# DART+ South West

## Volume 3J – Technical Optioneering Report –

## East of St. John's Road Bridge (Islandbridge) to North of the Phoenix Park Tunnel

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

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

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

| Reference | Description |
|---|---|
| TII | Transport Infrastructure Ireland |
| TMS | Train Management System |
| TPH | Trains per Hour |
| TPHPD | Trains per Hour per Direction |
| TPS | Train Protection System |
| Track Alignment | Refers to the direction and position given to the centre line of the railway track on the ground in the horizontal and vertical planes. Horizontal alignment means the direction of the railway track in the plan including the straight path and the curves it follows. |
| TSI | Technical Specifications for Interoperability |
| TSS | Train Service Specification |
| TTAJV | TYPSA, TUC RAIL and ATKINS Design Joint Venture (also referred to as TTA) |
| 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 between East of St. John's Road Bridge to North of the Phoenix Park Tunnel. 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
- 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.

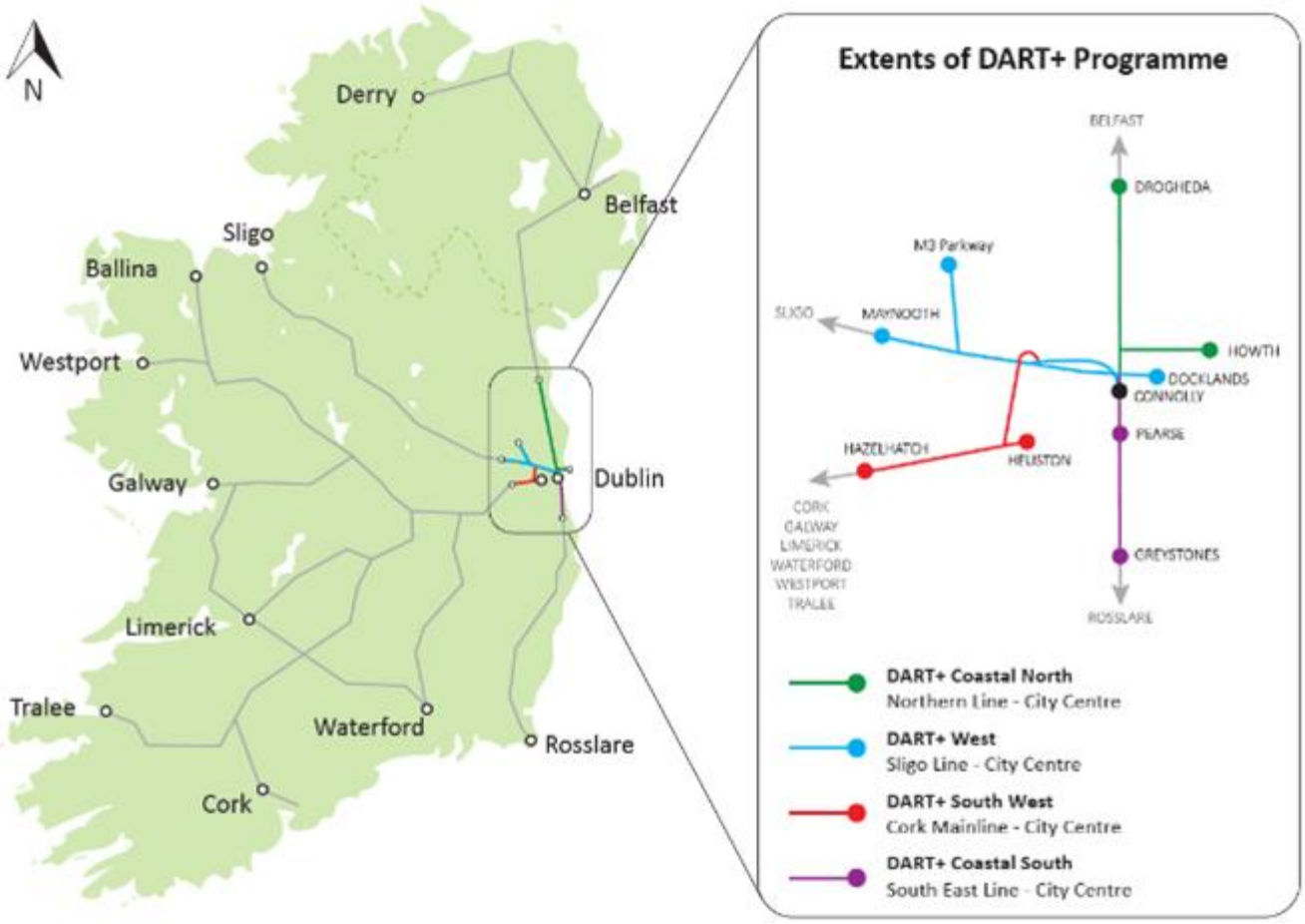


**Figure 1-1 DART+ Programme**

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.

- DART+ Fleet – 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 also has 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 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.

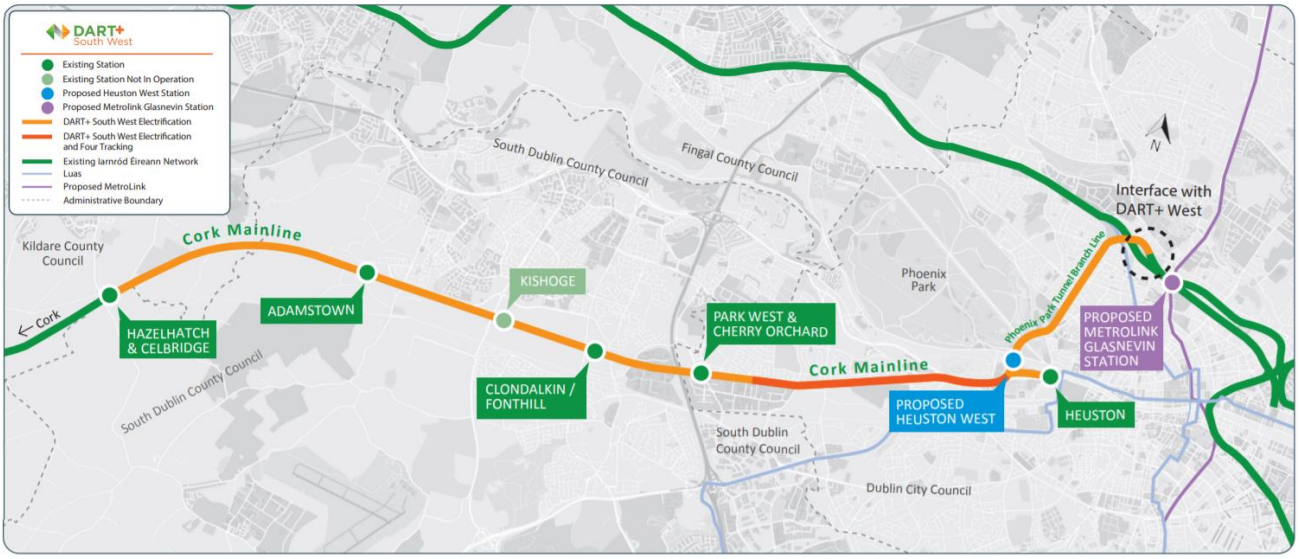


**Figure 1-2 DART+ South West Route Map**

## 1.4 Capacity Increase Delivered by 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 are as follows:

- 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** below.

