DART+ South West

Technical Optioneering Report

Park West to Heuston Station

Area around Kylemore Road Bridge (OBC5A)

Iarnród Éireann

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Glossary of Terms

Reference	Description
ABP	An Bord Pleanála
ACA	Architectural Conservation Area
APIS	Authorisation for Placing in Service
ASA	Application for Safety Approval
AsBo	Assessment Body
ASPSC	Application Specific Project Safety Case
ATP	Automatic Train Protection
CAF	Common Appraisal Framework
Cantilever	OHLE structure comprising horizontal or near horizontal members supporting the catenary projecting from a single mast on one side of the track.
Catenary	The longitudinal wire that supports the contact wire.
CAWS	Continuous Automatic Warning System
CBI	Computer-Based Interlocking
CCE	Chief Civils Engineers Department of IE
CCRP	City Centre Re-signalling Project
CCTV	Closed Circuit Television
CDP	County Development Plan
CIE	Córas Iompair Éireann
Contact wire	Carriers the electricity which is supplied to the train by its pantograph.
CPO	Compulsory Purchase Order
Cross overs	A set of railway parts at the crossing of several tracks which helps trains change tracks to other directions.
CRR	Commission for Rail Regulation (formerly RSC – Railway Safety Commission)
CSM RA	Common Safety Method for Risk Evaluation and Assessment
CTC	Central Traffic Control
Cutting	A railway in cutting means the rail level is below the surrounding ground level.

Reference	Description
D&B	Design & Build (contractor)
DART	Dublin Area Rapid Transit (IÉ's Electrified Network)
DART+	DART Expansion Programme
DeBo	Designated Body
Direct Current (DC)	Electrical current that flows in one direction, like that from a battery.
DCC	Dublin City Council
DRR	Design Review Report
DSR	Design Statement Report
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
Electrification	Electrification is the term used in supplying electric power to the train fleet without the use of an on-board prime mover or local fuel supply.
EMC	Electromagnetic Compatibility
EMU	Electric Multiple Unit (DART train)
EN	European Engineering Standard
EPA	Environmental Protection Agency
EPO	Emerging Preferred Option
ERTMS	European Rail Traffic Management System
ESB	Electricity Supply Board
Four-tracking	Four-tracking is a railway line consisting of four parallel tracks with two tracks used in each direction. Four track railways can handle large amounts of traffic and are often used on busy routes.
FRS	Functional Requirements Specification
FSP	Final Supply Points
GDA	Greater Dublin Area
GI	Ground Investigation
HAZID	Hazard Identification

Reference	Description
Horizontal Clearance	The horizontal distance between a bridge support and the nearest railway track is referred to as horizontal clearance. Bridge supports include abutments (at the ends of the bridge) and piers (at intermediate locations).
HV	High Voltage
IA	Independent Assessor
IÉ	Iarnród Éireann
IM	Infrastructure Manager (IÉ)
IMSAP	Infrastructure Manager Safety Approval Panel
Insulators	Components that separate electricity live parts of the OHLE from other structural elements and the earth. Traditionally ceramic, today they are often synthetic materials.
KCC	Kildare County Council
Lateral Clearance	Clearances between trains and structures.
LCA	Landscape Character Area
Mast	Trackside column, normally steel that supports the OHLE.
MCA	Multi-criteria Analysis
MDC	Multi-disciplinary Consultant
MEP	Mechanical electrical and plumbing
MFD	Major Feeding Diagram
MMDC	Maynooth Multi-disciplinary Consultant
MV	Medium Voltage
NDC	National Biodiversity Data Centre
NIAH	National Inventory of Architectural Heritage
NoBo	Notified Body
NTA	National Transport Authority
OHLE	Overhead Line Equipment
Overbridge (OB)	A bridge that allows traffic to pass over a road, river, railway etc.
P&C	Points and Crossings
Pantograph	The device on top of the train that collects electric current from the contact wire to power the train.

Reference	Description
PC	Public Consultation
Permanent Way	A term used to describe the track or railway corridor and includes all ancillary installations such as rails, sleepers, ballast as well as lineside retaining walls, fencing and signage.
POAP	Plan-On-A-Page, high-level emerging programme
PPT	Phoenix Park Tunnel
PRS	Project Requirement Specification
PSCS	Project Supervisor Construction Stage
PSDP	Project Supervisor Design Process
PSP	Primary Supply Points
QA/QC	Quality Assurance/Quality Control
RAM	Reliability, Availability, Maintainability
RC	Reinforced Concrete
Re-signalling	Re-signalling of train lines will regulate the sage movement of trains and increase the capacity of train services along the route.
RMP	Record of Monuments and Places
RO	Railway Order
RPS	Record of Protected Structures
RSC-G	Railway Safety Commission Guideline
RU	Railway Undertaking (IÉ)
SAM	Safety Assurance Manager
SAP	Safety Approval Panel
SDCC	South Dublin County Council
SDZ	Strategic Development Zone
SET	Signalling, Electrical and Telecommunications
Sidings	A siding is a short stretch of railway track used to store rolling stock or enable trains on the same line to pass
SMR	Sites and Monuments Records
SMS	IÉ Safety Management System

Reference	Description
TII	Transport Infrastructure Ireland
TMS	Train Management System
TPH	Trains per Hour
TPHPD	Trains per Hour per Direction
TPS	Train Protection System
Track Alignment	Refers to the direction and position given to the centre line of the railway track on the ground in the horizontal and vertical planes. Horizontal alignment means the direction of the railway track in the plan including the straight path and the curves it follows.
TSI	Technical Specifications for Interoperability
TSS	Train Service Specification
TTAJV	TYPSA, TUC RAIL and ATKINS Design Joint Venture (also referred to as TTA)
Underbridge (UB)	A bridge that allows traffic to pass under a road, river, railway etc. The underneath of a bridge.
VDC	Direct Current Voltage
Vertical Clearance	For overbridges, an adequate vertical distance between railway tracks and the underside of the bridge deck (soffit) must be provided in order to safely accommodate the rail vehicles and the OHLE. This distance is known as vertical clearance and it is measured from the highest rail level.
WFD	Water Framework Directive

1. Introduction

1.1. Purpose of Report

The purpose of this report is to provide technical input to the Preliminary Option Selection Report. This report shows the options considered as part of the project development and why the emerging preferred option was chosen.

This report provides the technical assessment of the area from East of the proposed Le Fanu Road Bridge (OBC7) to the East of IE700B (i.e. the points for the Inchicore headshunt turnout). This report presents the approach to option development, options assessment, and options selection. This optioneering process incorporates assessment by the following Design Workstreams and specialist Project Teams:

- Permanent Way
- Civils and Structures
- Signalling, Electrification and Telecommunications (SET) and Low Voltage Power
- Overhead Line Equipment (OLE)
- Environment
- Highways
- Geotechnical

The report provides:

- An area overview and a detailed description of the existing railway infrastructure and challenges.
- The Project Requirements for this area.
- The technical and environmental constraints, including the horizontal and vertical clearances at structures.
- The options considered for this area.
- The option selection process is leading to the identification of the Emerging Preferred Option, including the Sifting process and the Multi-Criteria Analysis process.

1.2. DART+ Programme Overview

The DART+ Programme is a transformative railway investment programme, that will modernise and improve the existing rail services in the Greater Dublin Area (GDA). It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

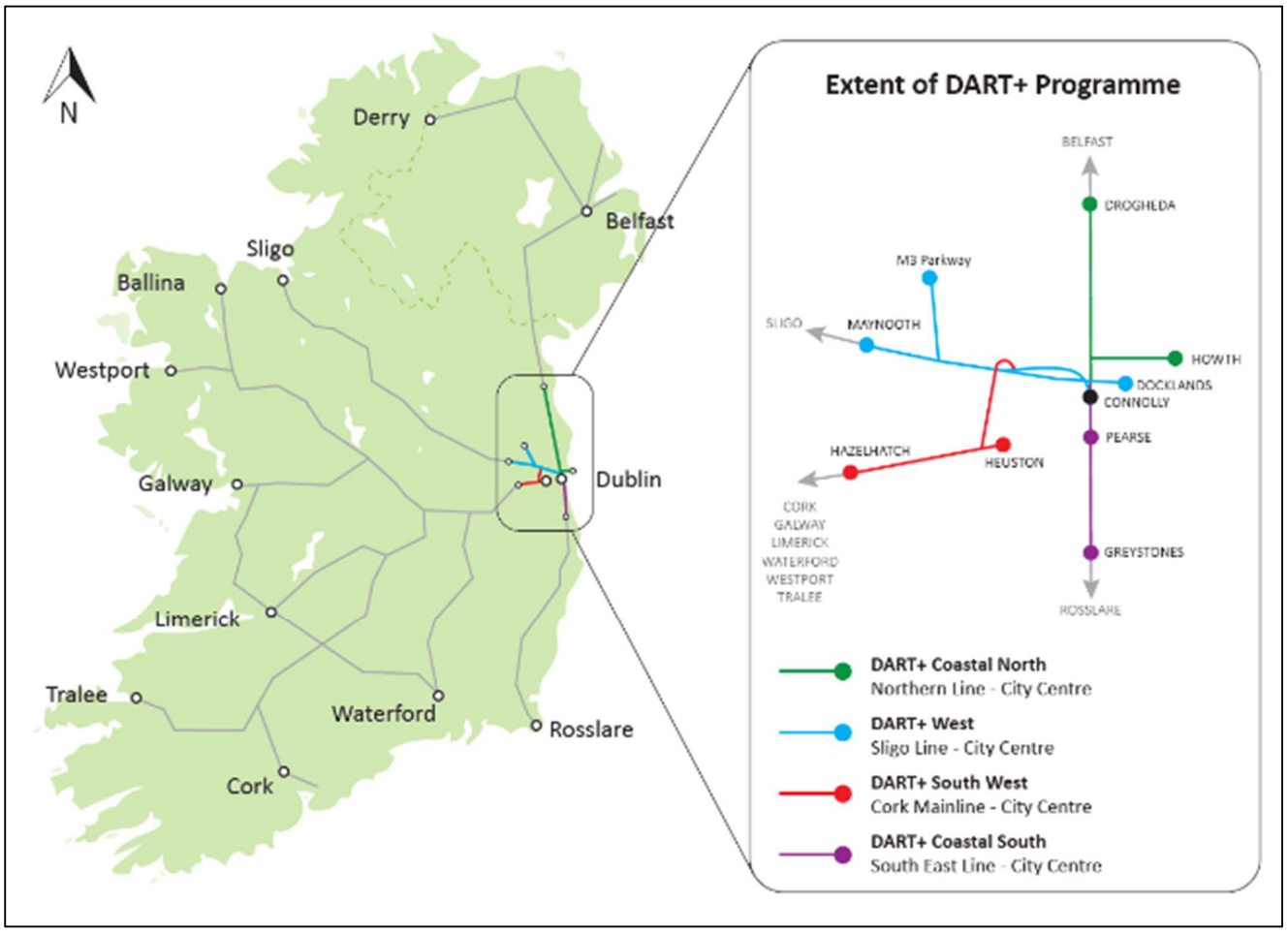

Figure 1-1 Schematic of Overall DART+ Programme

The current electrified DART network is 50km long, extending from Malahide / Howth to Bray / Greystones. The DART+ Programme seeks to increase the network to 150km. The DART+ Programme is required to facilitate increased train capacity to meet current and future demands, which will be achieved through a modernisation of the existing railway corridors. This modernisation includes the electrification, re-signalling, and certain interventions to remove constraints across the four main rail corridors within the Greater Dublin Area, as per below:

- DART+ South West (this Project) – circa 16km between Hazelhatch & Celbridge Station to Heuston Station and also circa 4km between Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line.
- DART+ West – circa 40km from Maynooth & M3 Parkway Stations to the City Centre.
- DART+ Coastal North – circa 50km from Drogheda to the City Centre.
- DART+ Coastal South – circa 30km from Greystones to the City Centre.

The DART+ Programme also includes the purchase of new electrified fleet to serve new and existing routes.

The DART+ Programme is a key element to the national public transportation network, as it will provide a high-capacity transit system for the Greater Dublin Area and better connectivity to outer regional cities and towns. This will benefit all public transport users.

The Programme has also been prioritised as part of Project Ireland 2040 and the National Development Plan 2018-2027 as it is integral to the provision of an integrated, high-quality public transport system.

Delivery of the Programme will also promote transport migration away from the private car and to public transport. This transition will be achieved through a more frequent and accessible electrified service, which will result in reduced road congestion, especially during peak commuter periods.

Ultimately, the DART+ Programme will provide enhanced, greener public transport to communities along the DART+ Programme routes, delivering economic and societal benefits for current and future generations.

1.3. DART+ South West Project

The DART+ South West Project will deliver an electrified network, with increased passenger capacity and enhanced train service between Hazelhatch & Celbridge Station to Heuston Station (circa 16km) on the Cork Mainline, and Heuston Station to Glasnevin via Phoenix Park Tunnel Branch Line (circa 4km).

DART+ South West Project will complete four-tracking between Park West & Cherry Orchard Station and Heuston Station and will also re-signal and electrify the route. The completion of the four-tracking will remove a significant existing constraint on the line, which is currently limiting the number of train services that can operate on this route. DART+ South West will also deliver track improvements along the Phoenix Park Tunnel Branch Line, which will allow a greater number of trains to access the city centre.

Upon completion of the electrification of the DART+ South West route, new DART trains will be used on this railway corridor, similar to those currently operating on the Malahide / Howth to Bray / Greystones Line.

