DART+ South West

Volume 3C – Technical Optioneering Report – Le Fanu to Kylemore Bridge

Iarnród Éireann

November 2021

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Glossary of Terms

Reference	Description
ABP	An Bord Pleanála
ACA	Architectural Conservation Area
AOD	Above Ordnance Datum
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
CIÉ	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
CSS	Construction Support Site, Interchangeable with Construction Compound
CTC	Central Traffic Control

Reference	Description
Cutting	A railway in cutting means the rail level is below the surrounding ground level.
D&B	Design & Build (contractor)
DART	Dublin Area Rapid Transit (IÉ's Electrified Network)
DART+	DART Expansion Programme
DeBo	Designated Body
DC	Direct Current, 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.
PC	Public Consultation

Reference	Description
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
STC	Single Track Cantilever
TII	Transport Infrastructure Ireland

Reference	Description
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)
TTC	Two Track Cantilever
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 the Report

The purpose of this report is to provide technical input to the Option Selection Report to inform Public Consultation No.2 (PC2). This report shows the options considered as part of the project development and why the preferred option for PC2 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 (OHLE)
- Environment
- Highways and Transportation
- Geotechnical
- Substations
- Construction Compounds

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 leading to the identification of the Preferred Option, including the Sifting process and the Multi-Criteria Analysis process.
- A summary of the feedback received from the first public consultation which was held in May and June 2021.
- An update on the design development
- An overview of the proposed construction methodology and requirements in terms of construction compounds.

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. It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

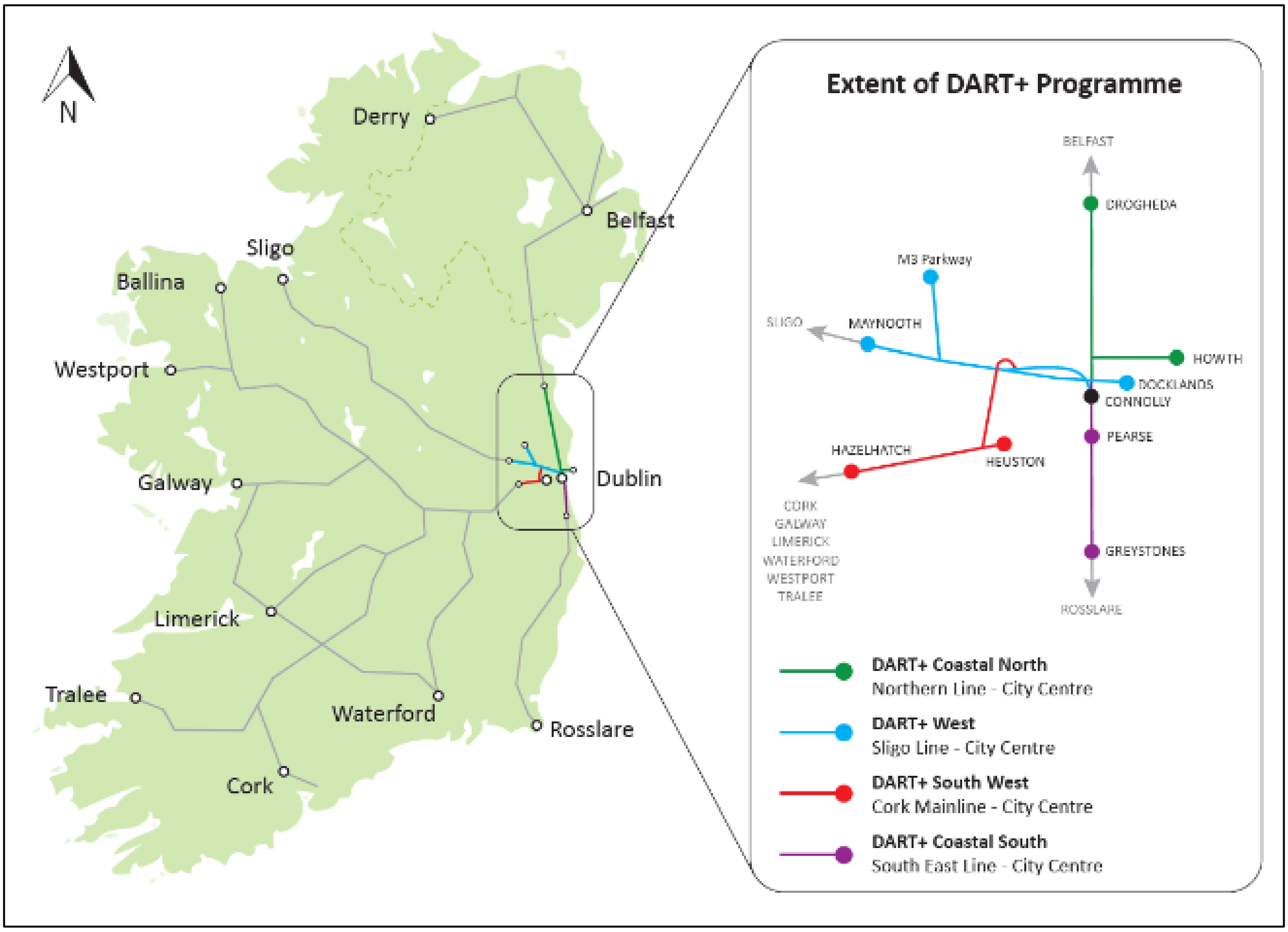


Figure 1-1 Schematic of Overall DART+ Programme

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 and Heuston Station and also circa 4km between Heuston Station and Glasnevin Junction, 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 2021-2030 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 improved 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 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 (i.e., where four tracks reduce to two), 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 DART+ South West electrification, new DART trains will be used on this railway corridor, similar to those currently operating on the Malahide / Howth to Bray / Greystones Line.

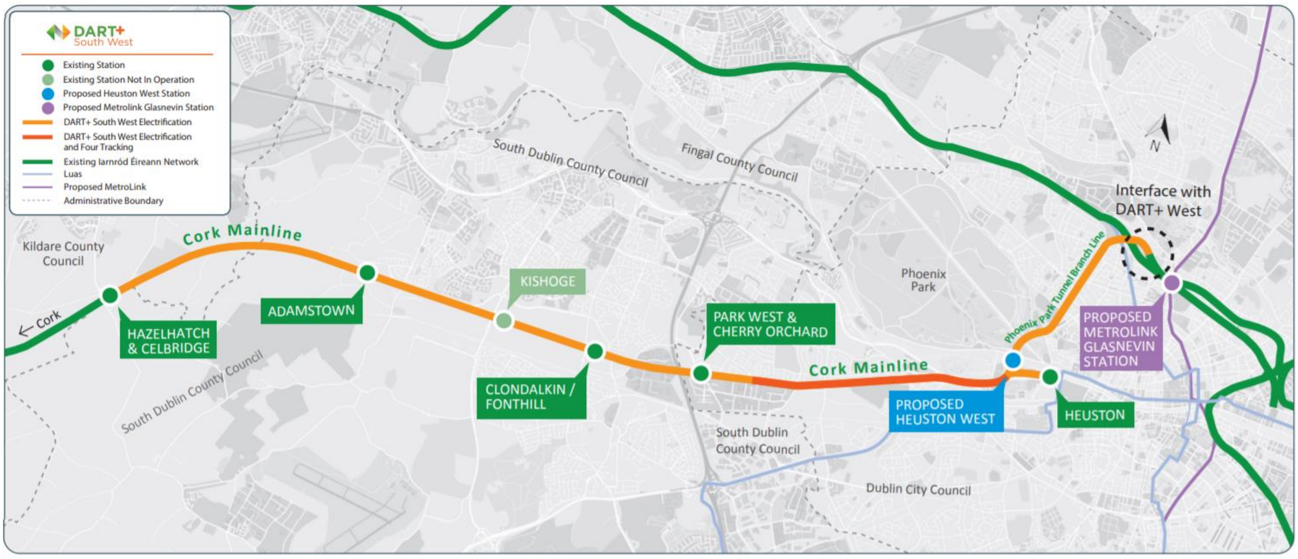


Figure 1-2 DART+ South West Route Map

1.4. Capacity Improvements 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 Junction, via the Phoenix Park Tunnel Branch Line, where it will link with the proposed DART+ West.
- Undertaking improvements / interventions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Delivery of a new Heuston West Station.

The '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 Station, the route also extends through the Phoenix Park Tunnel to Glasnevin. The area descriptions and extents are set out in **Table 1-1** and **Figure 1-2**.

Table 1-1 Route Breakdown

Area Name	Sub-area Description	Extents	Main Features
Hazelhatch to Park West	Area from Hazelhatch to Park West (Volume 3A)	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
Park West to Heuston Station	Area from Park West to Le Fanu (Volume 3B)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7)	Cherry Orchard Footbridge (OBC8B) Le Fanu Road Bridge (OBC7)

Area Name	Sub-area Description	Extents	Main Features
	Area from Le Fanu to Kylemore (Volume 3C)	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 from Kylemore to Sarsfield (Volume 3D)	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 Footbridge (OBC5)
	Area from Sarsfield to Memorial (Volume 3E)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Memorial Road (Volume 3F)	Area around Memorial Road Bridge	Memorial Road Bridge (OBC3)
	Area from Memorial Road to South Circular Road Junction (Volume 3G)	East of Memorial Road Bridge (OBC3) to 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 (Volume 3H)	Area at the South side of the Heuston Station Yard (non-DART+ tracks)	Heuston Station Sidings around Heuston Station
Heuston West Station	New Heuston West Station (Volume 3I)	Area to the West of Heuston Station, adjacent to Liffey Bridge (UBO1)	Heuston West Station
St John's Road Bridge (Islandbridge) to Glasnevin Junction	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel (Volume 3J)	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel	Liffey Bridge (UBO1). Conyngham Road Bridge (OBO2) Phoenix Park Tunnel
St John's Road Bridge to Glasnevin Junction	North of the Phoenix Park Tunnel to Glasnevin Junction (Volume 3K)	North of Phoenix Park Tunnel to South of Glasnevin Junction	McKee Barracks Bridge (OBO3) Blackhorse Avenue Bridge (OBO4) Old Cabra Road Bridge (OBO5)

Area Name	Sub-area Description	Extents	Main Features
			Cabra Road Bridge (OBO6) Fassaugh Avenue Bridge (OBO7) Royal Canal and LUAS Twin Arches (OBO8) Maynooth Line Twin Arch (OBO9) Glasnevin Cemetery Road Bridge (OBO10)

1.7. Stakeholder Feedback

A large volume of stakeholder submissions were received during the six week public consultation period, which ran from 12th May 2021 to 23rd June 2021, an additional week was provided, extending the consultation period until 30th June 2021. All submissions received either via email, post, telephone, or through the online feedback form, were analysed and recorded by the project team on a dedicated consultation database. Each individual submission was analysed to identify the themes that were raised by the respondent and each submission was classified according to the themes raised. All feedback provided, was then anonymised before being analysed under each of the themes. In addition, further engagement with relevant local authorities and prescribed stakeholders has been ongoing. Engagement with potentially affected landowners has also taken place since the commencement of PC1.

All submissions received as part of the first round of public consultation have fed into the design process and the selection of the Preferred Option. The project team has analysed the submissions and considered all relevant information in re-evaluation and further development of design options leading to the selection of the Preferred Option.

Numerous stakeholder submissions also expressed disappointment at a station around the Kylemore area not being included in the project scope and was labelled as ‘disingenuous’. It was cited that a station at Kylemore is the ‘essential ingredient’ to creating development in the area connecting the suburbs to the Grand Canal Greenway and the Red Line LUAS.

Further details of the Stakeholder Feedback are captured in the **Public Consultation No. 1: Findings Report, Volume 4.** Similarly, all feedback received on the Preferred Option at Public Consultation No.2 will feed into the development of the preliminary design, Railway Order and Environmental Impact Assessment Report (EIAR).

A high-level summary review of the above is also outlined in **Section 7.2** of the report.

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**.

Figure 2-1 Aerial view (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 (OBC5A). 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 retaining structures 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

2.3.1. 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 a vertical clearance of 4.335m.

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

2.3.2. 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 **Figure 2-3**.

Figure 2-3 Masonry retaining wall

2.3.3. 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 2-4**.

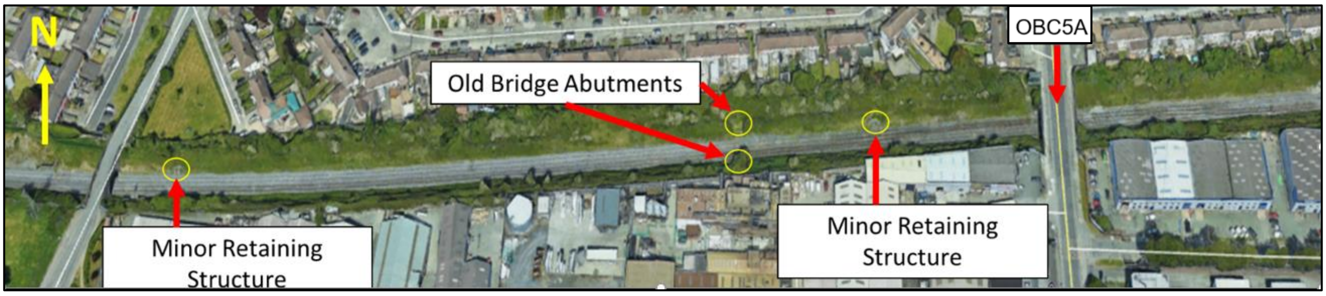
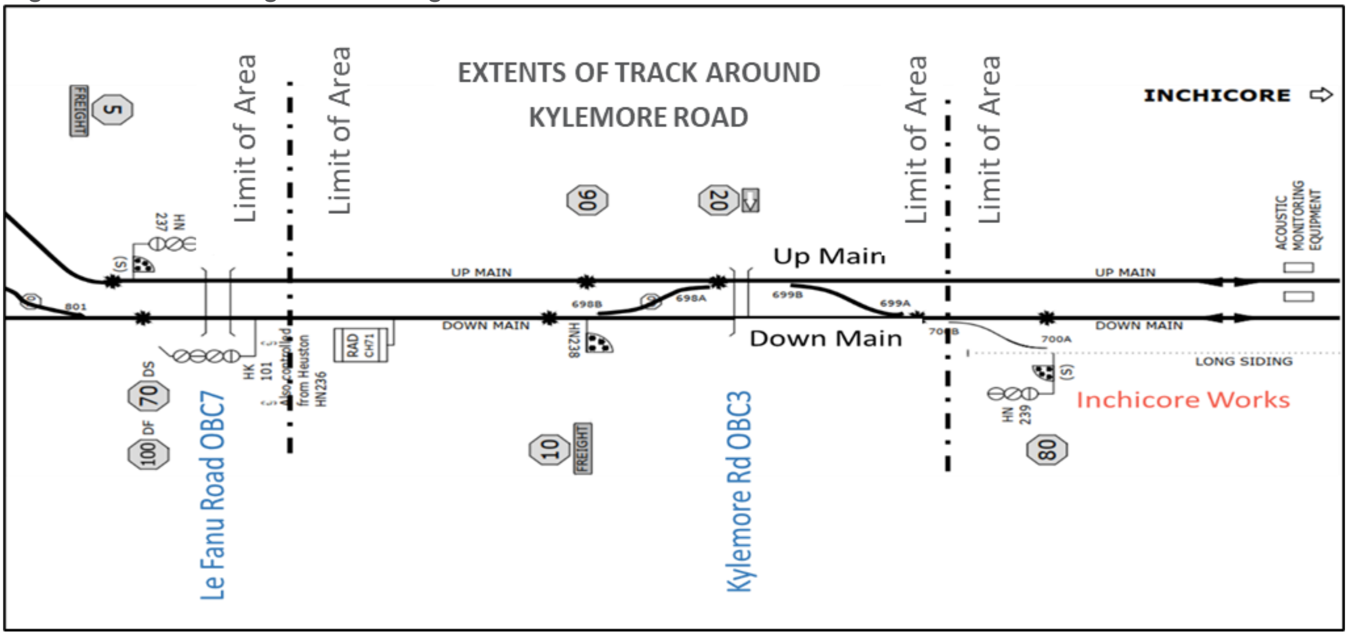


Figure 2-4 Location of minor retaining structures and old bridge abutments

2.4. Permanent Way and Tracks

There are 2 existing tracks entering the section from Le Fanu Road Bridge (OBC7) – the 'Up Main' on the north side and the 'Down Main' line on the south. Heading east beyond Kylemore Road Bridge (OBC3) there is a third line – the 'Long Siding' – which is the access to Inchicore Works, via crossover 700 A/B. This defines the end of the section within this report. Additionally, 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 as it passes under Kylemore Road Bridge (OBC5A); with a gradient of 1% (approximately) falling from the west to the 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

2.5.1. 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 **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 existing carriageway Kylemore Road (R112), between Kylemore Park North and Kylemore Avenue junctions comprises the following cross-sectional elements:

A single lane carriageway with paved footpaths along both sides of the kerbed carriageway. Existing lane widths are 4.5m in both directions, while the footpaths are 3.4m and 3.8m respectively south of the bridge. There is a 2.5m (approx.) verge between footpath and plot boundaries to the south of the bridge. In addition, there is a 4m (approx.) verge between kerb lines of Kylemore Road and the 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 existing ESB substation. The section of road between Landen Road and Kylemore Avenue continues with the same two-lane carriageway with 4m (approx.) tree lined verge separating services roads from Kylemore Road.

The junction of Kylemore and Landen Roads is signalised but other junctions within 200m of the bridge are not. The road falls at a gradient of 1% (approx.) towards the bridge along the southern approach and transitions to a steeper 3% (approx.) north of the bridge. Kylemore Road is considered the main collector road linking Ballyfermot Road to the Naas Road (R810), as well as to the industrial estates located between the Long Mile Road and the existing railway 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 slightly heavier traffic volumes to that of Le Fanu Road during the morning peak hour. However, the counts also indicate that Kylemore Road has approximately double the daily traffic volume to that of Le Fanu Road.

Kylemore Road is not designated as a BusConnects route, within the DART+ South West project area. It is however integral to several regular Dublin Bus routes; and is in the Dublin Cycle Strategy proposal as an orbital route (OB4).

The commercial/industrial plot boundaries along Kylemore Road (south of the bridge) are detailed as follows:

- low-level upstand walls along the western side of the southern approach plot boundary (mini-units).
- low-level retaining wall, with a 3m (approx.) high semi-ornate metal palisade fence along the eastern road corridor boundary (Westlink Industrial Estate).
- The accesses to these commercial estate/units are within 15m and 30m (approx.) of the bridge, respectively.
- There is also a residential service road access point onto Kylemore Road, between the bridge and Landen Road (within 5m of the existing north-west parapet wall).