**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<br>Adamstown Station<br>Clondalkin/Fonthill Station<br>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 | Cherry Orchard Footbridge (OBC8B) |

| Area Name | Sub-area Description | Extents | Main Features |
|---|---|---|---|
| | | East of the proposed Le Fanu Road Bridge (OBC7) | Le Fanu Road Bridge (OBC7) |
| | 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<br>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<br>South Circular Road Bridge (OBC1)<br>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<br>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 (Voume 3J) | East of St John's Road Bridge (OBC0A) to North of Phoenix Park Tunnel | Liffey Bridge (UBO1).<br>Conyngham Road Bridge (OBO2)<br>Phoenix Park Tunnel |
| **St John's Road Bridge to Glasnevin Junction** | North of the Phoenix Park Tunnel to Glasnevin Junction (Voume 3K) | North of Phoenix Park Tunnel to South of Glasnevin Junction | McKee Barracks Bridge (OBO3) |

| Area Name | Sub-area Description | Extents | Main Features |
|---|---|---|---|
| | | | Blackhorse Avenue Bridge (OBO4)<br>Old Cabra Road Bridge (OBO5)<br>Cabra Road Bridge (OBO6)<br>Fassaugh Avenue Bridge (OBO7)<br>Royal Canal and LUAS Twin Arches (OBO8)<br>Maynooth Line Twin Arch (OBO9)<br>Glasnevin Cemetery Road Bridge (OBO10) |

## 1.7 Stakeholder Feedback

A large volume of stakeholder submissions was 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.

Stakeholder feedback was in the main limited to concerns about potential increase construction, operational and maintenance noise, as well as construction traffic impact. Stakeholders were particularly concerned about noise levels and acoustic disturbances. It was noted in the submissions that the area around Memorial Bridge to Heuston Station is mapped by the Environmental Protection Agency as having one of the highest levels of day and night-time noise in the city and that this project will only increase this. Respondents welcomed that electrified trains would reduce noise pollution. Stakeholders urged Iarnród Éireann to consider noise reduction strategies and technologies, such as track silencing, soundproofing nearby properties and erecting sound barriers. Stakeholders noted that the increased volume of trains will result in increased sounding of train horns. It was noted that this is particularly disruptive and at present occurs in the early morning and late at night. Stakeholders

questioned whether Iarnród Éireann could consider alternative warning systems, specifically at the Phoenix Park tunnel.

Stakeholders noted that any improvements to the Liffey Bridge need to include improved access for bicycles and pedestrians as it provides a vital link to other areas.

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).

# 2 Existing Situation

## 2.1 Overview

This part of the scheme is approximately 1.1 km long and extends from East of St John's Road Bridge (OBC0A) to the north portal of Phoenix Park Tunnel, encompassing Liffey Bridge (UBO1) and Conyngham Road Overbridge (OBO2). This area excludes Heuston West Station, which is covered by Volume 3I.

The permanent way here consists of 2 tracks running the length of the area (the Up Branch and Down Branch as well as a third track, the Down Loop, terminating at the end of Heuston Station - Platform 10). 3 no. crossovers and a turnout facilitate operational moves around Platform 10 and the bi-directional running capabilities of the Down Branch and Down Loop lines – the Down Loop terminating with a buffer stop just beyond Platform 10.

The main feature in this area is the Phoenix Park Tunnel, that has a length of approximately 700m and has two ballasted tracks through the tunnel. A 300mm perforated pipe with filtration geotextile and granular material surrounds is located in the 6-foot. There is a lateral clearance issue in the tunnel with substandard separation between tracks and reduced clearances between trains and tunnel walls.

The permanent way in this area consists of 3 lines at grade until the branch lines cross the River Liffey over UBO1 where there are 2 tracks until the end of the area. The tracks pass beneath Conyngham Road OBO2 before entering the Phoenix Park Tunnel. An existing arch viaduct supports the tracks between the Liffey Bridge (UBO1) and the Conyngham Road bridge (OBO2).

There is a steel cantilever gantry HN331/HN332 located adjacent to 771A points at Heuston Station Platform 10.

The major infrastructural features are shown in **Figure 2-1**.