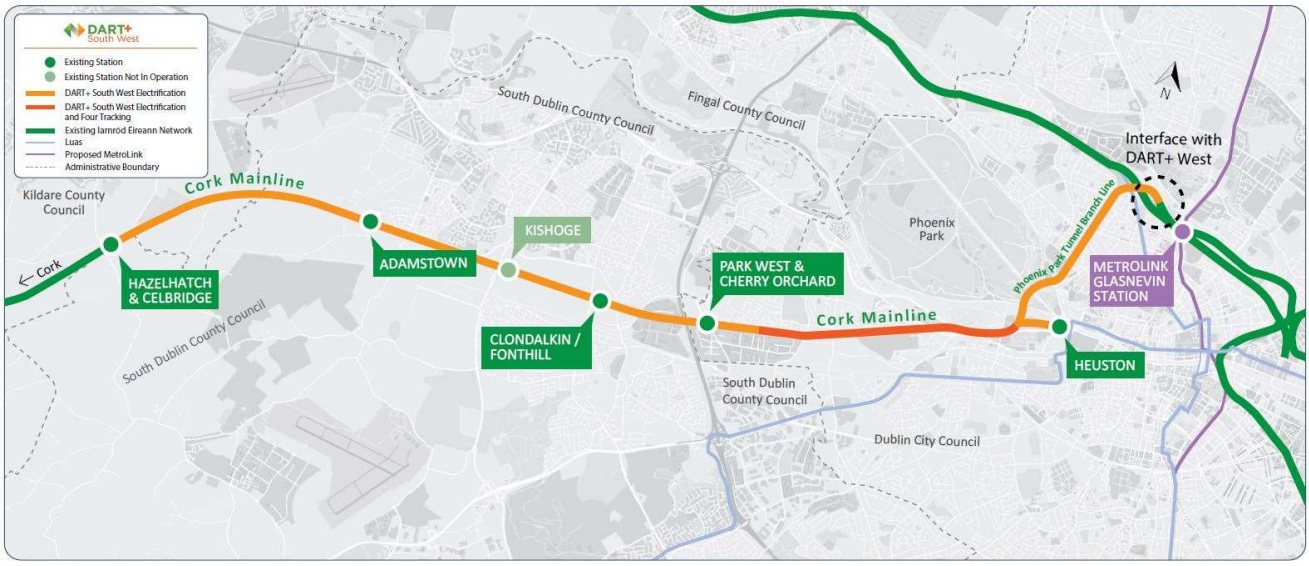

Figure 1-2 DART+ South West Route Map

1.4. Capacity increases associated with DART+ South West.

DART+ South West will improve performance and increase train and passenger capacity on the route between Hazelhatch & Celbridge Station to Heuston Station and through the Phoenix Park Tunnel Branch Line to the City Centre, covering a distance of circa 20km. It will significantly increase train capacity from the current 12 trains per hour per direction to 23 trains per hour per direction (i.e. maintain the existing 12 services, with an additional 11 train services provided by DART+ South West). This will increase passenger capacity from the current peak capacity of approximately 5,000 passengers per hour per direction to approximately 20,000 passengers per hour per direction. Upon completion of the DART+ South West Project, train services will be increased according to passenger demand.

1.5. Key infrastructural elements of DART+ South West Project

The key elements of DART+ South West include:

- Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station, extending the works completed on the route in 2009.
- Electrification of the line from Hazelhatch & Celbridge Station to Heuston Station and also from Heuston Station to Glasnevin, via the Phoenix Park Tunnel Branch Line, where it will link with proposed DART+ West.
- Undertaking improvements / interventions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Feasibility report and concept design for a potential new Heuston West Station.

The 'Emerging Preferred Option' will be compatible with the future stations at Kylemore and Cabra, although the construction of these stations is not part of the DART+ South West Project.

1.6. Route Description

The existing rail corridor extends from Heuston Station to Hazelhatch & Celbridge Station, the route also extends through the Phoenix Park Tunnel to Glasnevin. The area descriptions and extents are set out in **Table 1-1** below.

Table 1-1 Route Breakdown

Area Name	Sub-area Description	Extents	Main Features
Hazelhatch to Park West	Area from Hazelhatch to Park West	West side of Hazelhatch & Celbridge Station to 50m to west of Cherry Orchard Footbridge (OBC8B)	Hazelhatch & Celbridge Station Adamstown Station Clondalkin/Fonthill Station Park West & Cherry Orchard Station Cherry Orchard Footbridge (OBC8B)

Area Name	Sub-area Description	Extents	Main Features
Park West to Heuston Station	Area around Le Fanu Bridge (OBC7)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7)	Le Fanu Road Bridge (OBC7)
	Area around Kylemore Bridge (OBC5A)	East of the proposed Le Fanu Road Bridge (OBC7) to the East of IE700B (i.e. the points for the Inchicore headshunt turnout)	Kylemore Road Bridge (OBC5A)
	Area around Inchicore Works	East of IE700B (i.e. the points for the Inchicore headshunt turnout to the west of Sarsfield Road Bridge (UBC4)	Inchicore Works Depot
	Khyber Pass Bridge (OBC5)	Vicinity of Khyber Pass Footbridge (OBC5)	Khyber Pass Footbridge (OBC5)
	Area around Sarsfield Road Bridge (UB4)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Area around Memorial Bridge (OBC3)	Vicinity of Memorial Road Bridge (OBC3)	Memorial Road Bridge (OBC3)
	Area around South Circular Road Junction	East of Memorial Road Bridge (OBC3) East of St John's Road Bridge (OBC0A)	South Circular Road Junction South Circular Road Bridge (OBC1) St Johns Road Bridge (OBC0A)
	Area around Heuston Station and Yard	Area at Heuston Station Yard, including all platforms and sidings	Heuston Station Sidings around Heuston Station
St John's Road Bridge to Glasnevin Junction	Area from East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	East of St John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel	Potential new Heuston West Station Liffey Bridge (UBO1). Conyngham Road Bridge (OBO2) Phoenix Park Tunnel

Area Name	Sub-area Description	Extents	Main Features
	Area from Phoenix Park Tunnel to Glasnevin Junction	West of Phoenix Park Tunnel to South of Glasnevin Junction	McKee Barracks Bridge (OBO3) Blackhorse Avenue Bridge (OBO4) Old Cabra Road Bridge (OBO5) Cabra Road Bridge (OBO6) Fassaugh Avenue Bridge (OBO7) Royal Canal and LUAS Twin Arches (OBO8) Maynooth Line Twin Arch (OB09) Glasnevin Cemetery Road Bridge (OBO10)

2. Existing Situation

2.1. Overview

This section is 575m (approx.) long and extends from 10m east of Le Fanu Road Bridge (OBC7) to 50m west of 700B (points), located east of Kylemore Road Bridge (OBC5A). The Permanent Way currently consists of 2 No. tracks. The tracks fall in level from west to east throughout the area. There is currently no longitudinal drainage system installed along the Permanent Way.

The area includes Kylemore Road Bridge (OBC5A) which is a single-carriageway road overbridge carrying road traffic over the rail corridor in a north-south direction. This bridge is a major feature of the area.

The rail corridor is primarily in cutting (i.e., the rail level is below the surrounding ground level). The corridor is formed by earthwork cutting slopes along the north and south sides. The residential properties of Kylemore Drive and Landen Road back on to the railway corridor northern boundary, and the industrial units of Park West Industrial Estate and Westlink Industrial Estate back onto the railway corridor southern boundary. The major infrastructure features are illustrated in **Figure 2-1** below.

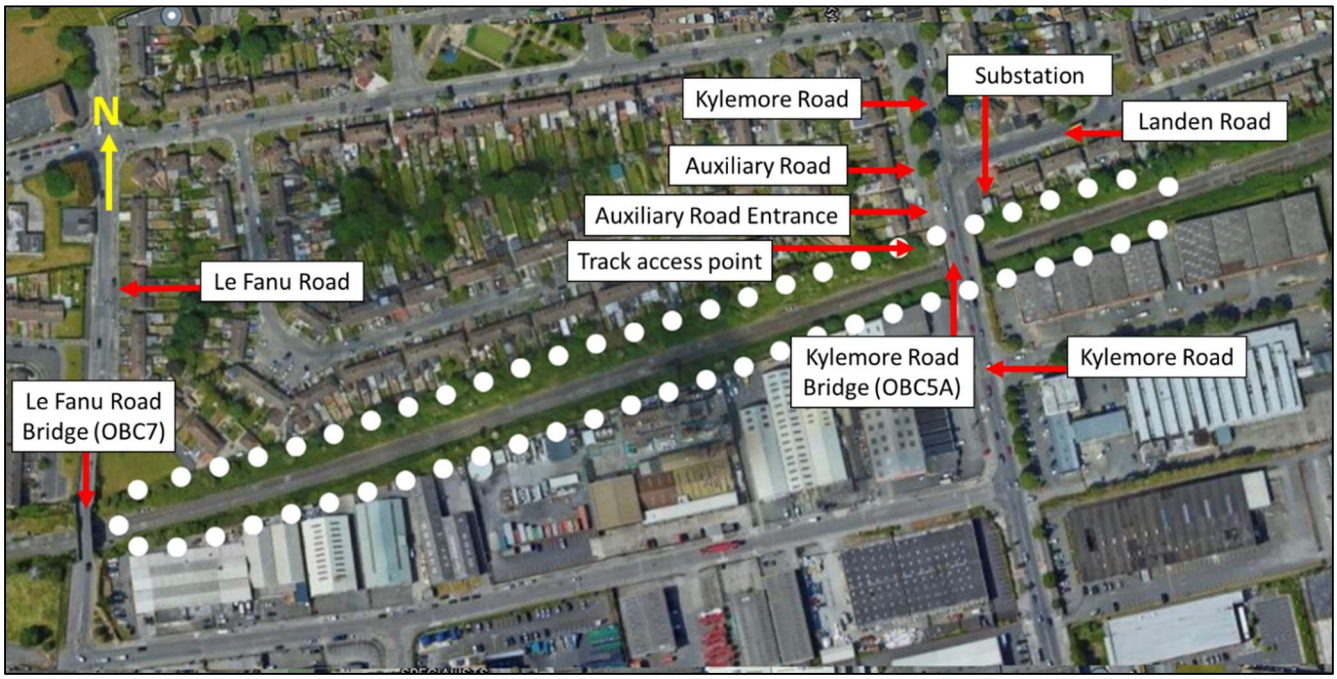

Figure 2-1 Aerial view of Area (white dotted outline)

The main Environmental features are described in Section 2.8 below.

2.2. Challenges

The project objective is to increase the number of tracks between Park West & Cherry Orchard Station and Heuston Station to 4 No. tracks and to electrify 2 No. tracks from Hazelhatch & Celbridge Station to Glasnevin Junction.

Additionally, the works need to be undertaken in such a way that space provision is made available for potential future platforms under Kylemore Road Bridge. This means that certain elements such as the bridge itself would be constructed with the appropriate span to avoid the necessity for major works in the future to the bridge structure, in the event that future platform construction is necessitated.

There are significant challenges that constrain the options available to achieve the Permanent Way and Overhead Line Electrification (OHLE) project requirements. There is insufficient space to add 2 No. additional tracks without intervention to the earthworks cutting slopes. The proximity of residential and commercial properties immediately outside the rail corridor boundary poses a constraint to the possible Options. Widening of the corridor can be achieved by installing a retaining structure along the north and south cutting slopes.

The existing Kylemore Road Bridge (OBC5A) structure, which currently has 2 No. tracks beneath it, has insufficient horizontal clearance for 4 tracks.

2.3. Structures

Kylemore Road Bridge (OBC5A)

Kylemore Road Bridge (OBC5A), carries northbound and southbound traffic along the Kylemore Road over the railway line. This is a single-span reinforced concrete structure built in the mid-1950s. The bridge structure consists of post-tensioned precast concrete beams on concrete abutments. The bridge has a clear span of 12.65m and a width of 17.22m consisting of a 9.14 m wide carriageway and 3.81 m wide footpaths at each side. Kylemore Road Bridge (OBC5A) goes over two railway tracks with an estimated vertical clearance of 4.335m.

Figure 2-2 Kylemore Road Bridge (OBC5A) - West Elevation

Minor Retaining Structures

Along the railway corridor, there are a number of minor retaining structures. Generally, their function is to retain the toe of the earth cutting slope and provide additional room for the provision of lineside equipment. An example of such a structure is shown in the **Figure 2-3** below.

Figure 2-3 Masonry retaining wall

Old bridge abutments

There exists a pair of old defunct bridge abutments, located adjacent to crossover 698AB, 150m (approx.) west of the Kylemore Road Bridge (OBC5A), refer to **Figure 2-6**.

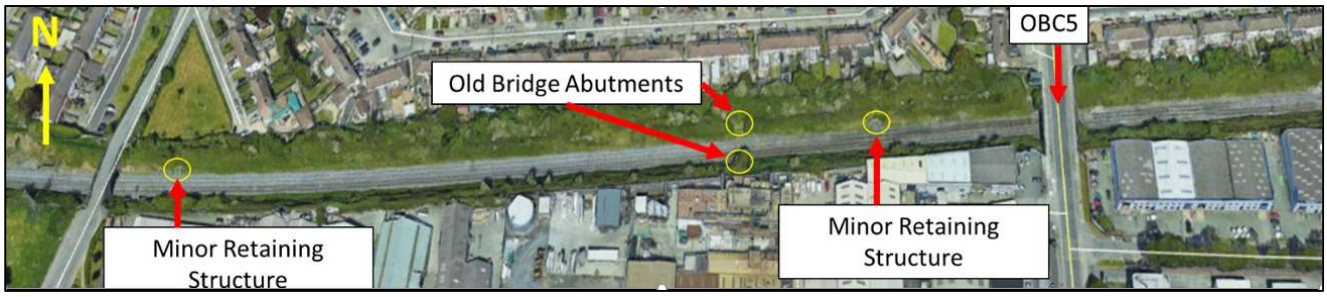

Figure 2-4 Location of minor retaining structures and old bridge abutments

2.4. Permanent Way and Tracks

Just east of the area 3 No. tracks (one of which is used as a siding) that approach from Inchicore. These 3 No. tracks converge into 2 No. tracks at the start of the area, resulting in two tracks that continue through the area (under Kylemore Road and to Le Fanu Road). These are referred to as the 'Up Main' on the north side and the 'Down Main' on the south. On the east side of the area limits is a connection to the Inchicore Works ('Down Main' is connected to the Long Siding at Points 700B). There are 2 No. crossovers (Points 698AB & 699AB) located at either side of Kylemore Road Bridge (OBC5A). They are used for access and egress from Inchicore Works. The track layout is represented in the **Figure 2-5** below.

