, social and cultural fabric of Ireland, in particular the southern region. Cork City is the largest urban centre in the Southern region, and it is recognised by the Regional Spatial Economic Strategy as one of five Metropolitan Areas in Ireland. Cork Metropolitan Area acts as an international location of scale, a complement to Dublin and a primary driver of economic and population growth in the Southern Region of Ireland.

The 2016 census data shows that the vast majority of people (83.5%) consider their general health to be 'Good' or 'Very Good' general health.

The CMATS states that Cork will become the fastest growing city region in Ireland in the period up to 2040 (CMATS, 2020). Demand for travel intensifies Ireland's current decarbonisation challenge as transport accounts for approximately 20% of the country's GHG emissions according to the EPA (CAP 2019).

9.5.2.2.1 Community/ Commercial Amenity Receptors

The 12 ETE Route Options are routed in proximity to largely the same number and type of community or commercial receptors for the majority of their alignments. Population and human health appraisals would typically have preference for ETE Route Options that have the least number of sensitive receptors along its alignment however cognisance is also required to the type or make-up of receptors likely to be impacted.

9.5.2.2.2 Major Accidents / Seveso Sites

In order to inform the Step C ETE Route Options assessment, the location of Seveso sites was reviewed as they could potentially influence the construction and operation impacts of light rail infrastructure. Seveso sites are controlled under the Seveso II Directive which is aimed at preventing major accidents involving dangerous substances and limiting the consequences in the event of a major accident. The Directive defines major accident hazard sites as those that store or can generate quantities of dangerous substances in excess of specified thresholds. Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EU is considered in this assessment. S.I. No. 209/2015 – Chemical Act (Control of Major Accident Hazards Involving Dangerous Substances (COMAH)) Regulations 2015 transposed the Seveso

III Directive into Irish law. The Seveso III Directive and the COMAH Regulations outline the legal obligations for operators of industrial establishments where dangerous substances are stored. These establishments are referred to as Seveso sites and are classified as Upper Tier or Lower Tier establishments. As per Regulation 25 of the COMAH Regulations, Upper Tier establishments are required to submit information regarding their operations to the Health and Safety Authority (HSA). Each Seveso site has a consultation zone which is the 'area liable to be affected by a major accident' at the site (Department of the Environment, Community and Local Government (DECLG 2015)). Therefore, if a development falls within the specified consultation zone of a Seveso site, the HSA must be consulted. There are currently six Seveso sites located within Cork City Council administrative area. There are two Seveso sites located within the Study Area and within proximity to the ETE Route Options under consideration:

1. Grassland Agro, Carrigrohane Road, Cork (Upper Tier Seveso Site); and
2. Goulding Chemicals Ltd., Centre Park Road, Cork (Lower Tier Seveso Site).

All of the ETE Route Options under consideration fall within the consultation zone of 1000 m for Grassland Agro and 700 m for Goulding Chemicals Ltd., albeit at different distances. ETE Route Options 5 and 6 are the closest proximity to this site at 650 m to Grassland Agro and 445 m to Goulding Chemicals Ltd.

9.5.2.2.3 Electromagnetic Currents

Electromagnetic Fields (EMF) are an important consideration in any electrical project. EMF is found in nature (from rocks and sunlight) and electrical devices (household electrical equipment, power lines, telephone lines, signals from existing telecommunications masts, underground communication cables, electrified trains, broadcast transmitters etc). Design standards require all underground cables to operate within existing public exposure guidelines from the International Commission on Non-Ionising Radiation Protection (ICNIRP) and as such there will be no effect from EMFs in terms of human health and interference to other electrical devices and systems. In this way, EMFs are not a differentiator between the ETE Route Options and are not assessed at this stage in the Proposed Scheme. A further assessment will be undertaken in the EIAR for the Proposed Scheme, but it is considered that there will be no adverse effects from the Proposed Scheme, as is the case on other similar light-rail projects in Dublin and throughout Europe.

The equipment of the Proposed Scheme will be similar to other light-rail projects in Dublin and throughout Europe and has been rigorously tested for Electromagnetic Compatibility. The requirements of S.I. No. 69/20–7 - European Communities (Electromagnetic Compatibility) Regulations 2017 (and other relevant requirements) will be fully met by the Proposed Scheme. Similarly, any radio equipment used by the Proposed Scheme will be developed to ensure to impact to other radio use in the area.

9.5.2.3 Conclusion: Population and Human Health

Population and human health appraisals would typically have preference for ETE Route Options that have the least number of sensitive receptors along its alignment however cognisance is also required to the type or make-up of receptors likely to be impacted. While the ETE Route Options that are routed to Mahon Point via Centre Park Road, The Marina, and the Blackrock-Passage West Greenway (i.e. Options 1, 2, 3 and 4) would likely impact fewer sensitive receptors (i.e. residential, commercial and community receptors), they would likely allow for a larger and more direct impact on the prominent community receptors of The Marina and Blackrock-Passage West Greenway than would otherwise be the case if other ETE Route Options were selected. As such all ETE Route Options have been rated equally in comparison to one another in respect to community and commercial amenity. All ETE Route Options are rated 'Yellow' given that potential impacts are expected to be limited in terms of duration, comparable in nature and extent and mitigatable. Two Seveso sites (Grassland Agro and Goulding Chemicals Ltd.) are located within the Study Area. All of the ETE Route Options under consideration fall within the consultation zone for both of these sites and as such have been assessed as comparable to one and other.

Table 9.15 presents the cumulative findings of this appraisal of population and human health constraints in respect to the proposed ETE Route Options. All ETE Route Options are considered to be comparable to one another, with no tangible advantages or disadvantages over other ETE Route Options.

Table 9.15: Summary of Predicted Population and Human Health Impacts for each ETE Route Option

ETE Route Options	Sub-Criteria: Population and Human Health		
	Community / Commercial Amenity	Major Accidents / Seveso Sites	Assessment Outcome
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

The Proposed Scheme has the potential to enhance accessibility and connectivity which can bring benefits to the population in terms of employment opportunities, economic growth and social interaction as well as direct and indirect benefits to human health. The Proposed Scheme has the potential to support reductions in energy demand from the wider transport sector through users switching from private vehicles. It can also relieve pressure on other transport infrastructure by providing an alternative means of travel within the city, improving connectivity and reducing journey times which can also result in similar benefits. As such, it is expected that the Proposed Scheme would have a significant positive impact on Cork City.

9.5.3 Sub-Criteria: Biodiversity – Flora and Fauna

This section discusses the potential impact of each of the proposed Route Corridor Options on the Biodiversity in the Proposed Scheme Study Area. Please refer to Volume 2: Drawings -Part B – Environmental Drawings of this OSR for Figures.

9.5.3.1 Methodology

The methodology for this stage of the assessment involved a high-level review of the 12 ETE Route Options using desktop resources and information gathered during the onsite survey undertaken in February 2022. During the site survey, habitats within the site and surrounding area were assessed for their potential to support rare or protected species and/or qualifying interests (QI) (Annex I habitats or Annex II species) associated with European sites. Each of the study areas were different dependant on the species and habitats that the proposed routes would fall within, which were specifically assessed throughout the option proposals selection. Any potential effects on biodiversity and ecological receptors in the absence of mitigation from construction and operation were assessed for the Proposed Scheme.

Each of the proposed ETE Route Options were comparatively assessed in relation to:

- Designated sites;
- Non-designated sites/habitats which are important for wildlife;
- Protected or notable species;
- Aquatic environment; and
- Invasive species.

The ecology receptors in the Study Area have been mapped and are presented in Figure 3 in Volume 2: Drawings – Part B – Environmental Drawings.

9.5.3.2 Existing Environment

The proposed ETE Route Options are located between Ballincollig (west) and Mahon (east) and are connected through Cork City centre. The majority of the proposed ETE Route Options are located within existing roads. There are several off-road sections, primarily in the western extent of the options. There were also several watercourse crossings associated with the proposed ETE Route Options. The surrounding land uses were predominantly mixed urban areas, parkland, and the offline sections were through agricultural lands. Scrub and woodland habitats were also present, mainly along field boundaries such as hedgerows and tree lines.

Potential impacts during the construction phase:

- Temporary loss and fragmentation of terrestrial and aquatic habitat within the footprint of the Proposed Scheme to facilitate access roads and construction compounds;
- Disturbance, habitat degradation and temporary displacement of birds, mammals, herpetofauna and aquatic species from the working corridor and in close proximity to the Proposed Scheme;
- Permanent degradation of terrestrial habitat surrounding the footprint of the Proposed Scheme and aquatic habitat downstream of the Proposed Scheme due to the spread of invasive alien plant species; and
- Pollution of surface waters, aquatic habitats and secondary effects on aquatic species.

Potential impacts during the operational phase:

- Permanent loss and fragmentation of terrestrial habitat within the footprint of the Proposed Scheme, impacting terrestrial species using the area for nesting/roosting/foraging and commuting;
- Permanent loss of aquatic habitats within the footprint of the Proposed Scheme , impacting aquatic species through habitat loss and fragmentation;
- Continued disturbance (light, noise) to terrestrial species breeding, foraging and commuting;
- Collision risk to flying species from overhead cables, and to mammals and herpetofauna from the trams; and
- Damage to habitats during maintenance.

9.5.3.2.1 Designated Sites

EU Directives 92/43/EEC ("the Habitats Directive") and 2009/147/EC ("the Birds Directive") list habitats and species which are, in a European context, important for conservation and in need of protection. These sites are generally referred to as the "European sites". European sites designated for wild birds are known as "Special Protection Areas" (SPAs) and sites designated for natural habitat types or other species are "Special Areas of Conservation" (SACs).

Natural Heritage Areas (NHAs) are sites designated under the Wildlife Act for the protection of flora, fauna, habitats and geological features of interest. Proposed Natural Heritage Areas (pNHAs) are published sites identified as being of similar conservation interest, but which have not been statutorily proposed or designated. Proposed NHAs are nonetheless afforded the same consideration and protection under planning policies and objectives as NHAs.

All ETE Route Options of the Proposed Scheme are not within or directly adjacent to an SAC, SPA, NHA or pNHA. Cork Harbour SPA (Site code 004030) is the nearest European site to the Proposed Scheme and is 230 m distance at its closest point. Cork Harbour SPA is designated for various wetland and waterbird species (NPWS, 2014a). All 12 ETE Route Options terminate at the eastern end of the Proposed scheme approximately 230 m from the SPA boundary.

All ETE Route Options of the Proposed Scheme are hydrologically connected to Cork Harbour SPA, Great Island Channel SAC and Douglas Estuary pNHA. The Proposed Scheme ETE Route Options all have a minimum of four crossing, at their closest point there is a hydrological distance of 3.8 km and 8.8 km to the SAC and SPA respectively. There is potential for the Proposed Scheme to impact upon these sites through pollution to watercourses and waterbodies connected to these designated sites. Pollution may arise from works associated to works at the watercourse crossings during the construction phase. Pollution has the likely potential to cause habitat degradation as well as a reduction in prey availability in the SPA and thus impacting the QI species present. Potential risks would be associated with both installing light rail tracks over existing bridges and the construction of new bridges.

9.5.3.2.2 Non-Designated Sites and Habitats

There are two non- designated sites within the Study Area, these are the Atlantic Pond and Carrolls Bog (Tramore Marsh). The Atlantic Pond is a freshwater pond surrounded by woodland and close to the Lee Estuary (lower) which is important for freshwater, coastal, and woodland bird species. It is also known to host otters. The ETE Route Options are proposed to run between the Atlantic Pond and Lee Estuary, 15 m from the north side of the pond.

Carrolls Bog (Tramore Marsh) is the site of the former city landfill, it formed into a bog overtime from deposition from the Douglas Estuary. This site is important for supporting wildfowl of the Douglas Estuary. The site is 1.1 km to the south of the Proposed Scheme.

There are no other non-designated sites within the Study Area, habitats of importance are detailed below.

Although urban habitats have generally low potential for wildlife, tree lined streets can be important for breeding birds. Where the Proposed Scheme will impact upon trees, this has the potential to impact breeding birds.

Arable and improved agricultural grasslands will be impacted by the Proposed Scheme where ETE Route Options pass through these habitat types. These habitats are by definition species-poor in plant composition and are less valuable ecologically than other habitats. However, these can provide opportunities for species of small mammal, invertebrates, birds and herpetofauna. There is potential for temporary and/or permanent habitat disturbance/loss and/or fragmentation leading to potential impacts on resting and/or breeding sites, foraging habitat and commuting habitat.

Woodlands, hedgerows and tree lines will be impacted by the Proposed Scheme where ETE Route Options pass through these habitat types. Woodlands and these boundary habitats are important for wildlife as they provide habitat for shelter, foraging and commuting. These habitats can host numerous species of small mammal, invertebrates, birds and herpetofauna. There is potential for temporary and/or permanent habitat disturbance/loss and/or fragmentation leading to potential impacts on resting and/or breeding sites, foraging habitat and commuting habitat. All ETE Route Options have a common offline section which runs

through agricultural land and several hedgerows and tree lines. This is the most significant section of habitat loss. ETE Route Options that run along a greenway in the eastern sections may also involve habitat loss. ETE Route Options 1-4 run along a longer section of the greenway and there is potential for a greater amount of habitat loss associated with these options.