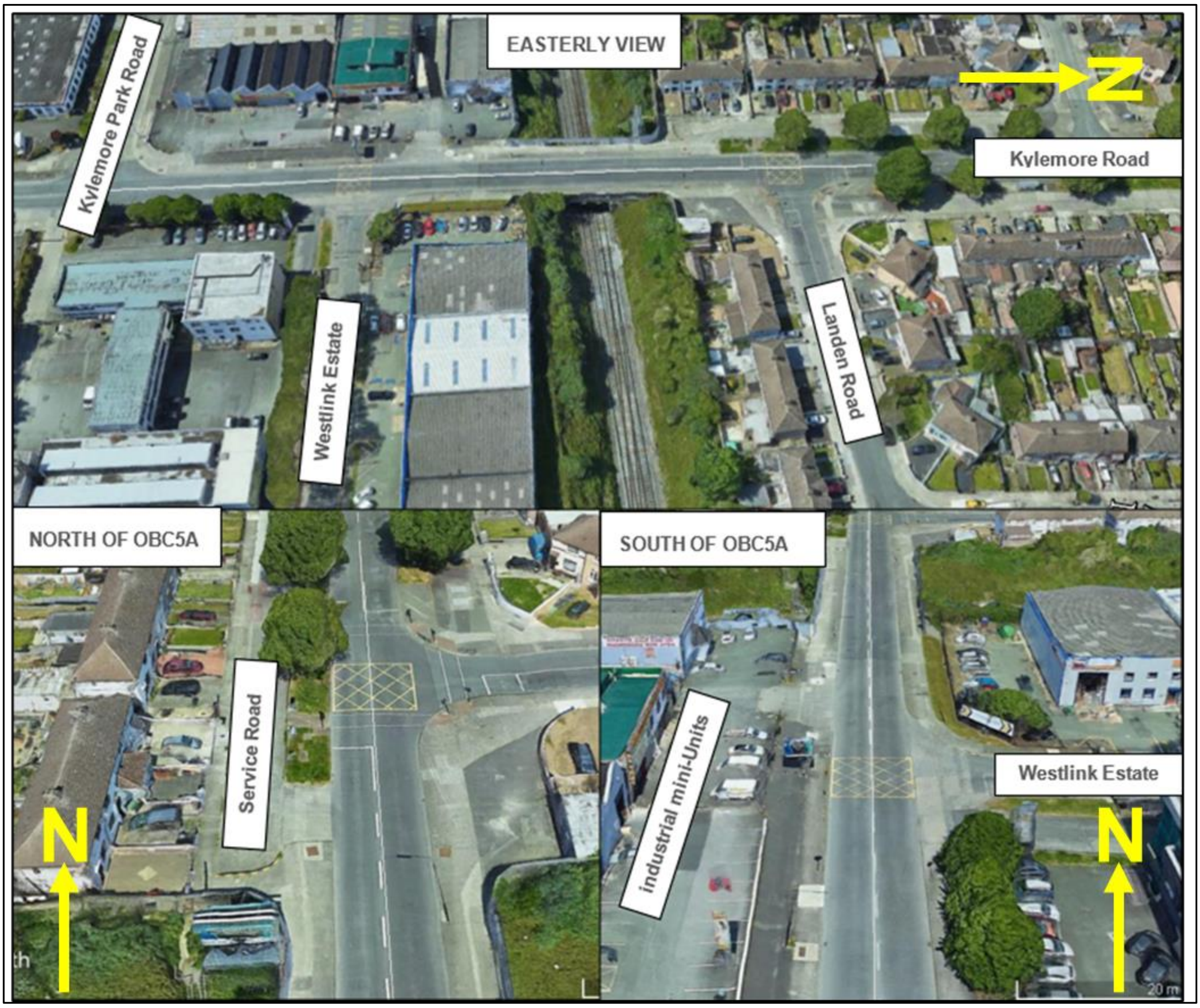


Figure 2-8 Aerial view of the roads affected by the raising of bridge levels.

2.7. 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.

A Ground Investigation is currently ongoing to verify the data obtained in the historical investigations. Preliminary results indicate the ground conditions at the site are as anticipated above.

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 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 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.

There are limited biodiversity features identified in the area; however, evidence of invasive alien 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; north of the railway line).

The railway line itself is the subject of several Dublin City Industrial Heritage Records associated with the Phoenix Park Tunnel Branch Line including Le Fanu Road Bridge (OBC7). Le Fanu Road Bridge (OBC7) and Kylemore Road Bridge (OBC5A) are not designated as on the DCC Record of Protected Structures an (RPS) or listed on the National Inventory of Architectural Heritage (NIAH) feature.

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
  - East verge of bridge: 1 x 110mm duct
  - West verge of bridge: 4 x 110mm ducts, 1 x 3-way multi-duct
- ESB Networks
  - Beneath carriageway: 1 x 125mm duct, 1 x 160mm duct
- Virgin Media
  - West verge: 2 x 110mm ducts
- BT Ireland
  - Underneath bridge: Longitudinal cable running along the rail corridor rises to ground level at the west side of the bridge and ties in under Kylemore Rd footpath. 1 x 100mm duct
- Gas Networks Ireland
  - East verge of bridge: 200mm steel pipe
  - West verge of bridge: 305mm HDPE pipe
  - North of bridge: DRI (District Regulator Installation) present at Kylemore Rd / Landen Rd junction.
  - South of bridge: Several gas pipes feeding building units east and west of Kylemore Rd
- Dublin City Council / Irish Water (Foul Water Sewers)
  - South of bridge: 225mm concrete pipe crosses Kylemore Rd approx. 10m south of bridge
- Dublin City Council / Irish Water (Water Supply)
  - West verge of bridge: 228.6mm (9”) pipe
- 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. As defined above, there are BT data cable/fibre optic services running along the tracks. Although a cable rises to Kylemore Rd level, the remaining cables continue along the tracks. There is a disused gas main present in the northern verge of the rail corridor. Consideration of the impacts on these services indicate that there will be a disruption to BT services and a diversion will be required, while the disused gas main is unlikely to affect designs or require a diversion.

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. These providers include;

- Telecoms: BT, EIR, Virgin Media
- Gas Networks Ireland
- ESB
- Dublin City Council / Irish Water (Foul Water Sewers)

DART+ South West aims to minimise disturbance to public by engaging with utility providers to coordinate these works well in advance.

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 in their final state.
- Maintain functionality of existing services/utilities (electricity, gas, water, etc).
- Facilitate crossing of railway by pedestrians and cyclists local to Kylemore Road Bridge (OBC5A) in the event that the bridge and its approaches require full closure for construction.
- Passive structural 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 span will consider spatial provision required to avoid future amendment to the span in the event the station proceeds in the future. The railway corridor will not be designed with spatial provision for the station 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 the 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. It is proposed that a standardised approach to electrification will be adopted, but area-specific interventions will also be required. Four power substations will be provided along this segment of the rail line to provide the requisite power for the network demand.

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 equipment rooms, including Relocatable Equipment Buildings (REB) to accommodate signalling equipment and associated power supplies and backup.

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. 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.

It should be noted that all OHLE diagrams in this report are for visual information only. Construction details will be determined during Detail Design, which will be developed at later stages of the project.

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

In the four 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. The project aims to achieve a minimum contact wire height of 4.4m throughout to ensure compliance with the relevant design standards, localised special conditions may be required. See **Figure 3-1** for a typical OHLE arrangement in a four-track open route.

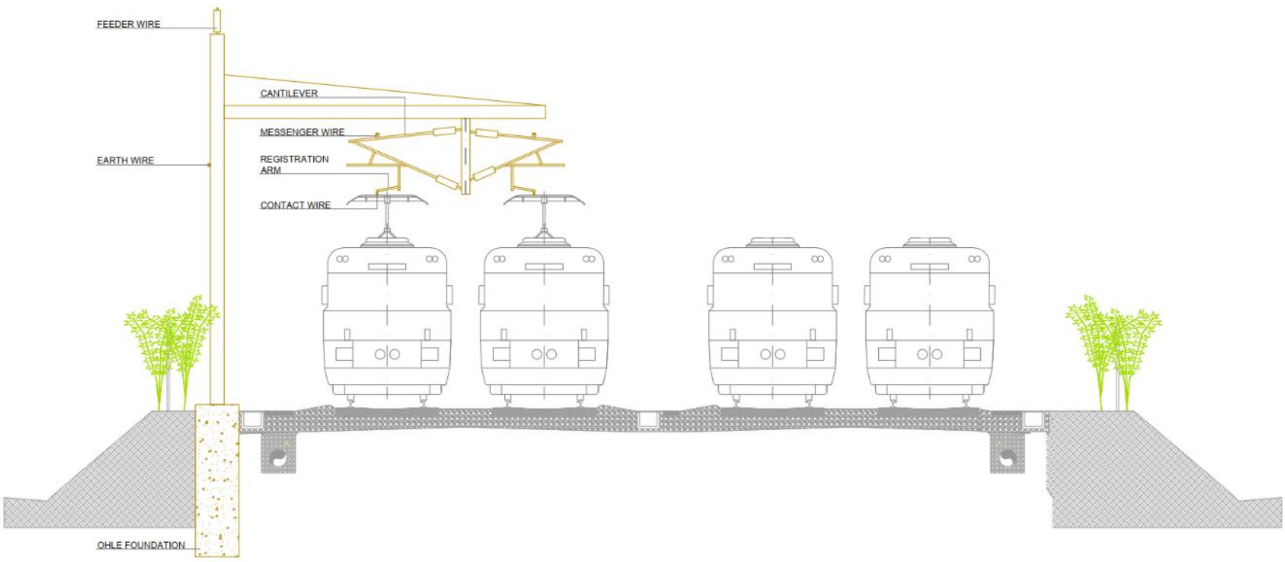


Figure 3-1 Typical OHLE arrangement in four track open route – Facing East

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. 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. See **Figure 3-2** for a typical anchor structure.

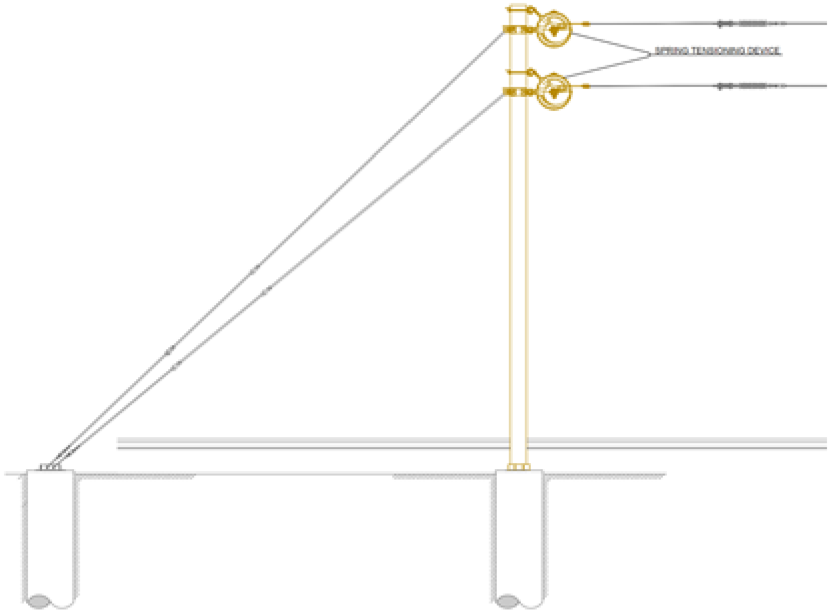


Figure 3-2 Typical anchor structure

The OHLE configuration through the overbridges for each track or civils option is being assessed using a clearance assessment tool derived from the System Wide Functional Requirement Specification (FRS) relating to Overhead Line Equipment (OHLE)and a set of configurations agreed with Irish Rail Signalling and Electrification Department 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. See **Figure 3-3** for a typical arrangement on approach to a low bridge.

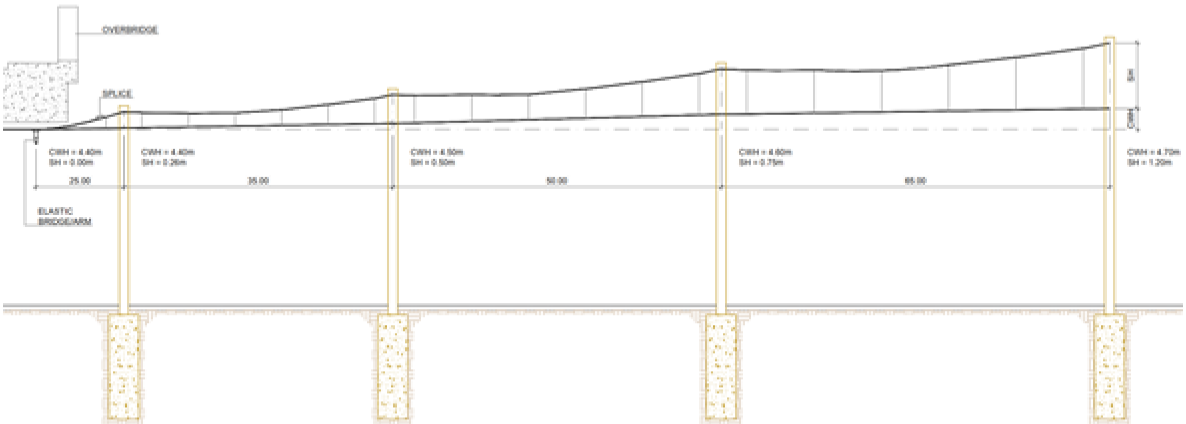


Figure 3-3 Typical arrangement on approach to a low bridge

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 along the route, one of them in the area between Kylemore Road Bridge and Sarsfield Road:

- Kylemore

3.2.2.1. Requirements and considerations

The siting technical requirements for substations for the DART+ South West Project which inform the Option selection process include:

- The location of the substation must comply with the requirements of the Power Study.
- The substation locations must be accessible to the ESB network. While the actual connections to the grid will be determined by ESBN following their in-house technical assessment process.
- The substations will be connected to the IÉ power distribution network and OHLE system which will deliver traction power to the electric train units. These cables will be installed in buried routes for additional protection. Hence, proximity to the railway corridor is a fundamental siting consideration.
- The substations must be accessible from the local road network for construction and maintenance purposes. 24-hour unimpeded access for ESB staff and Iarnród Éireann maintenance staff is required. The vehicular access route must be at least 3 m wide and the maximum allowable slope of the access route is 1:10.
- Consideration will be given to the land-use and development context of potential locations.
- Where practicable, substations will be located on Irish Rail property and positioned to have minimal impact on adjacent properties.

The substations will comprise a secured, fenced compound surrounding a building which will house all the necessary electrical switching and feeding equipment. Welfare facilities are also required for Irish Rail's maintenance teams. The characteristics of the substation compound and buildings for the DART+ South West Project are as follows:

- The footprint of the substation compound will generally be 50m (length) x 20m (wide). The substation dimensions will generally be 35 m (length) x 10 m (width) and 6 m (height).
- Consistent with the existing Irish Rail substations,
    - The substation compound will be secured by a 2.4 m high palisade / security fence, or similar.
    - The architectural finish will be grey brick / blocks. However, there may be site specific areas where a high architectural finish is required.
- The substation must be located at ground level in order to facilitate the installation or replacement of heavy electrical equipment, the immediate area around the substation should be level.
- Substations must be located so that the access doors open outwards onto a clearly marked low-risk fire area.
- The exterior and the access of the electrical substation must be illuminated with sufficient lighting to assure the mobility and the security of any operation during the hours of darkness.
- The design of the substations will be subject to further development during subsequent design phases and the inclusion of ESB requirements. The sizing of the proposed substations has been taken from information obtained from ESB.

3.2.2.2. DART+ Programme Power Study Requirements

As noted previously, a Power Study was commissioned by IÉ with the primary objective of ensuring uniformity and compatibility of equipment and systems across the IÉ network. The Power Study provides a power simulation study across the DART+ Programme providing a basis upon which consistency in design decisions can be made with regard to traction, signalling and operational power demand, establishing the existing KVA and future KVA demands for all areas across the DART+ network.

Regarding substation locations, the power simulation study assumed the locations proposed in the "DART Expansion – Electrification Assessment Report" previously commissioned by IÉ and produced by SYSTRA Ltd. The power simulation study then undertook a validation process of these locations, applying updates and modifications as necessary so that stated minimum criteria in relation to the following technical parameters were achieved (refer to Section 4.4 of the Power Study document):

- Rolling Stock – modelling of the proposed rolling stock taking into account power consumption, acceleration / deceleration profiles, line speed limits, etc.
- Railway Operation – modelling of the power demands due to the operational restrictions along the railway, accounting for stopping patterns, dwell time at stations and train services schedules
- Railway Alignment – modelling the proposed rolling stock and operational constraints against the known topography of the proposed railway alignment, taking account of longitudinal gradients and curve resistance along the proposed route as well as regenerative braking effects
- Substations – modelling to take account of max power demand / load, number of substations, feeder arrangements and line sectioning
- Overhead Line Equipment (OHLE) – modelling is undertaken to ensure that voltage and current values remain within technically acceptable limits for both normal and degraded conditions. The OHLE system within the model considers all aspects with regard to electrical characteristics of the rails, electrical feeders connecting the substations to the OHLE, return feeders connecting the rails back to the substations and operating temperature limits.
- Technical Operational Limits – other technical operational limits in terms of permissible minimum (1000V) and maximum (1800V) voltage values and currents (determining train traction power) are considered and the model 'tested' to ensure compliance with relevant technical standards in this regard.

The power simulation was run for a number of scenarios, including normal service (i.e. all substations operational) and degraded scenarios (i.e. various combinations of service disruptions at selected substations).

A key output of the power simulation is the optimal distribution of electrical substations across the network. The Study identified the following locations for proposed traction power sub-stations for the DART+ South West Project: Hazelhatch, Adamstown, Kishoge, Park West, Kylemore, Island Bridge.

3.2.2.3. Substation Location Requirements

Table 3-1 is an extract from Section 5.3.2 of the DART+ Programme Power Study and identifies the locations for the proposed substations on the DART+ South West project. It should be noted that the Datum point (i.e., 0.00km) for all distances provided is the overbridge at Glasnevin Cemetery (OBO10).