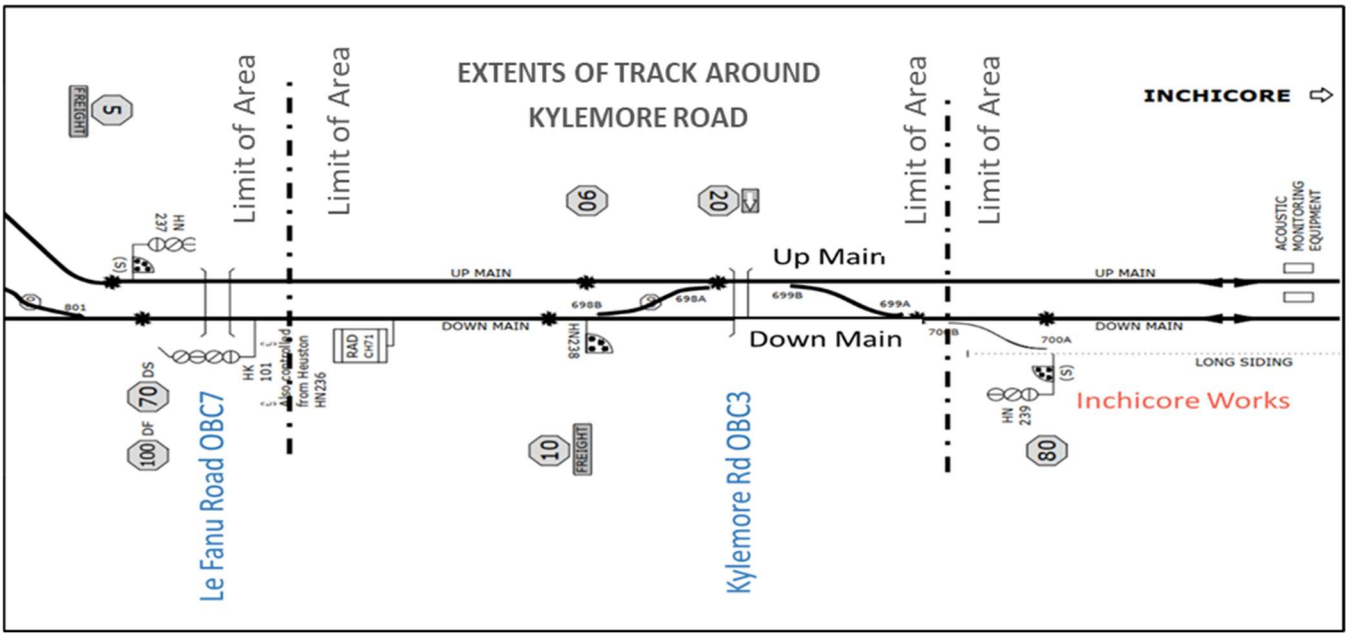

Figure 2-5 Track diagram showing the area

The horizontal alignment at the east side of the area is formed by a curve of radius 1,800m (approx.) followed by a straight section to Inchicore. The track is straight under Kylemore Road Bridge (OBC5A); with a gradient of 1% (approx.) falling west to east.

The track is comprised of a ballasted track with 54E1 rail and concrete sleepers. The points and cross-overs (P&Cs) are predominantly on timber bearers (while some of the units are on concrete bearers), protected from the thermal forces by adjustments switches. Crossover 698AB can be seen in the **Figure 2-6** below.

Figure 2-6 Crossover 698AB (Facing East)

2.5. Other Railway Facilities

Advertisement Sign and Access Stairs

There is a variable message advertisement sign at the top of the cutting slope on the north-west side of the bridge. Please see the **Figure 2-7** below. The sign is adjacent to a track access point and stairs. This track access point facilitates access from road level to track level for Iarnród Éireann maintenance staff.

Figure 2-7 Advertising Sign & Stairs at north-west of Kylemore Road Bridge (OBC5A)

2.6. Road Network

The immediate project area along Kylemore Road (R112), between Kylemore Park North and Landon Road junctions, would be affected by options proposed for the electrification and track widening. This section of carriageway comprises the following cross-sectional elements: A single lane carriageway with paved footpaths along both sides of the kerbed carriageway. Lane widths are 3.5m, while the footpath is 4m (approx.). There is an additional 4m (approx.) of verge between footpath and plot boundaries to the south of the bridge. In addition there exists a minimum of 4m verge between footpath and edge of auxiliary service road to the north-west of the bridge. The verge along the north-east approach to the bridge, includes a wider asphalted open space providing access and parking for an ESB electrical substation.

The junction of Kylemore Road with Landen Road is signalised, while its junction with Kylemore Park North (linking Kylemore Road to Le Fanu Road) is un-signalised. The road falls toward the bridge from the south with a gradient of 1% (approx.) and steepens to 3% (approx.) north of the bridge. Kylemore Road is considered the main collector road linking Ballyfermot to the Naas Road (R810), as well as to the industrial estates between the Long Mile Road and the existing rail line.

Historical traffic counts, at the Kylemore Road / Ballyfermot Road roundabout and the junction of Le Fanu Road with Ballyfermot Road, indicate that Kylemore Road has similar (but slightly heavier) traffic volumes to that of Le Fanu Road during the morning peak hour. However, the daily figures indicate that Kylemore Road has approximately double the volume of traffic to that of Le Fanu Road.

Kylemore Road is neither designated nor proposed as a BusConnects route, within the DART+ South West project area; however, it is integral to several regular Dublin Bus routes (particularly via Landen Road). The commercial/industrial plot boundaries along Kylemore Road (south of the bridge) are detailed as follows:

- low-level upstand walls along the western road corridor boundary (building industry mini-units).
- low-level retaining wall, with a 3m (approx.) high semi-ornate metal palisade fence along the eastern road corridor boundary (Westlink Industrial Park). The accesses to these facilities are within 15m and 30m (approx.) of the bridge, respectively. There is also a residential service road junction onto Kylemore Road, between the bridge and Landen Road (within 5m of the north-west Perway corridor).

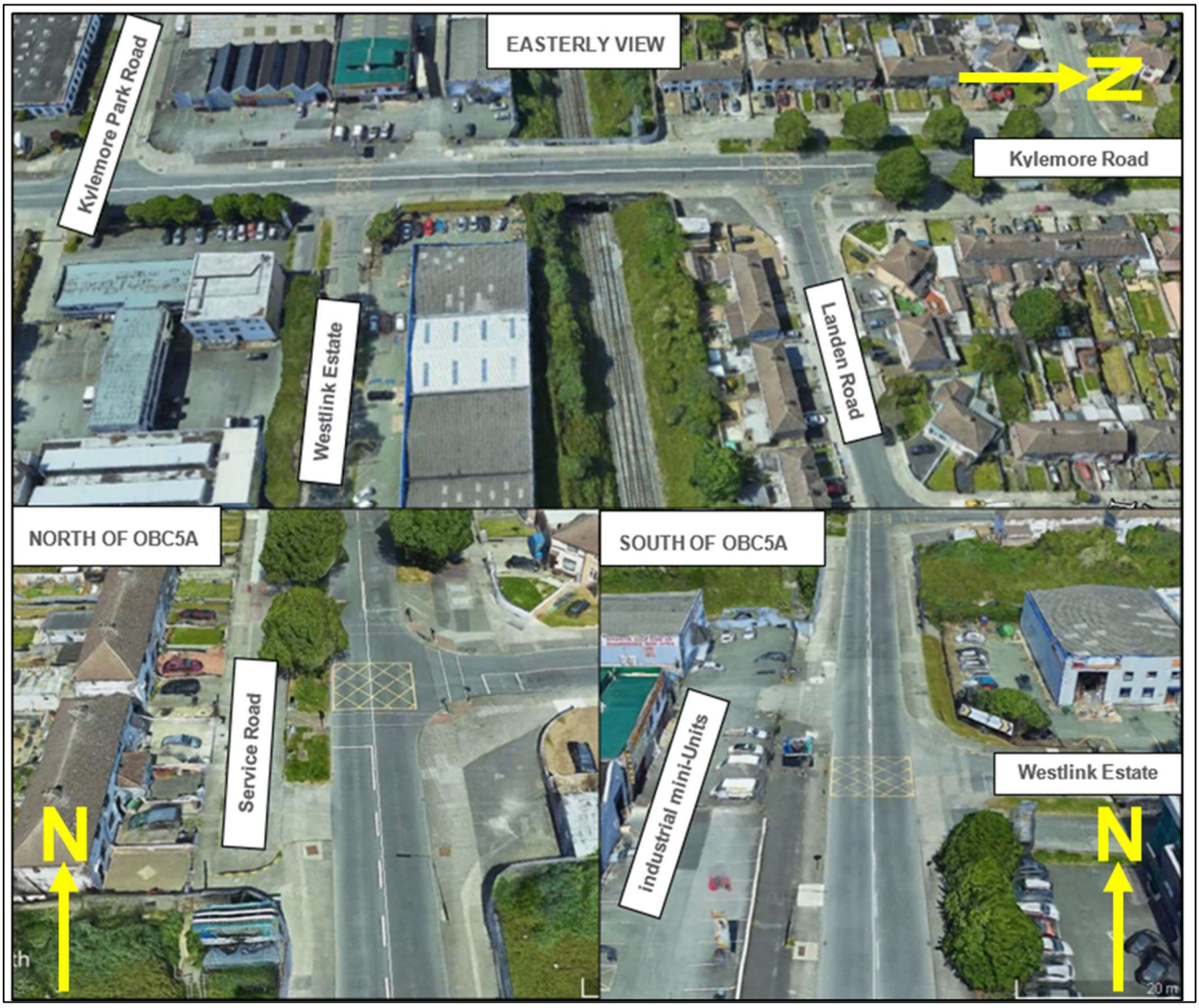

Figure 2-8 Aerial view of the roads potentially affected by the raising of bridge levels

2.7. Topography and Ground Conditions

Topographically, the ground slopes gently from west to east with the railway in a deep cutting throughout the area. At Kylemore Road Bridge (OBC5A), the railway is located within a steep cutting that is covered partially by vegetation, with industrial units forming the southern boundary, and the residential properties forming the northern

boundary. The general superficial geology in this area is anticipated to comprise till overlying bedrock (limestone and shale).

To the north of Kylemore Road Bridge (OBC5A), historical ground investigation information reports that the site comprises fill underlain by gravelly clay. A borehole was terminated at 6.10m bgl (37.19m AOD), due to a reported obstruction. To the south of the bridge, existing historical ground investigation information indicates the site to be underlain by gravelly clay overlying bedrock to a depth of 8.10m bgl (35.69m AOD) where an obstruction was encountered. The borehole was then continued using rotary follow on, and bedrock described as strong limestone was proven at 9.30m bgl (34.49m AOD). Should the bedrock be proved by additional GI to be at the same level at the bridge, then it would be at a depth of 3.6m (approx.) bgl below track level.

Groundwater was not encountered within any of the exploratory holes in the vicinity of Kylemore Road Bridge (OBC5A). Publicly available borehole information indicates the depth to bedrock to be greater than 5.0m bgl, and it is assumed ground level for this information has been measured from the top of the cutting.

2.8. Environment

On the north side of the existing corridor, there are significant residential properties along Landen Road, and Kylemore Drive, many within a 50m and 100m buffer of the current rail centreline. The area to the south of the corridor in this sub-area is predominantly commercial/industrial properties, and again many are within a 50m buffer. Some of the commercial/industrial operations to the south are operating under IPC (Integrated Pollution Control Licence) license including SRCL Ltd southeast of Kylemore Road Bridge (OBC5A) and Henkel Ireland, Thornton's Recycling and Labre Civic Amenity site west of Kylemore Road Bridge (OBC5A). The SEVESO site and associated area relating to Kayoform Woolfsen Ltd. is also located to the south of this sub-area. There are limited biodiversity features identified in the area; however, evidence of invasive plant species has been noted in the vicinity of Inchicore Works, and it is likely more may be found with detailed surveying. Kylemore Park, is a community park servicing the area and is located mid-way along Kylemore Avenue (the latter connects Kylemore Road to Le Fanu Road).

2.9. Utilities

The utilities networks in the area are extensive and contain a significant number of utility providers typical of an urban environment such as this. Service providers with network assets in this area include the following:

- EIR
- ESB Networks
- Virgin Media
- BT Ireland
- Gas Networks Ireland
- Dublin City Council Road Drainage (Storm Water Sewers)
- Dublin City Council / Irish Water (Foul Water Sewers)
- Dublin City Council / Irish Water (Water Supply)
- Dublin City Council Traffic Department (Traffic Signals & Communications)
- Dublin City Council Public Lighting

Data in the form of utility service records have been gathered from all providers in the area. The majority of services are located within the existing street and rail line bridge crossing at Kylemore Road bridge (OBC5A). Hence, where modifications are required to the existing bridge and/or to the road network in the immediate vicinity of the existing structure, impacts on utilities will be inevitable.

The presence of a number of services is also indicated at track level or within the railway corridor. These are limited to possible data cable/fibre optic connections and to disused gas mains. None of these services are indicated as crossing under the tracks in this area. Nevertheless, consideration of the impacts on these services will also be necessary.

A number of key network infrastructure elements for particular utility providers are present and will be challenging to deal with given that only limited-service outage time (if any) will be permissible. DART+ South West aims to minimise disturbance to public by engaging with utility providers to coordinate these works well in advance.