The main environmental features are described in **Section 2.9 Environment.**

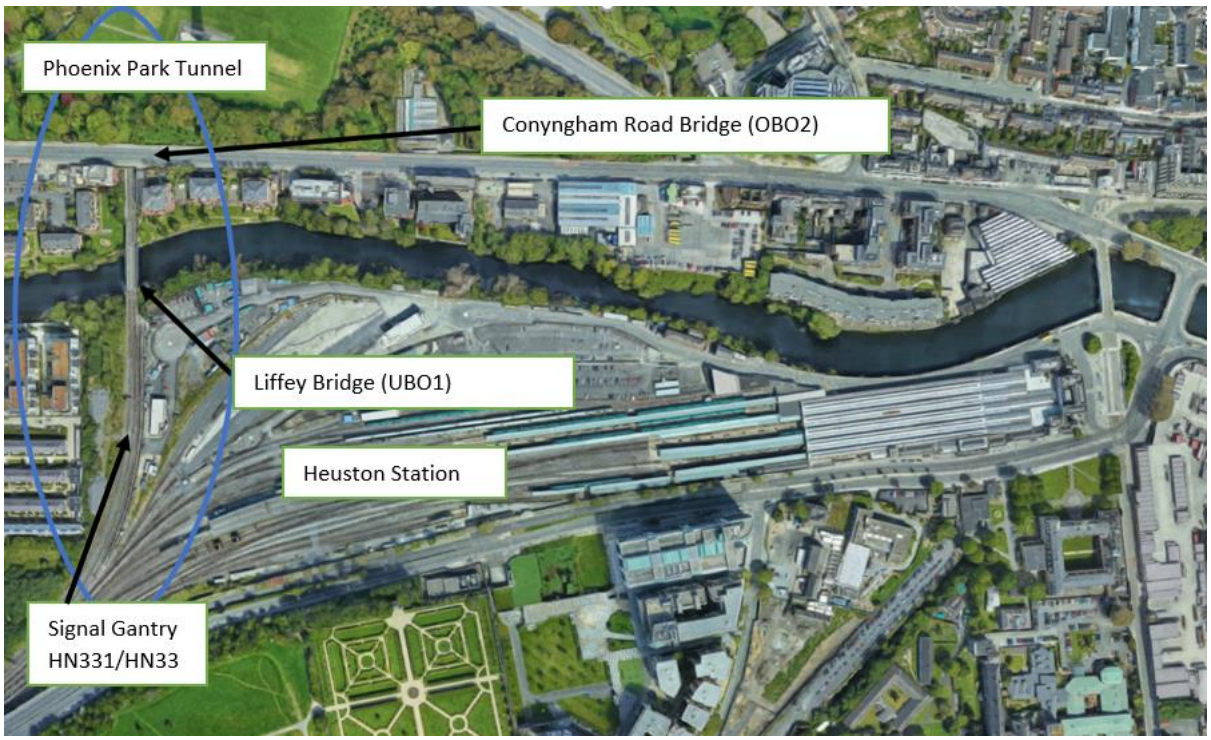


**Figure 2-1 Aerial view of the approach to the Phoenix Park Tunnel**

## 2.2 Challenges

The alignment of the tracks in this area is constrained by structures Liffey Bridge (UBO1), Conyngham Road Bridge (OBO2), the arch viaduct and the Phoenix Park Tunnel, all with limiting features in terms of width and/or height.

The most limiting feature is the Conyngham Road Bridge (OBO2) which has a limited clearance height and with limited scope for increasing the road level.

The existing fixed track system presently installed on Liffey Bridge (UBO1) is to be retained in order to avoid major bridge intervention.

The Phoenix Park Tunnel has limited lateral clearances, constraining the scope for track realignment

## 2.3 Structures

### 2.3.1 Signal Gantry HN331/HN332

HN331/HN332 is a steel cantilever gantry located adjacent to 771A points at Heuston Station Platform 10. This gantry will need to be removed to facilitate the installation of the electrification system.

### 2.3.2 Liffey Bridge (UBO1)

The Liffey Bridge (UBO1) is a rail bridge spanning the River Liffey near Heuston Station. Constructed between 1872 and 1877, the bridge is of wrought iron, 35m long and 10m wide. On either side of Liffey Bridge (UBO1), there are approach spans of three masonry, semi-circular arches built in stone. Historically used for freight traffic, the bridge has been reopened to regular passenger traffic since November 2016. There is no pedestrian or road traffic access to the bridge, while trains approach the bridge from the South at Heuston Station Platform 10 and from the North via the Phoenix Park Tunnel.

**Figure 2-2 Liffey Bridge (UBO1) (Deck Level – Facing South)**

### 2.3.3 Conyngham Road Bridge (OBO2)

Conyngham Road Bridge (OBO2) is a single span bridge which partially covers the entrance to the Phoenix Park Tunnel on the Heuston side. The road bridge has a width of 21m approx. and a clear span of 8.5m approx. The bridge superstructure consists of precast reinforced concrete beams of 760mm depth and 2280mm spacing, with precast reinforced concrete transverse slabs of 225mm thickness. The existing vertical clearance to the bridge soffit is 4.34m on the Down Line and 4.23m on the Up line based on the current alignment. An OHLE solution is not possible with the existing vertical clearance, and either a track and / or structure intervention would be required to achieve the necessary clearance.

**Figure 2-3 Conyngham Road Bridge (OBO2) – Southern Elevation**

### 2.3.4 Phoenix Park Tunnel

The Phoenix Park Tunnel was built in 1877 and begins at the Conyngham Road Bridge (OBO2) near Heuston Station, running underneath the Phoenix Park for approximately 700m before re-emerging close to the junction of the North Circular Road and Infirmary Road. The tunnel was originally built by the Great Southern and Western Railway company to connect Heuston Station to the Dublin Docklands and was primarily used for freight. It reopened to regular passenger traffic on 21 November 2016.

**Figure 2-4 Phoenix Park Tunnel, North Portal**

## 2.4 Permanent Way and Tracks

The Permanent Way between Islandbridge Junction and the north portal of Phoenix Park Tunnel consists of 3 tracks from St Johns Road Bridge (OBC0A) to the Liffey Bridge (UBO1) – Up Branch/ Down Branch/ Down Loop – then, once the Down Loop terminates at the existing Heuston West Platform 10, the 2 remaining tracks run the length of the scheme area. The third line terminates at Liffey Bridge (UBO1) with a buffer stop. 3 no. crossovers and a turnout facilitate operational moves around Platform 10 and the bi-directional running capabilities of the Down Branch and Down Loop lines. Maximum line speed on the Branch lines between Islandbridge Junction and Glasnevin Junction is 25mph (40 km/h), with 20mph (32 km/h) in the Down Loop.

The P&C point numbers for the crossovers are 720A&B and 771A&B (Down Branch to Up Branch – either end of Heuston Platform 10), 772 A&B (Down Branch to Down Loop) to the north of Platform 10 and 725 Points (Up Main to Down Loop connection, south of Platform 10). A schematic layout of the tracks is shown below.