The overall impact of the numerous route alignment on hedgerows and treelines should be minimised to avoid increased disturbance to the connectivity between and along these linear habitats. The design of the alignment will also take into account the need for connectivity within and across the tramway, therefore acting as an additional green corridor and restoring connectivity to the study area and existing habitats. It is noted that TII support the proposal for 'Improving performance of linear assets through green Infrastructure' published by CIRCA 2017.

9.5.3.2.3 Habitats

Habitats within the Study Area comprised a combination of natural, semi-natural and artificial habitats. The dominant habitats throughout the Study Area comprised mixed urban areas, parkland, improved agricultural grassland and hedgerows which formed most field boundaries.

The majority of the proposed routes run along existing roads through Cork City, land use here comprised of commercial, industrial, educational and residential land. There were areas of amenity grassland, scattered trees and small patches of woodland at various locations along the proposed routes.

There is a 2.2 km long offline section for all of the proposed routes which runs through improved agricultural grassland and arable land. There were multiple field boundaries containing hedgerows and tree lines present along the alignment of the proposed routes.

9.5.3.2.4 Protected or Notable Species

A search of the National Biodiversity Data Centre (NBDC) (NBDC, Accessed April 2022) returned numerous records for otter (*Lutra lutra*), bats and badger within the Study Area. No evidence of otters (resting sites (holts), tracks, markings, feeding signs or droppings) and no evidence of badger (resting sites (setts), tracks, markings, feeding signs or droppings) or bats (droppings, feeding remains) was found during the site surveys.

There was suitable habitat to support breeding birds present within the Study Area such as areas of hedgerows, treelines and scrub which were present lining roads, watercourses and field boundaries. The Birds Directive and the Wildlife Act protect the conservation status of Irish birds in Ireland.

A search of the NBDC returned numerous records for marsh fritillary (*Euphydryas aurinia*) within the Study Area, which cover the majority of the urban area of Cork City and some of offline sections. No suitable supporting habitat for marsh fritillary (habitat containing devil's bit scabious (*Succsia pratensis*), the larval food plant) was found during the site survey.

A search of the NBDC returned no records for common lizard (*Zootoca vivipara*), one record for smooth newt (*Lissotriton vulgaris*), and numerous records for common frog (*Rana temporaria*) within the Study Area. None of these species were identified during the site survey, however as there was suitable supporting habitat present within the Study Area and the common frog is a widespread species, it is assumed that they are present within the Study Area.

9.5.3.2.5 Aquatic Environment

The Proposed Scheme crosses several watercourses. The watercourses running through the Study Area all join the River Lee which flows out to sea via Cork Harbour. All the watercourses in the Study Area are hydrologically connected to designated sites at Cork Harbour, all are connected to Cork Harbour SPA and Great Island Channel SAC. The Proposed Scheme ETE Route Options all have a minimum of four crossing

locations; at their closest point there is a hydrological distance of 3.8 km and 8.8 km to the SAC and SPA respectively. Due to the hydrological connection, there is potential for significant impacts on the SPA, SAC and associated QI species as a result of construction activity in or near to the watercourses along the proposed routes. The Proposed Scheme ETE Route Options 1, 2, 7 and 8 also include a 125m span bridge likely requiring instream works and ETE Route Options 3, 4, 9 and 10 require a pedestrian bridge both of which are proposed to cross the Lee Estuary (lower). This as a result increases the potential impact on aquatic species, including, fish, birds and otter. Risks would be associated with both installing light rail tracks over existing bridges and the construction of new bridges.

9.5.3.2.6 Invasive Species

A search of the NBDC returned several records of the listed plant species Himalayan balsam (*Impatiens glandulifera*), Japanese knotweed (*Reynoutria japonica*) and three-cornered leek (*Allium triquetrum*) in the vicinity of the Proposed Scheme.

9.5.3.3 Conclusion: Biodiversity – Flora and Fauna

An assessment appropriate for this stage of the Proposed Scheme was undertaken for the 12 ETE Route Options. ETE Route Options 1-4 which run along the whole extent of an existing greenway in the eastern section have the potential for a greater amount of vegetation clearance. These options have the potential to have greater impacts on breeding birds, roosting bats, other terrestrial species and potential to spread invasive species. Whereas ETE Route Options 5-12 do not impact the existing greenway. Additionally, ETE Route Options 1, 2, 7 and 8 have a greater number of watercourse crossings than the other options, including a new bridge that crosses the Lee Estuary (lower) and therefore have greater potential to impact watercourses and aquatic species.

Overall considering watercourse crossings of both existing and new bridges with the potential impacts to the existing greenway, ETE Route Options 1-4 have been assigned the least preferred Options with 'Significant Disadvantages'. ETE Route Options 5, 6, 11 and 12 are the most preferred Options with 'Significant Advantages 'over others. This assessment is illustrated in Table 9.16.

Table 9.16: Summary of Predicted Biodiversity Impacts for each ETE Route Option

Sub-Criteria: Biodiversity – Flora and Fauna Ecological receptors present along routes.									
ETE Route Option	Designated Sites	Non-designated Sites and Habitats	Mammals (badger, otter etc)	Potential Bat Roosts	Breeding Birds	Herpetofauna	No. of Watercourse Crossings	Invasive Species	Assessment Outcome
1	✓	✓	✓	✓	✓	✓	5	✓	
2	✓	✓	✓	✓	✓	✓	5	✓	
3	✓	✓	✓	✓	✓		4	✓	
4	✓	✓	✓	✓	✓	✓	4	✓	
5	✓	✓	✓	✓	✓	✓	4	✓	
6	✓	✓	✓	✓	✓	✓	4	✓	
7	✓	✓	✓	✓	✓	✓	6	✓	
8	✓	✓	✓	✓	✓	✓	6	✓	
9	✓	✓	✓	✓	✓	✓	5	✓	
10	✓	✓	✓	✓	✓	✓	5	✓	
11	✓	✓	✓	✓	✓	✓	4	✓	
12	✓	✓	✓	✓	✓	✓	4	✓	

9.5.4 Sub Criteria: Soils, Geology and Groundwater

This section discusses the potential impact of each of the proposed ETE Route Options on the Soils, Geology and Groundwater in the Proposed Scheme Study Area.

9.5.4.1 Methodology

There are a number of aspects relating to soil and geology that will be considered as part of the Stage 2 MCA in determining the impacts of each option for comparison. This assessment has undertaken a high-level assessment based on the existing desktop information gathered as part of the pervious stage and publicly available information and relevant guidance documents. To differentiate the potential effects between the different scheme options, a buffer of 100 m from each scheme option has been used, as this is considered appropriate to identify the key potential risks in relation to the nature of the proposed works. The definitions of receptor sensitivity and importance for soils, geology and hydrogeology are based on NRA 2009 report 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' and IGI (2013) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements.

This soils, geology and groundwater assessment considers the impacts on the following:

- Geomorphology;
- Geohazards;
- Soils and superficial geology, including soil organic matter, sealing, erosion and compaction;
- Bedrock geology;
- Geological Heritage and Karst features;
- Hydrogeology, including aquifers and groundwater supply, groundwater vulnerability, groundwater dependent terrestrial ecosystems (GWDTEs) and groundwater abstractions;
- Potentially contaminated sites; and
- Economic Resources including Mines, Quarries & Mineral Resources (sand & gravel, granular aggregate and crushed rock).

Information sources have been used to identify the potential constraints associated withs soils, geology and hydrogeology within the Study Area. Relevant information generated as part of the biodiversity assessment has also been considered.

Figures showing the geology and hydrogeology information in the Study Area have been mapped and are presented in Figure 4.1 and Figure 4.2 in Volume 2: Drawings – Part B- Environmental Drawings.

9.5.4.2 Existing environment

The topography of the Study Area is dominated by the elongated, relatively flat lying lands surrounding the River Lee. A small number of localised, steeper gradients are evident in close proximity, or immediately adjacent, to the River Lee in the extreme west and northern central portions of the site as highlighted on. In addition, Beaumont Park (former Beaumont Quarry) in the eastern portion of the Study Area includes a localised escarpment.

The current geomorphology of the Cork area has been significantly affected by the last two glaciation events with glacial erosion grinding down underlying bedrock and forming glacial till (also known as boulder clay). The most widespread geomorphological features present comprise deglacial landforms such as glaciofluvial

terraces in the northwest and central parts of the Study Area. In addition, localised pockets of hummocky sand and gravel at the area's western boundary and at several locations in the area's central and southern portions. Two west-to-east trending Subglacial Lineation Striations are also recorded in the centre of the Study Area, reflecting the local direction of ice flow during the last glaciation event.

Bedrock Geology within the Study Area is dominated by rocks of the Carboniferous and Devonian age. The lithologies comprise sandstone, mudstone, siltstones, and limestones which run in broadly west-east bands in the Study Area. The primary lithologies are limestones of the Little Island Formation and Waulsortian Limestones which are typically 300-500 m thick.

Bedrock faults run both west-east and north-south across much of the Study Area. Bedrock is exposed along localised regions particularly in the west and at a grouping in the far east.

As the Study Area is predominantly developed land, the majority of the soils are recorded as made ground.

Potential impacts during construction and the operational phase include:

- Potential impacts on soils that may occur during construction include soil compaction, soil erosion and soil sealing. Soil sealing comprises covering the soil surface with an impermeable material, or urban development on areas of natural undisturbed land. Depending on the degree, soil sealing reduces natural soil functions and ecosystem services on the area concerned. Soil sealing can impact biodiversity and fertile agricultural land; and

- Soil erosion describes the displacement of the upper horizon of the soil due to exposure. Impacts from soil erosion can lead to loss of soil mass, impacts on surface water including turbidity and contamination and the mobilisation of contaminants that may be present which could affect groundwater.

9.5.4.3 Conclusion: Soils, Geology and Groundwater

The 12 ETE Route Options have been assessed against each attribute for soils, geology and hydrogeology in relation to potential impacts for the construction and operation phases of the Proposed Scheme in accordance with industry best practice for scheme appraisals. As construction is largely at-grade and no significant earthworks are anticipated, impact on topography and geomorphology are expected to be minimal. Landslide hazards are expected to be minimal for all ETE Route Options.

Construction is largely at-grade and significant earthworks are not anticipated; in addition, superficial deposits do not have any designated geological or heritage significance.

All of the ETE Route Options pass through areas of Extreme groundwater vulnerability and areas of karst or where rock is at or near the surface. There is no significant difference in the potentially affected areas between the ETE Route Options. In addition, little site-specific investigative data is available to correlate the potential vulnerability with the ground conditions. As such, the potential effect on groundwater vulnerability is considered to be similar for all ETE Route Options.

Each of the soils, geology and hydrogeology attributes has been assigned an MCA assessment outcome for each ETE Route Options. The overall ranking is based on the assessment outcomes for each assessment aspect and the relative importance of each assessment aspect at a project scale. This assessment is presented in Table 9.17.

Table 9.17: Summary of Predicted Soils, Geology and Groundwater Impacts for each ETE Route Option

Sub-Criteria: Soils, Geology and Groundwater													
ETE	Topography and Geomorphology	Geohazards	Soils and Superficial Geology	Bedrock Geology	Hydrogeology – Groundwater Resource	Hydrogeology- Water Supplies	Hydrogeology – Groundwater Vulnerability	Hydrogeol–gy – Karst	Mining and Economic Geology	Irish Geological Heritage Sites	Radon	Potentially Contaminative Land Uses	Assessment Outcome
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

As shown in Table 9.17, there are no significant advantages or disadvantages between the ETE Route Options for the majority of soils, geology and hydrogeology attributes, with impacts being common across all options. The exceptions are hydrogeology (karst) Irish geological heritage sites and potentially contaminative land uses, where marginal differences are present between the options.

ETE Route Options 1 to 2 have some advantages primarily based on a lower potential impact on hydrogeology (karst) and Irish geological heritage sites. These options do, however, pass the area of greatest historical contamination associated with south docklands (as do ETE Route Options 7-10). Hydrogeology (karst) is increased for ETE Route Options 5-12 based on proximity of Beaumont Quarry towards the east of the Study Area. Beaumont Quarry is also an Irish Geological Heritage Site, with ETE Route Options 5 to 12 passing in the vicinity of the site. However, as potentially contaminated land is considered to have the greater potential impacts, it is concluded that ETE Route Options 7 to 10 have some disadvantages over the other options.

9.5.5 Sub-Criteria: Hydrology and Flood Risk

This section discusses the potential impact of each of the proposed ETE Route Options on the hydrology in the Proposed Scheme Study Area.

9.5.5.1 Methodology

This assessment has undertaken a high-level assessment based on the existing desktop information gathered as part of the pervious stage and publicly available information and relevant guidance documents. The hydrology assessment considers the impacts on the following:

- Surface Water Quality; and
- Flood Risk.

In order to determine the overall significance of effect, it was noted that mitigation measures will be built into the design of the Proposed Scheme to reduce or remove impacts that may reduce the quality of the water body and increase flood risk to and/or from the Proposed Scheme, although there may still be a residual risk/impact for both aspects. The assessments have been carried out in the absence of mitigation or design measures at this stage.