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3. Requirements

3.1. Specific Requirements

- Increase the number of tracks from 2 No. tracks to 4 No. tracks.
- Electrification of 2 No. tracks for the DART+ South West (this Project).
- Provide vertical electrical clearance through existing structures or amend or reconstruct structures to provide the required clearance.
- Maintain functionality of existing roads.
- Passive load capacity provision for LUAS on Kylemore Road Bridge (OBC5A); no geometric passive provision to be provided i.e. not providing the full construction width, nor final finished alignment level above the bridge deck but rather allowing for future adaptability to widen the bridge.
- Passive provision for a potential future new railway station at Kylemore Road Bridge (OBC5A) only. The station is not part of DART+ Programme scope, but the new bridge will consider spatial provision required should the station proceed in the future. The railway corridor will not be designed with spatial provision in mind in order to minimise impact on the public.

3.2. Systems Infrastructure and Integration

In addition to the track and civil infrastructure modifications relating to them DART+ South West Project, there is a requirement to provide Overhead Line Electrification Equipment (OHLE) signalling and telecoms infrastructure.

The electrification system will be similar in style to that currently used on the existing DART network and integrated and compatible across the DART+ Programme. There will be a potential requirement to provide 6 additional power substations along the rail line to provide the requisite power for the network demand. It is envisaged that a standardised approach to electrification will be adopted, but those area-specific interventions will also be required.

The Low Voltage and Telecommunications networks required for Signalling will be 'global systems' and are unlikely to vary significantly between or within the various areas. In order to achieve the necessary capacity enhancements and performance required for the introduction of the new electric multiple unit (EMU) fleet, it will be necessary to upgrade the existing signalling system as well as replacing some of the legacy signalling system. This will include provision of Relocatable Equipment Buildings (REB) where required along the route in order to accommodate signalling equipment and associated power supplies and backup.

Significant upgrades to the existing telecommunications infrastructure will be required to facilitate improvements to the radio-based technologies used on the network and for signalling and communication with the existing and future network control centres.

3.2.1. Electrification System

The OHLE system architecture is being developed by the DART+ West Multi-disciplinary Consultant (MDC). The Dart wide programme will adopt a 1500V Direct Current (DC) OHLE system to provide electrical power to the network's new electric train fleet. The following details of the system are drawn from the draft *Functional*

Requirements Specification (FRS) (MAY-MDC-ELE-DART-SP-E-0001 version 2.0). For a full description of the OHLE system please refer to this document.

It should be noted that all OHLE diagrams in this report are for visual information only. Final dimensions, lengths, heights, and cantilever types are to be defined in the reference design and subsequent design stages of the project.

The OHLE concept comprises a pre-sagged simple (2-wire) auto-tensioned system, supported on galvanised steel support structures.

In 4 No. track areas, Two Track Cantilevers (TTCs) will generally only be placed on the north side of the line, to support OHLE on the northern two tracks. Supporting the OHLE by utilising structures positioned on the south side of the 4 No. tracks is not considered to be a feasible solution due to the loads involved.

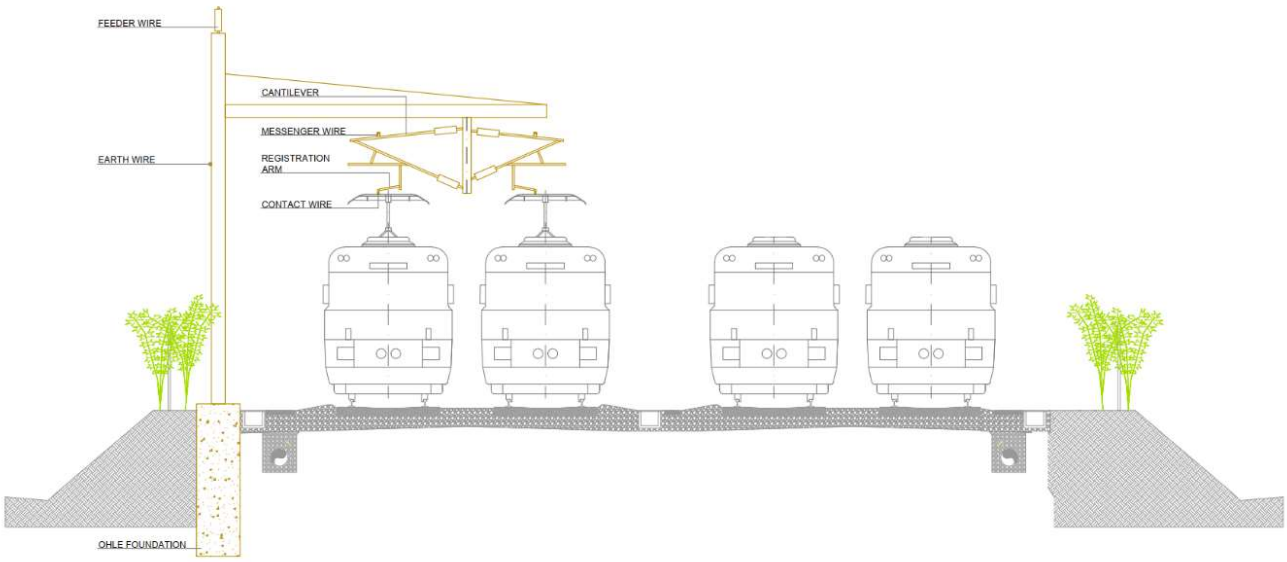

Figure 3-1 Typical OHLE arrangement in four track open route.

Nominal contact wire height is 4.7m, and heights through stations may be slightly higher to achieve minimum protection by clearance distances. Minimum contact wire height without a derogation is 4.4m under all conditions including sag, and it may be necessary at certain bridges to place the contact wire height at 4.2m under all conditions.

Additional feeder cables will be supported from the masts at heights between 6.5m and 8m on each side of the track. An earth wire will also be suspended from the masts.

Maximum tension length is 1600m, and maximum half tension length is 800m. Overlaps will comprise three spans, with spring tensioners used throughout. Midpoint Anchors (MPAs) will generally be of the tie-wire type, although the portal type may be needed in some locations.

At intervals of up to 1500m the OHLE wires will be anchored at an arrangement known as an overlap, and a new set of wires will take over. The anchors provide the mechanical tension that the wires need to perform reliably and safely. In areas of crossovers and junctions, additional wiring will be provided for the extra tracks, and these will also be provided with anchors.

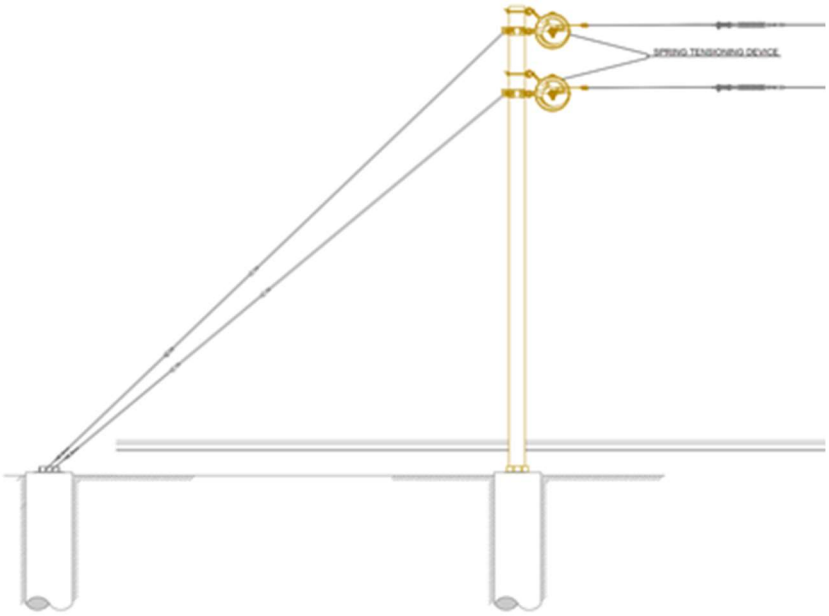

Figure 3-2 Typical anchor structure

The OHLE configuration through the overbridges for each track or civils option is being assessed using a calculator derived from the System Wide OHLE FRS, and a set of configurations agreed with Irish Rail through the Interface Coordination Document (ICD) process. This includes level and graded free running options, as well as level and graded options with elastic bridge arms fitted to the bridge.

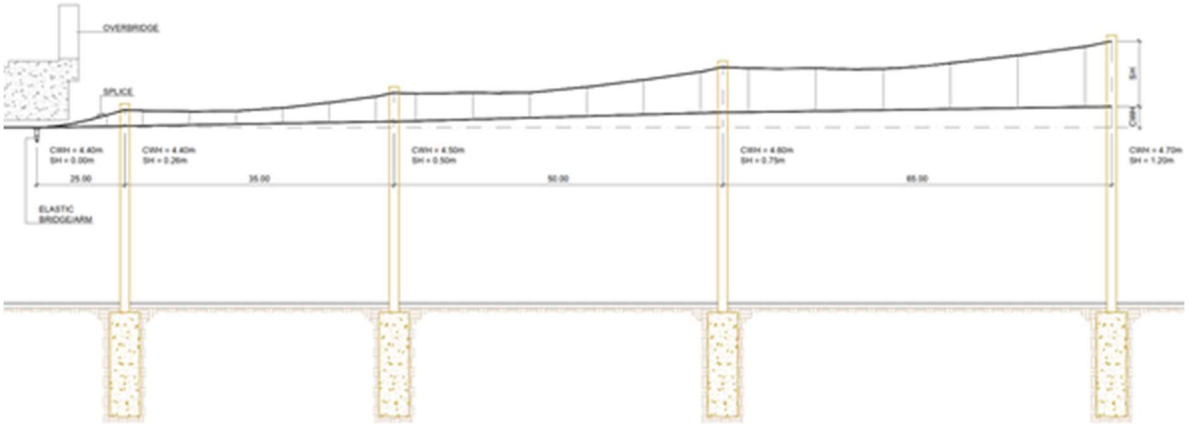

Figure 3-3 Typical arrangement on approach to a low bridge

The OHLE configuration through the tunnels is dependent on the shape, size and construction of the tunnel. Options available include continuation of the flexible OHLE system through the tunnel with a small system height with more frequent supports from the tunnel roof. This arrangement will be hidden within the tunnel.

Occasionally, the size, shape or construction of a tunnel may be restrictive enough that a rigid bar system needs to be used instead of flexible wires. This arrangement will also be hidden within the tunnel, but may extend for a short distance outside the tunnel before reverting to the flexible wire system.

3.2.2. Substations

In order to facilitate the introduction of the new OHLE scheme across the DART+ network a power supply study has been carried out. There is a requirement to provide 6 new substations at the following locations:

- Islandbridge
- Le Fanu
- Park West
- Kishoge
- Adamstown
- Hazelhatch

In principle, there are no proposed substations for this area.

3.3. Design Standards

Please refer to Annex 3.2 for the design standards that will be used for the scheme.

4. Constraints

4.1. Environment

The key environmental constraints relate to the proximity of residential properties to the north and commercial properties to the south of the corridor. The presence of a SEVESO site relating to Kayoform Woolfson, to the south, is also noted; and while having a Lower Tier classification it nevertheless will require additional consideration during the design and construction management phases.

4.2. Roads

The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional 2 No. tracks and electrifying 2 No. tracks.

Several key constraints listed below are deemed to govern the road level changes required in support of providing OHLE clearances at bridges; as well as geometric constraints to mitigating the impact on existing roads, properties; as well as the various road user categories during the construction phase and beyond.

- The structural depth of beam/slab options.
- The depth of feasible track lowering owing to the need to tie-in to the Inchicore Works track layouts, as well the potential geological substrate and ground water levels; to be confirmed with new GI.
- The National Cycleway Manual requires a maximum of 5% gradients for cycleways; restricting how rapidly one can chase levels back to existing road levels.
- TII and DMURS (Design Manual for Urban Roads and Streets) require a maximum of 3% gradient for the first 15m of roads, at junctions. This potentially extends the impact along branch roads, limiting the ability to chase levels back to existing road levels and so avoid impact on plot accesses.
- TII and DMURS stopping site distance compliance.
- The proximity of road junctions and plot accesses to the bridge poses significant constraints on the intention to minimise impact at these locations.
- Kylemore Road and Le Fanu Road cannot be closed concurrently during construction. Le Fanu Road Bridge (OBC7) and approach roads need to be completed to a satisfactory level of safety for before Kylemore Road Bridge (OBC5A) is closed.

4.3. Property

The density and proximity of the residential properties along the north side of the rail corridor between Le Fanu Road Bridge (OBC7) and Kylemore Road Bridge (OBC5A) is a major constraint in terms of achieving the project requirements. Extending the rail corridor to the north is not considered to be a feasible option. Please refer to Property Boundary lines on the Bridge and Permanent Way Options drawings in Appendix C. An Option to replace Kylemore Road Bridge (OBC5A) and achieve the vertical clearance required by only increasing road levels would significantly affect properties on the north side of the rail corridor.

Figure 4-1 Residential and Commercial Property Locations

4.4. Permanent Way

The vertical and horizontal track alignment is constrained by the elements summarised in the **Table 4-1** below.