Table 3-1 – DART+ South West Substations location (Source: DART+ Programme Power Study)

Line number	Station	km	Substation	km	Normal conditions (kW)	Degraded conditions (kW)	Fast speed Charging system (kW)	Depot power (kW)	MIC normal (kVA at 0.9 power factor)	MIC degraded (kVA at 0.9 power factor)
6	-	4,03	Islandbridge (New substation)	4,03	1956	3114			2173	3460
6	-	6,05								
6	Kylemore Road	7,10	Kylemore (New substation)	7,10	2655	3697			2950	4108
6	Park West & Cherry Orchard	8,90								
6			Park West (New substation)	9,83	2751	3792			3057	4213
6	Fonthill Road	10,75								
6	Kishogue	12,40								
6			Kishogue (New substation)	12,70	2531	3300			2812	3667
6	Adamstown	15,00								
6			Adamstown (New substation)	16,00	1945	3066			2161	3407
6	Hazelhatch and Celbridge	19,10	Hazelhatch (New substation)	19,10	1592	2439	3250		5380	6321

The locations identified in the DART+ Programme Power Study are an input to the DART+ South West Project and proposed substation site options have been identified and separation distances checked to ensure that compliance with the parameters of the power simulation model are maintained. Following acceptance of the proposed locations by ESB Networks, the power simulation to be updated to verify the network design. If the locations proposed are outside the tolerance limits, creating significantly longer distances between substations than those proposed by the Power study, further power modelling will be required to assess their viability for the DART+ South West programme prior to Railway Order.

To ensure the selection of potential substation sites are technically feasible, the distance provided between Datum (Glasnevin Cemetery Bridge OBO10) and Islandbridge must not be exceeded, i.e. 4.03km. Similarly, the distances proposed between all other subsequent substations (assuming an east to west sequential order) must not be exceeded so that the parameters of the power simulation commissioned by Irish Rail are not exceeded.

3.3. Design Standards

The project design is governed by various technical and safety guidelines, which include European, National and Iarnród Éireann internal standards and specifications.

Compliance with these standards will be ensured via internal and external technical and safety assurance processes throughout the delivery and commission stages of the project.

The reinstatement of vulnerable user routes (footpaths and cycle tracks/lanes are to comply with current published standards.

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. Further desk and field survey work has been undertaken to inform the environmental constraints identified in **Section 2.8** and the feedback from PC1 has been reviewed. Together that information has improved the understanding of the environmental constraints in the study area. Details of the further desk and field survey work is outlined below.

Ecological field surveys of the route have been carried out to establish the baseline ecological conditions. Surveys for mammals (badger, bats), amphibians, invasive alien species, birds and terrestrial and freshwater habitats have been carried out to date.

In relation to Built Heritage, a comprehensive desktop assessment of built heritage assets within 50m either side of the railway centreline has been undertaken by a Heritage Specialist. This assessment confirmed the designated status of the features of heritage interest due to their Protected Structure status and/or inclusion in the NIAH record, and/or inclusion in the Industrial Heritage Record. A meeting with Dublin City Council noted that a new City Development Plan for 2022-2028 is being prepared. The new City Development Plan for 2022-2028 may contain modifications (additions/deletions) to the Record of Protected Structures (RPS). A structure must be listed on the planning authority's RPS to qualify for protected status under the Planning and Development Act 2000 (as amended). The RPS will be monitored on an on-going basis by the Heritage Specialist.

A Flood Risk Assessment (FRA) is currently under preparation. The FRA will be completed in accordance with "The Planning System and Flood Risk Management – Guidelines for Planning Authorities" (DOEHLG, 2009). Detailed mitigation measures will be specified in the final FRA and will inform the EIAR which will be submitted to An Bord Pleanála for Railway Order approval.

4.2. Roads

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

Several key criteria listed below are deemed to govern the road level changes required in support of providing OHLE clearances at bridges. There are also 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 tie-in the changes 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 plot accesses.
- TII and DMURS stopping site distance compliance.

- The proximity of road junctions and plot accesses to the bridge pose 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 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 but also the entrance of the Westlink Industrial Estate.

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 for a potential future Kylemore Road Station. This potential future station would be similar in layout to Adamstown, Clondalkin, Park West 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.
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 existing Kylemore Road Bridge (OBC5A) has insufficient span length to accommodate 2 No. additional tracks and inadequate 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).

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.

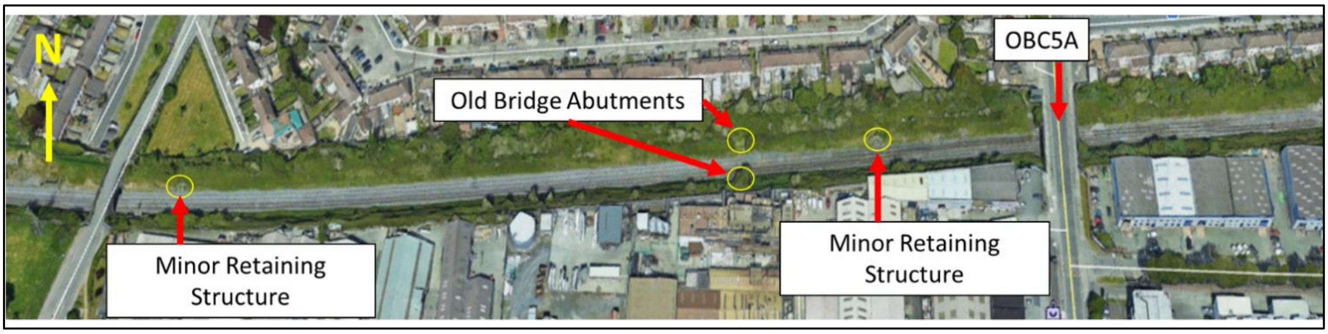


Figure 4-2 Residential and Commercial Property Locations

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). A temporary structure will be required to house these critical utilities during the works for the bridge. Utility providers have been consulted on this requirement upon which they understand that it is required in order to minimise service outage time.

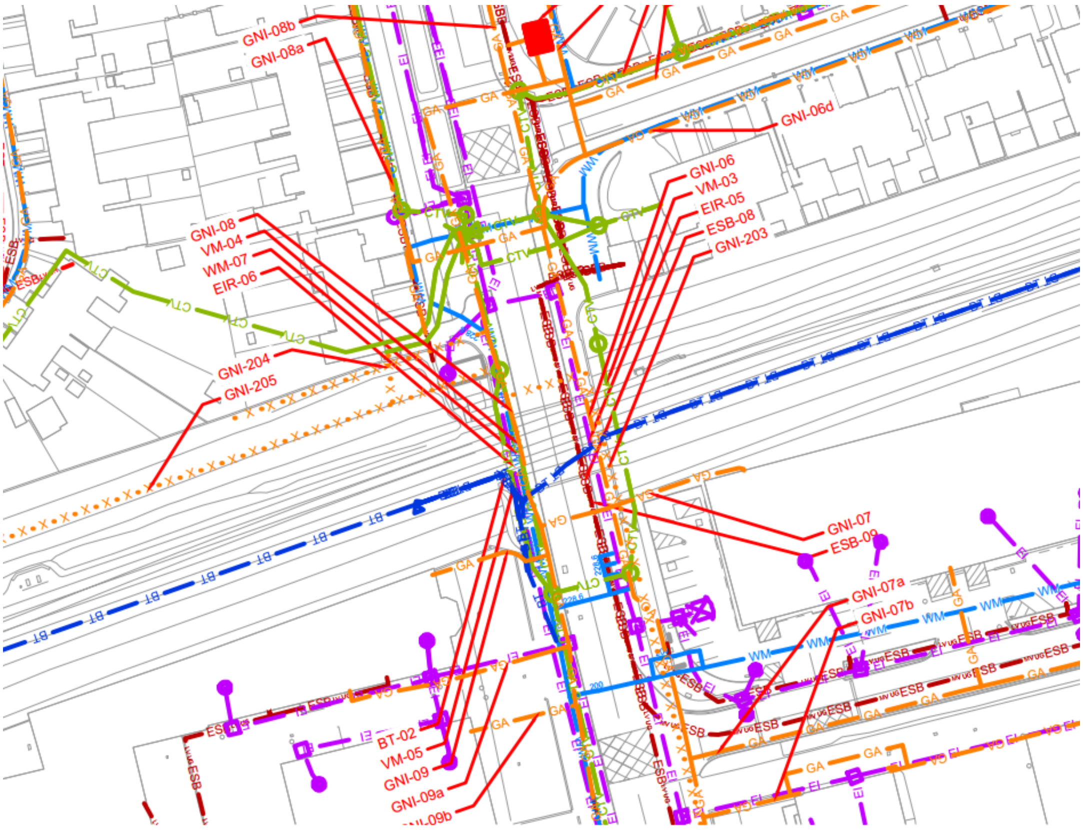


Figure 4-3 Existing Utilities at Kylemore Road Bridge (OBC5A)

5. Options

This section presents the options associated with the following elements at the corridor between Le Fanu and Kylemore Road Bridge:

- Civil and OHLE infrastructure solutions
- Substations
- Construction Compounds locations

5.1. Civil and OHLE

5.1.1. Kylemore Road Bridge (OBC5A)

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.

A summary of Options presented at PC1 as part of the Emerging Preferred Option Selection process is presented in **Table 5-1**.

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.

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 5.1.3. Permanent Way (All Do-Something Options)** for the Permanent Way Options.

5.1.1.1. 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.

5.1.1.2. 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.

5.1.1.3. 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; as well as not being compliant with the requirement 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

5.1.1.4. Option 3

This Option proposes to replace the existing Kylemore Road Bridge (OBC5A) bridge. The proposed bridge would have a span and height that would provide 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 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 Constraints**); namely, tie-ins to the Inchicore Works, as well as the potential impact on 3rd party landowners.

Roads, Utilities and Permanent Way Analysis:

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

5.1.1.5. 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.

Roads, Utilities and Permanent Way Analysis:

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

5.1.1.6. 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.

Roads, Utilities and Permanent Way Analysis:

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

5.1.1.7. 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.

Roads, Utilities and Permanent Way Analysis:

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

5.1.1.8. 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 9.0m wide carriageway with 3.65m wide segregated footpath & cycletrack on both sides of the road. 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.

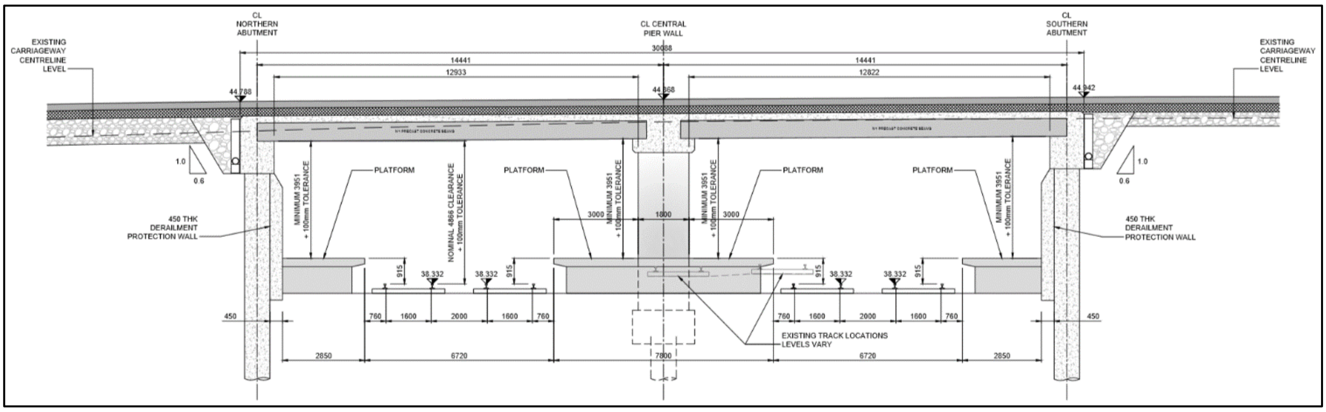


Figure 5-3 Typical 2-span bride section (Potential future platforms shown indicatively) – Facing East

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 to have the same bridge superstructure characteristics as this option, while 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).

This Option proposed that <u>all vertical clearances would be achieved by only raising the road and not amending the track levels.</u>

Roads Analysis:

- 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 4-7no. (approx.) residential properties in Landen Road losing their driveway accesses permanently. These plots boundary walls would require conversion to serve as footpath earthworks retaining structures and reinstatement of the boundary wall at a higher level; as well as to accommodate new pedestrian access down into the plots via a combination of steps and/or ramps. Land drainage modifications would need consideration to avoid internal ponding of rainwater runoff.
- The requirements for roadside retaining walls would also extend 15-40m either side of Kylemore Road (north of its junction with Landen Road); in addition to fully restricting vehicular access to the commercial plot units immediately southwest of the bridge.
- Further topographical survey, received in May 2021, validated the initial assumptions.

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 would potentially increase the duration of the overall road closures. Temporary utilities diversion bridges would be required to cross the railway both the eastern and western sides of the road bridge reconstruction owing to the volume and complexity of the diversions. The level of road level increase exacerbating this complexity compared to other options.

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.

5.1.1.8. 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. Temporary utilities diversion bridges would be required to cross the railway both the eastern and western sides of the road bridge reconstruction owing to the volume and complexity of the diversions. Regarding lowering the tracks, track level utilities comprising rail fibre and comms would need to be lowered and as such would require a phased lowering approach. This would enable Irish Rail to maintain these services for the rail network during construction.

Permanent Way Analysis

- The track lowering levels would not be 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 maximum design constraint on track lowering.

5.1.1.9. Option 9

The Option 9 provides the same deck superstructure and carriageway horizontal geometric layout as Option 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

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.

- Option 9 proposed road levels are very similar to Option 10 levels.
- A key Option strategy is to limit the road raising level to avoid permanently impacting 3rd party property accesses and preferably without applying for a derogation from road design standards.
- An additional extent 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 final track design levels achievable.
- It should be noted the Option 9 carriageway, footpaths and cycletracks would need to be redesigned in the event that a Luas was approved for implementation on approach to and across this bridge.

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.), to ensure rail tie-ins to Inchicore Works.

5.1.1.10. 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, by values 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.

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.

- 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 extent 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
- As with Option 9 should be noted that the Option 10 carriageway, footpaths and cycletracks would need to be redesigned in the event that a Luas was approved for implementation on approach to and across this bridge.

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.) to ensure rail tie-ins to Inchicore Works.

5.1.2. OHLE Arrangement (All Do-Something Options)

This bridge does not have sufficient vertical clearance in its existing configuration to be electrified with OHLE; therefore, Option 0 does not meet the project requirements and so has not been considered in terms of electrification.

For Options where the minimum contact wire height of 4.4m is achievable, then the contact wire shall be graded up and mast heights shall be designed accordingly.

For Options where the minimum contact wire height of 4.7m would be achievable, then the OHLE would pass beneath the bridge without being connected to it, and wire heights and mast heights would be increased accordingly. OHLE masts would be positioned at 20m from each side of the bridge.

5.1.3. 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 (100mph) on the Fast lines and 110km/h (70mph) 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 0.6% in this vicinity, slightly flatter than the existing 0.9%.

Note should the construction of Kylemore Road Station proceed, then some intervention to the P&C would be necessary – i.e. relocating the Down Slow-Up Fast crossover centred at CH.12+300 (approximately 140m to the west of Kylemore Road Bridge), along with track level adjustments to achieve a compliant platform track gradient – which will necessitate evaluation of the drainage system (see the Track Drainage section of 7.3.5 in this report).

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.

5.1.4. 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 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.

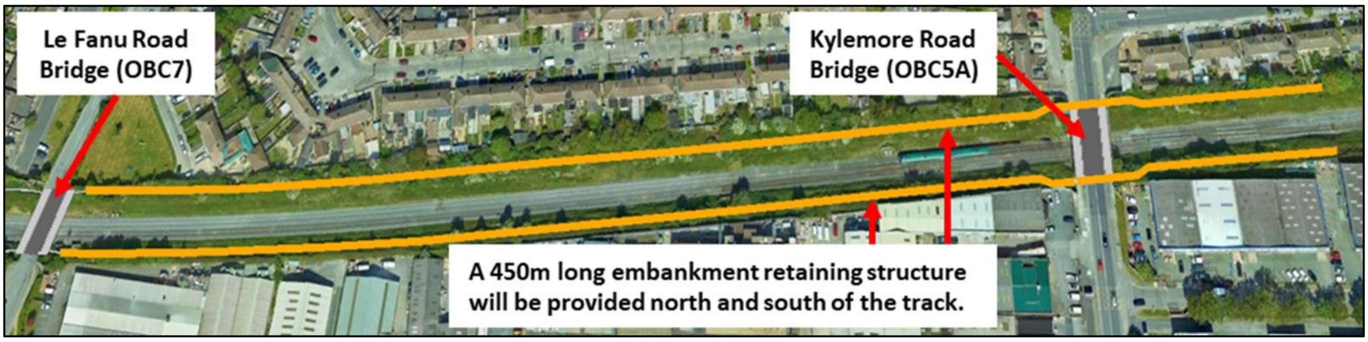


Figure 5-4 Proposed Retaining Wall Locations

- 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.

5.1.5. 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 raised roadway earthworks as well as provide a bespoke turning head for what would become be a cul-de-sac.

The constraints, as listed in the **Section 4 Constraints** of this report, were used in assessing the impact of Options 3 through to Option 10. Drawing DP-04-23-DWG-CV-TTA-61531 serves to indicatively represent the area that could potentially be impacted by the 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.

5.1.6. 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, as well as new containment routes to accommodate all new railway systems cabling throughout. These will be migrated in accordingly at each stage of construction .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.

5.2. Substations

The 'Do Nothing' Option does not meet the project requirements and as such has not been considered further. All 'Do Something' Options which propose the installation of new electrical substations to support electrification of the route have been brought forward for consideration as part of the option selection process.

The OHLE system will be supplied with electrical power at regular intervals, at locations known as substations. The preferred locations for the proposed substations have been identified, based on the findings from the power simulation study. The proposed locations were assessed as part of the options selection process. A total of 6 substations are required for the DART+ South West Project, one of the substations is located in the section from Kylemore Road Bridge to Sarsfield Road at the following locations:

- Kylemore

Details of the current status of design for optioneering are detailed at **Section 6 Options Selection Process**.

Based on the power simulation outputs, **Table 5-3** outlines the maximum distance between proposed substations.

Table 5-3 – Maximum Substation Separation (Source: DART+ Programme Power Study)

	Power Study Locations From Datum (km)	Distance between Substations
OBO 10	0.00	
Island Bridge	4.03	4.03
Kylemore	7.10	3.07
Park West	9.83	2.73
Kishogue	12.70	2.87
Adamstown	16.00	3.30
Hazelhatch	19.10	3.10

The above locations were mapped in accordance with the DART+ Programme Power Study which is based on the defined datum point 0.00km at Glasnevin Cemetery bridge (OBO10).