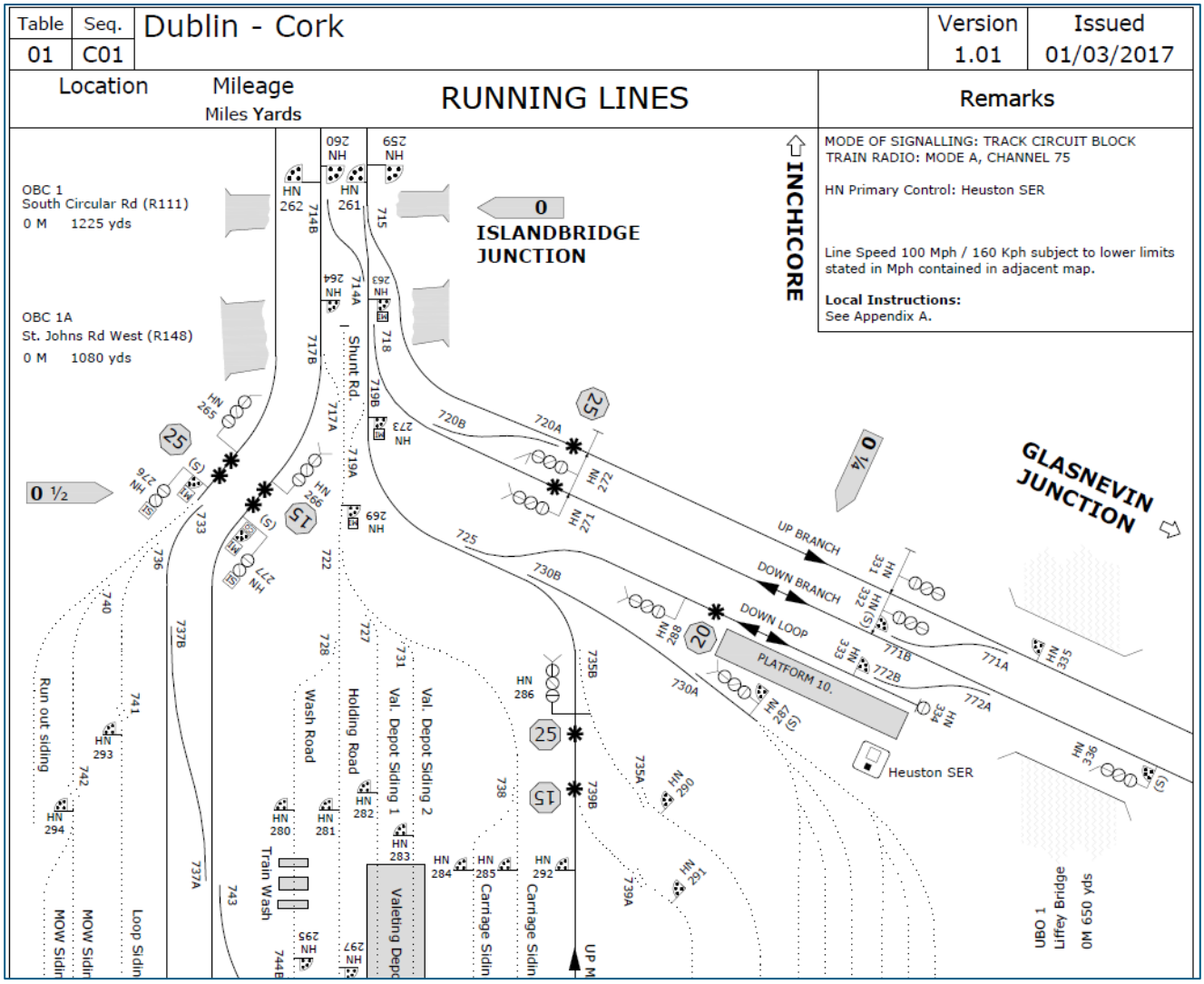


**Figure 2-5 Existing Track Layout in this area up to UBO1 (from Route Information Book) – showing the Up Branch and Down Branch lines between Islandbridge Junction and Phoenix Park Tunnel**

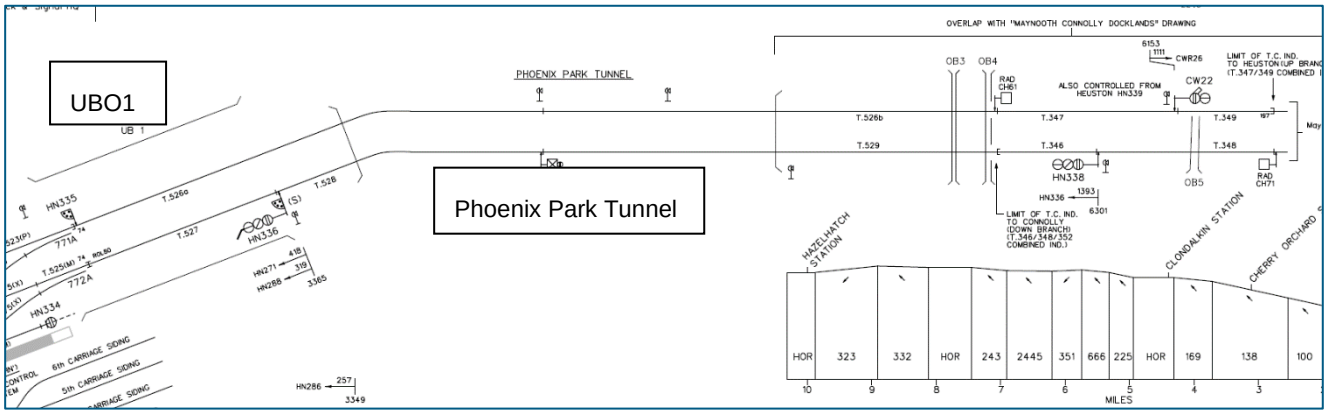


**Figure 2-6 Existing Track Layout in this area UBO1 to PPT (from Scheme Plan S.221/121)**

Heading north-east, where the branch lines depart from the main lines at Islandbridge Junction, the horizontal track alignment is on a tight left-hand horizontal curve, sub-350m radius. The alignment then straightens out

prior to the Liffey River Underbridge on the approach to Phoenix Park Tunnel. On entering the tunnel, the track proceeds on a sharp right-hand curve, where the minimum radii are circa 285m Up Branch and 233m Down Branch.

From Islandbridge Junction travelling north, the gradient falls steeply at 1 in 83 to a low point at Conyngham Road, before rising at 1 in 376 on the approach to Phoenix Park Tunnel.

The Up Branch and Down Branch lines on the Glasnevin route in this area are tightly constrained in both the horizontal and vertical plane by the existing structures – namely Liffey Bridge (UBO1), Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel, as can be seen from the following images.

**Figure 2-7 Liffey Bridge (UBO1) fixed rail restraint - Facing South**

The picture above clearly shows the fixed rail restraint system that constrains the alignment over the structure.

**Figure 2-8 Conyngham Road Bridge (OBO2) / Phoenix Park Tunnel South Portal**

The picture above shows the overbridge carrying Conyngham Road that constrains the alignment beneath the structure.

**Figure 2-9 View of Phoenix Park Tunnel.**

The picture above shows the arch structure of Phoenix Park Tunnel, which has limited clearance for realignment of the track and installation of OHLE equipment. It is worth noting that the tunnel lining alignment has a noticeable kink at around 170m from the south entrance.

## 2.5 Existing Retaining Walls

Retaining walls are located at the following locations:

**Table 2-1 Existing Retaining Walls**

| Track Section | Asset ID | Start Mileage | End Mileage | Side | Wall Type | Wall Height | Description |
|---|---|---|---|---|---|---|---|
| Connolly - Heuston | RWO000DA | 0m 0646yrds | 0m 666yrds | Down | Masonry | 7.0m | N/A |
| Connolly - Heuston | RWO000UA | 0m 0642yrds | 0m 0699yrds | Up | Masonry | 7.0m | N/A |

## 2.6 Other Railway Facilities

The current service Platform 10 of Heuston Station is located immediately south of the Liffey Bridge (UBO1). Note that **Volume 3I – Technical Optioneering report - Heuston West Station** assesses the feasibility of a station at Platform 10.

## 2.7 Road Network

Conyngham Road, which is located above Conyngham Road Bridge (OBO2), has a carriageway width of 12.6m, consisting of an outbound marked cycle lane, a single vehicular lane in either direction; as well as a dedicated inbound/eastbound bus lane. There are footpaths on both sides of the carriageway with widths of 2.4m to the North and 2.9-3.4m to the South.