Table 4-1 Permanent Way Geometrical Constraints

ID	Name	Description
1	Le Fanu Road Bridge (OBC7)	The track alignments through the area must be compatible with proposals for Le Fanu Road bridge (OBC7) due to their proximity. Le Fanu Road Bridge (OBC7) will have an impact on the horizontal and vertical alignment in the area around Kylemore Road Bridge (OBC5A)
2	Kylemore Road Bridge (OBC5A)	A three-platform arrangement is part of the passive provision design requirement. This potential future station would be similar in layout to Adamstown, Clondalkin, Parkwest and Kishoge stations which are also all located along the Cork Mainline. One island platform between Slow and Fast lines and two side platforms for the Up Slow and Fast Line. The maximum gradient through a platform is also normally limited for the safe operation of trains. Maximum track lowering at the bridge has been constrained to 1.0m (approx.) to allow for rail tie-ins to the Inchicore Works. This current design constraint on track lowering is still subject to further confirmation during preliminary design.
3	Inchicore Works	The connection to Inchicore Works must be retained. This will have an impact on the vertical levels on the east side of the area and through Kylemore Road Bridge (OBC5A) itself.
4	Properties	The private properties on the north and on the south of the corridor are constraints.

The main constraint to selecting a horizontal Permanent Way alignment through the area is the available width within the corridor. Additional constraints are the proximity and density of the private Residential and Commercial properties to the north and south side of the corridor, respectively.

4.5. Existing Structures

An initial bridge electrical clearance assessment has been carried out to determine whether an Overhead Line Equipment (OHLE) solution is possible without track lowering or structural intervention. The assessment found that an OHLE solution without track lowering is not possible.

The existing Kylemore Road Bridge (OBC5A) has insufficient span length to accommodate 2 No. additional tracks or adequate vertical clearance to implement track electrification. Proposed interventions include replacement of the bridge or to create openings through the wingwalls on the north and south side to create space for 2 No. additional tracks (1 No. north and 1 No. south).

A new bridge would require an increased vertical clearance (standard Iarnród Éireann requirement of 5.3m for new bridges) unless a derogation is granted. Even a reduced or derogated vertical clearance would require either track lowering and/or increases to road levels to facilitate the greater structural depth needed for the increased span, as well as horizontal clearances from the new edge of outer rails to abutments.

4.6. Geotechnical

Based on the existing information, no onerous soil or groundwater conditions are anticipated in this area. Bedrock is shown to be located at 35.7m AOD, close to Kylemore Road Bridge (OBC5A), and deep foundations for a replacement bridge option would be keyed or socketed into rock. This level is 2.5-3.5m (approx.) below existing track levels at the bridge.

The railway cutting is bounded to the north and south by a significant amount of residential, industrial and commercial properties. The existing railway corridor is not wide enough to accommodate four tracks, and the railway corridor will require widening. To facilitate the widening, new earthworks and retaining walls would be required to provide the necessary horizontal width for the railway and existing masonry and concrete retaining walls will be demolished. These would be required throughout the area on the north and south sides. A partially demolished bridge structure would also be fully demolished.

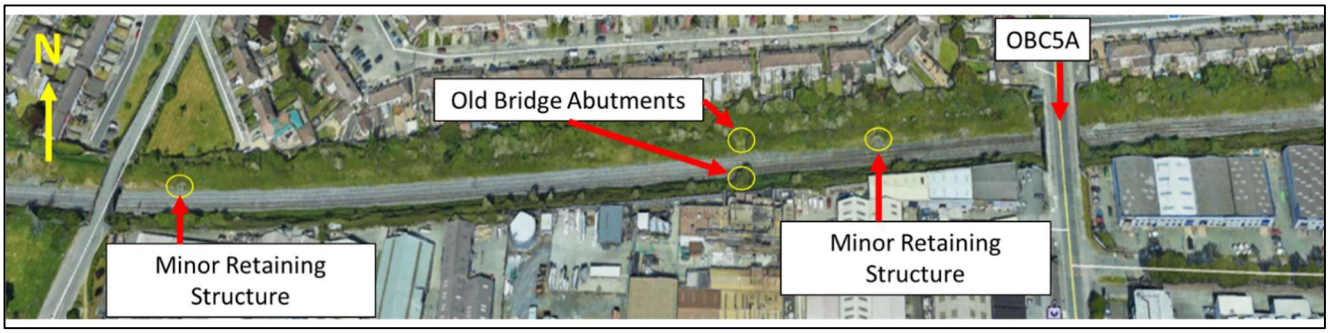

Figure 4-2 Residential and Commercial Property Locations

The use of bored pile walls would be considered as suitable, at this stage of the development, and the design will be progressively revised as ground investigation data becomes available . Existing nearby walls, buildings, structures, and earthworks may require monitoring (e.g. vibration monitoring) during any nearby piling works for new structures to ensure no structural damage or instability is caused.

4.7. Existing Utilities

The significant number of utilities (including gas, electrical, water and fibre telecommunication networks) pose constraints to the area-wide options during both the design and construction phases. As such, their treatment in

the temporary and permanent situations has been carefully considered during the development of options. There are several critical utilities crossing the rail corridor via Kylemore Road Bridge (OBC5A). Irrespective of the Option selected, the services in the existing bridge would need to be maintained or outage durations absolutely minimised. Where utility conflict arises, potential treatments are being discussed with the utility providers.

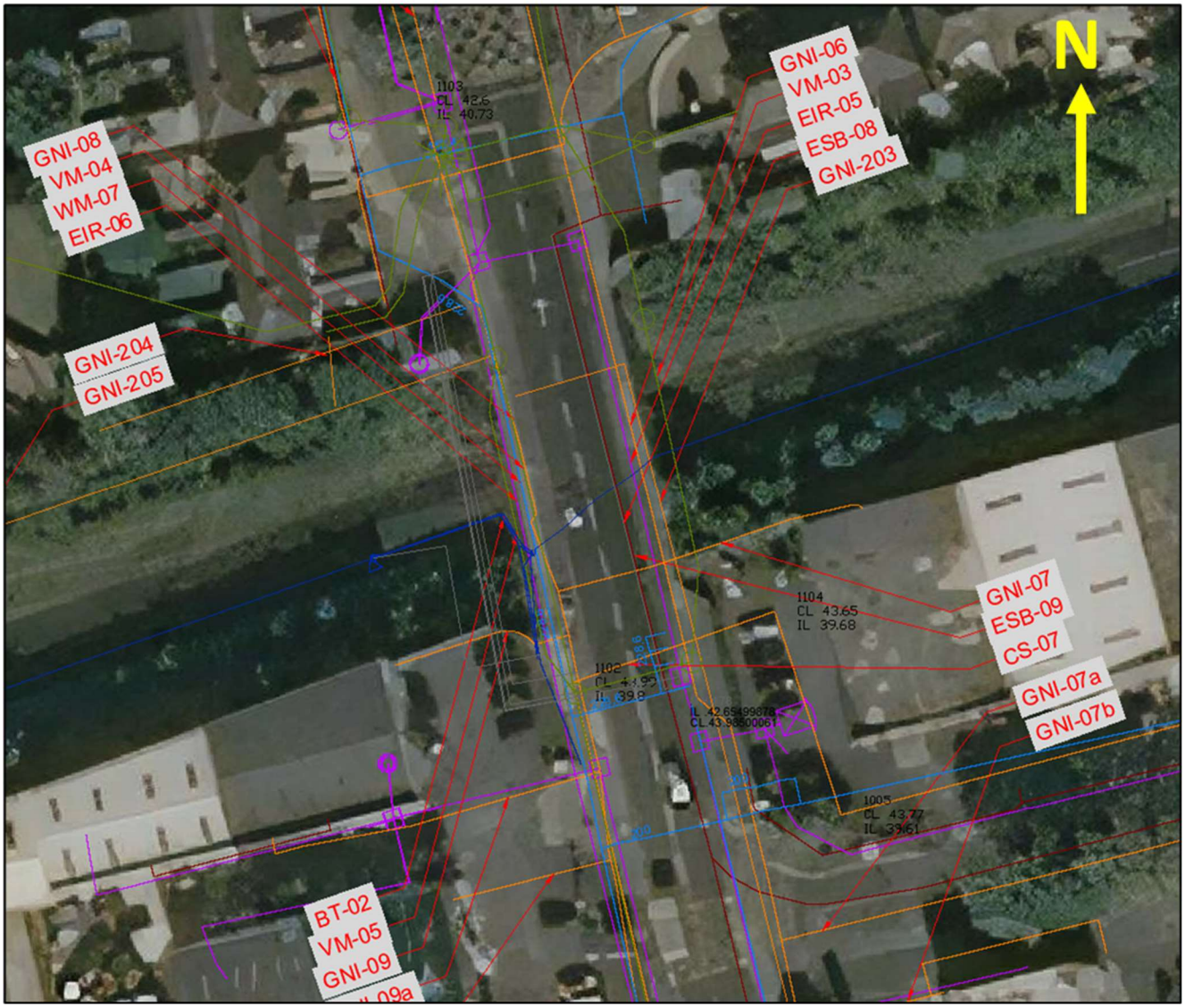

Figure 4-3 Existing Utilities at Kylemore Road Bridge (OBC5A)

5. Options

5.1. Options Summary

The existing Kylemore Road Bridge (OBC5A) structure, which currently has 2 No. tracks beneath it, has insufficient horizontal clearance for 4 No. tracks. The existing vertical clearance beneath Kylemore Road Bridge (OBC5A) is also insufficient for overhead line electrification (OHLE).

The potential intervention options are to either reconstruct the bridge (with sufficient clearances for four-tracking and OHLE) with various combinations of track lowering and/or road level increases or to retain the existing structure (2 No. tracks) and create openings through the existing bridge wingwalls for the additional tracks. Permanent way options comprise realignments to provide standard clearances, both vertically and horizontally for a two span bridge replacement options that could facilitate a 3 No. platform arrangement for a potential future Kylemore Road Station.

A total of 10 No. Options were developed. The Options include a 'Do-Nothing' Option and a 'Do-Minimum' Option.

- A Do-Nothing option means that the design endeavours to achieve the project requirements without any intervention to the existing infrastructure.
- A Do-Minimum option means that the design endeavours to achieve the project requirements with only minor intervention to the existing infrastructure.
- It should be noted that Options 3, 4, 5 & 6 below were developed using the principles of the previous concept baseline provided by IE to the MDC. They are presented herein as a record of Options development but the additional requirement for passive provision of LUAS loading meant that these Options were no longer relevant for further review (These Options relate single structural type).

Design development is by nature an iterative process; and as such the Emerging Preferred Option will be further developed and presented in greater detail at PC2.

A summary of Options is presented in the table below. A detailed description of each Option is included in **Section** Error! Reference source not found. below. Please refer to **Section** Error! Reference source not found. for a description of the permanent way Options for the area (that are compatible with the bridge Options referred to in Error! Reference source not found. below).

Table 5-1 Options Summary

Option	Description
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum	This option endeavours to achieve the four-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal clearance at Kylemore Road Bridge (OBC5A).
Option 2	This option would retain the existing Kylemore Road Bridge (OBC5A) and place 2 No. additional electrified tracks in an opening made at the side (i.e. through wingwalls). New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 3	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. It also included for a structural extension that could be used as part of a potential traffic management solution. The replacement bridge would not provide passive provision for LUAS. Adequate vertical clearance would be achieved by raising the existing road only.

Option	Description
	New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 4	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. It also included for a structural extension that could be used as part of a potential traffic management solution. The replacement bridge would not provide passive provision for LUAS, Adequate vertical clearance would be achieved by lowering the existing tracks only. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 5	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. It also included for a structural extension that could be used as part of a potential traffic management solution. The replacement bridge would not provide passive provision for LUAS, Adequate vertical clearance would be achieved by lowering the existing tracks and raising the existing road. Both the road levels and tracks levels would be adjusted by 50% of the total adjustment required for this Option. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 6	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. It also included for a structural extension that could be used as part of a potential traffic management solution. The replacement bridge would not provide passive provision for LUAS, Adequate vertical clearance would be achieved by lowering the existing tracks and raising the existing road. Both the road levels and tracks levels would be adjusted proportionately, other than by 50% of the total adjustment required for this Option. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 7	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. The replacement bridge would also provide passive provision for LUAS loading. Adequate vertical clearance would be achieved by raising the existing road only. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 8	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. The replacement bridge would also provide passive provision for LUAS loading. Adequate vertical clearance would be achieved by lowering the existing tracks only. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 9	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. The replacement bridge would also provide passive provision for LUAS loading. Adequate vertical clearance would be achieved by lowering the existing tracks and raising the existing road. Both the road levels and tracks levels would be adjusted by 50% of the total adjustment required for this Option. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.
Option 10	This option would replace the existing Kylemore Road Bridge (OBC5A) with a new bridge that has the additional horizontal and vertical clearance required for electrification, four-tracking and passive provision for potential future station platforms under the bridge. The replacement bridge would also provide passive provision for LUAS loading. Adequate vertical clearance would be achieved by lowering the existing tracks and raising the existing road. Both the road levels and tracks levels would be adjusted proportionately, other than by 50%, of the total adjustment required for this Option. New piled walls, new track beds for renewed lines and overhead line equipment throughout the area.

5.2. Options Description

This section describes the Options that have been considered for the area. With the exception of Option 0 (Do-Nothing) and Option 1 (Do-Minimum), there are some design disciplines that have technical features that are common to all Options (e.g. OHLE and Cable & Containment). Similarly, there are technical aspects that have been considered but are determined to have no (or insignificant) bearing on the development or selection of Options (e.g. ground conditions). To remove repetition among the Option descriptions, these issues are addressed at the end of the Option description section. Please refer to **Section 5.4** for the Permanent Way Options.

5.2.1. Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing road or rail infrastructure. The rail corridor would not be widened (inside or outside the Iarnród Éireann property boundary). The horizontal and vertical constraints at Kylemore Road Bridge (OBC5A) would not be resolved. As such, this option would not facilitate the inclusion of the additional 4th track or the installation of an OHLE system. The project requirements would not be achieved.

5.2.2. Option 1: Do-Minimum

This Option seeks to achieve the four-tracking and electrification by means of minor interventions only. A review of the constraints has concluded that there are no minor interventions alone that could achieve the project requirements.