The above locations were mapped with each substation located as close as technically feasible to the above identified locations to ensure compliance with the DART+ Programme Power Study.

In addition, the proposed substations are considered an integral operational element of the railway infrastructure and as such would be located as close as possible to the railway corridor which it serves. Furthermore, the power simulation did not envisage locating any substation away from the railway corridor which would add unnecessary length to cabling and negatively impact on voltage calculations. Therefore, only sites which share a boundary with the railway corridor would be considered feasible from a technical perspective. Property impact should also be considered in this regard. Siting a substation away from the railway corridor may lead to 3rd party land issues where installation of connecting cables is required and which may introduce 3rd party cable easements etc. In locating the substation immediately adjacent to the railway, there is greater opportunity for use of existing Irish Rail lands (i.e. reduced potential for acquisition of privately owned lands). Hence, to aid site identification, the study area at each location is limited to only those properties bounding the railway. As an aid to identification of same, the study area is mapped using a 50m lateral offset from the existing boundary fence on either side off the railway corridor.

5.2.1. Kylemore Substation

The power study determined the requirement for an electrical substation in Kylemore, it is a densely populated area close to Dublin City centre, to the north are heavily populated housing developments, to the south are industrial units, east and west is a mix of both residential and industrial space. The study area in Kylemore predominantly focuses on the area surrounding Kylemore Road. See **Figure 5-5**.

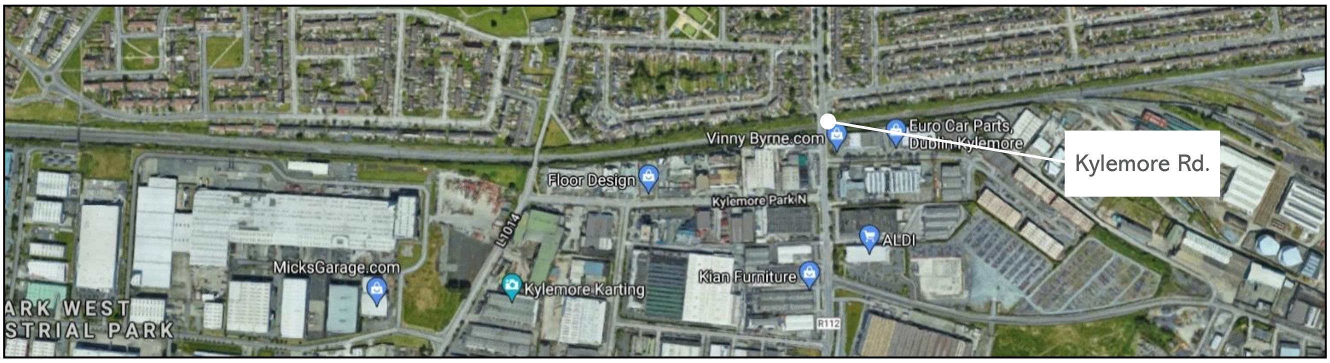


Figure 5-5 – Kylemore Substation Study Area

5.2.1.1. Constraints and Challenges

The main constraints for this location are as follows:

- Existing and proposed land use – the urban / city centre setting and presence of the adjacent industrial units means that the local area is dominated by privately owned developments / infrastructure and residential/commercial developments. Potential open field Options are limited due to the surrounding infrastructure and residential/commercial developments
- Grid connections – ESB infrastructure is located nearby adjacent to the L1014 Le Fanu Road. This is a busy distributor route connecting the Cherry Orchard and Ballyfermot areas to the R110 Naas Road and subsequently onto the M50 motorway. The final position of the substation will be subject to design development and confirmation from ESB in relation to suitability for incoming power supply connection.
- Road Network - the adjacent road network is busy, with a mix of HGVs serving the surrounding industrial units and privately-owned vehicles. There is a significant level differential between the trackside environment and the adjacent road network which is in the order of 5m in the area around Le Fanu Road and Kylemore Road.

Power simulation study – the proposed substation location as detailed in the DART+ Power Study. Based on the preferred solution at Islandbridge, the study area at Kylemore is focussed on a point not exceeding 3.07km from Islandbridge substation.

5.2.1.2. Options

A total of 2 no. options for substation locations were identified. These options are outlined as follows and illustrated in **Figure 5-6**.

Figure 5-6 – Kylemore Proposed Substation Options

<u>Option 1</u>

Option 1 is located at a commercial/industrial property currently in private possession. This Option has potential access from Kylemore road and is located on the southern side of the railway.

<u>Option 2</u>

Option 2 is located outside of IÉ land in a derelict industrial unit. It is in the possession of private landowners on the southern side of the railway.

5.3. Construction Compounds

One construction compound is required between Le Fanu to Kylemore Road Bridge:

- Kylemore Road Bridge

5.3.1. Kylemore Road Bridge Construction Compound

The bridge at Kylemore is being replaced by a larger structure to facilitate electrification and also the widening of the track corridor. As part of the rail corridor widening works, new retaining walls will be constructed, requiring plant access and construction materials processing. To facilitate the reconstruction of Kylemore Road Bridge and localised works associated with widening of the rail corridor, 4 discrete construction compounds will be required. Due to the nature of the works, the construction compounds are required in the immediate vicinity of the bridge.

On the north east side of the bridge, it is proposed to utilise the existing open space in this area. Access to the construction compound located at the North West side of the bridge is not as constrained, as there is potential access via a haul route from the north eastern Le Fanu road compound to this area. The railway corridor is also less constrained, as the new headshunt terminates on the eastern of the bridge. Therefore, a smaller compound is required in this location.

Figure 5-7 Kylemore Preferred Construction Compound Location

To the south east, the construction of a new retaining wall necessitates access from Kylemore and egress from Inchicore works via a haul road. A construction compound will be required at the south east corner of the bridge to serve as an access point, storage and transfer area for materials and plant.

To the southwest corner of the bridge, access will be required to facilitate construction of the retaining wall between Kylemore and Le Fanu. Access to the site on the northern side is via Kylemore Road to the Naas Road. Access to the southern compounds is via Kylemore Road to the Chapelizod Bypass.

The two construction compounds located to the south are located in existing car parks belonging to adjacent commercial units, as a result there will be an impact on the respective businesses and alternative accommodation may be required for the duration of the associated works.

The construction compound at the North West side of the bridge is located on Irish Rail property, the other sites are located on third party lands and will require temporary acquisition for the duration of the works.

6. Options Selection Process

6.1. Options Selection Process Summary

A clearly defined appraisal methodology has been used in the selection of the 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 two-stage approach as summarised below:

- Stage 1 Preliminary Assessment (Sifting)
- Stage 2 Multi Criteria Analysis (MCA)

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, a number of discrete elements extend beyond the boundary of the existing railway. The optioneering process has focused on these elements for which alternative options manifest, options which are markedly different from one another, and which have varied impact on the local environment. Examples of such include four tracking, bridge replacements, and options for the location of substations and construction compounds.

The above selection process has been used to asess the options associated with the following elements on the section between Le Fanu and Kylemore Bridge:

- Civil and OHLE Infrastructure
- Substations
- Construction Compounds

6.1.1. 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.

A total of 10 No. Options were initially developed for this area regarding Civil and OHLE, and one option was identified for construction compound locations.

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.

Where the sifting results in only one feasible option being retained, it is not required to complete a multi-criteria analysis (MCA) on that one option.

6.1.2. 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 (Sifting).

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 a 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 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 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 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'.

The stage adopted for the Stage 2 MCA involved assessing the performance of each option against relevant quantitative and qualitative indicators, the assessment was carried out 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 'some' 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 6-1 Comparison Criteria

Comparison Criteria Legend
Significant Comparative Advantage over Other Options
Some Comparative Advantage over Other Options
Comparable to Other Options / Neutral
Some Comparative Disadvantage over Other Options
Significant Comparative Disadvantage over Other Options

6.2. Civil and OHLE Option Selection

6.2.1. Stage 1 Sifting

The table below provides details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process.

Options which were assessed as feasible and fulfilled the project requirements were brought forward to Stage 2 MCA for a more detailed assessment.

Table 6-2 Sifting Process

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.

Option	Requirements		Description
		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).
		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	**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 1.14m. 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.

Option	Requirements		Description
		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
	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**

Option	Requirements		Description
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**
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.

Option	Requirements		Description
		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.
		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.

Option	Requirements		Description
		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**

A total of 10 No. Options were developed for the area for Civil and OHLE. Following the assessment completed as part of the Sifting Process, as shown in **Table 6-3**, a total of 2 No. Options were shortlisted and progressed to Stage 2 (MCA) of the assessment process.

Table 6-3 Summary of Sift Process Results

Main Option	Result	Brought forward to MCA
Option 0: 'Do Nothing'	**FAIL**	**No**
Option 1: Do Minimum	**FAIL**	**No**
Option 2	**FAIL**	**No**
Option 3	**FAIL**	**No**
Option 4	**FAIL**	**No**
Option 5	**FAIL**	**No**
Option 6	**FAIL**	**No**
Option 7	**FAIL**	**No**
Option 8	**FAIL**	**No**
Option 9	**PASS**	**YES**
Option 10	**PASS**	**YES**

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 structurally similar to 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.

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 requirement. Vertical clearance requirements would be achieved by a combination of track lowering and increases to road levels.

The difference between the two options relates to 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.

6.2.2. Stage 2 MCA

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

Table 6-4 MCA summary

CAF Parameters	Option 9 Assessment	Option 10 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.**

A total of 10 No. Options were initially developed for this area, following the selection process, Option 10 has been identified as the Preferred Option for this area with Option 9 being considered a design iteration of Option 10 for reasons outlined above.

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 Preferred Option for Kylemore Road Bridge (OBC5A) involves the replacement of 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 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 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.

6.3. Substations

A total of six substations are required for the DART+ South West Project, one of the substations is to be located in the section from Kylemore to Sarsfield Road at the following locations:

- Kylemore

The locations for the proposed substation are based on the findings from the power simulation study. The proposed locations were assessed as part of the options selection process. The following sections outline the associated selection process. See **Appendix C Drawings** for drawings of the proposed substation locations.

6.3.1. Option Selection Process Description

6.3.1.1. Stage 1 Preliminary Assessment Process (sifting)

Stage 1: Preliminary Assessment (Sifting Process): as outlined in Section 5, the 'Do Nothing' Option does not meet the project requirements and as such has not been considered further, all 'Do Something' Options have been considered as part of the option selection process. The process commenced with the Project Team identifying a study area within which a number of substation Option locations were possible. All potential substation Options within the study area were identified and mapped.

Consistent with CAF, the headline criteria which the options were assessed against included Engineering; Environment; and Economy. Of these, the key 'pass' or 'fail' criteria was Engineering and whether an option was 'Feasible' and met the Project objectives and requirements. The other sub-criteria considered as part of the process included:

- **Electrification**
  It is a fundamental project requirement to provide an electrification system that is the same as that to be deployed across all DART+ Projects. A standardised approach to the provision of traction power across the proposed DART+ projects is to be adopted. This aspect considered the feasibility of fitting a standardised ESBN / IÉ substation layout at each considered location / option and the feasibility of connecting to the existing ESB 38kV and/or MV grids.

- **Constructability**
  Constructability considers the installation of substation buildings, proposed access routes for construction traffic (plant and materials delivery) and installation / connectivity of feeder cables etc to the proposed DART lines (slow lines). Option specific constraints such as geographical location and topography are considered here.

- **Safety**
  Safety covers all aspects of the construction, operation and maintenance phases of the project. Given that the proposed substations will be newly constructed it is assumed that all solutions will meet a minimum safety standard. However, where minimum standards in terms of health and safety cannot be met due to local constraints / conditions the option will be deemed unfeasible.

Project objectives and requirements for substation Options include:

- **Proximity to the Railway Line**
  Ideally proposed substations would be located immediately adjacent to the proposed slow lines to allow for ease of connectivity of feeder cables to OHL equipment. Naturally, this aspect would favour existing vacant plots in the ownership of IÉ. However, other privately owned Options may also be considered. To avoid extensive cable easement requirements across privately owned lands or the requirement for extensive land acquisition any Option located more than 50m from the existing railway boundary fence would be considered unfeasible for the purposes of this assessment.

- **Vehicular Access**
  Fundamentally, given the Project is focused on an existing railway line and the interventions required are very localised; detailed design considerations (such as road design standards) have a direct bearing on the feasibility or otherwise of particular options. The proposed substations will require periodic access by

maintenance staff from both IÉ and ESB Networks. Hence, the feasibility of a proposed access route between the substation and the public road network is considered under this criterion.

Substation options which failed to meet the necessary Engineering Feasibility and Project Requirements were discounted. Options which met the necessary Engineering Feasibility and Project Requirements were brought forward to Stage 2: MCA for more detailed assessment.

6.3.1.2. Stage 2 Multi Criteria Analysis (MCA)

Following the Phase 1: Sifting, the Design Team developed the feasible options for presentation and consideration by a multi-disciplinary team in the next stage of the optioneering process.

Following a review of the CAF criteria, Physical Activity was not considered appliable to the process in that the criteria does not directly address matters that will differentiate substation options and will therefore yield a 'No comparative difference / Neutral' for the purpose of the comparative evaluation of options. The remaining CAF parameters were split into a number of sub-criteria considered relevant to substation Option selection for the DART+ South West Project.

The CAF parameters, criteria and considerations for comparative analysis are set out in **Table 6-5**. These include qualitative and quantitative indices.

The assessment was informed by substation locations, access arrangements and typical arrangement drawings A spatial envelope for each option including the likely extent of permanent and temporary works required was identified. The spatial envelope and GIS software was used to collate, map and analyse information in relation to environmental and other data sets to assist the specialists in undertaking the Stage 2: MCA.

The key environmental data / constraints are available in **Volume 4.4: Option Selection – Constraints Report**. This baseline data informed the baseline characteristics of the environmental topic / CAF sub criteria under consideration. It, inter alia, identified areas or Options with specific statutory protection, which are recognised as important and / or sensitive from a planning and environmental perspective e.g., European and National designated Options, Protected Views, Record of Protected Structures etc.

Relevant considerations include:

- The assessment is a comparative analysis between options presented, not an impact assessment of each option. The impact from the Preferred Option will be assessed in the Environmental Impact Assessment Report in the next phase of the development.
- Not all sub-criteria may be relevant in every case. Those that are relevant to the assessment, i.e., that have differentiated options, are highlighted in the narrative.
- For each option there are potential design variations. In due course design variations will be subject to detailed technical analysis (in respect of the Preferred Option and Railway Order design).
- For each option an indicative envelope was identified for the extent of permanent works required; a worst-case scenario was considered. The extent of temporary works was also considered.
- The envelope around each option was used to spatially represent environmental constraints within / proximate to the options.
- There are direct and indirect effects associated with either or both the construction and operational activities (including maintenance) associated with the options. These are highlighted where relevant, and in particular where they have differentiated options under particular sub-criteria.
- The changes in land use are considered under the planning policy consideration under the CAF Integration criteria (specifically Land Use Integration).

- The changes in traffic and associated impacts on the 'economy' are addressed under the CAF Economic criteria (specifically Traffic functionality and associated economic activities and opportunities) and are not duplicated as part of the Environment Assessment.

Table 6-5 CAF Parameters, Criteria and Considerations for Comparative Analysis

CAF Parameters	Criteria	Basis for Comparative Analysis	Qualitative and/or Quantitative Considerations (as appropriate)
1. Economy	Capital Expenditure (CAPEX): construction, land acquisition, servicing requirements, temporary works required to implement the option.	This sub-criterion considered comparative cost of construction, land cost (if any) and temporary works cost, servicing requirements of each Option. A high-level cost comparison was undertaken for each option (including potential land acquisitions (permanent and temporary, zoned or un-zoned land). The lowest comparative cost option was preferable to higher cost options.	Estimated high level comparative cost of construction of option. Extent and type of 3rd party lands required permanently. Extent and type of 3rd party lands required temporarily for temporary works during construction (where known).
	OPEX: day to day operational costs (IE or other entities), potential for obsolescence to maintain the option.	This sub-criterion considered long term maintenance costs. The option with less risk for long term maintenance issues (and hence cost) was preferable to options with greater risk of long-term maintenance issues.	Estimated risk of maintenance cost associated with the improvement or deterioration of the condition of the substation.
2. Integration	Equipment integration	The option which best integrates with existing equipment and other infrastructure and services was preferable to other options.	Minimising distance of the Option to the proposed slow lines (future DART lines), i.e. northern most tracks). Minimising distance to nearest MV and/or 38kV network. Note – connection to 38kV grid is 'preferred' under this assessment.
	IE land use integration	The option which best integrates with existing IÉ-owned property / facilities and IÉ land use strategies was preferable to other options.	Compatibility with IÉ land development potential Buildability of the solution during operation. Potential to impact rail service / IR operations during construction.

CAF Parameters	Criteria	Basis for Comparative Analysis	Qualitative and/or Quantitative Considerations (as appropriate)
	Road access integration	The option which best accesses the road network was preferable to other options.	Consideration of ease of access for ESB Networks and IÉ staff for ongoing / periodic maintenance purposes.
	Other Land use integration	The option with greater consistency and compliance with planning policy was preferable to others.	Consistency with land use strategies, regional and local plans including: Changing character of area (future urban regeneration proposals, extant planning permission etc). The extent to which an option provides / supports opportunity for regeneration - such as an improved urban environment.
	Geographical Integration	The option which minimise disruption and accessibility during construction was preferable.	Potential to impact on external links during construction. Potential to impact on external links during operation. Consideration for any community severance impacts.
		The option with greater consistency and compliance with other government policy was preferable to others.	Integration with Government Policy, Smarter Travel, Investment Programmes, Climate Action Plan etc.
	Adaptability in the future (robustness in the solution)	The option with greater adaptability for the future was preferable to others.	Ability to continue to function successfully despite future changes in circumstances
3. Environment - considers impacts, such as emissions to air, noise, and ecological and architectural impacts.	Noise and Vibration Air quality and Climate Landscape and Visual Biodiversity (flora and fauna) Cultural Heritage, archaeological and architectural heritage	The Option which minimises potential effects on the environmental factor under consideration was preferable to other options.	Based on the professional judgement of specialists qualified in the specialist areas taking into consideration sensitivity of the sub-criteria and the significance of the likely effect, and in general terms whether potential effects can be mitigated.