The road gradient is at an average of 1%, falling from east to west, towards the South Circular Road intersection with Conyngham Road.

This is currently the main pedestrian connector for those choosing to walk between the city centre and Chapelizod / Islandbridge. Separate to this CIE project, Dublin City Council has outline proposals for an upgrade to this route as part of the provision of its quality bus corridors, the proposals will reduce the vehicular carriageway widths to allow for wider segregated footpaths and cycle tracks.


**Figure 2-10 Overview of Conyngham Road**

## 2.8 Ground Conditions

The topography is generally flat, with the land north and south of the River Liffey sloping gently towards the river. South of the River Liffey on the west side of the railway, the ground level of the existing Clancy Quay development is approximately 4m to 5m below the existing track level. North of the River Liffey the railway is located on masonry arches on the approach to Phoenix Park Tunnel with the surrounding ground levels located circa 4m to 5m below the track level.

According to geological mapping, the superficial deposits in this area are anticipated to comprise urban (made ground), alluvial and gravel deposits overlying bedrock (limestone and shale). It is expected that a layer of till will exist below the made ground deposits. On the south approach to UBO1, the superficial deposits are described as gravel deposits. The superficial deposits on the banks, beneath the River Liffey and close to the southern portal of Phoenix Park Tunnel is described as alluvium. The superficial deposits surrounding the Phoenix Park Tunnel are shown to comprise till overlying bedrock (limestone and shale).

Historical ground investigations south of the River Liffey show the ground conditions to typically comprise made ground, underlain by clays and gravels overlying limestone bedrock. Made ground generally consisted of clay gravel with concrete, red brick, steel with a maximum thickness of 3.50m. Made ground deposits were underlain by gravelly clay and gravel (of limestone) with occasional layers of sand. Bedrock comprising of strong to moderately strong limestone with laminated mudstone and shale was encountered at depths ranging from 22.70m bgl (13.49m AOD) to 24.55m bgl (15.39m AOD). Hazardous and non-hazardous material insoil samples was identified in 2019 near to the current location of the National Train Control Centre within Heuston Station.

North of the River Liffey, historical ground investigation west of the railway typically comprise made ground (recorded as clay and rubble), underlain by gravel and sand. Bedrock was encountered between 6.70m bgl to 10.67m bgl. A historical ground investigation east of the railway encountered made ground (fill) underlain by clay and a coarse gravel. Sandy ballast and large ballast is recorded between 8.50m bgl and 15.50m bgl. The superficial deposits overlie bedrock recorded as black limestone at 15.50m bgl.

Groundwater strikes were recorded at 7.50m bgl and 13.50m bgl to the south of the River Liffey, whereas groundwater was recorded between 4.40m bgl to 9.80m bgl, north of the River Liffey.

A Ground Investigation is currently ongoing to verify the ground conditions, preliminary results have revealed that the crown of the arches at the Liffey River bridge (UB01) were not encountered shallower than a depth of 1.1 mbgl and the ground conditions anticipated from the historical GI data have been verified onsite.

Preliminary results from the foundation and track bed investigation pits carried out at the tunnel southern portal entrance indicate the invert depth of the tunnel align with the existing historic cross section of the tunnel profile.

## 2.9 Environment

Clancy Quay on the western side of the rail corridor is one of Ireland's largest private sector rented residential developments with a number of apartment blocks. This relatively new development includes several residential types, outdoor amenity space e.g. playground and there is also reference to roof terraces. There are also several buildings and features listed on the National Inventory of Architectural Heritage (NIAH) that are associated with the Clancy Quay site. An officer's house and a guard house are located approx. 100m from the rail centreline on Artillery parade which are both listed on the NIAH (of regional importance). There are also three workshop buildings which are each an NIAH (of regional importance) and an RPS.

The Liffey Bridge (UBO1) which spans the River Liffey near Heuston Station is also a listed heritage feature on the NIAH (regional importance), as is a sentry box on the southern bank and approximately 150m west of the rail centreline. The Liffey is known to host salmonid fish species, and the section of the river from just upstream of bridge all the way to the coast is designated as an Annex I Habitat, as it is the uppermost part of the Liffey Estuary. DCC has a landscape protection objective (Z11) to "protect and improve canal, river and coastal amenities", which includes the River Liffey.

The tracks pass beneath Conyngham Road OBO2 before entering the Phoenix Park Tunnel. Conyngham Road Bridge (OBO2) is not listed on the NIAH and is also not listed as RPS. The existing rail line then heads under the Phoenix Park through the Phoenix Park Tunnel. The Phoenix Park itself is a key recreational and amenity area for residents and tourists and is classed by Dublin City Council as a site of archaeological potential and a Conservation Area. The Wellington Monument, approx. 100m to the east of the tunnel is an NIAH, and the view from this monument is a DCC Protected View.

The People's Park is located in the area south of the tunnel and has a playground adjacent to Infirmary Road; the People's Park is also an NIAH (of regional importance). The Sean Heuston Monument is located approx. 100m to the south of the centreline of the tunnel and is an NIAH; another feature just south of this monument is classed as an RPS.

The whole of the Phoenix Park is also a Geological Heritage Area/ County Geological Site (recommended for Geological Natural Heritage Area). Just to the west of the Garda Headquarters, the southern part of Dublin Zoo falls within the 100-300m buffer band from existing rail centreline. As the tunnel emerges from Phoenix Park, there is a block of apartments adjacent to the rail corridor (Park Lodge Apartments). To the east of the rail corridor, the North Circular Road area has a DCC landscape protection objective (Z2) to "protect and improve the amenities of residential conservation areas" which encompasses the North Circular Road area extending to the boundary of the Phoenix Park. Within this area, there are several houses on the National Inventory of Architectural Heritage (NIAH) either side of the North Circular Road, and many houses on the Record of Protected Structures (RPS) on either side of the North Circular Road and further north along the Drumalee Road. O'Devaney Gardens, which is a residential area and also a Strategic Development Regeneration Area (SDRA), is located to the east of the rail corridor and the North Circular Road. Within this area (approx. 400m from the east side of the rail centreline) is Saint Brian's Military Hospital.

The area is also within one of Dublin City Council's (DCC) Zones of Archaeological Potential which encompasses the historic core of the city.

The presence of the existing rail line has reduced biodiversity potential along the route to a large degree, however there remain hotspots of interest in relation to hedgerows and treelines for bats in particular (Phoenix Park Tunnel has bat roost potential). Invasive species were noted; the 2020 ecology survey noted a significant linear stand of Japanese knotweed running adjacent to the rail corridor from the Liffey Bridge (UBO1), past Platform 10 as far as the South Circular Road. The groundwater vulnerability underlying the river corridor is classed as moderate/high. The subsoils underlying much of this area are tills derived from limestones; alluvial deposits are found along the River Liffey and some gravel tills under Clancy Quay, however much of the 'subsoil' directly adjacent the river corridor is classed as 'urban' reflecting city development. The groundwater vulnerability under the Phoenix Park is rated as low.