5.2.3. Option 2

Option 2 proposes to create openings in the sides of the existing Kylemore Road Bridge (OBC5A) structure to create space for 2 No. additional tracks (1 No. on each side of the existing tracks). New buried portal structures would be constructed on the north and south approach embankments. The existing bridge would consequently become a 3-span structure.

The existing main span has insufficient vertical clearance for OHLE. The new openings would require additional vertical clearance, relative to the existing tracks, to provide the additional headroom required for the OHLE equipment. The track lowering would also take account of the depth of the roof slabs for the new portals. Retaining walls would be required between the additional tracks and the existing tracks to maintain the difference in levels required.

New retaining walls would be required to remove the existing cutting slopes on the approach and departures from the existing bridge. The new retaining walls would require 4.5m clearance to the edge of the new outer rail locations (or 2.5m derogated with a derailment impact loading design). There is not sufficient room to achieve the derogated clearance requirement given the existing structure dimensions.

The wing walls to the north and south approach embankments are not of sufficient length to achieve the geometrical requirements of this Option.

Structure Analysis:

- As the existing bridge is retained, this option would not provide passive provision for a potential future station nor passive provision for LUAS.

Roads Analysis:

- The impact on roads requires no assessment as the Option is not considered feasible from an operational and track safety perspective not compliant with the brief to provide passive provision for the LUAS loading with adaptability for widening.

Permanent Way Analysis:

- The proposal of having the lines to the north and south electrified while leaving the existing through the bridge, is not feasible from the perspective of the required line designation from north to south of Up Slow DART, Down Slow DART, Up Fast Intercity, Down Fast Intercity.
- Four tracks would be laid in this area doubling the existing 2 No. tracks at the existing Kylemore Road Bridge (OBC5A). The 2 No. central tracks would follow the existing alignment with and 1 No. new track on either side would go through the structure openings. In this solution, the lateral clearance to the existing bridge abutment would not be compliant with the IÉ standards (i.e. 2.5m to the abutments). The connection to Inchicore Works would for this proposal would be complex and require substantial additional 'land-take' south-east of the bridge.

Figure 5-1 Kylemore Road Bridge (OBC5A), north-east wingwall

Figure 5-2 Kylemore Road Bridge (OBC5A), south-east wingwall

5.2.4. Option 3

This Option proposes to replace the existing Kylemore Road Bridge (OBC5A) bridge. The proposed bridge would have a span and height that provides sufficient vertical and horizontal clearance for electrification, four-tracking and passive provision for potential future station platforms at the bridge.

In addition to the bridge reconstruction, the Option also proposed the inclusion of a bridge extension that could be considered for temporary traffic management but only if it could be form part of a potential future Kylemore Road Station. The potential future station, however, is not within the scope of the DART+ South West Project.

The proposed bridge structure would have a total clear span (i.e. clear spans plus pier widths) of 28.25m (approx.), and a total width of 28.5m (approx.), the extra width with respect to the existing bridge structure would allow for the extension referred to above. The bridge deck would be constructed using prestressed beams and an in-situ concrete deck. The horizontal clearance to the abutments and piers would be less than 4.5 m, and therefore they would need to be designed for derailment impact loading. The piers would be formed using discrete columns. Both abutments and piers would be piled.

All vertical clearances would be achieved by road raising only to achieve and acceptable soffit height required for an acceptable minimum OHLE contact wire height of 4.4m, and where possible the preferred contact wire height of 4.7m. This all being subject to the other constraints (referred to in **Section 4**); namely, tie-ins to the Inchicore Works, as well as the potential impact on 3rd party landowners.

Structure Analysis:

- This Option was proposed prior to confirmation being provided by IE that the new Kylemore Road Bridge (OBC5A) proposals should include passive provision for LUAS capacity loading, along with adaptability for future bridge widening.

- Without an approved station and/or LUAS scheme design (neither of which are part of the DART+ Programme) the option presented could not be progressed further for review.

Roads, Utilities and Permanent Way Analysis:

- As the Option could not satisfy baseline requirements, the impacts associated with these aspects of infrastructure construction were no longer considered for review.

5.2.5. Option 4

The Option 4 proposal is the same structurally as Option 3, but the vertical clearance requirements would be achieved by lowering the track levels only unlike Option 3.

All vertical clearances would be achieved by track lowering to achieve and acceptable soffit height required for an acceptable minimum OHLE contact wire height of 4.4m, and where possible the preferred contact wire height of 4.7m. This all being subject to the other constraints relating to tie-ins to the track level at Inchicore Works turn-outs, as well as the potential impact on 3rd party landowners.

Structure Analysis:

- This Option was proposed prior to confirmation being provided by IE that the new Kylemore Road Bridge (OBC5A) proposals should include passive provision for LUAS capacity loading, along with adaptability for future bridge widening.
- Without an approved station and/or LUAS scheme design (neither of which are part of the DART+ Programme) the option presented could not be progressed further for review.

Roads, Utilities and Permanent Way Analysis:

- As the Option could not satisfy baseline requirements, the impacts associated with these aspects of infrastructure construction were no longer considered for review.

5.2.6. Option 5

The Option 5 proposal is also the same structurally as Option 3, but the vertical clearance requirements would be achieved by raising road levels and lowering the tracks levels in equal proportions (50% of the total adjustment required for this Option).

Vertical clearances would be split evenly between road level increases and track lowering to achieve and acceptable soffit height required for an acceptable minimum OHLE contact wire height of 4.4m, and where possible the preferred contact wire height of 4.7m. This all being subject to the other constraints relating to tie-ins to the track level at Inchicore Works turn-outs, as well as the potential impact on 3rd party landowners.

Structure Analysis:

- This Option was proposed prior to confirmation being provided by IE that the new Kylemore Road Bridge (OBC5A) proposals should include passive provision for LUAS capacity loading, along with adaptability for future bridge widening.
- Without an approved station and/or LUAS scheme design (neither of which are part of the DART+ Programme) the option presented could not be progressed further for review.

Roads, Utilities and Permanent Way Analysis:

- As the Option could not satisfy baseline requirements, the impacts associated with these aspects of infrastructure construction were no longer considered for review.

5.2.7. Option 6

Option 6 is the same as Option 3, but unlike option 5 as the vertical clearance requirements would be achieved by raising road levels and lowering the tracks levels in differing proportions (not a 50% sharing of the total adjustment required for this Option.

Vertical clearances would be split evenly between road level increases and track lowering to achieve and acceptable soffit height required for an acceptable minimum OHLE contact wire height of 4.4m, and where possible the preferred contact wire height of 4.7m. This all being subject to the other constraints relating to tie-ins to the track level at Inchicore Works turn-outs, as well as the potential impact on 3rd party landowners.

Structure Analysis:

- This Option was proposed prior to confirmation being provided by IE that the new Kylemore Road Bridge (OBC5A) proposals should include passive provision for LUAS capacity loading, along with adaptability for future bridge widening.
- Without an approved station and/or LUAS scheme design (neither of which are part of the DART+ Programme) the option presented could not be progressed further for review.

Roads, Utilities and Permanent Way Analysis:

- As the Option could not satisfy baseline requirements, the impacts associated with these aspects of infrastructure construction were no longer considered for review.

5.2.8. Option 7

This Option 7 proposes to replace the existing Kylemore Road Bridge (OBC5A) with a new structure that would incorporate passive provision for LUAS loading and the adaptability for potential future extension by others. In addition, the proposed bridge would have a span and height that provides sufficient vertical and horizontal clearance for electrification, four-tracking and passive provision for potential future station (3 No. platform) arrangement under the bridge. All vertical clearance requirements would be achieved by raising the road levels and amending structural depth only.

The proposed bridge solution is a 2-span bridge to facilitate a potential future Kylemore Road Station (3 No. platform arrangement). The overall bridge width would be similar to that of the existing bridge, 17m (approx.) and with a total clear span of 28m (approx.). The deck layout would include a 9.3m wide carriageway with 3.5m wide combined footpath/cycletrack on both sides. The bridge deck would be constructed using prestressed beams and an in-situ concrete deck.

The bridge would be at a skew angle of 6 degrees (approx.). The horizontal clearance to the abutments and piers would be less than 4.5m, and therefore they would need to be designed for derailment impact loading. The piers would have discrete columns. Both abutments and piers would be piled.

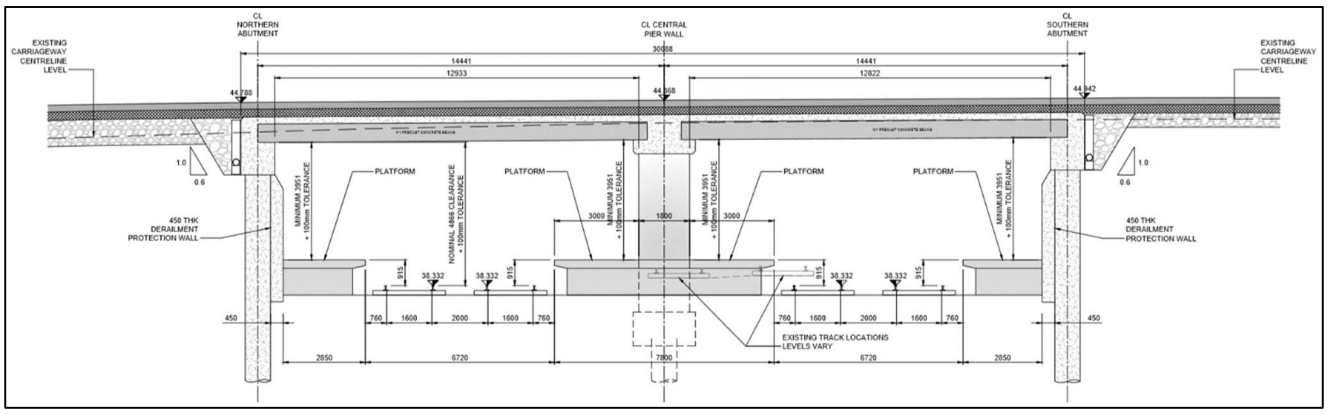

Figure 5-3 Typical 2-span bride section (Potential future platforms shown indicatively)

If a LUAS is deemed a future requirement, the deck could potentially be widened either side and the carriageway and footpath/cycletrack as proposed for DART+ South West (this project) could be modified to accommodate a combined LUAS/Road arrangement.

The Options 8, 9 & 10 below are all proposed have the same bridge superstructure characteristics the difference in the Options is the methodology presented to achieve a minimum acceptable contact wire height clearance of 4.4m (requiring a derogation) or preferably 4.7m (not requiring a derogation).

The Option & proposed that all vertical clearances would be achieved by only raising the road and not amending the track levels.

Roads Analysis:

- It is clear from Drawing, ref: DP-04-23-DWG-CV-TTA-60275, that to achieve the required clearance through only raising the road level at the bridge, with the geometric constraints listed previously, that it would require a significant level of additional level of road layer works construction along the approach roads. The area impacted would extend past the junction with Landen Road, as well as extending along Landen Road itself.
- The Option 7 would require road level raising to an extent that would result in 4-7 (approx.) residential properties in Landen Road losing their driveway accesses permanently. These plots with the likely boundary walls would require conversion to footpath earthworks retaining structures; and accommodate new pedestrian access to the plots via a combination of steps and/or ramps.
- The requirements for roadside retaining walls would also extend 15-40m either side of Kylemore Road (north of its junction with Landen Road; as well as fully restrict access to the commercial plot immediately southwest of the bridge.
- Validation of the potential impact to Landen Road plots requires further topographical survey information, (expected in May 2021) but the impact of this Option is not likely to differ substantially.

Utilities Analysis:

- A substantial increase in the Utility diversion lengths would be required, owing to increased complexity and limiting the ability to carry some advanced works packages. This has potential to increase the duration of the overall road closures. A temporary utilities diversion bridge/s will be required.

Permanent Way Analysis

- This option does not change the existing track levels and as such the additional new tracks levels would be designed to be similar to that of the existing track subject to the required interface with the Inchicore Works.

5.2.9. Option 8

The Option 8 provides the same deck superstructure and carriageway horizontal geometric layout as 7 but the vertical clearance requirements would be achieved by only lowering the track levels and not changing the road levels. The characteristics of the bridge solutions described for Option 7 remain applicable for Option 8.

Roads Analysis:

- The impact on Kylemore Road itself would be limited to an at-grade reinstatement local to the bridge. The footpath and cycle track across the bridge, as well as the first 15m (approx.) of the approaches, would be reconstructed to provide a clearer understanding of the routes for vulnerable users.

Utilities Analysis:

- Many of the wet and dry utility company valves and junction chambers are located either at Landen Road or the Business Park junctions, respectively or at the edge of the proposed new bridge. So while the road works might be isolated to the vicinity of the bridge the diversions are likely to extend to the junctions as a minimum. A temporary utilities diversion bridge/s will still be required.

Permanent Way Analysis

- The track lowering levels are not achievable as track lowering at the bridge has been constrained to 1.0m (approx.) to allow for rail tie-ins to the Inchicore Works. This this is the current design constraint on track lowering but is still subject to further confirmation during detailed design. This

5.2.10. Option 9

The Option 9 provides the same deck superstructure and carriageway horizontal geometric layout as Options 7 but with this Option the vertical clearance requirements would be achieved by raising the road levels and lowering the track levels. Both the road levels and tracks levels would be adjusted by 50% of the total adjustment required for this Option; in order to achieve an approved minimum contact wire clearance of 4.4m (requiring a derogation) or the preferred contact wire height of 4.7m (not requiring a derogation from standards).

The bridge deck would be constructed using prestressed beams and an in-situ concrete deck. The characteristics of the bridge solutions described for Option 7 remain applicable for Option 9. The final solution to achieve an approved vertical clearance beneath the structure will be impacted by the results of the final GI investigation and the preliminary design track alignment.

Roads Analysis.