9.5.5.2 Existing Environment

For the purposes of this assessment the study area was divided into three Areas which include:

- Area 1 – 15.5 km^2;
- Area 2 – 12.2 km^2; and
- Area 3 – 15.3 km^2.

The Study Area covers approximately 43 ha. The Study Area is located in the OPW's Unit of Management '19 Lee, Cork Harbour and Youghal Bay River Basin'. In general, the topography falls from west to east i.e. Ballincollig to Mahon (Area 3 to Area 2), with all watercourses discharging to the River Lee. The Study Area is heavily urbanised, particularly in the centre of Cork City (Area 1 and Area 2). The main watercourses within the Study Area are presented in Table 9.18.

Table 9.18: Watercourses in the Study Area

Area 1	Area 2	Area 3
• River Lee (north & south channels); • Glasheen River; • Curragheen River (border with Area 3); • Twopot River; • Raheen Stream; and • River Bride.	• River Lee; • Douglas River; • Moneygurney River; • Lehanagh Beg; and • Tramore River.	• River Lee; • River View; • Shournagh River; • Curragheen River (border with Area 1); • Maglin River; and • Grange Hill Stream.

The River Lee is the major watercourse within the Study Area. The Lee drains an area of approximately 1250 km^2 and flows in an easterly direction through the Study Area.

The Curragheen River flows in a north and then westly direction prior to discharging into the River Lee (South Channel). The Curragheen drains an area of 55 km^2 and also receives flows from the Twopot River, Raheen Stream, Maglin River and Grange Hill Stream.

The Glasheen River also flows in a northerly direction and drains an area of 8 km^2 prior to discharging to the Curragheen River immediately upstream of the River Lee (South Channel) confluence.

To the north, the River Bride and Shournagh River discharge into the River Lee. The River Bride drains an area of approximately 30 km^2 and has a confluence with the River Lee (North Channel) near the Christy Ring Bridge. The Shournagh drains an area of 225 km^2 and has its confluence with the River Lee just downstream of Ballincollig.

The Douglas River drains an area of approximately 25 km^2 and also receives flows from the Moneygurney River, Lehanagh Beg and Tramore River prior to discharging to the River Lee. There is a confluence between the Rivers Lee and River View which drains an area of 30 km^2.

The WFD waterbody status of the nine main watercourses crossed have been identified and are presented in Table 5.4 in Volume 6 - Environmental Appraisal Report & Associated Appendices. Two of the waterbodies identified have a Good WFD Status; Lee(Cork)_090 and Moneygurney_010, both of which are under review. Five of the waterbodies identified have a moderate WFD Status and are currently At Risk of not achieving Good Status, these include; Curragheen(Cork City)_010; Bride(Cork City)_020; Lee (Cork) Estuary Upper; Lee (Cork) Estuary Lower; and Lough Mahon. For further information please see Table 5.4 in Volume 6 Environmental Appraisal Report & Associated Appendices of this OSR.

Fluvial and coastal flood risk areas were obtained from the OPW's CFRAM Flood Mapping, as published on https://www.floodinfo.ie/map/floodmaps/. Due to its location and elevation, Cork has a long history of flooding from both fluvial and coastal sources, primarily from the River Lee. The OPW and Cork City Council are progressing the Lower Lee (Cork City) Flood Relief Scheme. This scheme extends from the River Lee/River View Confluence to Cork city centre, just downstream of the north and south channel confluence, the benefitting lands are in Area 1 and Area 2. The Douglas Flood Relief Scheme is also being progressed and the Cork City Docklands Regeneration project aims to provide flood protection infrastructure and immediate flood risk management along the lowest lying quay in Docklands at Albert Quay West.

Potential impacts during construction and the operational phase include:

- Potential impacts to surface water bodies such as rivers, lakes/ponds, estuaries include increased sediment in surface water run-off during construction as a result of direct works within or close to water bodies such as culverting, diversions or bridge construction as well as cement run-off or hydrocarbon / oil spillages can negatively impact water quality;

- Operational impacts to surface water bodies include surface water run-off with routine contaminants, from both road and rail, such as suspended solids, heavy metals and hydrocarbons; increased surface water runoff may result in changes to hydrological flows and geomorphological features; new crossing structures may also impact upon geomorphological features;

- The associated floodplain of each watercourse was also considered in the assessment as there is the potential for flood risk to be increased if an existing watercourse and/or floodplain flows are impeded by the by the new road construction; and

- There is potential for flooding of the Proposed Scheme from watercourses overtopping their banks could create hazardous conditions and prevent its use; and potential increased flooding can in turn cause a greater impact in terms of water quality in the event of an unexpected hydrocarbon or oil spillage during construction.

9.5.5.3 Conclusion: Hydrology and Flood Risk

An assessment was made of all 12 ETE Route Options with respect to their potential for significant impacts on hydrology and flood risk. For hydrology, consideration was given to the crossings of water bodies, the sensitivity of local water bodies, the number and length of new crossings and proximity to other water bodies and SACs. For flood risk, consideration was given to the length of each option within flood zones.

The ETE Route Options with the greatest potential to impact water bodies and with significant disadvantages over other options were 3, 4, 9 and 10. All of these options included the long crossing of the Lee Estuary Lower from Kent Station. These options also had the greatest lengths within flood zones. ETE Route Options

5, 6, 11 and 12 had only one new crossing, a short one, and the shortest lengths within flood zones and so had significant advantages over other options.

This assessment is presented in Table 9.19.

Table 9.19: Summary of predicted Combined Hydrology and Flood Risk impacts for each ETE Route Option

ETE Route Option	Sub-Criteria: Hydrology and Flood Risk		
	Hydrology	Flood Risk	Assessment Outcome
1			
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9.5.6 Sub-Criteria: Air Quality and Climate

This section discusses the potential impact of each of the proposed Route Corridor Options on the Air Quality in the Proposed Scheme Study Area.

9.5.6.1 Methodology

9.5.6.1.1 Air Quality

The assessment of the construction phase of the Proposed Schemescheme have been considered following the IAQM guidance on the assessment of dust from demolition and construction (IAQM 2016). The sensitivity of an area to the potential impacts of each construction activity is defined at various distances from the Proposed Scheme depending on sensitivity and number of receptors. IAQM categorises these in several distance bands at 20, 50, 100, 200 and 350 m. Distance band buffers were utilised using GIS software to determine the number of receptors located within the distance bands for each of the 12 ETE Route Options. During construction there is likely to be some rerouting of traffic due to road closures. At this stage of assessment there is limited data on construction and therefore this has not been assessed.

The assessment of the operational phase of the involved a receptor count using ArcGIS to determine the number of sensitive receptors within 50 m of each of the 12 ETE Route Options. This is in accordance with the NRA Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Scheme (NRA 2011). The counts were used to compare the number of sensitive receptors affected across each of the 12 ETE Route Options. During operation there is likely to be some rerouting of traffic. At this stage of assessment there is limited data on road traffic and therefore this has not been assessed. Detailed air quality modelling will be undertaken at the preferred options stage of the commission.

NRA's guidance defines sensitive receptors as locations where members of the public are likely to be regularly present, including residential housing, schools, hospitals, places of worship, sport centres and shopping areas. Designated ecological habitats must also be considered, including Natural Heritage Areas (NHA), Special Areas of Conservation (SAC), Special Protection Areas (SPA), National Parks, Nature Reserves, Refuges for Fauna, Refuges for Flora, Wildfowl Sanctuaries, Ramsar Sites, Biogenetic Reserves and UNESCO Biosphere Reserves.

The Study Area of the Proposed Scheme varies in land use, including a mixture of urban (i.e. residential, commercial and industrial) and rural settings (i.e. farmland). Other notable human receptors within the Study Area include a number of educational facilities (i.e. schools, universities and colleges), place of worship, hospitals, sport centres and shopping areas; all of which are deemed as sensitive receptors in accordance with the NRA guidance.

9.5.6.1.2 Climate Change

The methodology for climate change considerations involved a review of the latest EPA GHG emissions data and a review of each of the 12 ETE Route Options for the construction and operational phases of the Proposed Scheme.

9.5.6.2 Existing Environment

The EU Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (EU, 2008) was published to consolidate previous European Directives on ambient air quality. The Air Quality Standards Regulations 2011 (Government of Ireland, 2011)13 transposes Limit Values set out in the directive into Irish legislation.

Article 3 of the EU Directive 2008/50/EC requires Member States to nominate the competent authority for the assessment of air quality (which in Ireland is the EPA) and it may be interpreted that only the competent authority can determine compliance with the Limit Values. The EPA is required to provide an annual air quality report to the Minister for the Environment, Climate and Communications and to the European Commission.

Member States are also required to establish "zones" and "agglomerations" throughout their territory. Four zones were established in the Air Quality Standards Regulations 2011; all ETE Route Options are located within Zone B, which under the Regulations is defined as Zone B – Cork Conurbation.

Air quality in the vicinity of the 12 ETE Route Options is considered to be primarily influenced by emissions from road traffic, such as vehicles using the N8, N20, N22, N27, N40, regional roads and local roads. Other potentially significant sources of pollutant emissions within the area include industrial sectors and other forms of transportation (i.e. rail (namely diesel trains), and maritime).

The Ireland wide GHG emissions from the most recent published EPA dataset (i.e. 2019 and 2020) states that the total GHGs for Ireland in 2020 were estimated to be 57.70 million tonnes carbon dioxide equivalent (Mt CO2 eq). These were 3.6% lower than emissions in 2019 and a decrease of 4.0% in emissions in 2019 compared to 2018. The decrease in emissions in 2020 is reflected across most sectors with the exception of increases in residential, agricultural and public services. The increase in residential emissions is attributed to home working due to COVID and more heating days compared to 2019. Transport emissions significantly decreased in 2020 as a result of the impact of COVID restrictions.

Potential impacts during the construction and operational phase include:

- Construction dust has the potential to cause short term, temporary in nature, localised impacts through deposition of dust at the nearest sensitive receptors. The construction phases for each ETE Route Option will involve a number of activities including emissions of dust generated through demolition, excavation, construction, earthworks and trackout activities; and
- Climate impacts are likely to occur both during the construction and operational phases of the Proposed Scheme due to GHG emissions arising from the manufacture of construction materials, the transportation of materials to site and the use of plant and machinery.

9.5.6.3 Conclusions: Air Quality and Climate

9.5.6.3.1 Air Quality:

An air quality assessment appropriate for this stage of the scheme was undertaken for each of the 12 ETE Route Options. Counts were carried out using ArcGIS to determine the number of sensitive receptors within IAQM distance bands of up to 350 m for construction. Counts were also carried out using ArcGIS to determine the number of sensitive receptors within 50 m of the centreline of each ETE Route Option in accordance with TII guidance for operation. Overall, ETE Route Option 1 and 3 were found to affect the least number of sensitive receptors and therefore considered to have advantages over the other options. This assessment is presented in Table 9.20.

Table 9.20: Summary of predicted Air Quality and Climate impacts for each ETE Route Option

ETE Route Option	Sub-Criteria: Air Quality			
	Total Construction Sensitive Receptors within 350 m of Scheme	Total Operational Sensitive Receptors within 50 m of Scheme	Combined Total Sensitive Receptors	Assessment Outcome
1	13,134	1,866	15,000	
2	13,214	1,994	15,208	
3	13,288	1,644	14,932	
4	13,859	1,806	15,665	
5	17,223	2,198	19,421	
6	17,303	2,326	19,629	
7	14,395	2,153	16,548	
8	14,475	2,281	16,756	
9	15,040	1,965	17,005	
10	15,120	2,093	17,213	
11	16,922	2,120	19,042	
12	17,002	2,248	19,250	

9.5.6.3.2 Climate Change:

Climate impacts are likely to occur both during the construction and operational phases of the Proposed Scheme due to GHG emissions arising from the manufacture of construction materials, the transportation of materials to site and the use of plant and machinery. Each of the 12 ETE Route options will involve the construction of a similar number of stations (between 23 and 24 stations across the 12 ETE Route Options) and a similar overall length of rail track. All 12 ETE Route Options require the construction of a bridge crossing over waterbodies.

There is the potential for GHGs to be released into the atmosphere during the construction phase of all options. GHG sources such as plant and construction vehicles will be considered further at the preferred options stage. For the purpose of Step C, all options will require similar construction works and therefore GHG emissions will be comparable across all options.

The Proposed Scheme supports mass transit and provides a sustainable travel option compared to more polluting forms of transport, such as private vehicle trips. The rail infrastructure will be powered by electricity and will involve the construction of between 10 and 13 substations. Potential emissions of dielectric gas, sulphur hexafluoride (SF6) from substations have not been quantified as the gas will require the

implementation of strict protocols within the design for construction and maintenance, including leak detection measures, to avoid fugitive emissions.

Climate change appraisal appropriate for this stage of the scheme was undertaken for each option. Each ETE Route Option spans a similar physical environment comprising urban and rural areas and will have similar operational capacities. Any effects therefore on the microclimate are likely to be similar across all options. All options are considered comparable to each other but have the potential for a positive impact for climate change.