## 2.10 Utilities

This area contains 15 no. known utilities along Conyngham Rd as well as 3 no. utility crossings that cross beneath the tracks south of Conyngham Rd. Phoenix Park contains several utilities that cross above the Phoenix Park Tunnel. Service providers with network assets in this area include the following:

- Aurora
- British Telecoms (BT)
- Eir
- ESB Networks
- Dublin City Council / Irish Water (Foul Water Sewers)
- Dublin City Council / Irish Water (Water Supply)
- Dublin City Council Public Lighting
- Gas Networks Ireland (GNI)
- Virgin Media

Data in the form of utility service records have been gathered from all providers in the area. The majority of services are located within Conyngham Road through Conyngham Road Bridge (OBO2). Hence, where modifications are required to existing bridges and/or to the road network in the immediate vicinity of existing structures, impacts on utilities will be inevitable.

The 3 no. utilities present at track level cross the railway corridor below the tracks. Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

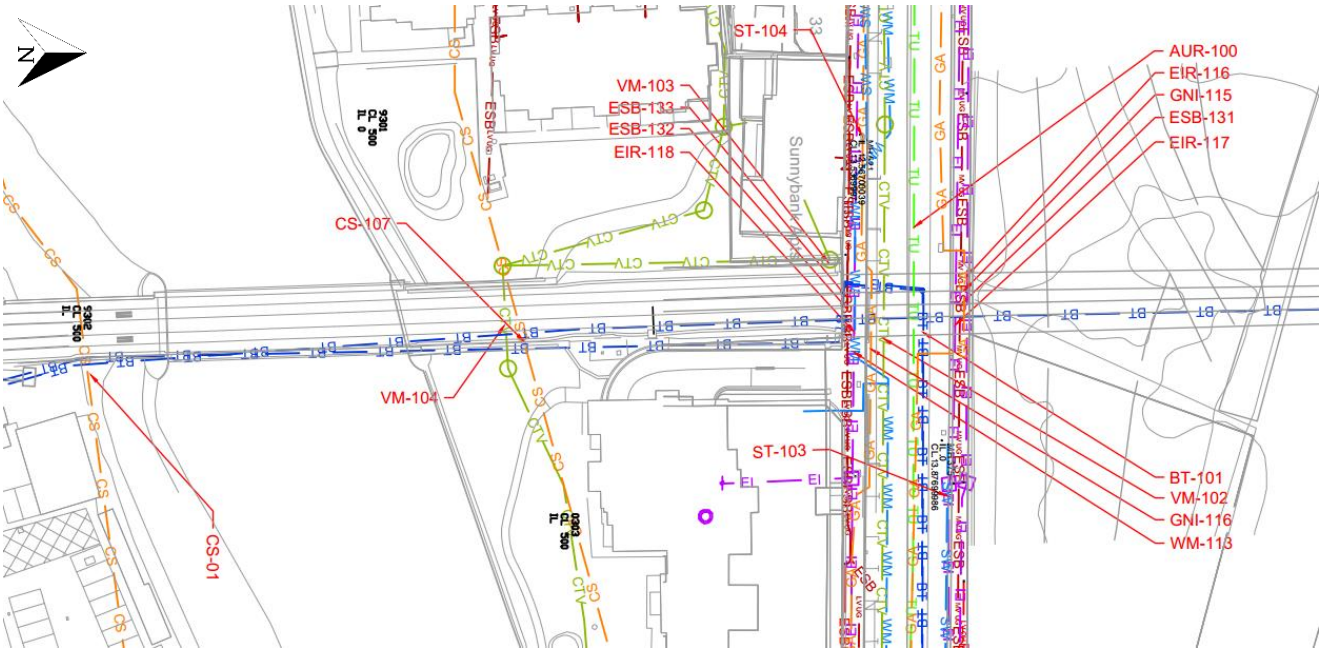


**Figure 2-11 Existing Utilities at Conyngham Rd Bridge (OBO2) and the Liffey Bridge (UBO1)**

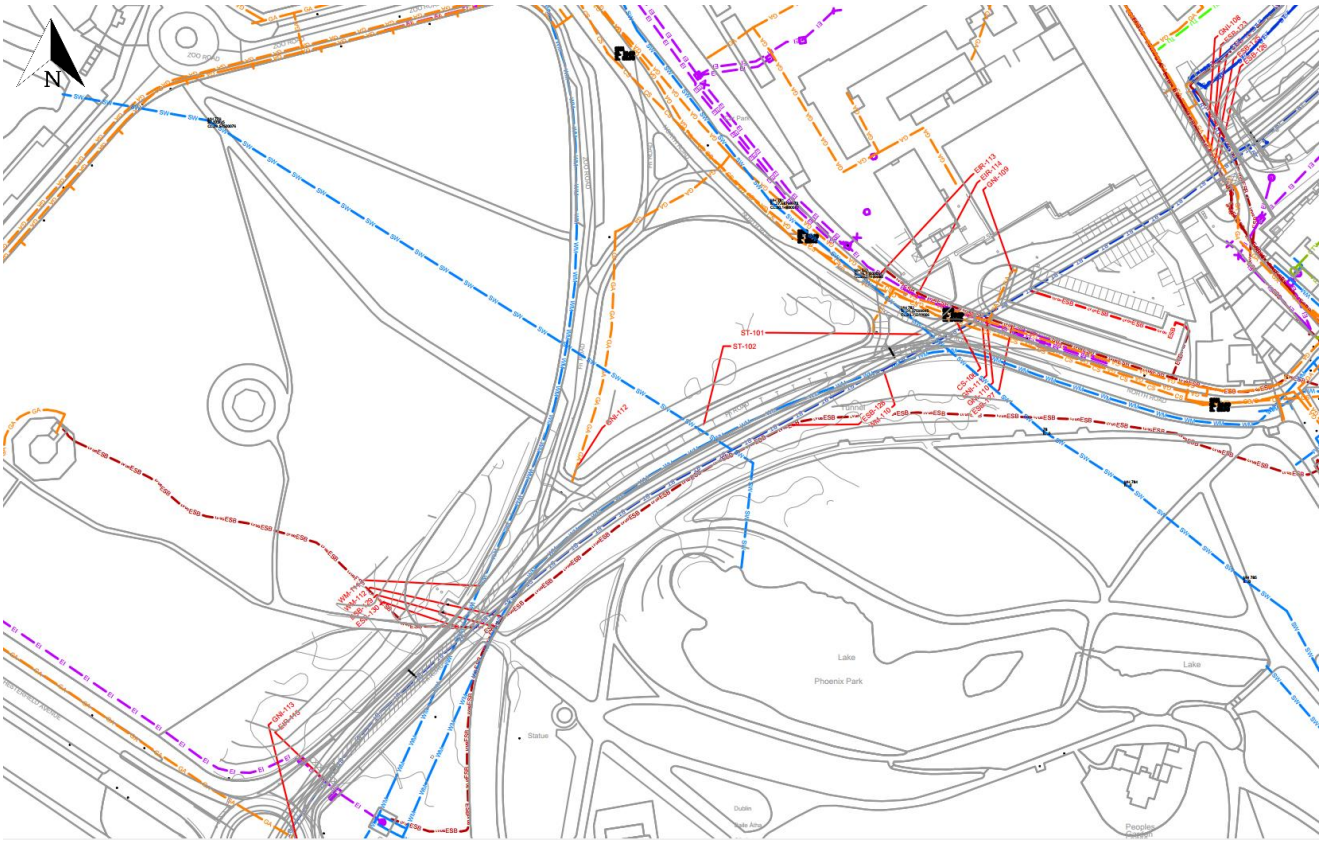


**Figure 2-12 Existing Utilities in the Phoenix Park**

In addition there are 2 no. main utilities that are impacted by the attenuation tank and track works at the location of the proposed new Heuston West Station. Notable; BT fibre optic cables and a combined sewer vitrified clay pipe, required works in this area will result in diversions for these services. It will be challenging to deal with these utilities given that only limited service outage time (if any) will be permissible to the service and its customers. Significant forward planning and coordination will be necessary for such instances where modifications are necessary.

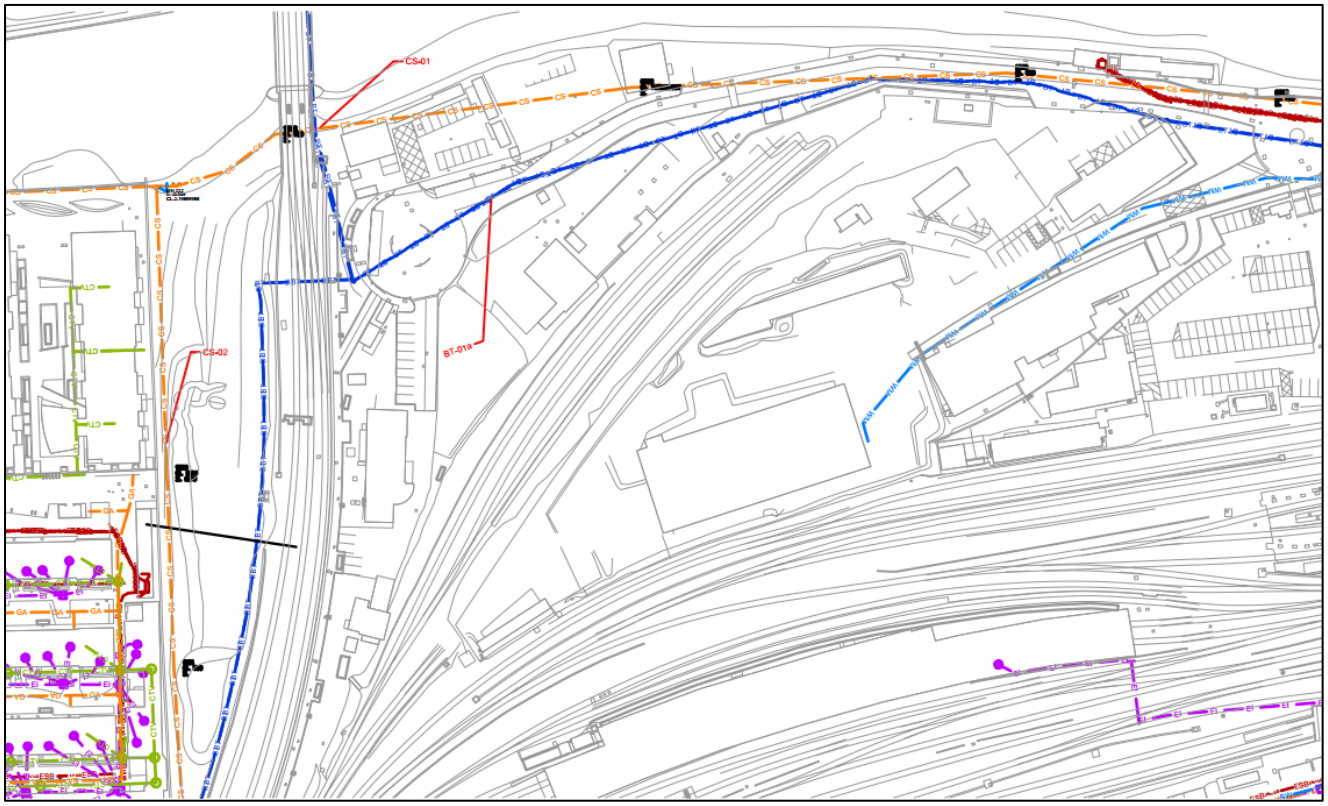


**Figure 2-13 Existing Utilities in the Vicinity of Heuston West Station**

## 2.11 Track Drainage

Information available identifies a 300mm perforated pipe with filtration geotextile, granular material surrounds and topped with track ballast to drain and convey runoff waters. This drainage pipe is located in the 6-foot, as shown in **Figure 2-14** and seems to give continuity to the existing drainage from Cabra Station and along the tunnel.