- It should be noted the Option 9 carriageway horizontal and/or vertical geometrical requirements of a combined LUAS/road system on the approach roads as a potential future LUAS design it is not part of the DART+ South West design brief.
- Option 9 proposed road levels are very similar to Option 10 levels.
- The Option strategy is to limit the road raising to a level that avoids permanently impacting 3rd party property accesses without applying for a derogation from road design standards.

- An additional level of full road layer works construction will be required up to and including Landen Road junction; with a range of road raising between 0.5 and 0.95m depending on the track design levels achievable.

Utilities Analysis:

- Refer to the General utilities section comments.

Permanent Way Analysis:

- The current Option falls within the maximum track lowering constraint of 1m (approx.), however the feasibility of this is still subject to preliminary design confirmation of the track alignment as well as the geotechnical investigation; the final solution will be within a track lowering range of between 0.5 and 0.95m.

5.2.11. Option 10

The Option 10 provides the same deck superstructure and carriageway horizontal geometric layout as Options 7 but the vertical clearance requirements would be achieved by raising the road levels and lowering the track levels. Both the road levels and tracks levels would be adjusted proportionately, other than by 50% of the total adjustment required for this Option; in order to achieve an approved minimum contact wire clearance of 4.4m (requiring a derogation) or the preferred contact wire height of 4.7m (not requiring a derogation from standards).

The characteristics of the bridge solution described for Option 7 remains applicable for Option 10. The bridge deck would be constructed using prestressed beams and an in-situ concrete deck. The final solution to achieve an approved vertical clearance beneath the structure will be impacted by the results of the final GI investigation and the preliminary design track alignment.

Roads Analysis.

- The Option 9 road horizontal and/or vertical geometrical requirements of a combined LUAS/road system on the approach roads to accommodate a potential future LUAS design it is not part of the DART+ South West design brief.
- As with Option 9 the strategy is to limit the road raising to a level that avoids permanently impacting 3rd party property accesses without applying for a derogation from road design standards.
- Option 10 proposed road levels are very similar to Option 9 levels but has a greater range of adaptability.
- An additional level of full road layer works construction will be required up to and including Landen Road junction; with a range of road raising between 0.5 and 0.95m depending on the track design levels achievable during preliminary design development

Utilities Analysis:

- Refer to the General utilities section comments.

Permanent Way Analysis:

- The current Option falls within the maximum track lowering constraint of 1m (approx.). The final solution will be within a track lowering range of between 0.5 and 0.95m however the feasibility of this is still subject to preliminary design confirmation of the track alignment as well as the results of further geotechnical investigations;

5.3. OHLE Arrangement – All Do-Something Options

This bridge does not have sufficient vertical clearance in its existing configuration to be electrified with OHLE; therefore, bridge Options 0 and 1 are not feasible.

In all the bridge Options above, a 3.5m clearance between the pantograph and standing surface of the potential future Kylemore Station platforms cannot be achieved but a 3m clearance can be achieved. A risk assessment would be required.

5.4. Permanent Way

A single Permanent Way option has been developed, with the optimum horizontal footprint to achieve the project requirement of spacing the tracks such that the interval between the pair of Slow lines on the north side and the Fast lines on the south could, in future, accommodate the construction of Kylemore Road Station. This passive provision would enable an island platform in the wide-way (ten-foot) between the Slow and Fast lines, with an additional single facing platform to the north and south extremities – servicing the Up Slow and Down Fast lines respectively. This design option complies with IÉ design standards and fulfils the speed requirements of 160km/h on the Fast lines and 110km/h on the Slow lines.

Vertically, the track alignment achieves the necessary lowering required to ensure electrical clearance at the overline structures, Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) respectively, with all lines on a gradient of 0.7% in this vicinity, slightly flatter than the existing 0.9%.

Note that in the event of Kylemore Road Station being constructed then some intervention to the P&C would be necessary – i.e. relocating the Down Slow-Up Fast crossover centred at Ch. 260+250, along with possible track level adjustments to achieve a compliant platform track gradient.

Table 5-2 Permanent Way Options

ID	Name	Description
Perway Option 1	Three Platform Configuration for potential future Kylemore Road Station (passive provision for platforms)	The horizontal track alignment would be compatible with the passive provision required for a possible alternative platform configuration for potential future Kylemore Road Station. This Perway Option is compatible with the single span bridge reconstruction option at Le Fanu Road Bridge (OBC7). The original concept design vertical profile shows a track lowering through Kylemore Road Bridge (OBC5A) of 0.8m (approx.). The vertical alignment can be adjusted to comply with the required vertical clearances for electrification.

5.5. Geotechnical (All Do-Something Options)

All engineering options (excluding those associated with bridge Option 0 and Option 1) would require some form of four-tracking and electrification and would require a detailed geotechnical design for the following elements:

- Earthworks and track bed formation design for new tracks
- Overhead Line Equipment foundation (preliminary) design

For Options 4 through to 6 and Options 8 through to 10, in addition to the above, track lowering is proposed to achieve vertical clearances and therefore track bed design to facilitate track lowering would be required. Bedrock has been indicated at 34.5m to 35.7m AOD (approx.), in the vicinity of Kylemore Road Bridge (OBC5A). This potentially indicates rock at a depth of 2.5-3.5m (approx.) below track level. Options that propose significant track

lowering close to anticipated bedrock levels are less desirable Options. Where insufficient clearance to bedrock is present for traditional track bed formation, a slab track may be required.

The impacts of track lowering on existing earthworks and minor retaining wall assets outside the immediate vicinity of Kylemore Road Bridge (OBC5A) will be confirmed by ground investigation as will any requirements for follow on remedial works or new replacement structures.

For Options 3 through to Option 10, any new bridge or existing bridge modifications would also require detailed geotechnical design.

The proposed structural elements that fall into this category include:

- New bridge abutment piles and bridge wingwall modifications.
- New retaining wall designs along the northern and southern boundary of the railway. The retaining walls would be required to provide the necessary horizontal width for the four-tracking. The proposed wall height (north and south) would be 4m to 5m (approx.). The retaining wall heights local to Kylemore Road Bridge (OBC5A) would be 7m to 9m in height where Options require the greatest level of track lowering. Bored pile walls are considered to be suitable at this stage of development.

Figure 5-4 Proposed Retaining Wall Locations

- Existing nearby walls, buildings, structures and earthworks may require monitoring (e.g. vibration monitoring) during any nearby piling works for new structures to ensure no structural damage or instability is caused.
- For road level raising in Options 3, 5 to 7, 9 and 10, the actual amount of raising will be limited by the surrounding roads and driveway access locations as well as levels. Additional minor retaining or earthwork structures may be required at road level surrounding Kylemore Road Bridge (OBC5A) to facilitate the proposed road level raising options.

5.6. Roads (All Intervention Options)

The auxiliary/residential plots service road junction immediately north-west of the bridge would need to be closed for all feasible options passing the sifting process due to the requirement for a retaining wall to retain the carriageway for a temporary bridge transition road but also in the permanent state to provide a new bespoke turning head for what would become be a cul-de-sac.

The constraints, as listed in the **Section 4** of this report, were used in assessing the impact of Options 3 through to Option 10. Refer to drawing DP-04-23-DWG-CV-TTA-60275 for a comparative representation of impact in plan and profile based on increasing the road levels to achieve an acceptable contact wire clearance for a number of scenarios represented by the Options. Drawing DP-04-23-DWG-CV-TTA-60276 serves to indicatively represent the area that could potentially be impacted by the Emerging Preferred Option road interventions. None of the

bridge (and associated approach road) Options consider the horizontal and/or vertical geometrical layouts required for a potential future LUAS line; nor the associated potential future impact on 3rd party properties or existing infrastructure associated with a potential future LUAS line being located along Kylemore Road.

5.7. Cable and Containments (All Do-Something Options)

With the exception of Option 0, all Options will require the relocation of a variety of service cables, utilities and containments throughout the area. The existing maintenance access point at the northeast side of Kylemore Road Bridge (OBC5A) would be relocated to a new location where safe access can be provided.

6. Options Selection Process

6.1. Options Selection Process

A clearly defined appraisal methodology has been used in the selection of the Emerging Preferred Option for the Project. Consistent with other NTA projects, it is based on 'Guidelines on a Common Appraisal Framework for Transport Projects and Programmes' (CAF) published by the Department of Transport, Tourism, and Sport (DTTAS), March 2016 (updated 2020) and informed by TII's Project Management Guidelines (TII PMG 2019). The Option Selection Process involves a three stage approach as summarised below:

- Stage 1 Preliminary Assessment (Sifting)
- Stage 2 Multi Criteria Analysis (MCA)
- Stage 3 Emerging Preferred Option

The starting principle of the optioneering process and a focus of the Project Team has been to reduce the potential impacts on the surrounding environs by accommodating necessary works and interventions within the existing rail corridor, where practicable. However, it is acknowledged that as the Cork Mainline is an existing operational rail line operating in a pre-defined corridor, the options to accommodate the necessary works at some locations along the route are limited due to spatial constraints.

6.2. Stage 1 Preliminary Assessment (Sifting)

The Stage 1: Preliminary Assessment (Sifting) involves an initial assessment of a long list of options, each of which are assessed against Engineering, Economics and Environmental criteria.

The assessment is based on whether an option meets the Project Objectives / Requirements and whether the option is technically feasible. All feasible options are brought forward to the second stage of the assessment process (MCA) to be explored in greater detail.

This section under consideration is 575m (approx.) long and extends from 10m east of Le Fanu Road Bridge (OBC7) to 50m west of 700B (points), east of Kylemore Road Bridge (OBC5A). A total of 10 No. Options were initially developed for this area.

The options assessed, ranged from a 'Do-Nothing' Option, Do-Minimum' Option to a range of 'Do-Something' Options, each of the options were assessed to determine if they were feasible and met the Project Objectives / Requirements.

The 'Do-Something' Options in this area involve the widening of the existing rail corridor to accommodate the required four tracks. Widening of the rail corridor is proposed on the north side of the existing tracks to minimise impact on the private residential and commercial properties located on the southern side of the existing rail corridor. Existing structures in this area were analysed to determine if they could accommodate the additional tracks and installation of the new Overhead Line Electrification (OHLE) system. The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional 2 No. tracks and electrifying 2 No. tracks in this area.

6.3. Preliminary Assessment (Sifting)

Table 6-1 Preliminary Assessment (Sifting)

Option	Requirements		Description
0	**Engineering**	Constructability	Not applicable. No intervention proposed.
		Geometrical fitness for intervention	Not applicable. No intervention proposed.
		Safety	Not applicable. No intervention proposed.
		four-tracking Park West-Heuston	FAIL. No intervention proposed. four-tracking is not achieved.
		Electrification of DART+ tracks	FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved.
		Vertical electrical clearance in structures	FAIL. No intervention proposed. Vertical electrical clearance at structures not achieved.
		Bridge Design Standards	Not applicable. No intervention proposed.
		Keep current functionality of roads	PASS. No intervention proposed.
		Passive provision for LUAS loading only	FAIL. No intervention proposed. This option does not achieve passive provision for LUAS loading.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
1	**Engineering**	Constructability	PASS. Minor interventions to the rail corridor are possible.
		Geometrical fitness for intervention	PASS. Minor interventions without geometrical fitness concerns are possible.
		Safety	PASS. Minor interventions that pose no safety concerns are possible.
		four-tracking Park West-Heuston	FAIL. Minor interventions only cannot achieve four-tracking.
		Electrification of DART+ tracks	FAIL. Minor interventions only cannot achieve electrification of the DART+ tracks.
		Vertical electrical clearance in structures	FAIL. Minor interventions only cannot achieve vertical electrical clearance requirements at structures.
		Bridge Design Standards	PASS. Minor interventions to the rail corridor in accordance with standards are possible.
		Keep current functionality of roads	PASS. Minor interventions to rail corridor that do not affect road functionality are possible.
		Passive provision for LUAS loading only	FAIL. Minor interventions. This option does not achieve passive provision for LUAS loading.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
2	**Engineering**	Constructability	FAIL. This option is not feasible due to the geometry of the existing structure and design standard requirements.
		Geometrical fitness for intervention	FAIL. This option does not permit a feasible Perway design in accordance with design standards.
		Safety	FAIL. Minimum requirements for (derogated) horizontal clearances to structures would not be achieved.
		four-tracking Park West-Heuston	PASS. This option would achieve four-tracking (but is not constructible).
		Electrification of DART+ tracks	PASS. This option would achieve electrification of DART+ tracks (but is not constructible).

Option	Requirements		Description
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (but is not constructible).
		Bridge Design Standards	FAIL. Option would not be in accordance with design standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
		Passive provision for LUAS loading only	FAIL. This option does not achieve passive provision for LUAS loading.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
3		Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. There is no track lowering required.
		Safety	PASS. No issues.
	Engineering	four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	FAIL. This would require a minimum road level increase of 1.14m. This amount of road level increase at Kylemore Road Bridge (OBC5A) would require extensive works to the approach roads. It is not a feasible solution in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	FAIL. This option does not achieve passive provision for LUAS loading.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
4	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	FAIL. This would require a minimum track lowering of 1.14m. This amount of track lowering is considered not feasible from a technical perspective in terms of track gradients and longitudinal drainage.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
		Passive provision for LUAS loading only	FAIL. This option does not achieve passive provision for LUAS.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible

Option	Requirements		Description
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
5	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a minimum track lowering of 0.57m. This amount of track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a minimum road level increase of 0.57m. This amount of road level increase is considered feasible in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	FAIL. This option does not achieve passive provision for LUAS.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
6	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a minimum track lowering of 0.87m. This amount of track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a minimum road level increase of 0.52m. This amount of road level increase is considered feasible in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	FAIL. This option does not achieve passive provision for LUAS.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**

Option	Requirements		Description
7	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. There is no track lowering required.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	FAIL. This would require a minimum road level increase of 1.29m. This amount of road level increase at Kylemore Road Bridge (OBC5A) would require extensive works to the approach roads and impact on property accesses. It is not a feasible solution in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	PASS. This option achieves passive provision for LUAS loading only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
8	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	FAIL. This would require a minimum track lowering of 1.29m. This amount of track lowering is considered not feasible from a technical perspective in terms of track gradients and longitudinal drainage.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. Current road functionality maintained.
		Passive provision for LUAS loading only	PASS. This option achieves passive provision for LUAS loading only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
9	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a track lowering of 0.65m. This amount of track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.