CAF Parameters	Criteria	Basis for Comparative Analysis	Qualitative and/or Quantitative Considerations (as appropriate)
	Water resources		
	Agricultural and non-agricultural		
	Geology and soils (including waste)		
4. Accessibility and Social Inclusion - considers social deprivation, geographic isolation and mobility and sensory deprivation	Neighbours	The option which can provide a higher level of amenity to neighbours is preferable.	Maximised distance to residential properties.
5. Safety - Safety is concerned with the impact of the investment on the number of transport related accidents.	Rail Safety	The option which provided the best rail safety solution was preferable.	Manageable acceptable conditions of the structures above, below and alongside the railway. Manageable acceptable conditions for safe operation of the railway.
	RAM	The option which provides the best performance in terms of Reliability, Availability and Maintainability of the option	A brief assessment of the Reliability, Availability and Maintainability.
	Users / People's Safety	The option which provides the best safety solution for maintenance staff and passers-by. The focus is on operational phase not construction.	

6.3.2. Kylemore Substation

6.3.2.1. Stage 1 Preliminary Assessment (Sifting)

Option 0 'Do Nothing' does not meet the fundamental project requirement to provide electrification of the railway and hence is discounted from further consideration. All other Options are feasible options and are brought forward for further detailed assessment.

Full details of the initial sifting assessment are provided at **Appendix A Sifting Process Backup**. A summary of the findings of the sifting assessment is provided in **Table 6.6**.

Table 6-6 - Sifting Assessment Summary

Kylemore Sifting	Result	Comments	Brought forward to MCA
Option 0: 'Do Nothing'	FAIL	Electrification not achieved	No
Option 1	FAIL	Failed on economy criteria	No
Option 2	PASS	Feasible	Yes

Option 0 'Do Nothing' does not meet the fundamental project requirement to provide electrification of the railway and hence is discounted from further consideration.

Option 1 is located on private land to the south of the railway line, adjacent to Kylemore bridge. The proposed site is located in the car park of a commercial unit, there is insufficient space in this area to accommodate the electrical substation as such the commercial unit would need to be acquired and demolished, there would also be a potential impact on adjoining businesses during the construction of the substation. The costs associated with this option are deemed to be prohibitive and as such this option has been ruled out.

Whilst Option 2 is also located on private land in a derelict/unused site and as such the impacts on adjoining businesses and the costs associated with this option are deemed to be more favourable.

6.3.2.2. Stage 2 MCA

As only one Option has made it through the sifting process, a comparative MCA analysis is not required.

6.3.2.3. Preferred Option

Option 2 becomes therefore the preferred option for the location of the substation at Kylemore. Option 2 is located outside of IÉ land in a derelict industrial unit. It is in the possession of private landowners on the southern side of the railway.

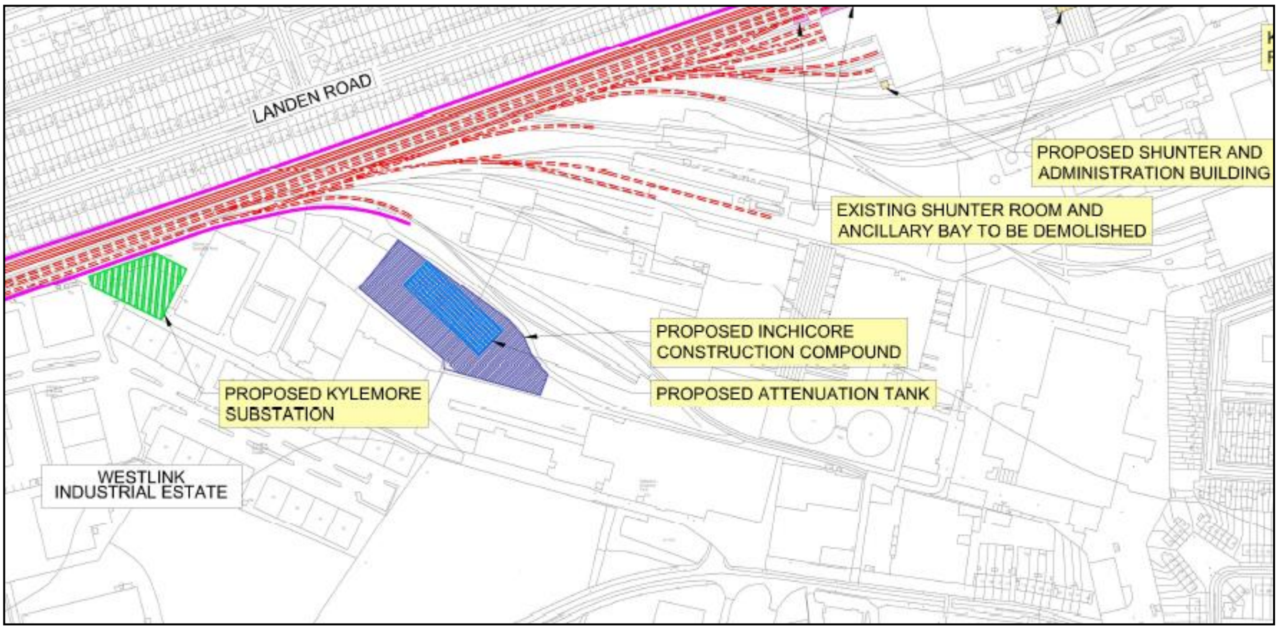


Figure 6-1 Kylemore Substation Preferred Location

The preferred option for the Kylemore substation falls out of the scope of this volume (Le Fanu to Kylemore Bridge), and the implementation of this substation does not impact on any of the design options considered for OHLE or civil works. The preferred option falls within the limits of **Volume 3D – Technical Optioneering Report – Kylemore to Sarsfield Road**.

6.4. Construction Compounds

6.4.1. Kylemore Road Bridge Construction Compound

As outlined in Section 5, to facilitate construction works along this section of the rail corridor, Construction Compounds are required. Access is required for localised works, in particular the bridge reconstruction, the proposed locations for the construction compounds are required to facilitate this work. As no other suitable alternative locations in the area were identified through the option development process, the selected construction compound locations did not require multi-criteria analysis.

Figure 6-2 Kylemore Preferred Construction Compound Location

7. Preferred Option Design Development

7.1. Review of Preferred Option

The baseline information or outcomes of design development since PC1 (inclusive of stakeholder input) have not materially impacted the optioneering and MCA outcomes that resulted in the selection of Option 10 as the Preferred Option.

7.2. Review of Stakeholder Feedback

The current proposal for road reconstruction provides compliance with the Irish Wheelchair Association minimum clear width recommendations. As noted earlier, the proposed footpaths and cycle tracks/lanes are being designed in accordance with the prevailing national standards. A temporary vulnerable user bridge will provide uninterrupted access across the railway for the duration of the road/bridge closure.

7.3. Design Development

The following sub-sections provide greater clarity on the development of the design towards the preferred option, this section includes the following:

1. Structures
2. Permanent Way
3. Signalling, Electrical and Telecommunications (SET)
4. Roads
5. Drainage

7.3.1. Structures

7.3.1.1. Bridges

As noted earlier in the report, electrifying the route requires the installation of overhead electrical lines along the railway. The lines pass under existing bridges. In many instances the existing bridges are too low to accommodate the overhead lines at their normal heights and special measures are warranted to facilitate the electrification. In relation to Kylemore Road Bridge (OBC5A), a total of nine (10 No.) Options were initially developed, following the selection process, Option 10 was identified as the Preferred Option for this area. This Option requires the reconstruction of the existing bridge with a slightly wider cross-section and longer span and with a different beam/deck arrangement to the existing humpback arch structure to accommodate OHLE clearances and reinstatement of utilities.

The requirement for a potential future 3No. platform arrangement required the use of double span bridge to avoid the impact that an increase in beam depth to facilitate the larger span would have on the road levels and accordingly vehicular accesses to 3rd party lands. The reduction in vertical clearance requirements (see **Section 3 Requirements for** requirements) also facilitated both a shared raising in track design levels as well as a further lowering of road level changes the initially envisaged at PC1.

See **Figure 7-1** and **Figure 7-2** for a general arrangement of the bridge and the deck longitudinal section.

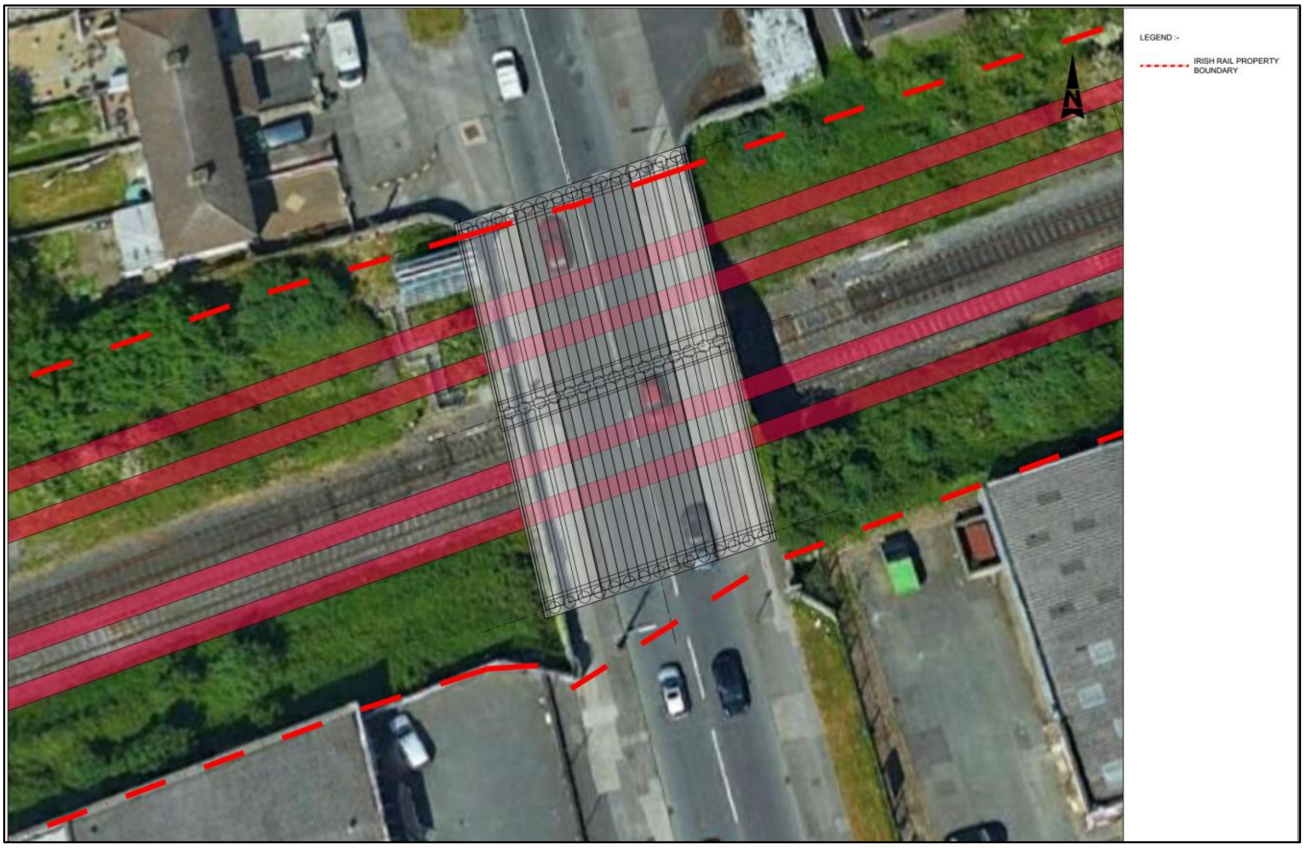


Figure 7-1 Kylemore Road Bridge (OBC5A) General Arrangement

Design development has focused on providing a bridge structure that facilitates (as a minimum) the same road corridor width that currently exists over the structure. Summary of the proposed bridge details:

- Proposed Bridge Type = Prestressed Beams and In-situ Deck seated on Secant Piles Abutment.
- Proposed Bridge Span (incl. Abutment Length) = 30.77m
- Proposed Bridge Width (incl. Parapets) = 18.5m
- Proposed Bridge Slab Depth = 0.25m
- Proposed Bridge Beam Depth = 0.85m
- Proposed Parapet = H4A containment walls 1.8m higher than adjacent footpath
- Proposed Utility Space Proofing = include duct and pipe containment for the reinstatement of the gas and watermains as well as multiple fibre optics and ESB cables in deck or between the beams, subject to the preference of the utility company at detailed design stage.

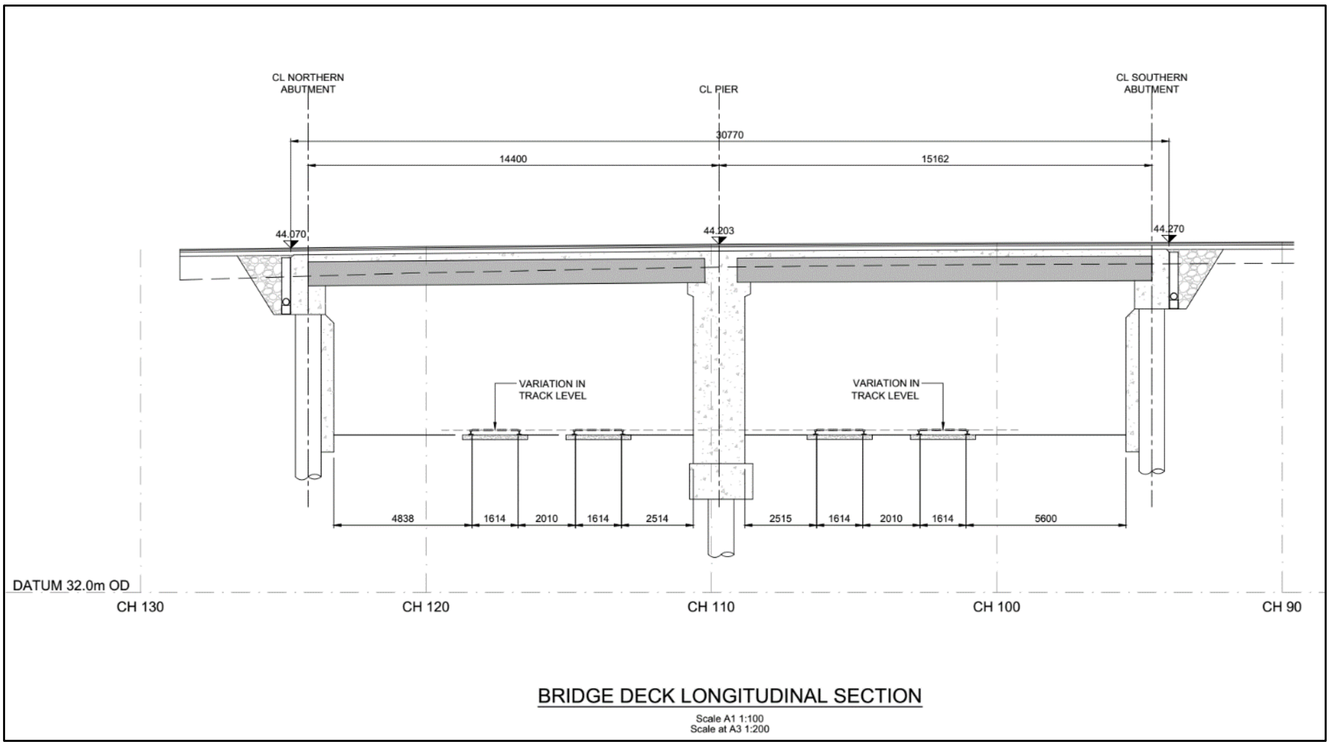


Figure 7-2 Kylemore Road Bridge (OBC5A) Bridge Deck Longitudinal Section – Facing East

The current bridge structure and parapets have little to no aesthetic appeal but equally it would be out of place to install a similar masonry stone finish to the reconstructed bridge, as one would envisage for Memorial Road Bridge (OBC3) or Le Fanu Bridge (OBC7). The priority is to firstly provide H4A containment levels for safety track and road user safety but there are numerous examples of aesthetic/architectural concrete finishes or stone cladding solutions to suit the surrounds (see **Figure 7-3** and **7-4**). Cladding would however not be considered for the track facing side of the parapet due to potential detachment safety concerns.

Figure 7-3 Parapets and/or H4A containment wall finishes for precast concrete

Figure 7-4 Precast panels fully cladded with masonry

7.3.1.2. Retaining Walls

The over steepened nature of the existing cutting slopes, proximity of the adjacent domestic and industrial properties and height of the cutting slope to be retained, necessitates a piled wall solution with the inclusion of soil nails or ground anchors along both the north and south sides of the rail corridor between Le Fanu and Kylemore section.

To facilitate the widening along the northern perimeter to form the northern (slow) tracks cess edge and retain the northern slopes of the cutting, the retaining wall height (above track cess level) will vary between 6 and 7.5 m along this section and a bored secant pile wall solution will be adopted for this section of retaining wall.

To facilitate the widening along the southern perimeter to form the southern (fast) tracks cess edge, the retaining wall height will vary between 4 and 6 m along this section and a bored secant pile wall solution will also be adopted for this section of retaining wall.

Additional minor retaining or earthwork structures may be required at road level surrounding Kylemore Road Bridge (OBC5A) to facilitate the proposed road level raising.

An example of a typical section of the wall and finished wall are shown in **Figures 7-5, 7-6** and **7-7**.