The Proposed Scheme has the potential to reduce emissions of GHGs from transport by providing an alternative electric mode of transport for Cork City. It aligns with the main goals of the Cork City Council Climate Change Adaption Strategy 2019- 2024, to make Cork City as climate resilient as possible and to proactively engage with all citizens on climate action and the Proposed Scheme aligns with the National CAP23 which aims to tackle climate change and bring about change in Ireland's climate ambition over the coming years. It is expected that overall road traffic vehicle kilometres will reduce for all options during the operational phase and therefore result in a reduction in associated greenhouse gas emissions, detailed air quality modelling will be undertaken at the preferred options stage of the Proposed Scheme.

9.5.7 Sub-Criteria: Noise and Vibration

This section assesses the noise and vibration impacts across the 12 ETE Route Options in line with relevant standards. Noise and vibration impacts have the potential to occur during the construction and the operational phase of the Proposed Scheme.

9.5.7.1 Methodology

The methodology for this stage of the assessment involved undertaking a count using ArcGIS software to obtain the number of Noise Sensitive Receptors (NSRs) within 100 m of each of the 12 ETE Route Options NSRs include Environmental Noise Directive (END) Quiet Areas, residential properties, educational establishments, medical facilities, historic buildings and places of worship/spiritual uses. Comparatively, the fewer numbers of NSRs within 100 m, the smaller the potential impact both during the construction and operational phases of the scheme.

In addition to the receptor counts described above, the assessment of the construction phase of the Proposed Scheme involved an assessment of the number of proposed bridge structures required to cross waterbodies for each of the options as there is potential for increased noise and vibration impacts, in particular piling works have the potential to cause disturbance to nearby NSRs. A review of the EPA Round 3 strategic noise mapping was also carried out to establish indicative baseline noise levels along the proposed options.

In the operational phase, noise impacts have the potential to occur where the light rail vehicles have to negotiate sharp turns, potentially resulting in 'curve squeal' which may cause adverse noise impacts at nearby NSRs. A quantitative assessment was undertaken to establish the number of NSRs within 100 m of 'tight' curves (i.e. curves with a radius less than or equal to 100 m) from each option, potentially impacted as a result of 'curve squeal'.

Additionally, where light rail vehicles change speed or brake such as at proposed stations, noise levels have the potential to increase at nearby NSRs. An assessment was undertaken to compare the proposed number of stations, ranging from 23/24 depending on the ETE Route Option assessed. The operational phase of the assessment also included the consideration of the number of NSRs that have the potential to be affected during maintenance works. Maintenance activities may be scheduled outside normal working hours and may be potentially noisy. For example, power washing, grass cutting, and chain saw activity have the potential to cause adverse noise impacts.

A review of potential vibration sensitive receptors was undertaken within 100 m of all 12 ETE Route Options. Vibration sensitive receptors include those where human beings are present and which may be disturbed by vibration (e.g. residential properties and commercial premises), as well as receptors with the potential to be subject to damage from vibration, e.g. buildings and cultural heritage sites.

9.5.7.2 Existing Environment

9.5.7.2.1 Noise Sensitive Receptors

In addition to dwellings, other NSRs include education establishments, medical facilities, amenity areas, historic buildings, places of worship and Environmental Noise Directive (END) Quiet Areas. These include educational establishments such as University College Cork, Munster Technological University (MTU), Cork English College, Ballincollig Early Years Pre-School, Gaelscoil Uí Ríordáin, Scoil Naomh Mhuire, Rockboro Primary School and Pre School, and School of the Divine Child. Hospitals include Mercy University Hospital, Mater Private Hospital, South Infirmary Victoria University Hospital and Cork University Hospital. Amenity areas including Mardyke Sports Ground, Blackrock National Hurling Club, Ballinlough Pitch & Putt Club and Cork Constitution Rugby Football Club. Historic buildings include The English Market, Cork City Courthouse, and Cork City Hall. Religious buildings include Saint Augustine's Church, Trinity Presbyterian Church, Saint Patrick's Church, Saint mary's & Saint john's Church, Cork Gospel Hall, Church of the Holy Spirit and St. Peter and Paul's Roman Catholic Church. At the time of writing there are no END Quiet Areas within 100 m of any of the 12 ETE Route Options.

9.5.7.2.2 Baseline Noise Levels

The EPA Round 3 strategic noise mapping (EPA 2022) identified road noise as the dominant noise source within the Study Area.

9.5.7.3 Conclusion: Noise and Vibration

An assessment appropriate for this stage of the scheme was undertaken for the 12 ETE Route Options. Counts were carried out using GIS to determine the number of NSRs within 100 m of each of the options and a comparison between the options was discussed. An assessment of the noise impact of 'tight' curves was also undertaken to assess the number of NSRs potentially affected by 'curve squeal'. Again, this was carried out using GIS to count the numbers of NSRs within 100 m of each of the tight curves. ETE Route Option 3 and ETE Route Option 4 were found to affect the fewest number of NSRs both in terms of overall receptors and those potentially affected by 'curve squeal' and were therefore considered to have advantages over the other options. This assessment is presented in Table 9.21.

Table 9.21: Summary of predicted Noise and Vibration impacts for each ETE Route Option

ETE Route Option	Sub-Criteria: Noise and Vibration					
	NSRs (Residential)	NSRs (Community /Institutional)	Total NSRs	Proposed number of new bridge crossings	All NSRs within 100 m Buffer of Curve Radius ⩽100 m	Assessment outcome
1	4210	297	4507	2	1278	
2	4453	296	4749	2	1435	
3	3726	250	3976	1	1039	
4	4062	257	4319	1	1208	
5	5248	271	5519	1	1382	
6	5491	270	5761	1	1539	

ETE Route Option	Sub-Criteria: Noise and Vibration					
	NSRs (Residential)	NSRs (Community /Institutional)	Total NSRs	Proposed number of new bridge crossings	All NSRs within 100 m Buffer of Curve Radius ⩽100 m	Assessment outcome
7	4882	314	5196	2	1680	
8	5125	313	5438	2	1839	
9	4491	275	4766	1	1451	
10	4734	274	5008	1	1610	
11	5213	262	5475	1	1344	
12	5456	261	5717	1	1503	

9.5.8 Sub-Criteria: Landscape and Visual

This section sets out the landscape and visual impact assessment (LVIA) of the 12 ETE Route Options in line with good practice guidelines. Landscape and visual effects have the potential to occur during the construction phase and the operational phase of the Proposed Scheme. This LVIA is a proportional assessment, and the methodology involved a comparative and qualitative assessment of the potential significant landscape character and visual effects of the 12 ETE Route Options at the operational stage.

9.5.8.1 Methodology

The methodology used at for this assessment broadly aligns with the recently published Landscape Character Assessment (LCA) and Landscape and Visual Impact Assessment (LVIA) of Proposed National Ro–ds – Standard and LCA (TII 2020), and LVIA of Specified Infrastructure Projects – Overarching Technical Document (TII 2020), along with the Guidelines for Landscape and Visual Impact Assessment (GLVIA) (GLVIA 2013).

The LVIA focuses on identification of the key sensitive landscape elements, valued/designated landscapes and historical and cultural landscapes as well as the key sensitive visual receptors including viewers and designated views. These landscape character areas and visual receptors are presented in tabulated form for ease of identification and assessment. At this stage the magnitude of change has not be assessed, only the potential significance of effect in absence of mitigation.

Desktop study and information gathered during the walkovers in April 2022 by the landscape assessment team were used to establish the baseline landscape and visual receptors and to inform the assessment. A review of the existing landscape character assessment as set out within Cork City and Cork County Development Plans was also undertaken. It was found to cover the generic landscape character types within Cork City, rather than geographically specific areas of local character necessary for meaningful assessment of the Proposed Scheme options at a more detailed scale. Outside Cork City, the County landscape character classification refers to units of a much larger scale than those needed to assess the effects of the Proposed Schemes options. As such, a project-specific landscape character assessment has been undertaken and used as basis for this LVIA, taking account of natural, cultural/social features, movement within landscape, cultural heritage aspects and aesthetic/perceptual qualities. This assessment has identified forty distinct LCAs along the ETE Route Options as likely to be significantly affected by one or more of the ETE Route Options.

It is derived from the drawings of the ETE Route Option alignments and the proposed structures. A site visit was conducted as part of the assessment. The landscape sensitivity of each LCA has been assessed and the visual sensitivity of visual receptor groups has been assessed, see Volume 6- Environmental Appraisal Report

& Associated Appendices. In LVIA sensitivity is specific to the particular project or development that is being proposed and to the location in question. Figures showing the Landscape and Visual information in the Study Area have been mapped and are presented in Figures 8.1 to 8.3 in Volume 2: Drawings- Part B- Environmental Drawings.

Each of the proposed ETE Route Options has then been assessed in relation to likely significant effects on landscape as well as visual receptors and protected views. The selected protected views relevant to this assessment can be found in Figure 8.1 in Volume 2: Drawings- Part B- Environmental Drawings.

Effects common to all options have been covered briefly, in one table for both landscape and visual receptors as they do not assist with the identification of the preferred ETE Route Option. The main focus has been put on the assessment of those receptors which help to differentiate between the options. The differentiator landscape and visual receptors have been assessed in Volume 6 – Environmental Appraisal Report & Associated Appendices.

Magnitude of effect has not been assessed at this stage and to keep the assessment proportional at this stage, but the description/nature of the likely significant effects has been provided in relation to the sensitivity of the receptors and their ability to accommodate the proposed changes. An initial list of potential landscape and visual mitigation recommendations has also been developed for each LCA.

9.5.8.2 Conclusion: Landscape and Visual effects

The Landscape and Visual assessment effects are presented in Table 9.22.

Table 9.22: Summary of predicted Landscape and Visual impacts for each ETE Route Option

ETE Route Option	Sub-Criteria: Landscape and Visual
	Assessment Outcome
1	
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ETE Route Option 12 would be most preferred from a landscape and visual effects perspective as it avoids the highly sensitive Cork to Blackrock-Passage West Greenway, Centre Park Road and Marina Parkland as well as the South Mall and Grand Parade LCAs. It runs along the less sensitive 'Merchant's Quay and Clontarf Street, using existing bridge across the southern channel of the Lee, and the follows Eglinton Street and South City Link Road, which is wide enough to accommodate the light rail without losing existing trees in the central reservation island. It then continues along Boreenmanna Road, Churchyard Lane South, Skehard Road and Mahon Link Road to the terminus at Mahon Point. At the western end of the scheme, this option includes a single light rail segregated track and a single traffic lane through the sensitive Ballincollig Town Centre LCA, allowing to maintain the pleasant character of the town centre by leaving more space for wider footways used for cafes, seating, street trees and planters. It means the substation could be located more appropriately in the less sensitive and already industrial in character Leo Murphy Link Road Trade Centre LCA. Although more residential visual receptors in Station Road and Carriganarra Road in Ballincollig would experience effects due to this light rail loop configuration, it is considered less significant than reducing the footway width and public

realm extent and introducing a substation within the Ballincollig town centre. Station Road footways need improvement, and this option could bring that about.

The second preferred option from a landscape and visual effects perspective would be the ETE Route Option 11. The only difference between this option and Option 12 is that this option includes a double light rail track through the Ballincollig town centre LCA along with a single traffic lane, which would result in increased land-take, having a substation in the Main Street, removal of cycleway at pinch points and reduction of the well-used space outside shop fronts which includes cafes, street furniture, trees etc.

The least preferred options in landscape and visual effects terms would be ETE Route Option 1, ETE Route Option 2, ETE Route Option 3 and ETE Route Option 4.

ETE Route Option 1 option goes through the Cork to Blackrock-Passage West Greenway LCA for approximately 1.5km. This LCA, located along the old railway route in a cutting dug during the Great Famine, is a unique feature in the city and is locally designated as Cork City High Value Landscape. The route, currently undergoing improvements, is densely vegetated, features picturesque views of historic bridges and follies and is popular with walkers and cyclists. The introduction of fast-moving trams with the associated infrastructure and noise effects within this designated narrow and currently traffic-free LCA would permanently alter its essential characteristics and perceptual qualities, such as tranquillity, and views as well as reduce the already limited space available for use by walkers, cyclists, joggers etc. Light rail development in this corridor would mean it is no longer' a 'greenway' set aside for recreational use or environmental protection.

This option also goes through the Marina Parkland LCA, a large area of natural heritage importance in the city, locally designated as Cork City High Value Landscape. The area has a long history of recreational use being home to various sports clubs since mid- 19th Century and the promenade along the southern bank of River Lee has been planted with trees since mid-19th Century (originally elm trees). The area is highly popular with walkers, joggers and cyclists as well as wildlife and offers a sense of tranquillity and scenic views along the long tree-lined walkways, across the Atlantic Pond and across the Lee towards the Montenotte / Tivoli ridge.

To the south of the river promenade is a recently opened high quality New Marina Park and further regeneration around the area is planned as part of part of a regional eco-park creation for the City Council. The introduction of fast-moving trams with the associated infrastructure and noise effects within the waterfront edge of this scenic, designated LCA is likely to result in loss of the mature avenue trees which are one of the defining characteristics of this LCA and would alter the perceptual qualities of the area, such as tranquillity, as well as views to and from this LCA.