**Figure 2-14 Existing 300mm perforate pipe at Phoenix Park Tunnel**

In addition to the above, there is an existing 500 mm concrete pipe coming outside of the tunnel that connects with the 300mm perforated pipe at tunnel station 90.

The performance of this system (especially regarding its outfall) is not fully known, being assumed from site visits that some elements exist which convey the water to the discharge point at Liffey River.

# 3 Project Requirements

## 3.1 Area-Specific Requirements

In addition to the general feasibility requirements of constructability, general fitness for intervention and safety, the specific requirements for this area are:

- Electrification of the DART Slow lines (Up Branch & Down Branch) and the associated electrical power substations and connections to the ESB power network.
- Provide sufficient vertical clearance for OHLE at structures through track lowering and / or structural interventions.
- Safe rolling stock passing clearance.
- Compliant road design.
- Track alignment and drainage requirements (in accordance with their respective standards)
- Maintain current functionality of the existing network and public roads and services/utilities (electricity, gas, water, etc).

## 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. One new electrical power substation will be provided along this segment of the rail line to provide the requisite power for the network demand. It is proposed that a standardised approach to electrification will be adopted, but area-specific interventions will also be required.

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

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

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 currently being developed. The DART wide programme will adopt a 1500V DC (Direct Current) 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. See **Figure 3-1** for typical OHLE arrangements in a two-track open route.