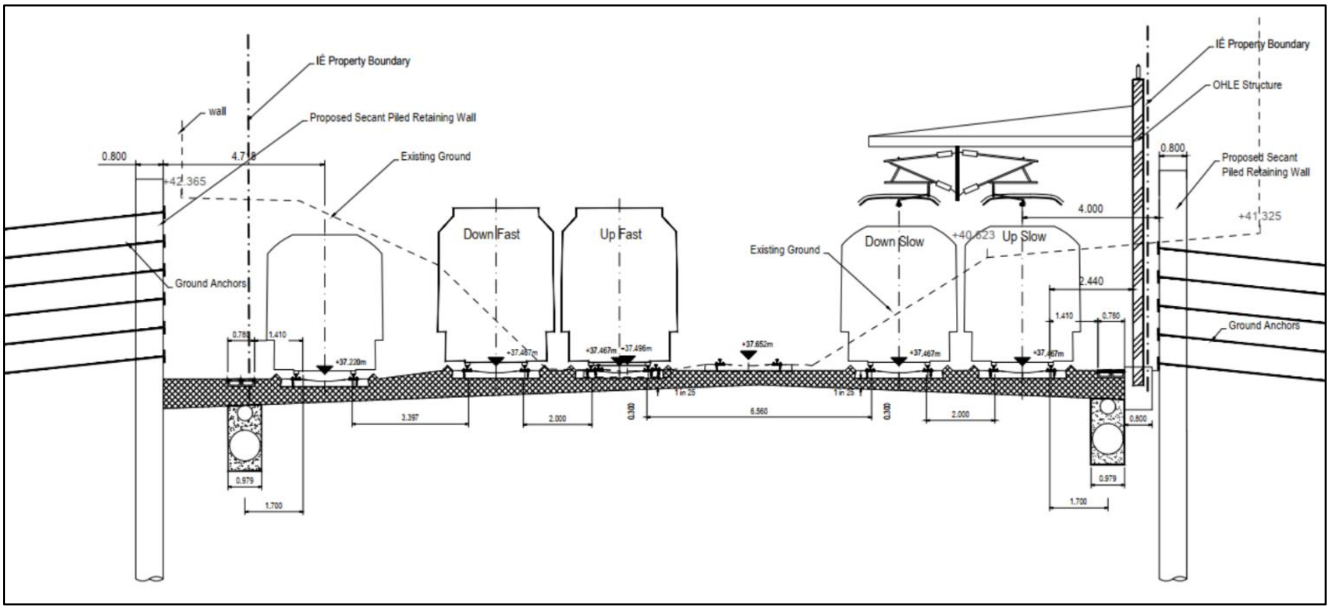


Figure 7-5 East of Kylemore Road Retaining Wall & Ground Anchors – Facing West

Figure 7-6 Example of a Secant Wall

Figure 7-7 Examples of Retaining Walls

7.3.1.3. Signalling Cantilevers

Where possible, signalling infrastructure will be located within IE existing land. Foundations for the signalling infrastructure will be either a shallow cast in-situ reinforced concrete footing or small diameter pile foundation.

Where space for foundations in the Cess is not available consideration will be given to integrating the signalling cantilevers into the retaining wall structural design locally.

Access to the top of man access cantilevers will be from steps within the Cess unless local access from IE land is safer and operationally more efficient.

7.3.1.4. Track Bed Design

Track lowering up to 0.5 m is proposed to achieve vertical clearances and therefore a new track bed design is required along this section. Bedrock has been indicated between Le Fanu and Kylemore Road Bridge near elevation 36.3 m AOD, and to facilitate the track lowering, the new track bed formation shall be constructed consisting of subgrade, sub ballast and ballast.

7.3.2. Permanent Way

The proposed 4-track layout comprises 2 existing tracks realigned on the south side of the rail corridor to become the Fast lines. 2 new tracks – the Slow lines – will be situated on the north side of the corridor as shown in the **Figure 7-8**.

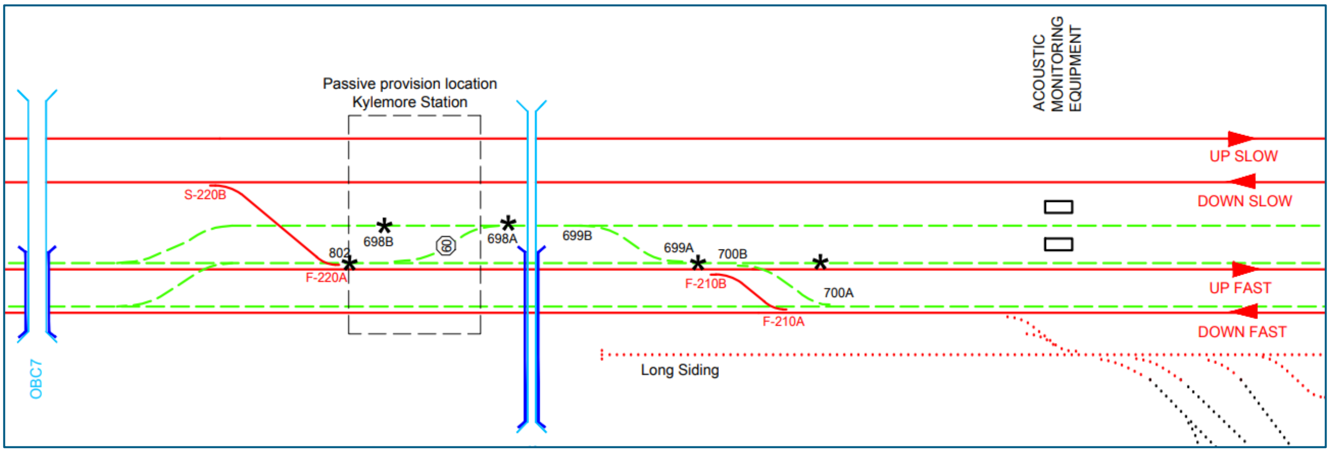


Figure 7-8 Le Fanu Road Bridge (OBC7) to Kylemore Road Bridge (OBC5A) – Track Plan Layout

(new tracks = red, removed tracks = dashed green, structures = blue)

The horizontal layout of the tracks features a wide track interval between the Slow and Fast lines – 6.8m, which is considerably more than the standard clearance of 3.4m. This is necessary in order to accommodate the bridge abutments of the proposed new 2-span structure, which in itself has been designed to provide adequate room for a future Kylemore Station. Note that if a station were to be built at Kylemore in the future, then this would necessitate realignment of the plain line (i.e. the main lines for the Fast lines on the south side of the corridor) to widen the ten foot interval between the Slow and the Fast lines so that a new island platform could be built. As a further consequence the Down Slow-Up Fast crossover would need to be relocated.

Vertically, the Slow and Fast tracks are co-planar (at the same level and gradient) through this section, in order to accommodate the crossover between the Down Slow and Up Fast lines to the west of Kylemore Road Bridge (OBC5A) and facilitate a level bridge deck across the new span perpendicular to the tracks. The magnitude of the track lowers at Kylemore Road Bridge (OBC5A) is 0.5m at the western parapet; this is in order to achieve the minimum acceptable contact wire height of 4.4m for the slow tracks.

The gradient through the section is 0.600%, for all 4 tracks, between Le Fanu Road Bridge (OBC7) and Kylemore Road Bridge (OBC5A).

The line speeds through the section are 160km/h (100mph) for the Fast lines and 110km/h (70mph) for the Slow lines, in accordance with the project scope.

Retaining walls are required to both the north and south sides of the rail corridor as the 4-track corridor is in cutting, as can be seen in **Figure 7-9**.

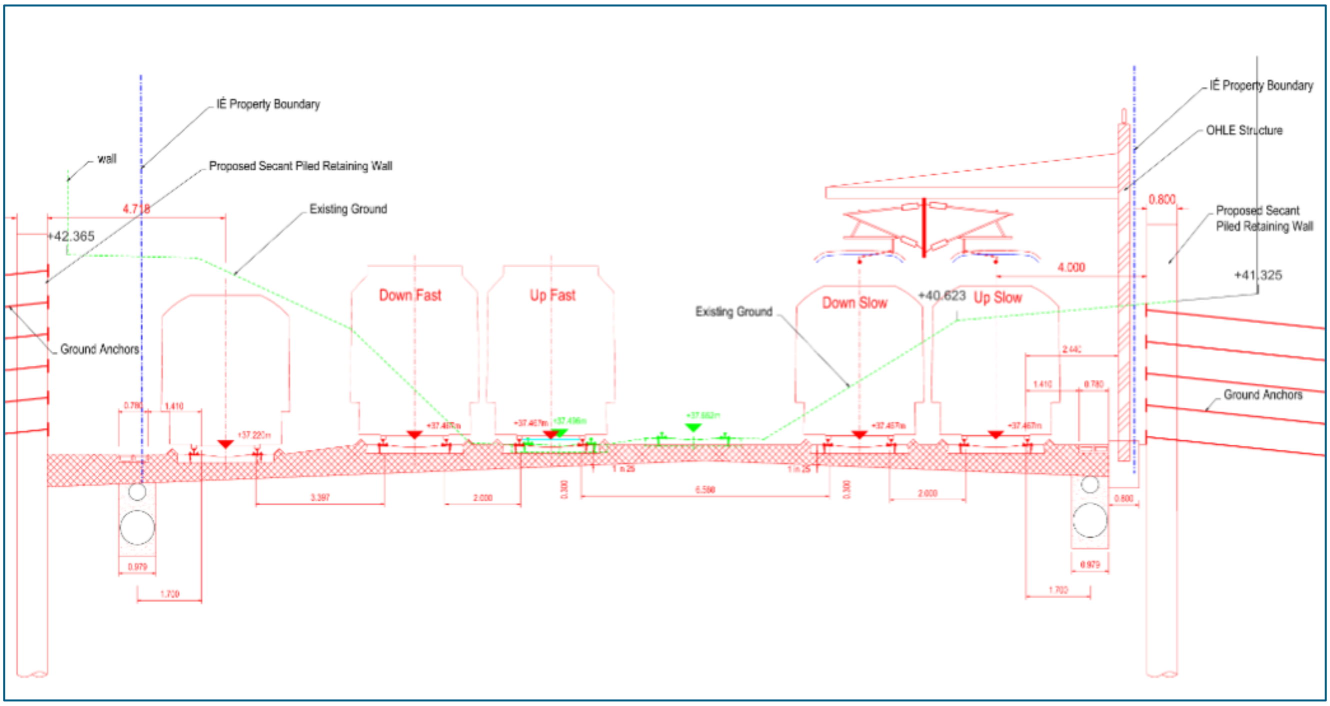


Figure 7-9 Cross Section looking West at CH 12+030, 30m East of Kylemore Road Bridge (OBC5A) – Facing West

7.3.3. Signalling, Electrical and Telecommunications (SET)

This section provides detail on the proposed SET equipment and components which will be distributed along this section of the railway. More information on the typical SET equipment is included in the **Technical Options Report Volume 2**.

7.3.3.1. Signalling

The signalling system is used to safely control and monitor train movement on the Irish Rail network. The system comprises a network of sensors, controls, signs and lights. It also includes localised control cabinets and cabins.

A Signalling scheme plan has been developed for the entire route, the section pertaining to this area is detailed in **Figure 7-10**. The scheme plan shows the number and type of signals that will be allocated on this section of the route and the points and crossings that they interface with. The following details the physical signalling infrastructure that will be installed.

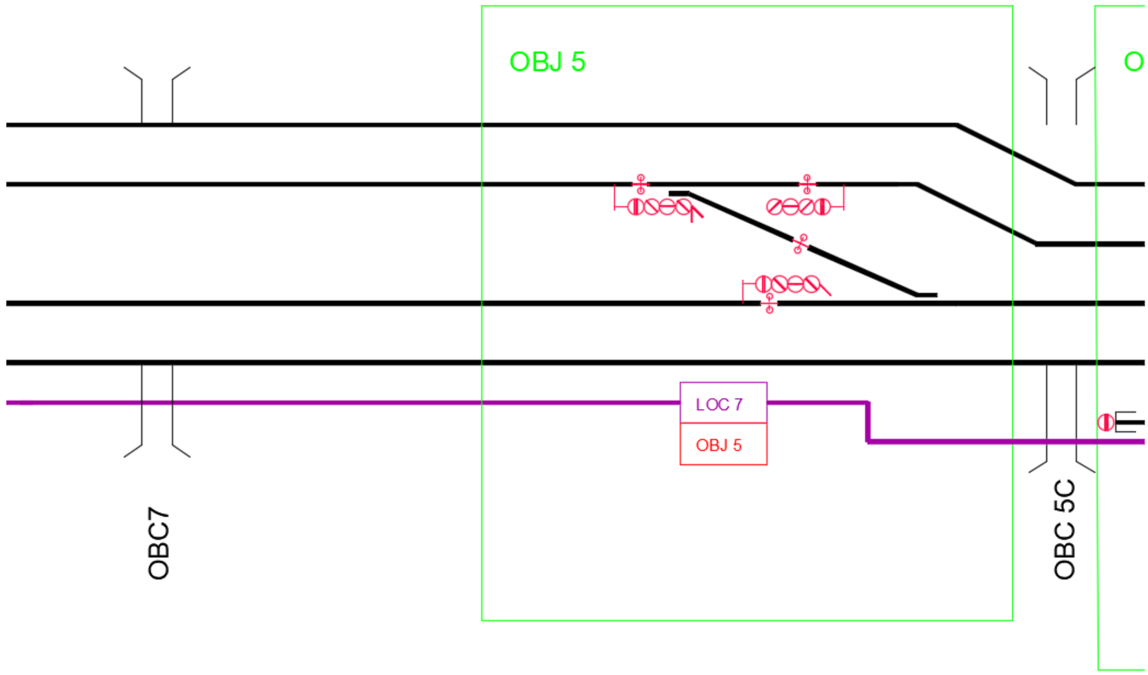


Figure 7-10 Signalling Scheme Plan (Park West – Le Fanu Bridge)

Legend:

- Purple line: 650 V line
- Purple square: LV cabinet
- Orange square: OBJ cabinet (signalling)
- Green square: OBJ influence area
- Black lines: Tracks
- Red: Signals

The physical signalling infrastructure has been developed and is indicated in **Figure 7-11**. This figure shows an Object Controller Cabinet (blue box) and a Location Case (black box). All equipment is expected to be located within the existing IE land boundary to minimise the impact to the public.

Figure 7-11 Signalling Infrastructure (Approx. 160m west of Kylemore Road Bridge)

Infrastructure highlighted as follows:

- Blue box – Object Controller Cabinet
- Black box – Location case

7.3.3.2. Signalling Post

There are currently no proposed signalling cantilevers or gantries in this section and trackside signals would be located on signal posts adjacent to trackside. A typical signalling post is shown in **Figure 7-12.**

Figure 7-12 Typical Signalling Post

7.3.3.3. Object Controller Cabinet (OBJ)

In the railway system, the movement of the train is controlled by an interlocking system. Such an interlocking system consists of different parts. From a logical perspective, there is a central device (computer) that controls and senses the condition of important equipment such as switches, signals, track circuits, etc. This equipment is collectively referred to as an object or rail side object. The equipment that handles the interface between the central device and the object is referred to as an object controller. A typical Object Controller Cabinet is shown in **Figure 7-13**.

Figure 7-13 Typical Object Controller Cabinet

7.3.3.4. Location Case

Location Cases (Locs) accommodate railway signalling equipment to detect the location of trains, control the trackside signals and switch the points. They link the physical asset to the control equipment within. Additionally, they are used to accommodate the required power distribution to the signalling equipment. A typical Location Case is in **Figure 7-14**.

Figure 7-14 Typical Location Cases

7.3.3.5. Cable Containment

A cable containment strategy has been progressed and following review of several alternatives such as traditional concrete troughing and direct burying cable routes, a secure trough antislip walkway is the preferred alternative, with ladder rack being used on tunnel walls (see **Figure 7-15**). This takes up the same footprint as traditional concrete troughing but is of lighter more manageable construction. As this trunking also acts as a designated non-slip walkway it will help to mitigate space constraint issues along the route as well as minimise the aesthetic impact to the public. It also has the added advantage that it provides security of cabling from theft and damage as well as providng easy maintenance going forward.

Figure 7-15 Containment walkway

Cable containment route will run adjacent to the track in accordance with standard railway practice and will cross under the track where required using under track crossings (UTX) and secure turning chamber. Type of containment at each stage of the track will be highlighted in the design drawings.

7.3.3.6. Telecommunications

No new Telecom Equipment Building (TER) is needed in this section

7.3.3.7. Electrification

In Le Fanu to Kylemore Bridge section, in 4 track area, the electrification equipment will be supported by TTC structures and STC structures where the OHLE to be terminated with anchor arrangement required in limited space, as detailed in **Section 3.2.1.** See **Figure 7-16.**

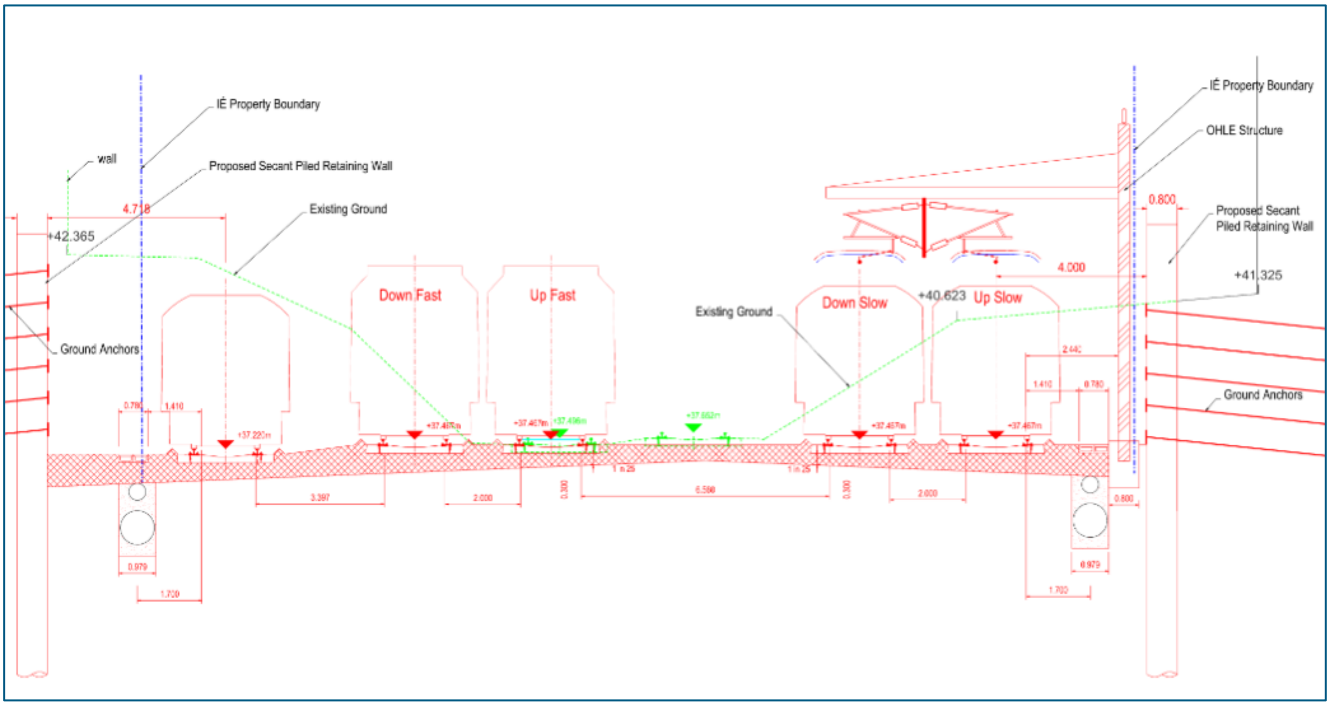


Figure 7-16 Typical OHLE TTC arrangement in four track open route

Kylemore Road Bridge (OBC5A) will be designed to provide a soffit height of 4.91m. In this configuration the OHLE will be graded down with a minimum contact wire height of 4.4m through the bridge under all conditions. OHLE through the bridge will be fitted, with elastic bridge arms supported from the bridge at a single location in the middle of the bridge due to its length. Electrical clearance from the live OHLE to the bridge will be 100mm static and 80mm dynamic. These connections would not be visible from road level.