Finally, this option follows Centre Park Road dating back to mid-19th Century when it served as the former central road of the Cork City Park Racecourse. Its defining characteristics are the lines of trees planted to mark the opening of Henry ford's first Irish factory. Over more than a century the trees have grown and joined crowns over the road creating a pleasing, symmetrical archway, offering shelter and a sense of enclosure. A number of these veteran lime trees was lost in recent years due to Storm Ophelia and Storm Ali and have not been replaced since.

The Centre Park Road tree lines are highly valued by the locals evoking memories of times gone by. Their likely removal to make way for the tramway would result in the erosion of Centre Park road's essential character even further and it would take many decades for any newly planted trees to replace it. ETE Route Option 2 is as ETE Route Option1 but with a single light rail loop in Ballincollig.

ETE Route Option 3 is as ETE Route Option 1, but it would also run through the highly sensitive South Mall and Grand Parade LCAs. Both streets have a strong sense of place arising from historic building facades

softened by a large number of mature trees. This option is likely to result in the loss of those trees. In terms of visual effects, the view west along South Mall is a protected linear view to St Fin Barre's Cathedral and the moving trams and associated infrastructure are likely to become part of that view or obscure it intermittently.

ETE Route Option 4 is as ETE Route Option 3 but with a single light rail loop in Ballincollig.

9.5.9 Sub-Criteria: Archaeological, Architectural and Cultural Heritage

This section sets out the Archaeological, Architectural and Cultural Heritage assessment of the 12 ETE Route Options in line with good practice guidelines.

The receiving Cultural Heritage baseline environment is defined by archaeological, architectural and cultural heritage constraints within the Study Area. Archaeological, architectural and cultural heritage was considered under the following four sub-topics: archaeology, architectural heritage, cultural heritage and the historic landscape.

Cultural Heritage is afforded legal protection through their inclusion within the Record of Monuments and Places (RMPs) in accordance with the National Monuments Act 1930-2014. Section 2 of the National Monument Act 1–30 – 2014 defines a National Monument as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic, or archaeological interest attaching thereto'.

Section 12 (1) of the National Monuments (Amendment) Act 1994 requires the establishment and maintenance of an RMP. Sites included in the RMP are legally protected and are referred to as Recorded Monuments. The RMP is maintained by the National Monuments Service (NMS) of the Department of Housing, Local Government and Heritage who have defined Zones of Notification around each Recorded Monument. Zones of Notification do not define the extent of a site but are defined for the purposes of notification to the Minister under Section 12 of the National Monuments Act (1930-2004).

The Sites and Monuments Record (SMR) is the national database of the Archaeological Survey of Ireland (ASI) compiled and maintained by the NMS. The SMR details all sites where a monument is known to the ASI pre-dating AD 1700 and includes a selection of monuments from the post-AD 1700 period. The addition of a monument to the SMR does not confer legal protection.

The Planning and Development Act 2000 sets out the conditions relating to the protection of architectural heritage. Structures of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest are protected under this Act, through their inclusion on the Record of Protected Structures (RPS) and are known as Protected Structures.

Both the Cork County Development Plan (Cork County Council, 2022) and the Cork City Development Plan (Cork City Council, 2022) include a list of Architectural Conservation Areas (ACAs) protected under the Act and have been reviewed and taken into consideration. In addition, both plans include objectives for the protection of archaeology, architectural heritage and cultural heritage, such as Objective 8.5 (Protection of Cork's City Wall and Defences) which seeks to ensure the preservation in situ of the medieval city wall and defences (Cork City Council, 2022).

Undertaken under the Architectural Heritage (National Inventory) and Historic Monuments (Miscellaneous Provisions) Act 1999 the National Inventory of Architectural Heritage (NIAH) is a nationwide survey of architectural heritage including buildings, structures, and historic gardens and designed landscapes. Inclusion on the NIAH alone does not in itself confer legal protection. The NIAH includes an assessment of the significance of structures based on an appraisal of their contribution to architectural heritage. Significance ratings are: International, National, Regional, Local and Record Only. Structures which are considered of

International, National and Regional significance are recommended by the Minister to the relevant Local Authority for inclusion in their RPS.

9.5.9.1 Methodology

Based on the available design information for the 12 ETE Route Options and proposed locations of the depots and park and rides, potential impacts on archaeology, architectural heritage, cultural heritage and the historic landscape were identified. Impacts can be categorised as direct or indirect. Direct impacts occur where a constraint is physically located within the footprint of a potential ETE Route Options, including additional land-take required for construction, and may result in the permanent removal of part, or all, of a constraint. Indirect impacts may occur where a constraint or its setting is located in close proximity to a potential route alignment and may result from noise and visual intrusion for example from temporary construction activities, including the movement and operation of plant, as well as the permanent presence and operation of new infrastructure in proximity to a constraint.

The assessment of effects was used to inform the screening of the 12 ETE Route Options and the proposed locations of the depots and park and rides based on a MCA, undertaken in line with Common Appraisal Framework (CAF) criteria. This screening was comparative using professional judgement informed by the number of significant effects (i.e. effects of moderate or above significance) and the significance of these effects. An overall MCA outcome was described to each of the 12 ETE Route Options based on the outcome of the comparative assessment.

Figures showing the Archaeology, architectural and Cultural Heritage information in the Study Area have been mapped and are presented in Figures 9.1 to Figure 9.5 in Volume 2: Drawings- Part B – Environmental Drawings.

9.5.9.2 Existing Environment.

Within the Study Area, a total 202 archaeological constraints comprising one National Monument, 114 Recorded Monuments, 85 sites recorded on the SMR, one protected wreck and one additional archaeological constraint identified from historic mapping were identified. These constraints evidence the human presence in the Study Area from the prehistoric to the post-medieval period and include evidence of domestic and industrial, religious, commemorative and ritual activity in the city of Cork and its environs. A total of 3376 architectural heritage constraints comprising 884 Protected Structures, 2379 structures included on the NIAH, 37 ACAs and nine Historic Street Character Areas (HSCAs) and 67 demesne lands identified from historic mapping were also identified within the Study Area. These characterise the post-medieval urban development largely centred on the expansion of the city and its suburbs during the 18th to 20th centuries, as well as more recent residential and commercial infill. Further information on these constraints can be found in Volume 6 - Environmental Appraisal Report & Associated Appendices – Part B – Heritage Assessment.

In addition, a total of 246 non-designated cultural heritage constraints were identified from a review of historic Ordnance Survey mapping (6" to 1 mile, 1837 – 1842, and 25" to 1 mile, 1888-1913). These constraints are characterised by the sites of post-medieval buildings and structures, including infrastructure associated with the former railway network and riverside industry and commerce, domestic architecture including the sites of dwellings, public and municipal buildings and street furniture. These non-designated cultural heritage constraints contribute to the understanding of the existing baseline. Further information on the non-designated cultural heritage constraints identified since is provided in Volume 6 - Environmental Appraisal Report & Associated Appendices –Part C – Heritage Inventory.

Potential impacts during construction include:

- Partial removal of a National Monument, Protected Structures or recorded monuments;
- Construction activities, including the construction of the cut and fill earthworks, could introduce new sources of noise and visual intrusion into a setting;
- Permanent severance of fields, change in the historic field pattern and change in land use within the Historic Fields HLCA or the potential removal of boundary features;
- Construction of all 12 ETE Route Options has the potential to introduce new sources of noise and visual intrusion as a result of the movement and operation of plant in proximity to Cultural Heritage features; and
- All 12 ETE Route Options are located within the area of very high archaeological potential comprising the historic core of the city of Cork. Construction may result in the removal of (as yet unidentified) buried archaeological remains. As this effect is common to all ETE Route Options it is not considered to be a differentiator between ETE Route Options.

During Operation:

- All 12 ETE Route Options would result in a new element of infrastructure and has the potential for noise and visual intrusion as a result of the permanent presence of new infrastructure and movement of trams.

9.5.9.3 Conclusion: Archaeological, Architectural and Cultural Heritage

The results of the assessment are presented in Section 9 (Archaeological, Architectural and Cultural Heritage) of Volume 6 - Environmental Appraisal Report & Associated Appendices –Part A – Environmental Appraisal Report and in Table 1 in Volume 6 - Environmental Appraisal Report & Associated Appendices –Part B: Step C Multi-Criteria Analysis (MCA): Archaeological, Architectural and Cultural Heritage Assessment. A summary of the assessment is provided below and significant effects for each ETE Route Option is presented in Table 9.23.

Following the assessment and based on the number of unmitigated significant effects during construction and operation and the significance of these effects, ETE Route Options 1, 2, 4, 5, 9, 10 and 12, have been assessed to be comparable for archaeological, architectural, and cultural heritage.

Construction and operation of ETE Route Option 6 would result in 42 significant effects (one Profound, 16 Significant and 25 Moderate) and 42 significant effects for ETE Route Option 7 (one Profound, 14 Significant and 27 Moderate). Based on the number of unmitigated significant effects during construction and operation, ETE6 and ETE7 have been assessed to have some disadvantages over other ETE Route Options for archaeological, architectural, and cultural heritage.

In addition construction and operation of ETE Route Option 8 would result in 45 significant effects (one Profound, 14 Significant and 30 Moderate). As ETE Route Option 8 has the highest total number of significant effects of all the ETE Route Options and has been assessed to have significant disadvantages over other options.

Construction and operation of ETE Route Option 3 would result in 32 significant effects (one Profound, 15 Significant and 16 Moderate). As ETE Route Option 3 has been assessed to have the lowest number of significant effects during construction and operation of all the ETE Route Options it has been assessed to have significant advantages over other ETE Route Options for archaeological, architectural, and cultural heritage.

Table 9.23: Significant Heritage Impacts for Each ETE Route Option

ETE Route Option	Sub-Criteria: Cultural Heritage				
	Archaeological Heritage Indicators	Architectural Heritage Indicators	Non-Designated Cultural Heritage Indicators	Historic Landscape Indicators	Assessment Outcome
1	9	17	6	4	
2	9	20	6	4	
3	7	16	5	4	
4	7	19	5	4	
5	9	19	7	4	
6	9	22	7	4	
7	11	19	8	4	
8	11	22	8	4	
9	9	18	6	4	
10	9	21	6	4	
11	10	14	5	4	
12	10	17	5	4	

Please note, this table uses the term 'indicators' this is synonymous with the use of 'constraint' above and in the Environmental Appraisal Report.

As the design of the Proposed Scheme progresses it may be possible to avoid or further reduce effects on archaeological, architectural, and cultural heritage constraints.

9.5.10 Environment Summary

The MCA for Environment has assessed the 12 ETE Route Options across a range of sub-criteria. Following the assessment, it was determined that ETE Route Options 11 and 12 have significant advantages over other ETE Route options. With ETE Route Options 5 and 6 having some advantages over other route options.

ETE Route Options 1, 2 and 4 have significant disadvantages over other ETE Route Options with ETE Route Options 3, 7, 8, 9 and10 having some disadvantages over other ETE Route Options. The summary of the Environmental assessment are shown in Table 9.24.

Table 9.24: Environment MCA Assessment Summary

Environment	ETE Route Options											
Sub-Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Population & Human Health												
Biodiversity												
Soils and Geology												
Hydrology and Flood Risk												
Air Quality and Climate												
Noise and Vibration												
Landscape & Visual												
Cultural Heritage												
Assessment Summary												

9.6 Safety

The Safety criteria is the fifth of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- Road Interfaces; and
- Cycling & Pedestrian.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.6.1 Road Interfaces

This sub-criteria considered for safety is based on the level of segregation for each ETE Route Option of the Proposed Scheme and its level of segregation and interface with the road network. Table 9.25 shows the assessment for the 12 ETE Route Options based on their respective levels of segregation. The lower the proportion of Luas route shared with (with flow) the road network reduces the potential conflict areas, and therefore the likelihood of conflicts or collisions between the operation of the Proposed Scheme and road users i.e. the line with the greater dedicated segregated length would expect a better safety performance.

Table 9.25: ETE Route Options Road Safety Segregation Assessment Criteria

Sub Criteria: Road Interfaces			
ETE Route Options	**Total distance (km) shared with traffic**	**% of alignment segregated from traffic**	**Assessment Outcome**
1	11.2km	68% - greater than 65%	
2	9.9km	71% - greater than 65%	
3	11.6km	66% - greater than 65%	
4	10.3km	70% - greater than 65%	
5	12.6km	64% - 65% or lower	

6	11.3km	68% - greater than 65%	
7	12.8km	65% - 65% or lower	
8	11.5km	68% - greater than 65%	
9	13.2km	63% - 65% or lower	
10	11.9km	66% - greater than 65%	
11	12.4km	65% - 65% or lower	
12	11.1km	68% - greater than 65%	

The ETE Route Options comparison assessment for the Road Interfaces sub-criteria was completed using the NTA South Western Regional Model as well as a qualitative review of the Step C designs for each ETE Route Option. Further details on the modelling work and outputs extractions can be found in the Transport Modelling Report.

The assessment found that Options 1, 2, 3, 4, 6, 8., 10, and 12 were considered to have some advantages compared to Options 5, 7, 9, and 11 based on their determined level of segregation.

9.6.2 Cycling & Pedestrian (active travel)

The assessment for this sub-criteria assessed active travel safety resulting from the Proposed Scheme. The assessment considered the expected perception of active travel safety for the 12 ETE Route Options, where an improved level of safety would be expected across the network as these options would provide an active travel enhancement.