Option	Requirements		Description
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a road level increase of 0.65m. This amount of road level increase is considered feasible in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	PASS. This option achieves passive provision for LUAS loading only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**
10	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This would require a track lowering of 0.60m. This amount of track lowering is difficult to achieve from a technical perspective in terms of track gradients and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		four-tracking Park West-Heuston	PASS. This option achieves the four-tracking.
		Electrification of DART+ tracks	PASS. This option achieves the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option achieves electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Option is in accordance with derogated standards.
		Keep current functionality of roads	PASS. This would require a road level increase of 1.06m. This amount of road level increase is considered feasible in terms of maintaining the functionality of roads.
		Passive provision for LUAS loading only	PASS. This option achieves passive provision for LUAS loading only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**

6.4. Summary of Sift Process Results

A total of 10 No. Options were developed for the area. Following the assessment completed as part of the Sifting Process, as shown in **Table 6-2** below, a total of 2 No. Options were shortlisted and progressed to Stage 2 (MCA) of the assessment process.

Table 6-2 Summary of Sift Process Results

Main Option	Sifting Process Result
Option 0: Do Nothing	FAIL
Option 1: Do Minimum	FAIL
Option 2	FAIL
Option 3	FAIL
Option 4	FAIL
Option 5	FAIL
Option 6	FAIL
Option 7	FAIL
Option 8	FAIL
Option 9	PASS
Option 10	PASS

The following options did not meet the necessary Engineering Feasibility and Project Requirements and were not brought forward to Stage 2 (MCA) of the assessment process:

- **Option 0** - The Do-Nothing Option proposes no changes to the existing road or rail infrastructure, as such, this option would not facilitate the inclusion of the required 4 No. tracks or the installation of the OHLE system. The project requirements would not be achieved as such this option was not brought forward.
- **Option 1** - This Option seeks to achieve the four-tracking and electrification by means of minor interventions only. Due to the constraints in this area, minor interventions would not be sufficient to achieve the project requirements, as such this option was not brought forward.
- **Options 3, 4, 5 & 6** - These Options were developed using the principles of the previous concept baseline provided by IE to the MDC. They are presented herein as a record of Options development but once confirmation of the requirement for passive provision of LUAS loading was received, these Options which all relate to a single structural Type were no longer relevant for further review.
- **Option 7** - This option involves the replacement of Kylemore Road Bridge (OBC5A) to provide the same carriageway cross-sectional widths as the existing structure. This structure would be capable of withstanding the dynamic and static loading tolerance of a potential future LUAS line; in addition, . the structure would allow for widening, by others. The bridge structure is to provide passive space provision for potential future station platforms and be of a span and provide clearances that limit major works to both bridge, track and road local itself. It would require the road level to be increased by a minimum of 1.3m but with no track lowering. This option was not brought forward because the road raising level would impact the ability for 3-7 residential units permanently from retaining vehicular access to their plots. It would further impact the vehicular access to the ESB substation.
- **Option 8** - This Option is the same structurally as Option 7. However, it would require track lowering by a minimum of 1.3m but with no road raising. This option was not brought forward because the track lowering level cannot be achieved while at the same time providing connectivity to Inchicore works sidings. Furthermore, it would require a low point for pumped track storm water drainage.

The following options met the necessary Engineering Feasibility and Project Requirements and were brought forward to Stage 2 (MCA) for detailed assessment:

Options 9 and 10 propose to replace the existing Kylemore Road Bridge (OBC5A). The proposed bridge would have a span and height that provides sufficient vertical and horizontal clearance for electrification, four-tracking and passive provision for potential future station platforms. The new structure would also incorporate passive provision for LUAS loading over the bridge but the impact on the geometric alignment of the approach roads associated with a potential future LUAS was not part of the brief. Vertical clearance requirements would be achieved by a combination of track lowering and increases to road levels.

The difference between the two options lies on the methodology used for adjusting the road and track levels along with structural changes to achieve the space provision requirements for the required 3 platform arrangement:

- To achieve the vertical clearance beneath the structure, Option 9 proposes to split the additional vertical clearance needed between road level increases (50%) and track lowering (50%).
- To achieve the vertical clearance beneath the structure, Option 10 proposes to increase the road level at the bridge to the level indicated as the top of LUAS slab-track level used for the now-defunct KRP2 project and then lower the track levels as needed to achieve the additional required vertical clearance. This is considered the maximum level achievable without permanently impacting the ability to provide vehicular access to some residential properties in Landen Road.

After completing the Stage 1 Preliminary Assessment (Sifting) it was noted that there was a distinct choice in routing and/or spatial variation in the options for around Inchicore and South Circular Road, which would lend themselves well to the MCA process. However, in respect of this area of Le Fanu Road Bridge (OBC7) the spatial difference in the feasible options was much less clear. In this case, only two feasible options progressed through the Stage 1 Preliminary Assessment (Sifting) process and the differences between the options were focused on technical design matters.

Notwithstanding this, the options were reviewed by a range of specialists undertaking the Stage 2: MCA. The observations of the findings of the Stage 1 Preliminary Assessment (Sifting) for this Kylemore Road Bridge (OBC5A), were confirmed when the specialists could not discern a noticeable difference between the two feasible options across a wide range of sub-criteria and assessed the two options as ‘comparable / neutral’.

In order to streamline and simplify the reporting of results, it was considered appropriate at this stage (i.e., after the Stage 2: MCA process), to combine the two feasible options at this location into a single option which would be the Emerging Preferred Option. The detailed technical design differences between the options remaining a potential design iteration and /or comparator to be further explored through the future design process.

6.5. Stage 2: Multi-Criteria Analysis (MCA)

Stage 2 Multi-Criteria Analysis (MCA) comprises a detailed multi-disciplinary comparative analysis of those options which passed through Stage 1: Preliminary Assessment (Shifting). The options are assessed against the criteria of Economy, Safety, Environment, Accessibility and Social Inclusion, Integration and Physical Activity in line with the criteria required for multi-criteria analysis under the Department of Transport, Tourism and Sport (DTTAS), Common Appraisal Framework (CAF) for Transport Project and Programmes (March 2016).

The assessment compares the options, identifying and summarising the comparative merits and disadvantages of each alternative under all applicable criteria and sub-criteria leading to an Emerging Preferred Option.

Relevant considerations include:

- This is a comparative analysis between the various options, not an impact assessment of each option. The impact from the Emerging Preferred Option will be assessed in the Environmental Impact Assessment Report in the next phase of the development.
- Not all sub-criteria and qualitative and/or quantitative indices may be relevant in every case.
- For each option there are potential design variations. In due course design variations will be subject to detailed technical analysis (in respect of the Emerging Preferred Option).
- For each option, an indicative envelope was identified for permanent and temporary works, property and/or land take; a worst-case scenario was considered. Detailed design, technical and construction related solutions will seek to minimise land take in respect of the Emerging Preferred Option.
- The envelope around each Option was used to spatially represent environmental constraints within / proximate to the options.

The options which were brought forward from the Preliminary Screening were developed further to facilitate the more detailed Stage 2 Multi Criteria Analysis. General arrangement drawings were developed for all options, focusing on key design aspects – bridges, roads, and permanent way.

These arrangement drawings were overlain to identify an overall spatial envelope for each option identifying the likely extent of permanent and temporary works required. The spatial envelope and GIS software was used to run queries in relation to environmental and other data sets to assist the specialists in undertaking the Stage 2: Multi-Criteria Analysis (MCA) (also refer to Technical Appendices Volume 2.1 ‘Environmental Constraints Reporting’ for details of

The MCA Process involved assessing the performance of each option against relevant quantitative and qualitative indicators, the assessment was carried out at dedicated MCA workshops by a multi-disciplinary team including commercial, technical, safety and environmental specialists.

Presented in a matrix format, each specialist included a commentary of his/her analysis for each option. They then compared the options relative to each other based on whether an option had a ‘slight’ or ‘significant’ advantage or disadvantage over other options or whether all options were ‘comparable / neutral’. This basis of comparison is consistent with the NTA Guidelines which use the following five-point ranking scale when comparing options against each other for comparative analysis.

Table 6-3 Comparison Criteria

Comparison Criteria Legend
Significant Comparative Disadvantage over the Other Option
Slight Comparative Disadvantage over the Other Option
Comparable to the Other Option / Neutral
Slight Comparative Advantage over the Other Option
Significant Comparative Advantage over the Other Option

6.6. Multi-Criteria Analysis Summary

Table 6-4 shows the summary findings of the comparative assessment undertaken during the Stage 2 MCA, the detailed matrix is provided in Appendix B.

Table 6-4 MCA Summary

CAF Parameters	Option 5 Assessment	Option 6 Assessment
1. Economy	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
2. Integration	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
3. Environment	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
4. Accessibility and Social Inclusion	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
5. Safety	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
6. Physical Activity	Comparable to the Other Option / Neutral	Comparable to the Other Option / Neutral
Conclusion	**Comparable to the Other Option / Neutral**	**Comparable to Other Option / Neutral**

Economy:
In terms of the Economic criteria, there is no comparative advantage or disadvantage between both options.

Integration:

In terms of the Integration criteria, there is no comparative advantage or disadvantage between both options. Neither Option 9 nor 10 allow for phased construction to allow for uninterrupted use of the bridges; and both would require temporary traffic diversions resulting from the need to close bridge and immediate approach roads.
In terms of Integration, both options are identified as comparative.

Environment:

In terms of the Environmental criteria, there is no comparative advantage or disadvantage between both options.
In terms of Environment, both options are identified as comparative.

Accessibility and Social Inclusion:

In terms of Accessibility and Social Inclusion, there is no comparative advantage or disadvantage between the options.
In terms of Accessibility and Social Inclusion, both options are identified as comparative.

Safety:

In terms of Safety, there is no comparative advantage or disadvantage between both options.
In terms of Safety, both options are identified as comparative.

Physical Activity:

In terms of Physical Activity, there is no comparative advantage or disadvantage between both options. ***In terms of Physical Activity, both options are identified as comparative.***

6.7. Emerging Preferred Option

A total of 10 No. Options were initially developed for this area, following the selection process, Option 10 has been identified as the Emerging Preferred Option for this area with Option 9 being considered a design iteration of Option 10 for reasons outlined above. Drawings DE-04-23-DWG-ENG-ST-TTA-60891 to 60893 identify the representative bridge for Option 9.

There were significant challenges and constraints on the options available to achieve the project requirements in this area. Primarily these were the existing junctions and plot accesses close to the overbridge (north and south). The rail corridor is primarily in cutting, the rail level is below the surrounding ground level, which imposed further constraints in terms of the track requirements.

The Emerging Preferred Option for Kylemore Road Bridge (OBC5A) would replace the existing bridge with one having a longer span, to facilitate the additional track width. The new bridge structure would also incorporate passive provision for LUAS loading over the bridge. To overcome the lack of height available for the electrification infrastructure, the road level would be raised in combination with lowering the rail track.

Retaining walls would be required to the north and south of the corridor to allow the widening of the corridor while minimising the impact on the adjacent properties. The raising of the road level will also mean that retaining walls would be required along the road to the north and south of the railway. The 2 No. slow tracks and 2 No. fast tracks will be between 0.65m to 1.0m lower than the existing track levels at the location of Kylemore Road Bridge (OBC5A). In terms of permanent way, this Option is on the limits of achievable track gradients to tie into Inchicore works, located east of the Kylemore Road Bridge (OBC5A). A 2-span symmetrical bridge would be considered

the only viable option due to track lowering to the depths required for a single span bridge being unachievable; with the latter requiring a substantially deeper beam depth

In terms of utility diversions there would be no substantial difference between this Emerging Preferred Option and the other Options owing to the nature of the road raising that will occur to improve the geometrics and provide the necessary OHLE clearances.

Signalling, Telecommunications and Low Voltage cable containments would be moved to new positions. OHLE masts would be installed along the north side of the rail corridor. OHLE equipment would be fitted to the new Kylemore Road Bridge (OBC5A) to allow for continuous electrification through the structure.

The opportunities for allowing uninterrupted flow of public vehicular access over the bridge during construction of the bridge and approach roads is not possible or at best limited. The entire bridge and its approaches require closure to raise the road and reconstruct the new bridge. This Option would provide the optimum solution in terms of minimising traffic disruption. The aim would be to formally divert traffic to Le Fanu Road Bridge (OBC7) via Kylemore Park North (northbound) and via Kylemore Avenue and Ballyfermot Roads (southbound), LDVs and HGVs respectively for the latter, in order to cross over the rail corridor during the intervention.

The Emerging Preferred Option is also considered the optimum solution in terms of minimising impacts on third party property owners. Based on the level of information and design available at this time for Public Consultation No. 1, the extent of permanent works is not envisaged to interfere with third party residential or commercial property rights. There may be temporary interference of property rights during construction along the rail corridor and around the bridge works however technical and construction related solutions will seek to minimise these. Construction requirements (including potential temporary interference of property rights) and methodologies will be presented at Public Consultation No. 2.

Appendix A – Sifting Process Backup

Appendix B – MCA Process Backup

Appendix C – Supporting Drawings

The following drawings accompany the Technical Report for this area:

Bridge Drawings

DE-04-23-DWG-ST-TTA-60891

DE-04-23-DWG-ST-TTA-60892

DE-04-23-DWG-ST-TTA-60893

Roads Drawings

DP-04-23-DWG-CV-TTA-60275

DP-04-23-DWG-CV-TTA-60276

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-60750

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