Typically, OHLE masts would be positioned between 20m and 40m on each side of the bridge before reverting to normal spacings. The contact wire will be graded up. **Figure 7-17** shows an example of a cross section for OBC5A fitted OHLE system in the four-tracking area.

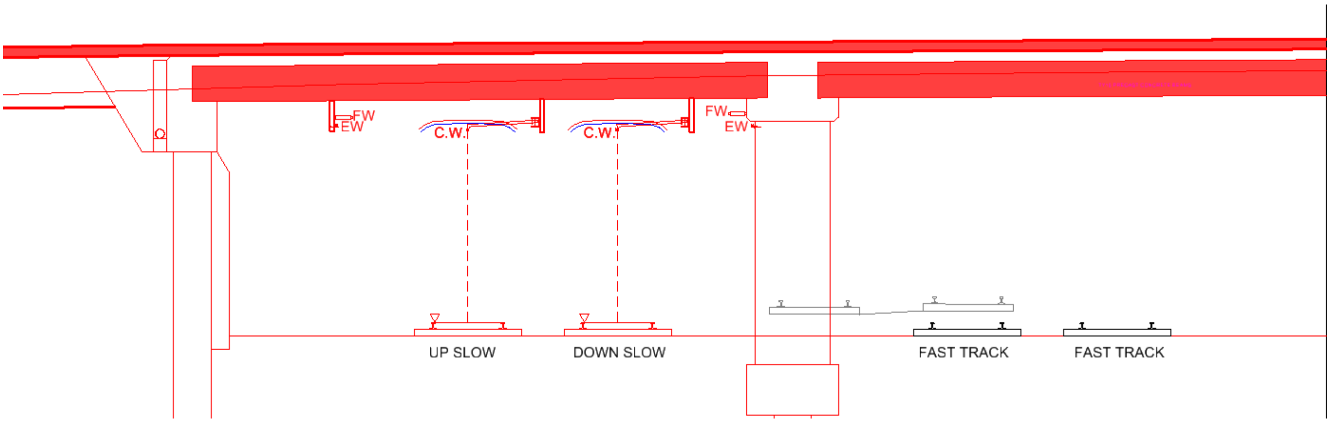


Figure 7-17 Example cross section for OBC5A fitted OHLE system in four tracking area.

With the OHLE configuration above, 3.5m clearance between standing surface and pantograph at the future Kylemore station cannot be achieved but 3m clearance can be achieved. Risk assessment might be required in these cases.

The current design for OHLE mast position in this area has not consider the future Kylemore station. Due to the length of the station building, the OHLE configuration will need to be modified to be fitted to the future station building depends on the station design.

Overlaps has been placed at each side of the proposed future Kylemore station for future maintenance and insulation purpose.

7.3.4. Roads

The project will provide a footpath width that would be compliant with current Design Manual for Urban Roads and Streets (2011); as well as a cycle lane/track width that is compliant with the National Cycle Manual (2013).

Figure 7-18 shows the roadway plan and section at Kylemore Road over the area reinstated to accommodate the bridge raising.

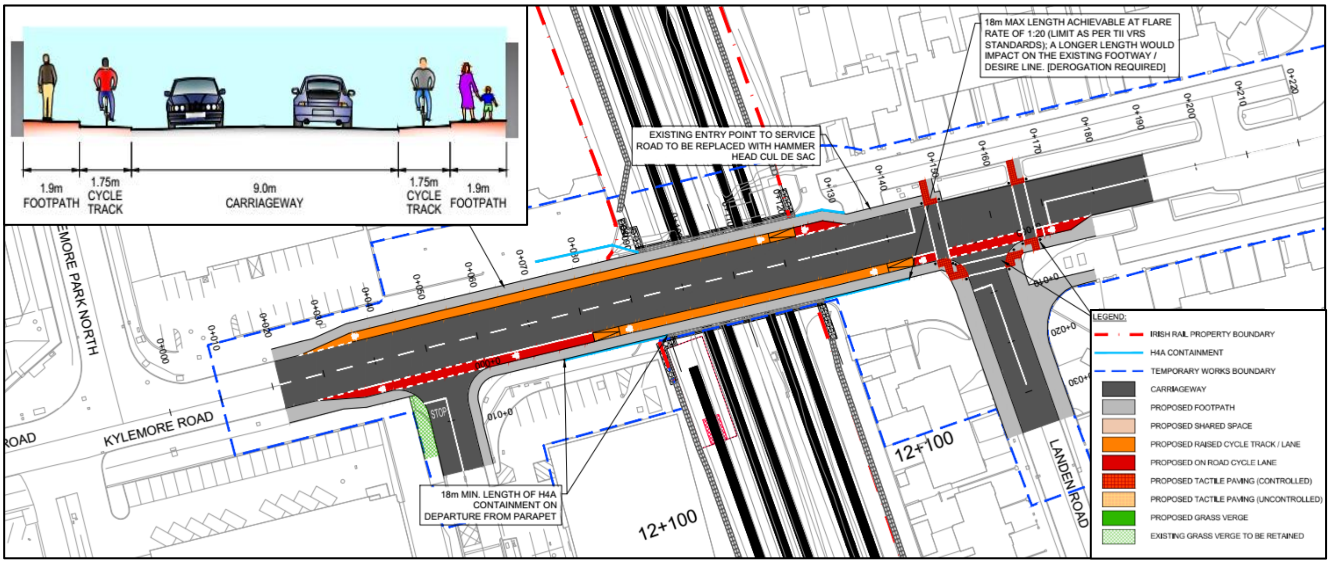


Figure 7-18 Kylemore Road - Plan and Section

Careful attention has been made to balance the provision of off road segregated cycle tracks while providing unhindered access to existing properties. Where the geometry of the road and junctions dictate, the cycle tracks revert to on-road cycle lanes but still independent of the vehicular lane.

The carriageway lane widths remain 4.5m in each direction over the bridge as currently exists.

- in the event that the revised National Cycle Manual requires widening of both the footpath and cycle track as provided this could be taken from the existing lane widths in this area without requiring a further bridge widening. Still leaving sufficient lane width and segregation for safe operation of buses and large commercial vehicles

The proposed footpath and cycle track arrangement, for both sides of the road over the bridge, and on all departures and approaches to the bridge would include:

- 1.75m wide cycle track segregated from the carriageway with a 50mm kerb height
- 1.9m wide footpath with 75mm kerb height to the cycle track adjacent; separating it from the cycle track
- An additional 0.3m buffer strip to the parapet face for potential fixings.
- Appropriate drop kerbs and tactile paving would be provided for vulnerable users at crossing points.

As was noted in PC1 the Kylemore Road would be raised on the northern side of the bridge by approximately 650mm. The resultant impact is that the edge of road corridor on the northern side of the bridge requires a retaining wall (of variable heights, 400-650mm) to support the layer works. This localised footpath retaining wall is to avoid encroachment of the works into the residential service road (north west of the bridge) as well as to provide LDV access to the local ESB substation (north east of the bridge) in the event that this substation is not relocated and remains operational in its present location.

The southern entrance to the residential service road mentioned above would be closed permanently and the road convert to operate as a cul-de-sac; similar to the arrangement already visible to the north east of the Kylemore/Landen Road junction. Utility company or removals trucks have facilities at the second entrance to this service road to turn off Kylemore road and prepare to reverse back down the service road. This revised waste services access protocol is in use on a number of roads in the same area.

The proposed design layout limits the impact on the mature trees while still providing segregation and transitions to improve the vulnerable user journey through this section of road considering all the associated constraints and the short length of reinstatement works.

7.3.5. Drainage Requirements

7.3.5.1 Road Drainage

The road drainage would be reinstated with typical pipe and gulley collection system, with gullies located similarly to the current drainage layout. Additional gullies would however be provided to account for the change in kerb edge geometry. All low points would typically be reinstated with a double gulley configuration to provide a level of mitigation against the potential for blockages. Where feasible gullies would be located on the high ends of the bell-mouth entry point at junctions to avoid and/or in advance of pedestrian crossings to avoid the potential build-up of water at pedestrian crossing points.

7.3.5.2 Track Drainage

The proposed drainage system includes filter drains to collect runoff waters from the ballast and surrounding areas, and carrier pipes to convey collected runoffs to the proposed attenuation structure and discharge point, located west of Inchicore Depot. The proposed filter drains discharge into the collector pipes through manholes spaced between 30 to 50 metres.

The drainage network for this track section consists of two main branches running parallel to the track beneath the ballast layer.

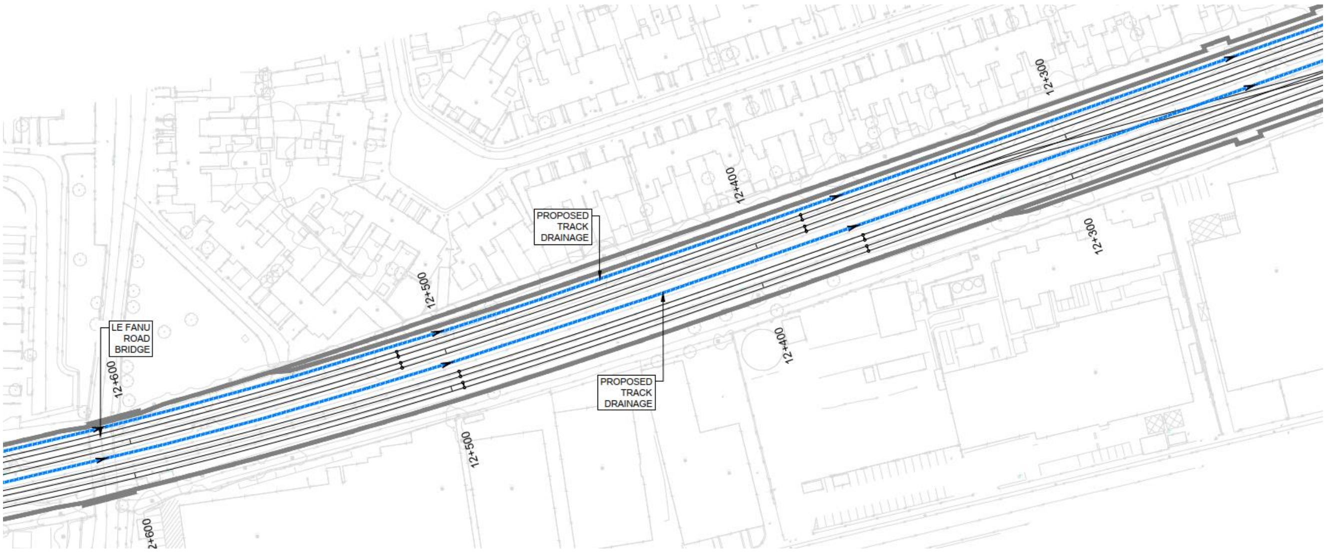


Figure 7-19 Proposed Track Drainage Layout between Le Fanu and Kylemore

No track drainage attenuation structures are proposed in this section between Le Fanu Road and Kylemore Road. The retention tank and outfall point, for the network are located in the Inchicore Yard lands.

In the event of Kylemore Road Station being constructed, the proposed track drainage layout will be adjusted to suit new levels and track arrangement.

8. Construction

This section of the report sets out the approach in relation to the construction methodology for the works in the area of Kylemore Bridge (OBC5A).

8.1. Summary of the Proposed Works

Kylemore Road Bridge (OBC5A) will be demolished and reconstructed. The section of the railway corridor has to be widened from Le Fanu Road Bridge (OBC7) to Kylemore Road Bridge (OBC5A) to accommodate the additional 2 no. tracks for the new DART+ service. In addition, the 2 no. northern tracks through this area (Slow Tracks) will be electrified. The cross section varies through this area but is predominantly in cutting, with property boundaries close to the top of the cut slopes. The widening operation is further complicated by the need to lower the tracks through this area so that roads that cross the corridor on bridges are not raised too much (creating significant impact on local properties and road infrastructure).

8.2. Retaining Structures

To achieve the widened cross section, to limit the impact of the construction works on adjacent properties and to reduce land acquisition, it is proposed to construct walls along each side of the corridor where there is a level difference between the tracks and the adjacent land.

8.2.1. Secant piled walls and contiguous bored piled walls

Secant and contiguous bored piled walls are constructed using a top down method i.e. they are constructed through the soil and then the soil in front of the walls is removed. Large piling rigs are required to core large diameter holes through the soil using augers through soil and corers through rock. Once the soil is removed a reinforcement cage is lowered into the holes and concrete is poured. New piles are added to the side of the first to create a wall. Secant pile walls have continuous piles interconnected with each other and contiguous piles have gaps between the piles and are infilled between to create continuous support.

The boring of the piles, the removal of spoil, the supply of reinforcement cages and concrete to and from the wall position is a significant operation requiring large piling equipment, cranes, dump trucks, and large concrete and rebar supply and dump vehicles. These operations require good access and egress, a stable operational platform and significant working space.

8.2.2. Soil Nailing

Soil nailing is a top down walling method. From the top, soil is excavated over a short height. The surface of the excavation can be spray concreted with steel mesh placed in position if required. When the concrete has cured sufficiently, long steel rods are driven into the retained soil and stressed to give the wall global stability and strength. The area beneath the constructed section of wall can then be excavated and the process repeated until the entire height is complete.

The main advantage of soil nailing is that relative to other options it has less impact on the properties in terms of noise and disruption. It also does not need so much large plant to install the wall and is therefore considered safer to the railway operation.

The main disadvantage of this method is that vertical walls cannot generally be created so more land take is required to form the wall. Also, the nails are required to extend several metres past the face of the wall and may encroach into property outside of the ownership of Irish Rail. In this case a wayleave or other ownership mechanism may be required under certain properties.

8.2.3. Retaining Walls Design

It is proposed that a bored secant pile wall solution will be adopted for the section of retaining wall along the perimeters to form the northern and southern tracks cess edge. The retaining walls vary between 4 and 7.5 m in height and will be constructed utilising access from track side within Irish Rail lands.

To minimise the pile size and associated lateral movement of the upper portion of the walls and to maintain the integrity of the infrastructure beyond the crest of the retained slope, the retaining walls along this section shall be anchored using soil nails extending into the existing slope substratum beneath the properties on both the northern and southern side of the rail corridor. The length of the soil nails/ground anchors will vary based on the height of the cutting slope to be retained and are anticipated to be approximately 10 to 15 m in length.

The soil nails/ground anchors will be installed utilising access from track side within Irish Rail lands.

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.

8.3. Bridges

In order to demolish and reconstruct Kylemore Road Bridge (OBC5A) a full road and bridge closure is necessary. The plan would be to limit the duration of impact on existing residential unit driveway accesses north west of the bridge by balancing the implementation of discrete works packages versus the imperative to complete the whole structure and road reinstatement as quick as possible. See Section 8.7 – Temporary Traffic Management.

Before any such demolition and/or long term closure of the road can commence 2 no. of temporary bridges have been identified as being necessary:

- A temporary vulnerable user bridge (with min. 3.15m operational width) would be require in advance of said works to provide an uninterrupted direct access (at this location) between the residential area to the north and the industrial area to the south of the bridge. It is proposed to locate this bridge to the east of the existing structure as close as is deemed safe while limiting impact on residential service road adjacent. The same temporary bridge will include most of the temporary utility diversions.
- To the west of the structure a single lane temporary vehicular bridge (with min. 4.5m operational width) will be provided with an additional 1.5m protected pedestrian space. This will provide additional pedestrian only relief as well as flexibility during demolition and construction operations.

The Perway piled retaining wall on the northern side of the 4-track widening corridor would need to be installed for much of its length in this section of track, and particularly in the vicinity of the existing bridge, in advance of the 2 no. temporary bridge installations. This would be necessary to provide the abutment support on the north side of the track for the temporary bridges and also to complete the major piling works in advance of the diversion for vulnerable users, owing to the size and nature of construction plant used for piling operations. To the south the temporary bridges will be founded on temporary spread pad foundations but there too the piling would have to be completed under these temporary bridges in advance of their installation. The latter piling requires mobilising the piling rigs within the carparks of the existing industrial units south of the bridge (between the buildings and the boundary of the road corridor). The rail corridor piled retaining walls would be constructed from the trackside.

The abutments for the new Kylemore Road Bridge (OBC5A) are currently assumed to be piled abutments, while the central pier would be constructed using rising formwork over a piled foundation; alternatives might be proposed by the contractor. There is potential for the initial abutment piling work for the new bridge to be installed prior to the bridge demolition. This would be completed using local road diversions to the works.

It would be further preferable to complete as much of this work prior to the temporary bridge installation, and full road closure but it is not an imperative; it is also subject to further confirmation of existing utilities.

8.4. Permanent Way

Track lowering will be required through this area areas to facilitate the provision of four tracking and electrification. Works will comprise:

- Diversion or closure of the operational track, utilities and ancillary infrastructure
- Where excavations are significant, support of adjacent operational track
- Excavation of track bed
- Excavation of sub strata
- Replacement of utilities and ancillary infrastructure
- Construction of new track bed

8.5. OHLE Infrastructure

Structures will be required at a maximum spacing of 60m along the track to support the catenary cables. The support structures are generally supported from one side of the track (cantilever) or from both sides (portal) depending on the permanent way layout. Where there are adjacent walls the support structure can be fixed to the walls negating the need for vertical supports (stanchions).

Support structures will be either founded by means of piles or spread foundations, depending on soil conditions or the contractor's preferred methodology.

It is envisaged that the OHLE will be constructed in safe zones adjacent to the live railway or in night-time possessions. As there will be predominantly 2 working railway tracks through the Cork line and ultimately 4 tracks will be provided, it is envisaged that a safe zone will be possible for construction works.

8.6. Substations

One new substation will be constructed in the outer limits of this area. From a constructability perspective, the substations are relatively straightforward; the main consideration for each site is the large equipment that needs to be brought to site and installed within the buildings. This may necessitate cranage from either within the site or in an adjacent suitable position. The buildings will need to be designed for constant access for maintenance and equipment replacement. Land will need to be purchased unless the land is already within Irish Rail ownership. Secure fencing will be required around each site to prevent unwanted entry.