Conversely, a poorer perception of safety is expected of routes next to busier roads or where it might not be possible to provide full active travel infrastructure such as cycle facilities. The options comparison for the Cycling and Pedestrian Segregation and Priority criteria was completed by undertaking a qualitative review of the Step C designs for each ETE Route Option. Table 9.26 presents the sub-criteria considered for active travel safety.

Table 9.26: ETE Route Options Cycling & Pedestrian Segregation and Priority Assessment Criteria

Traffic Network Integration		
ETE Route Options	**Percentage of alignment with new active travel infrastructure**	**Assessment Outcome**
1	75% - lower than 80%	
2	73% - lower than 80%	
3	74% - lower than 80%	
4	72% - lower than 80%	
5	88% - higher than 80%	
6	86% - higher than 80%	
7	90% - higher than 80%	
8	89% - higher than 80%	
9	89% - higher than 80%	

10	87% - higher than 80%	
11	89% - higher than 80%	
12	88% - higher than 80%	

The assessment found that Options 5, 6, 7, 8. 9, 10, 11 and 12 had some advantages compared to Options 1, 2, 3, and 4. This showed that options 1 - 4 which utilise the greenway are considered to have some disadvantages, as the greenway will remain in its current configuration across Options 5-12, providing a more comprehensive level of priority for active travel across the network.

Table 9.26 illustrates options that have 80% or greater of their alignment completed with a new cycle track, it proved as an advantage when compared to other options which failed to meet over 80%.

9.6.3 Safety Summary

Table 9.27 presents a summary of the assessment across the 12 ETE Route Options for Safety Criteria. Summarising the assessment from the Road Interfaces and Cycling and Pedestrian (active travel) sub-criteria.

Table 9.27: Safety MCA Assessment Summary

Safety	ETE Route Options											
Sub-Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Road Safety Segregation												
Cycling & Pedestrian Segregation and Priority												
Assessment Summary												

ETE Route Options 6, 8, 10 and 12 were considered to have advantages compared to ETE Route Options 1, 2, 3, 4, 5, 7, 9 and 11, as they collectively performed better across both sub-criteria.

9.7 Physical Activity

The Physical Activity criteria is the sixth of the six main MCA appraisal criteria, and is made up of the following sub-criteria for assessment of the ETE Route Options:

- Infrastructure Upgrades; and
- Space Availability for Cyclist Facilities.

The sub-criteria were assessed and compared to the other ETE Route Options to determine an MCA outcome for each.

9.7.1 Infrastructure Upgrade

At Step C it was proposed that the physical activity be included for increased consideration of complementary active mode (walking and cycling) facilities.

This considers a comparative assessment on if the new infrastructure being put in place presents a loss or gain on cycle and pedestrian facilities and its effect on physical activity compared to the existing infrastructure:

- ETE Route Option 1 is scored as having disadvantages due to the cycle facility alignment along the Greenway. The existing Greenway layout is an open area for cyclist and pedestrians to use. With the introduction of an LRT along the Greenway, it will take away from the free open space available and will be a loss to all active mode users;
- ETE Route Option 2 is scored as having some disadvantages due to the cycle facility alignment along the Greenway. The existing Greenway layout is an open area for cyclist and pedestrians to use. With the introduction of an LRT along the Greenway, it will take away from the free open space available and will be a loss to all active mode users;
- ETE Route Option 3 is scored as having some disadvantages due to the cycle facility alignment along the Greenway. The existing Greenway layout is an open area for cyclist and pedestrians to use. With the introduction of an LRT along the Greenway, it will take away from the free open space available and will be a loss to all active mode users;
- ETE Route Option 4 is scored as having some disadvantages due to the cycle facility alignment along the Greenway. The existing Greenway layout is an open area for cyclist and pedestrians to use. With the introduction of an LRT along the Greenway, it will take away from the free open space available and will be a loss to all active mode users;
- ETE Route Option 5 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 6 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 7 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 8 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 9 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 10 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway;
- ETE Route Option 11 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway; and
- ETE Route Option 12 is scored as having some advantages. For the entirety of the route, the proposed cycle infrastructure will be an upgrade on the existing infrastructure. With this alignment, users will be able to use the improved facilities along the LRT alignment as well as use the existing Greenway.

Table 9.28: End-to-End Options Cycling Facilities Comparative Assessment

	ETE Route Options											
Sub-Criteria	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Cycle Facilities Available & Space Availability for Cycle Tracks												

For this criteria the benefits vs disbenefits were measured against each options alignment and its impact on physical activity infrastructure. The existing Greenway provides a pedestrian and cyclist friendly legacy infrastructure, free of any road traffic. The proposed alignments for Options 1 – 4 would require reconfiguring space for the LRT, which may reduce levels of priority comparative to the existing configuration. Table 9.28 shows that the first four options of the 12 ETE Route Options are considered to be at a disadvantage compared to other options.

9.7.2 Space for Availability for Cycle Facilities

The operation of the Luas Cork should positively affect cyclists and pedestrians as the use of public transport modes is strongly connected with active transport modes, such as elevated levels of walking and cycling. Specifically, for cyclists, providing cycle friendly Luas stops that would significantly contribute to increasing the participation in active modes and subsequently users' physical activity.

Across all 12 ETE Route Options there is a comparable amount of stops with the expected space to support Luas Cycle + Ride. It is expected that over 90% of all stops across all option will have the available space to support cyclist, illustrated in Table 9.29.

Table 9.29: ETE Route Options Space Availability for Cycle Facilities Comparative Assessment

Sub-Criteria: Key Trip Attractors		
ETE Route Options	**Number of Luas stops with expected space availability to support Luas Cycle + Ride**	**Assessment Outcome**
1	19	
2	20	
3	19	
4	20	
5	21	
6	22	
7	20	
8	21	
9	20	
10	21	
11	21	
12	21	

9.7.3 Physical Activity Summary

Table 9.30 presents a summary of the assessment across the 12 ETE Route Options for Physical Activity, summarising the scoring from the Cycle Facilities Available & Space Availability for Cycle Tracks and the Space Availability for Cyclist Facilities sub-criteria. The summary colour indicated is from a collective assessment of each criteria for each option.

Table 9.30: Physical Activity MCA Assessment Summary

Physical Activity	ETE Route Options											
Sub-Criteria	1	2	3	4	5	6	7	8	9	10	11	12
Cycle Facilities Available & Space Availability for Cycle Tracks												
Space Availability for Cyclist Facilities												
Assessment Summary												

As shown in Table 9.30 Options 5 – 12 have some advantages compared to Options 1 – 4. As outlined above this is due to the use of the greenway public space in the first four options. As Space Availability for Cyclist Facilities was comparable across all 12 ETE Route Options, sub-criteria Cycle Facilities Available & Space Availability for Cycle Tracks was the determining factor.

9.8 Step C MCA Summary

The individual Assessment Outcomes from the MCA have been combined into a final assessment summary table to present the six main criteria (Economy, Integration, Environment, Accessibility, Social Inclusion, Safety and Physical Activity) for all 12 ETE Route Options. The results of the total MCA summary are shown in Table 9.31 and the summary for all ETE Route Options in Table 9.32.

Table 9.31: Total MCA Assessment Summary

Appraisal Criteria			ETE Route Options											
No.	**Main Criteria**	**Sub-Criteria**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	**Economy**	BCR (Benefit and Cost Assessment)												
		Patronage (Outputs from SWRM)												
		Journey Time												
2	**Integration**	Land Use Policy, Residential Population and Employment Catchments												
		Bus Network Compatibility												
		Rail Integration												
		Traffic Network Integration												
		Active Modes (Cyclist & Pedestrian)												
3	**Accessibility & Social Inclusion**	Key Trip Attractors												
		Deprived Geographic Areas												
4	**Environment**	Population & Human Health												
		Biodiversity												
		Soils and Geology												
		Hydrology and Flood Risk												
		Air Quality and Climate												
		Noise and Vibration												
		Landscape & Visual												
		Cultural Heritage												
5	**Safety**	Road Safety - Segregation												
		Cycling & Pedestrian segregation and priority												
6	**Physical Activity**	Cycle Facilities available & Space Availability for Cycle Tracks												
		Space Availability for Cyclist Facilities												

Table 9.32: Summary Table of Main MCA Criteria for all 12 ETE Route Options

Main MCA Criteria		ETE Route Options											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Economy												
2	Integration												
3	Accessibility												
4	Environment												
5	Safety												
6	Physical Activity												

Following the Step C MCA, with all inputs and sub-criteria assessments considered, the top two ETE Route have been identified.

- **ETE Route Option 8:** This ETE Route Option is the joint strongest performing option when all criteria are considered. Option 8 has advantages when considering all sub-criteria on Economy compared to other options, although has a marginally lower BCR and slower journey time when compared to Option 10. ETE Route Option 8 also performs well when compared to other options and has advantages relating to Integration, Accessibility, Safety and Physical Activity. Whilst this option has some disadvantages on Environment, this would be subject to mitigation measures and further detailed assessment. The future network will be subject to some redistribution of general traffic, allowing flexibility for greater levels of LRT priority if this option was to be carried forward as the EPR; and

- **ETE Route Option 10**: Similar to ETE Route Option 8, ETE option 10 is the joint strongest performing option from the 12 ETE Route Options. Option 10 performs comparatively well with some advantages on Economy, Integration, Accessibility, Safety and Physical Activity. Option 10 also has some disadvantages in relation to the Environment criteria, in particular the Hydrology and flood risk sub-criteria due to the alignment alongside the River Lee. However, this would be subject to mitigation measures and further detailed assessment.

Option 8 connects directly to Kent Station, via St Patrick's Street crossing north of the River Lee via the existing St Patrick's Street bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment would interchange directly with Kent Station via a new LRT stop and revised external layout arrangements. A new proposed LRT bridge would link the LRT across the River Lee to Kennedy Quay, accessing Furlong Street and Centre Park Road.

Option 10 does not connect directly to Kent Station but proposes a pedestrian connection between Kent and to the station via a new active bridge which would be achieved via Grand Parade linking with South Mall, crossing south of the River Lee via the existing Parnell Place bridge. The proposed alignment would then link with Albert Quay before transitioning onto Kennedy Quay. It is proposed that the connection to Kent Station would be served by a 125m active travel bridge from an LRT stop location on Kennedy Quay linking to

Penrose Quay on the northern side of the River Lee, resulting in a total distance of 270m to Kent Station for pedestrians and cyclists.

9.8.1 City Centre Alignment Options Comparison

Following completion of the Step C MCA which assessed the 12 ETE Route Options, the best performing options were identified. These options were:

- **ETE Route Option 8;** and
- **ETE Route Option 10.**

Following completion of the MCA, and given the outcome for the relative scoring in which both ETE Route Option 8 and Option 10 were scored as 'equal best' options across all main criteria, further detailed consideration was given to whether the EPR for the Proposed Scheme should serve Kent Station and the north side of the River Lee directly (ETE Route Option 8), in comparison to a pedestrian connection via a new active bridge on the south side of the river as the Proposed Scheme traverses the city centre section (ETE Route Option 10).

Therefore, it was considered prudent to carry out and present a more detailed assessment of the city centre section of the Proposed Scheme by comparing the two best performing options through the city centre that emerged from the analysis of the Step C MCA. A separate City Centre Alignment Options and Feasibility Study was completed with a supporting technical note prepared to provide a more detailed analysis.

The full City Centre Alignment Options Comparison technical note is included in Volume 5: Transport Assessment Part C - City Centre Options Alignment Study. Figure 9.1 shows the area of assessment undertaken for the City Centre Alignment Options Comparison.

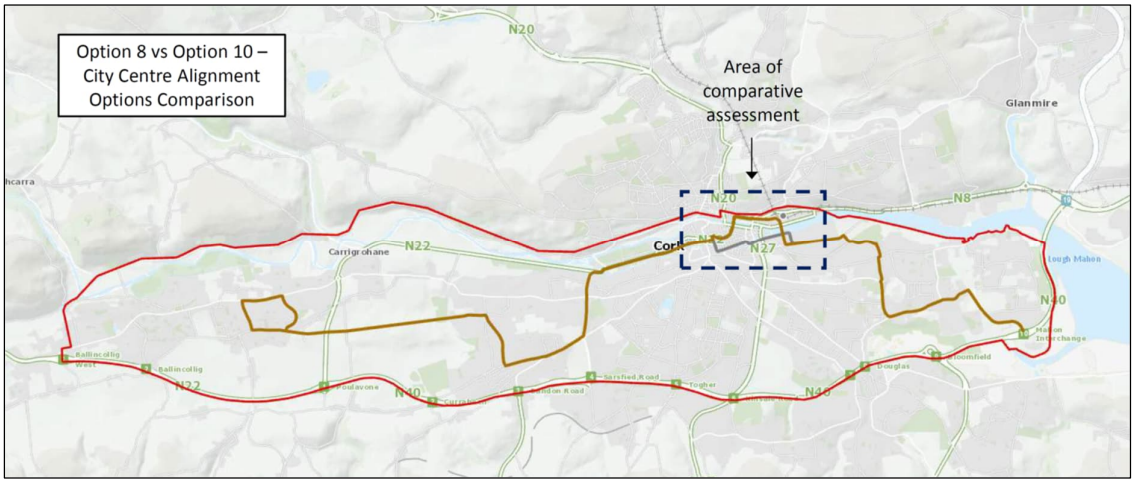

Figure 9.1: Area of comparative assessment for the City Centre Alignment Options Comparison

For purposes of comparison, the technical note compared and assessed Option A (associated with end-to-end Option 8), Option B (end-to-end Option 10) and Option C (which utilises a mixture of alignment sections from Option A and Option B). A description of the three City Centre alignment options is outlined below and Figure 9.2 shows their respective route connections.