The typical duration of construction for an electrical substation is six months, including civil, mechanical, and electrical works. The area reserved for construction works is approximately 1,000 m^2.

8.7. Construction Compounds

Works on this linear scheme will require Construction Compounds at specific locations. The sites will need to accommodate offices for the contractor and client teams, storage facilities, recycling facilities, parking for cars and plant and potentially fabrication areas. It is a prerequisite that the compounds are located close to and ideally with direct access to the site. The sites must be fully serviced with electricity, water, sewerage and telecoms and must have good access to the public road.

The compounds are required at specific construction sub-sites and also distributed along the scheme by geographical features. For example, compounds will be required at each of the bridge reconstruction locations plus will be required to for material processing and storage of construction components. The compounds will be used to support earthworks, ecological clearances, enabling works, site clearance, utility diversions work, civil works, the demolition of bridges, OHLE, track installation, signalling and telecoms equipment and all ancillary works.

Fencing and in some cases screening along with topsoil bunds where topsoil has been removed may be required for each construction compound. Noise screening and temporary guide rail fencing may be required at access locations to the railway corridor. Security fencing will be required for security purposes of both the workforce and the public. Gated access to the site and compounds will be required to check vehicles and personnel arriving on site are permitted to gain access. An access road will also be required from each compound to the site and also joining up to the public road. These access roads will be the main route for vehicles entering the site, including deliveries and arrival and departure of the workforce.

The construction compounds will be located such that they require minimal modification, if any, over the duration of the construction programme. The compounds will typically consist of areas of hardstanding for vehicles and materials and therefore the water runoff will be managed and treated as required.

Section 5 Options outlines the preferred locations for the construction compounds required for this area; Section 6 Options Selection Process provides more detail of the option selection methodology. A construction compound (Split into 4 discrete sites) is required for the reconstruction of Kylemore Road Bridge.

Figure 8-1 Kylemore Preferred Construction Compound Location

8.8. Temporary Traffic Management

8.8.1. Kylemore Road Closure

Kylemore Road Bridge (OBC5A) reconstruction requires a full closure of the existing bridge on Kylemore Road. The temporary traffic management solutions being considered at this time are set out below:

- The provision of a temporary northbound single directional vehicle bridge on the western side of the proposed new permanent bridge structure. This bridge is anticipated to accommodate northbound traffic while southbound traffic will be required to be re-routed. The bridge will also provide a 1.5m footpath to cater for pedestrians on the western side of Kylemore Road. The proposed bridge profile is shown in **Figure 8-2** below.
- The proposed layout and associated temporary bridge locations are shown in **Figure 8-3**.
- The reason for the selection of the northbound traffic to be retained over the southbound traffic is for the two following reasons:
  - The western side of Kylemore Road Bridge provides more space, particularly for vehicle re-entry into the road network; and
  - Northbound traffic volumes are greater than the southbound direction. Traffic counts conducted on the 6th May 2021 confirm that daily northbound volumes are approximately 7.1% greater than the southbound volumes. The associated traffic data is shown in **Table 8-1** below.
  - Bridge Exit Option 1 is preferable as 1st phase to limit the temporary impact on the residential properties in the north western service road. The first 2 no. houses north of the bridge could temporarily lose vehicular access to their plot for most of the duration of the works but with parking proposed to be made available in the median (between the service road and Kylemore Road) approximately 30m from the houses.
  - Bridge Exit Option 2 would be required for Phase 2 in order to reconstruct Kylemore and Landen Roads, as represented in Road Plan No. DP-04-23-DWG-CV-TTA-61531, and tie-into the new bridge. The exit point is indicative of the current service road exit shown in **Figure 8-3.** All 15No. properties in the service road would be temporarily impacted; at times possibly having to return home from the south over the single lane bridge. Alternatives to reduce the impact locally will be investigated further.

Figure 8-2 Single Directional Temporary Vehicle/Pedestrian Bridge - Kylemore Road

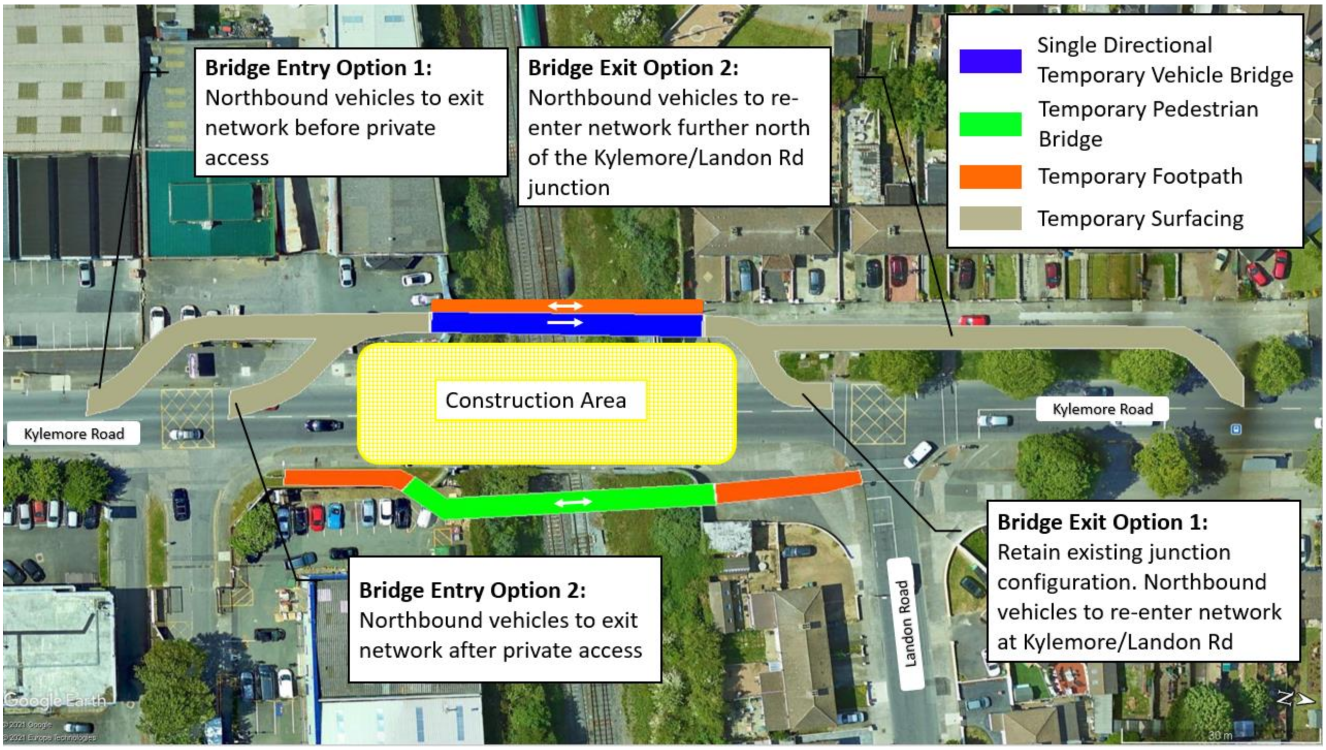


Figure 8-3 - Northbound Traffic Diversion – Mitigation Measures

Table 8-1 Traffic Volumes over Kylemore Rd Bridge (Count data 06/05/2021)

Traffic Type	Northbound	Southbound	Northbound % Diff.
Daily Traffic (07h00 – 19h00)	28 365	26 476	7.1%

The southbound traffic is anticipated to be distributed onto the surrounding network via the Le Fanu Road Bridge (OBC7). Heavy Vehicles (HVs) will be restricted from using Kylemore Ave and will be required to travel via Ballyfermot Rd instead. The proposed diversion routes for light traffic is shown in **Figure 8-4** below while heavy traffic diversion routes are shown in **Figure 8-5**.

In order to cater for the additional traffic volumes, it is anticipated that temporary traffic signals will be required at the following existing priority junctions:

- Kylemore Rd & Kylemore Ave; and
- Kylemore Park Rd & Le Fanu Rd.

The junction locations are shown in **Figure 8-4, 8-5 and 8-6.**.

Figure 8-4 – Kylemore Southbound Traffic Diversions – Light Vehicles

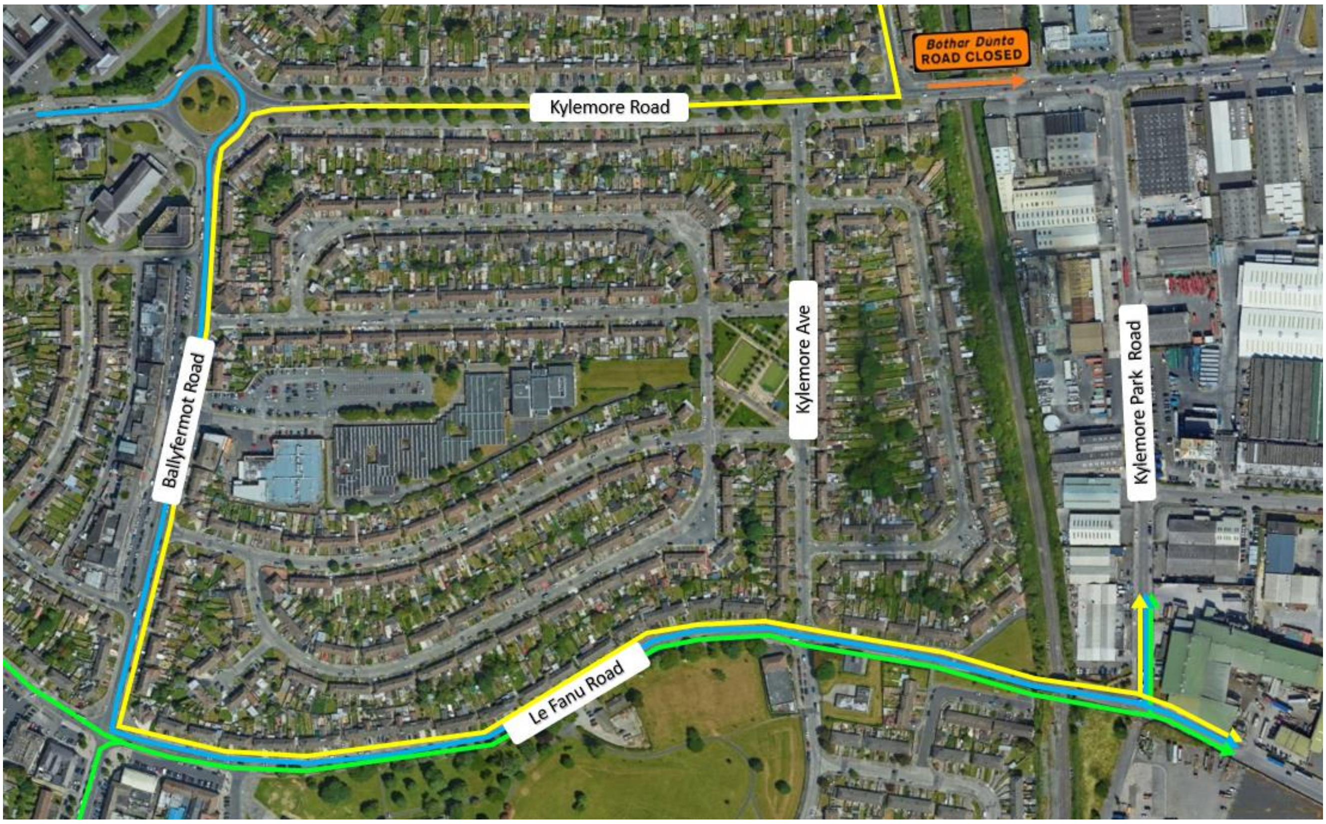


Figure 8-5 - Kylemore Southbound Traffic Diversions – Heavy Vehicles

Figure 8-6 - Temporary Traffic Signal Locations

Owing to the lengthy duration of this closure; vehicular users are anticipated to experience initial congestion at the start of the closure, followed by a gradual decrease in total vehicle volumes and congestion.

Overall pedestrian and cycling connectivity are expected to be maintained throughout the closure period and, as a result, is expected to maintain a high level of service. Pedestrian facilities are expected to be provided on both sides of the construction area via two temporary bridges.

The only bus route anticipated to be affected by the Kylemore Rd bridge closure will be the Dublin Bus Route 18 - Hollyville Lawn to Dromard Terrace. This route will be required to be diverted via Kylemore Park & Kylemore Ave as shown in **Figure 8-7**. Landen Road stop (ID: 2702) would also need to be relocated further north on Kylemore Rd in order to serve the revised route 18.

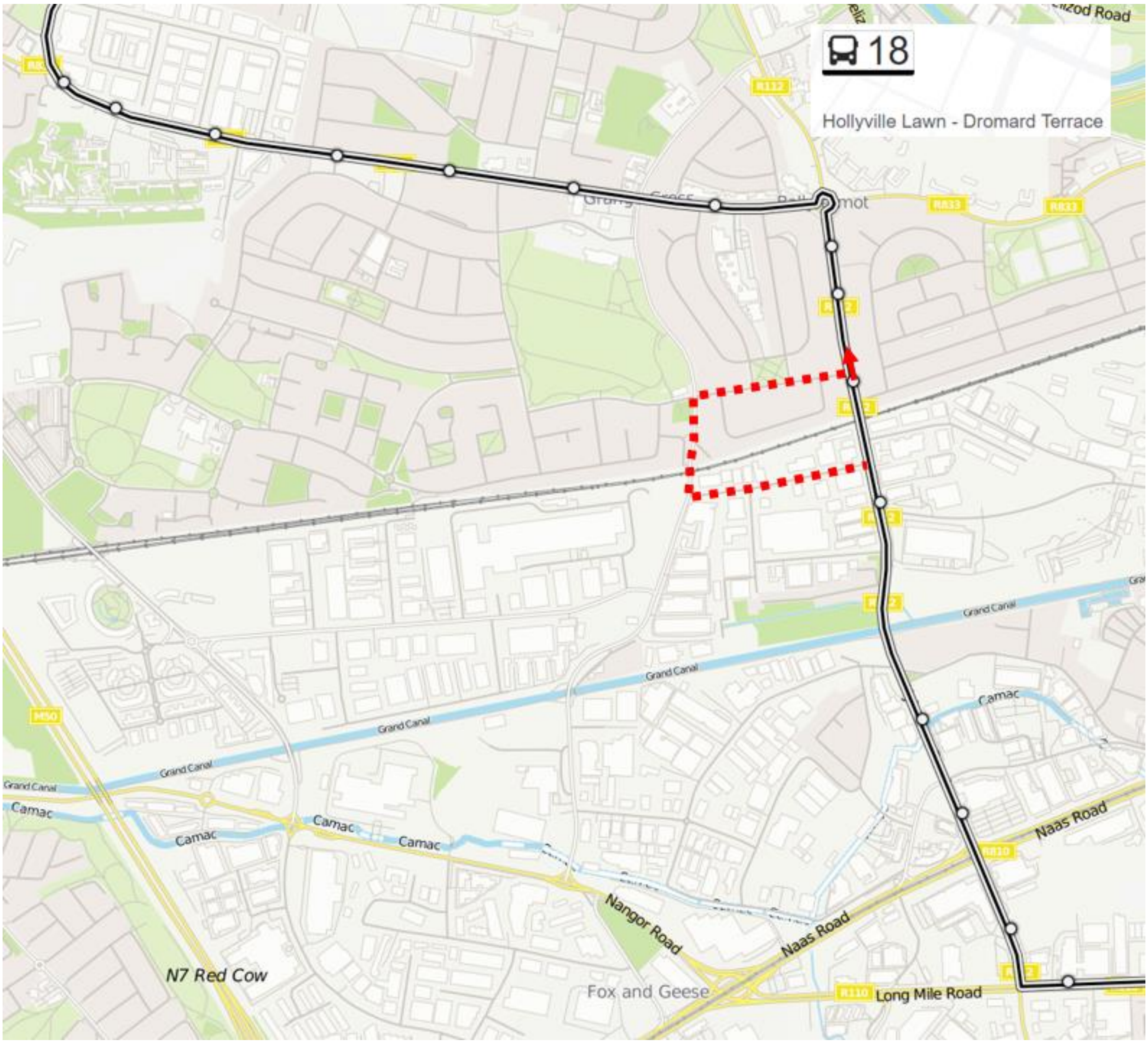


Figure 8-7 - Dublin Bus Route 18 - Hollyville Lawn to Dromard Terrace

8.9. Restrictions

There are restrictions associated with working on or adjacent to the live railway line. Irish Rail will mandate a safe system of work which will invariably include barriers between the live tracks and the working area or full possession of the railway (no trains running).

Every attempt will be made to control materials delivery times to outside peak traffic hours; particularly for construction HGV's known to restrict natural flow of traffic. In addition, where possible, long duration night works will be limited in residential areas unless appropriate noise mitigation can be provided.

A full methodology of the setup and construction methods will need to be sympathetic to both the railway operations, as well as residents and/or employers in the area. The methodologies will be fully reviewed by the Irish Rail team before the works are given approval to proceed (taking account of all stakeholder concerns from the public consultation phases as well as planning compliance criteria stipulated in the Railway Order).

Appendix A – Sifting Process Backup

A.1 Sifting Process Backup - Corridor Preferred Option Selection at Le Fanu to Kylemore Bridge area

A.2 Sifting Process Backup - Traction Substations Site Location

- Kylemore

Appendix B – MCA Process Backup

B.1 MCA Process Backup for Corridor Preferred Option Selection

Appendix C – Supporting Drawings

The following drawings accompany the Technical Report for this area:

<u>Bridge Drawings</u>

DP-04-23-DWG-ST-TTA-62120: Kylemore Road Bridge (OBC5A) – General Arrangement

DP-04-23-DWG-ST-TTA-62121: Kylemore Road Bridge (OBC5A) – Bridge Deck Plan

DP-04-23-DWG-ST-TTA-62122: Kylemore Road Bridge (OBC5A) – Bridge Deck Longitudinal Section

DP-04-23-DWG-ST-TTA-62123: Kylemore Road Bridge (OBC5A) – Bridge Deck Cross Section

<u>Roads Drawings</u>

DP-04-23-DWG-CV-TTA-61531: Kylemore Road Bridge (OBC5A) – Road – Plan and Profile

<u>Permanent Way Drawings</u>

DP-04-23-DWG-PW-TTA-61990: Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) – Track Plan Layout

DP-04-23-DWG-PW-TTA-61991: Kylemore Road Bridge (OBC5A) and Le Fanu Road Bridge (OBC7) – Cross Section at Ch 12+030

<u>Substation Drawings</u>

DP-04-23-DWG-EL-TTA-09422: Kylemore – IE Proposed Substation Location