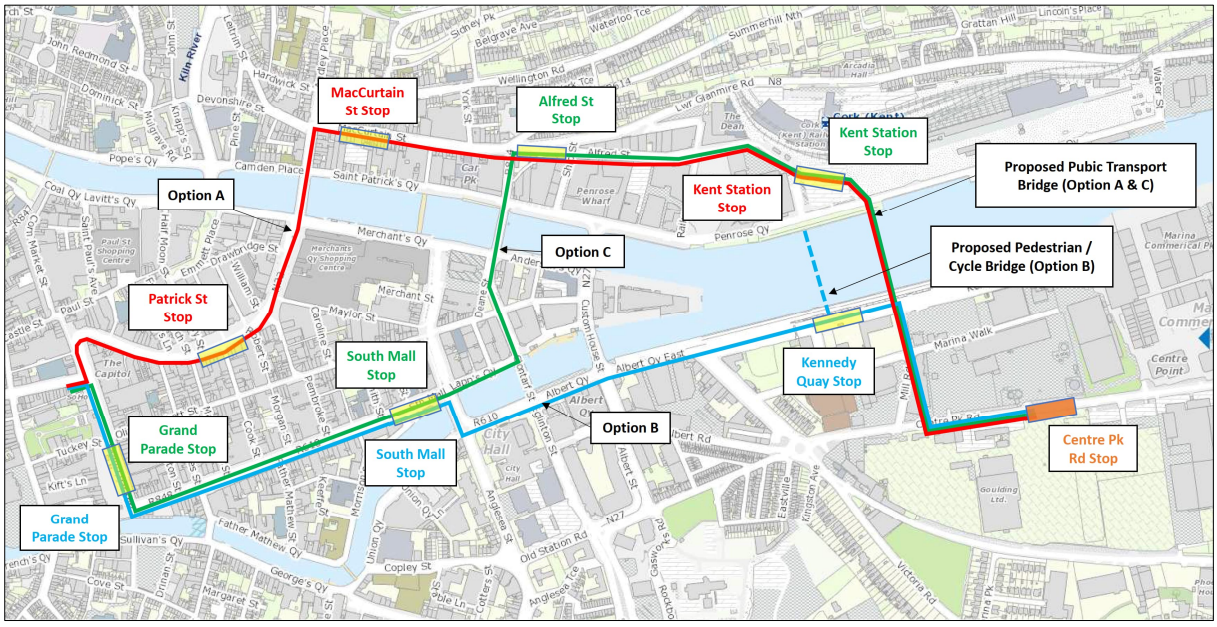

Figure 9.2: Route of Options A, B and C Connections to Kent Station

Option A: Travelling eastbound, a direct connection to the station would be made from Washington Street to Grand parade, then via St Patrick's Street, crossing north of the River Lee via the existing St Patrick's Street bridge, linking with MacCurtain Street and then Alfred Street. The proposed alignment would interchange directly with Kent Station via a new LRT stop and revised external layout arrangements. A new proposed public transport bridge would link the LRT across the River Lee to Kennedy Quay, accessing Mill Street and Centre Park Road.

Option B: Travelling eastbound, an in-direct connection to the station would be achieved via Grand Parade linking with South Mall, crossing south of the River Lee via the existing Parnell Place bridge. The proposed alignment would then link with Albert Quay before progressing to Kennedy Quay. It is proposed that Option B would be served by a 125m active travel bridge from an LRT stop location on Kennedy Quay linking to Penrose Quay on the northern side of the River Lee, resulting in a total distance of 270m to Kent Station for pedestrians and cyclists.

Option C: Travelling eastbound, a direct connection to the station would be achieved via Grand Parade linking with South Mall before then linking with Lapps Quay and transitioning to a northbound direction along Clontarf Street, crossing the River Lee via the Brian Boru Bridge and then Alfred Street. The proposed alignment would interchange directly with Kent Station via a new LRT stop and revised external layout arrangements. A new proposed public transport bridge would link the LRT across the River Lee to Kennedy Quay, accessing Mill Street and Centre Park Road.

9.8.1.1 Scope of City Centre Alignment Options Comparison Technical Note

The scope of the Technical Note was to comparatively assess Option A and Option B and their form of connection to Kent Station to determine which one will provide the preferred option under different criteria, including the transport interchange and the connectivity with the railway network at Kent Station. For robustness, a third option (Option C) was also assessed. Option C is a hybrid of Option A and B, to form a direct connection to Kent Station. The outcomes of this, in tandem with the conclusion of the Step C MCA was used to determine the overall EPR.

9.8.1.2 Technical Note Methodology

The three options were assessed comparatively to determine which route was the preferred option. The connectivity with the railway network at Kent Station and the transport interchange were considered in the assessment.

The analysis of the city centre options was completed broadly in line with the approach and methodology utilised in the MCA of the 12 end-to-end route options, but with further location specific information at a more disaggregated and granular level. The analysis of both city centre options focused on the following criteria:

- Integration;
- Accessibility, Social Inclusion and Mobility;
- Environment; and
- Economy.

Similarly, to the MCA of the 12 ETE Route Options, the comparative assessment of the city centre options utilises a five-point scale. The five-point scale is colour coded, with the option showing significant advantages over the other option graded "dark green", an option showing significant disadvantages over the other option graded "red", orange and light green being adopted for "some" advantages/disadvantages between the options, and "yellow" being used for when both options deliver comparable results to each. This is deemed the most appropriate approach, as that assessment is comparing a wide range of primary and sub criteria.

9.8.1.3 Summary of Technical Note Analysis

The summary of the comparative assessment between City Centre Options is outlined in Table 9.33:

Table 9.33: The summary of the comparative assessment between Option A, B and C

Primary Criteria	Option A	Option B	Option C
1. Integration			
2. Accessibility and Social Inclusion and Mobility			
3. Environment			
4. Economy			

Integration

In relation to overall Integration, Option A is deemed the most viable. Whilst there are some challenges in terms of integration with existing streets and traffic in the vicinity of St. Patrick Street (west), Grand Parade and Washington Street, analysis has demonstrated that these can be accommodated and the provision of longer bus bays, as well taxi and loading set downs allow for BusConnects and Luas Cork to co-function on St Patrick Street. The direct connection with Kent Station in Option A also provides a distinct advantage over Option B in relation to public transport integration. Whilst Option C shares the same connection proposal to Kent Station as Option A, analysis has shown that there are greater challenges from a traffic perspective in relation to the reduction of capacity on Brian Boru Bridge which is a major traffic artery for the city. Options C is constrained by Lapps Quay and would require construction of additional infrastructure to accommodate pedestrian movements. Option C faces some constraints in relation to successful integration with BusConnects on Clontarf St and intercity services on Alfred Street.

All options will provide cycle and walking infrastructure to add to the city centre network, enhancing sustainable travel access to the main shopping district in Cork City. It should also be noted that all options would require careful consideration of cycle integration, in the context of a constrained and historic streetscape. Cycle permeability and safety needs to co-exist with the Luas network, whether through segregated infrastructure, viable diversions or adjacent alternative routes

The linear alignment for Option B allows higher average running speeds and a shorter journey time when compared to Option A. The sequential network of streets along Grand Parade, South Mall, Albert Quay and Kennedy Quay have sufficient width to accommodate full LRT segregation along this section lending well to high reliability of the service.

Accessibility, Social Inclusion and Mobility

Options A and C connect the Proposed Scheme both north and south of the river. However Option A captures a greater number of trip attractors, which appears to increase overall accessibility or catchment when compared to Option B and C. Connecting both sides of the river would appear to provide greater levels of city-wide inclusivity on a qualitative level for Option A and coupled with its direct connection to Kent Station would provide the optimal rail integration with LRT, with reduced requirement for wayfinding between modes.

Environment

The Proposed Scheme has the potential to enhance accessibility and connectivity which can bring benefits to the population in terms of employment opportunities, economic growth and social interaction as well as direct and indirect benefits to human health. It has the potential to support reductions in energy demand from the transport sector though electrification and it can also relieve pressure on other transport infrastructure by providing an alternative means of travel within the city, improving connectivity and reducing journey times which can also result in similar benefits.

The assessment of Option A, Option B and Option C for environment found that for Cultural Heritage, Option A was marginally preferred due to the lower risk of impact on underground archaeological remains. For Landscape the opportunities for urban landscape improvements could be achieved across all three route options, but different in response to the distinct characters of the streets and spaces. As a result, the route options are considered to be comparable. The preference for Physical Environment would be for Option B as although both routes propose to connect Kennedy Quay and Kent Station via a new bridge, Option B proposes a pedestrian bridge which would be smaller in size and involves a less extensive construction period reducing the risk of run-off/pollution to occur during the construction of the bridge.

Economy

The Economy assessment for options A, B and C focussed on the outputs from the comparative exercise on modelling, as well as a comparative capital cost build up. The modelling of the options in the strategic Southwest Regional Model provides useful insights on the Proposed Schemes performance. Patronage on the Proposed Scheme is slightly higher in Option C due to its additional stop and its wider coverage of the north and south sides of the city, with Option B presenting the lowest patronage (Option A+3% and Option C +9% in 2035 – 24h boardings). Total economic benefits over the appraisal period for Option C are valued €1,116m, which is €117m higher than Option B (10.6% difference), and €125m higher than Option A (11.2% difference).

9.8.1.4 Outcome of City Centre Alignment Options Comparison

Option A is considered to offer the following benefits:

- The significant benefit of providing rail-based public transport connectivity at Kent, offering a legible, fully accessible and integrated multi-modal interchange.
- The potential benefit of serving the main thoroughfare of the city centre, St. Patrick Street, through the centre of the island catchment, which is also identified in CMATS and the Cork City Development Plan (2022-2028).
- Option A is compatible with Cork City Council's proposal for a public transport bridge, funding for which has been approved under the Urban Regeneration and Development Fund, with respect to the Cork City Docklands Scheme. Should that scheme progress there will be opportunities to cost share and thereby reduce the overall project cost for the bridge, which is currently assumed as a full project cost to the Proposed Scheme. Progressing and integrating both scheme plans would allow for a more efficient use of exchequer funding, and reduce the assumed costs for Option A, as well as being of benefit to non-LRT users;
- Option A serves all the identified trip attractors and social hubs and has a broader reach within the city. As such, it can facilitate both anticipated and less obvious travel patterns and open latent demand, generating diagonal connectivity between the northside of the city and the Docklands and Blackrock to the east and Curragheen and Bishopstown to the west.

Option B is considered to offer the following benefits:

- The alignment is simple and direct and satisfies many of the project criteria.
- It serves the city core in an uncomplicated manner for people travelling from both the west and the east of the city.
- The pedestrian bridge connection to Kent, although less than ideal in terms of mobility and accessibility, offers an active travel link north and south of the Lee; and
- There are opportunities for riverside regeneration associated with this option, along Kennedy Quay, Lapps Quay, and South Mall, which would benefit the city.
- The availability of space along the cross-section of Option B allows for greater flexibility for space allocation, with potential for less disruption to the existing modes along this route.
- It is cheaper than Option A and C whilst achieving similar patronage and benefits.

Option C is considered to offer the following benefits:

- The significant benefit of providing rail-based public transport connectivity at Kent, offering a legible, fully accessible and integrated multi-modal interchange.
- Option C is compatible with Cork City Council's proposal for a public transport bridge, funding for which has been approved under the Urban Regeneration and Development Fund, with respect to the Cork City Docklands Scheme. Should that scheme progress there will be opportunities to cost share and thereby reduce the overall project cost for the bridge, which is currently assumed as a full project cost to the Proposed Scheme. Progressing and integrating both scheme plans would allow for a more efficient use of exchequer funding, and reduce the assumed costs for Option C, as well as being of benefit to non-LRT users;
- Option C serves a high number of trip attractors and social hubs and has a broader reach within the city. As such, it can facilitate both anticipated and less obvious travel patterns and open latent

demand, generating diagonal connectivity between the northside of the city and the Docklands and Blackrock to the east and Curragheen and Bishopstown to the west.

All of the three city centre options assessed present viable alignments that would work as part of an End-to-End scheme option for Luas Cork, each with comparable advantages and disadvantages.

All of the three city centre options assessed present viable alignments that would work as part of an End-to-End scheme option for Luas Cork, each with comparable advantages and disadvantages. Based on the review and comparative analysis of Option A, Option B and Option C it is deemed that Option A would be ranked as the strongest option across the MCA Criteria, followed by Option C and then Option B.

10 Emerging Preferred Route

10.1 Introduction

The key outcome of this Stage 1 assessment of Luas Cork is the determination of the EPR. That is, the route which, based on evidence and assessment, presents the best opportunity to meet the Proposed Schemes objectives. The Stage 1 Step C process, developed from the outcomes of Step B and subsequent design development, assessed 12 ETE Route Options using a comprehensive and detailed MCA.

Following the outcomes of the MCA, a City Centre Alignment Study was completed, in order to assess key aspects of the best performing alignments and determine the form of the Luas Cork connection to Kent Station. Having examined the city centre options in closer detail, under all CAF topics, the Study confirmed the findings of the Step C MCA. When considering the outcomes of the MCA in conjunction with the recommendations of the City Centre Alignment Options Comparison, the conclusion is that ETE Route Option 8 should form the EPR for Luas Cork. This process for Step C for ETE Route Option development and assessment is outlined in Figure 10.1.

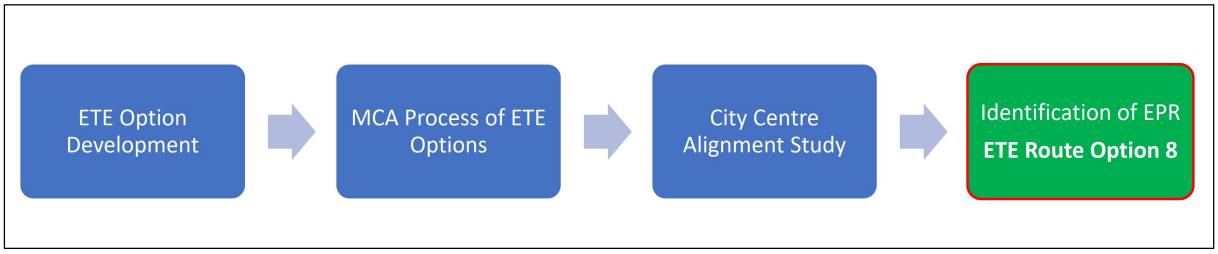

Figure 10.1: Overview of Step C Process to identify the EPR

10.2 Overview of EPR – ETE Route Option 8

The following section provides a descriptive summary of the proposed alignment for the EPR, starting from the western extents in Ballincollig in Sub-Area 3, to the eastern extents in Sub-Area 2. Figure 10.2 shows Option 8 as the EPR.

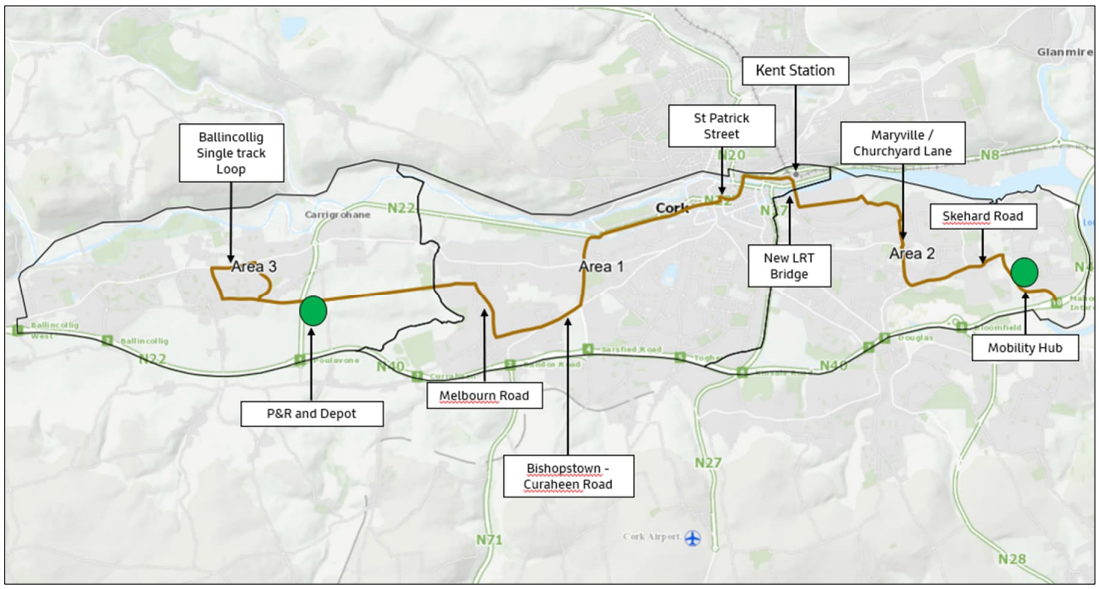

Figure 10.2: Emerging Preferred Route Alignment – Option 8

On completion of the Stage 1 assessment, the EPR for Luas Cork is ETE Route Option 8. Option 8 provides a comparably direct route between the western extents of the scheme at Ballincollig to the eastern extents in Mahon. Of the six CAF Criteria assessed, Option 8 scored best or equal best in the following sub-criteria:

- Economy – BCR;
- Economy – Patronage;
- Integration – Land Use Policy, Residential Population and Employment Catchment;
- Integration – Rail Integration;
- Integration – Traffic Network Integration;
- Integration – Active Modes;
- Accessibility & Social Inclusion – Key Trip Attractors;
- Safety – Road Safety (Segregation);
- Safety – Cycling & Pedestrian Segregation & Priority; and
- Physical Activity – Cycle Facilities.

Upon review of the higher performing sub-criteria for ETE Route Option 8, the following observations are made:

- ETE Route Option 8 is one of the longer routes in terms of overall track length which allows the alignment to serve a higher number of key trip attractors, increasing accessibility to Luas Cork and increasing the patronage and leading to a comparably stronger BCR of 0.97;
- The alignment proposals for ETE Route Option 8 can be readily synchronised with the proposed BusConnects network, where BusConnects could provide some important enabling works through its delivery, in turn reducing levels of risk and improving the efficiency of a future Luas Cork construction programme;
- ETE Route Option 8 connects directly to Kent Station, providing an important transport interchange point on the network;
- ETE Route Option 8 provides direct access to St Patricks Street, encouraging city centre regeneration and enabling the simplification of the city centre traffic network, through co-location with bus services.
- Option 8 transverses St Patrick's Street bridge, utilising a traffic calmed corridor along MacCurtain Street, providing important catchment opportunities comparable to other options

The route alignment for ETE Route Option 8 – allows for a phased pathway for future construction, while at points minimising the network impacts when compared to other options. The single-track loop through Ballincollig offers more flexibility within its cross-section to integrate with other modes. This will be important at several geometrically constrained points in the town centre of Ballincollig, with more scope for access to be maintained during a future construction phase.

ETE Route Option 8 then follows the same alignment as the other options, through greenfield sites, facilitating maximum levels of priority for Luas Cork.

The on-going rollout of BusConnects Cork has also been considered alongside Luas Cork and ETE Route Option 8, most notably in relation to proposed BusConnects corridor F, which is proposed to operate along Curraheen Road (R849), Wilton Road (R641) and Western Road (N22). It is considered that rationalisation of BusConnects services may be required along these sections to ensure maximum efficiency and integration of both services for a 2035 year of opening for Luas Cork.

10.3 Summary of EPR: Cost Estimate, Benefits and BCR

It is proposed that Luas Cork would commence construction on ETE Route Option 8 by the year 2030, with the Proposed Scheme to be completed by summer 2035. These proposed timelines provided the forecast years for calculation of future patronage levels, accrued benefits for the Proposed Scheme and cost estimation.

The forecast patronage levels for ETE Route Option 8 are shown in Table 10.1. This shows a forecast comparison for 2035 against the 2016 Base Year and a Do Minimum scenario each.

Table 10.1: Forecast patronage levels for ETE Route Option 8

	Boardings per Mode (24H)			
Scenario Name	**DART + Irish Rail**	**Luas Cork**	**Urban Bus + Other Bus**	**TOTAL**
Base2016	9,561	0	66,245	**75,806**
2035 Do Min	22,801	0	114,122	**136,923**
2035 ETE8	23,922	51,978	81,690	**157,591**

10.3.1 Benefits

The Irish version of Transport User Benefit Appraisal (TUBA) software was used to calculate economic benefits. The modelled forecast years were included in the calculations, over a 60-year appraisal period. Table 10.2 shows the level of accrued benefits for the Proposed Scheme.

Table 10.2: TUBA Economic Benefits (k€)

	ETE Route Option 8
Economic Efficiency: Consumer Users (Commuting)	299,489
Economic Efficiency: Consumer Users (Other)	376,541
Economic Efficiency: Business Users and Providers	341,259
Wider Public Finances (Indirect Taxation Revenues)	-25,986
Present Value of Benefits (PVB)	**991,343**

Should the EPR – ETE Route Option 8 – be adopted for Luas Cork, it would be anticipated that other benefits will result, such as improved accessibility and independent mobility and active mode participation, particularly cycling. Cycle facilities which are anticipated to consist of parallel cycle path and stop facilities will also integrate with the existing and proposed Cork cycle network well. Such cycling improvements will allow for many work or recreational trips to take place in the local vicinity of the new stops and towards centres of employment in the city centre or further afield with transfer.

10.3.2 Option Cost Estimate and BCR

Costs provide a key input to the economic appraisal process and allow the calculation of a BCR to ascertain value for money and comparison across route options. On completion of the costing exercise, ETE Route Option 8 was ranked 12th from the 12 ETE Route Options for the Option Cost Estimate, with Options 7 (ranked 11th) and 10 (ranked 10th) lower by -1.88% and -4.54% respectively.

The cost estimate for ETE Route Option 8 is outlined Table 10.3.

Table 10.3: Cost Estimate for ETE Route Option 8

	Light Rail Works	
ETE Route Option	Main Works	Depot
8	€1,924,559,571	€247,709,803

In tandem with the benefits outlined section 10.5 and taking costs back to 2011 prices, as required of an economic assessment, calculates the ETE Route Option 8 a BCR of 0.97.

10.4 Incorporating Potential Park & Ride with Luas Cork

The provision of a potential P&R as part of the Proposed Scheme could be an important component in the success of the Proposed Scheme and the delivery of the objectives. The P&R facilities that have been identified would offer riders the opportunity to park adjacent to a strategic stop location with a circa 1000 space capacity at Link Road (in close proximity to Ballincollig) and the provision of a mobility hub at Mahon Point. The P&R facilities would enable riders to travel to the city more quickly, affordably and reliably than they would otherwise be able to by private vehicle.

The P&R facility and mobility hub could help provide benefits, particularly in the form of reduced journey times, for road users accessing the city from Ballincollig, the N22, the N40 and further afield. The numbers of forecasted P&R facility users will be expected to continue to rise in later years as road congestion becomes more significant – therefore the P&R related benefits accrued to the Proposed Scheme will also compound over time.

10.5EPR Performance against Proposed Scheme Objectives

The following outlines the performance of ETE Route Option 8 as the EPR against high-level objectives for Luas Cork, established at the outset of Stage 1.

Table 10.4: Scheme Objectives and EPR Performance

Objectives	EPR response to Objective
Deliver high quality public transport and journey time reliability to cater for existing and future public transport travel increased demand within the city and its suburbs.	The EPR alignment integrates well with BusConnects and provides a more direct route to Kent Station and Mahon, lending well to Journey time reliability for Luas Cork.
Support the continued important economic development of the Cork Metropolitan Area, futureproofing for NPF growth and beyond, in a cost-efficient manner	The EPR brings additional resilience to the transport network, allowing for future growth and regeneration within the city centre with the ability to cater for demand. The EPR will also catalyse important economic regeneration in the Docklands, at MTU and UCC, in Ballincollig and in Mahon.
Facilitate connection to key trip attractors and support public transport network integration by providing high quality passenger interchange points	The selected alignment will serve a remarkably high number of major city trip attractors, such as Ballincollig, Munster Technology University, University College Cork, Cork University Hospital, Cork City Centre, Pairc Uí Chaoimh and Mahon. The EPR for Luas Cork has been closely coordinated with the proposed BusConnects scheme, to minimise operational conflicts and provide public transport network integration.

Objectives	EPR response to Objective
Plan, construct and operate in an environmentally sustainable manner, facilitate a reduction in urban congestion and contribute to the environmental enhancement of the city and region.	The route alignment for ETE Route Option 8 – allows for a phased pathway for future construction, while at points minimising the network impacts when compared to other options.
As part of the scheme, provide a 'strategic Park and Ride' for motorists who currently travel to the City Centre from the N22	The Proposed Scheme will provide a strategic park & ride with a capacity of circa 1,000 spaces adjacent to the Link Rd on the outskirts of Ballincollig adjacent to the N22. A further Mobility Hub will also be provided at Mahon.
Design a modern and attractive light rail system which is accessible to all users, and which integrates appropriately into the existing urban fabric and character of the city.	The EPR for the Proposed Scheme utilises a mix of sharing the cross sections of a series of existing street links as well as sections of off-line priority. The links that will be integrated with Luas Cork, will also benefit from improved public realm and accessibility for all.

10.6 Conclusion

At the close of this study, it has been determined that ETE Route Option 8 is the EPR for Luas Cork. This corridor is anticipated to deliver best against the six CAF criteria and objectives of Luas Cork in tandem with presenting a deliverable solution against operational challenges in the city centre between Luas Cork and BusConnects.