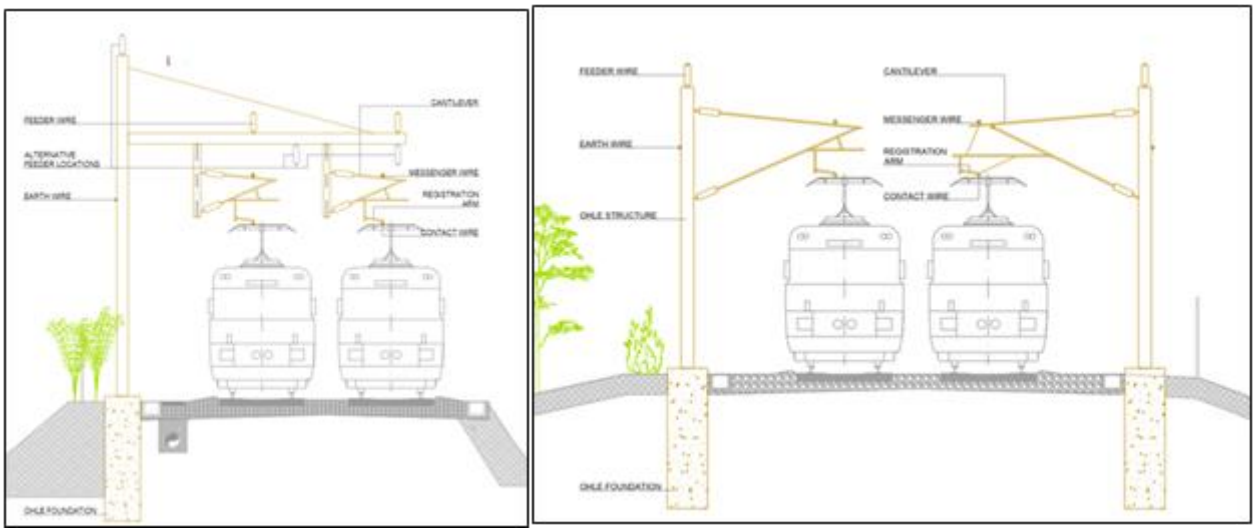


**Figure 3-1 Typical OHLE arrangements in two track open route**

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 installed 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.

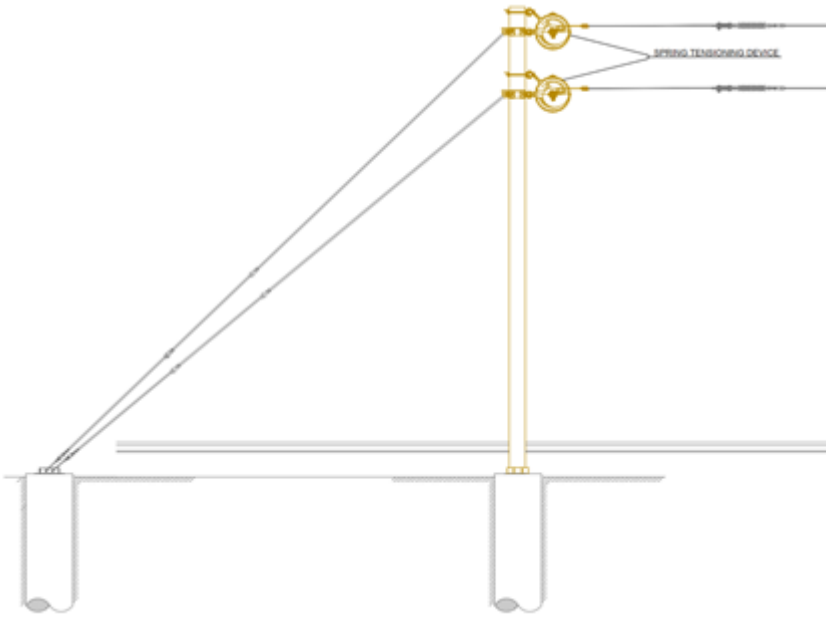


**Figure 3-2 Typical anchor structure**

The OHLE configuration through the overbridges for each track have been assessed using a clearance assessment tool derived from the System Wide Functional Requirement Specification (FRS) relating to Overhead Line Equipment (OHLE). 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.

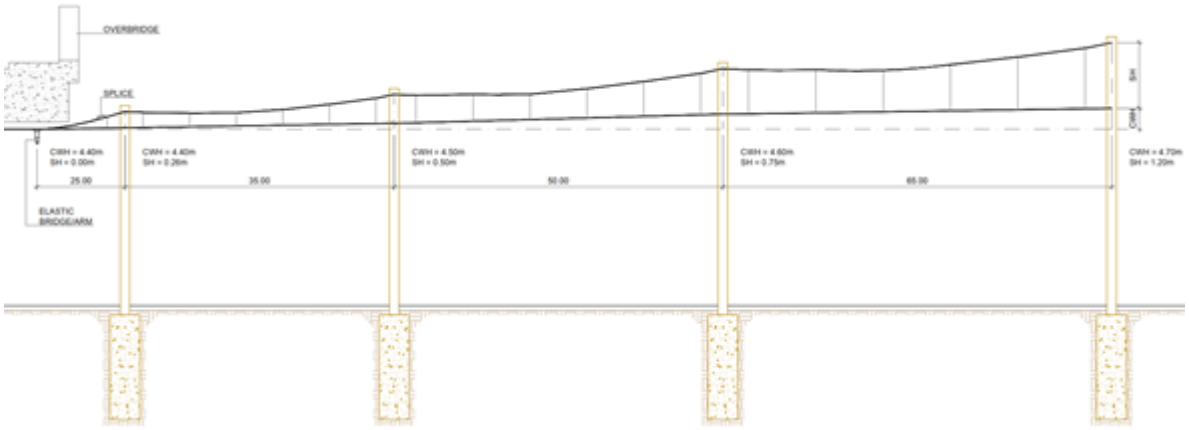


**Figure 3-3 Typical arrangement on approach to a low bridge**

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

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

## 3.2.2 Substations

In order to facilitate the introduction of the new OHLE scheme across the DART+ network a power supply study has been carried out. There is a requirement to provide six new substations on the DART+ South West scheme. One substation is required on this section of the route at the following location:

- Islandbridge

### 3.2.2.1 Requirements and Considerations

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

- The initial substation location is an output of the DART+ Programme power study, and an input to the Optioneering process undertaken by DART+ South West, and will be validated by subsequent Dart+ South West Power Study which will refine the final location, using the constraints listed below. Further details on section 3.2.2.2.
- 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, 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 locationsas 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

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.

# 4 Constraints

## 4.1 Environment

Further desk and field survey work has been undertaken to inform the environmental constraints identified in **Section 2.9 Environment** 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. Bat dusk emergence and dawn re-entry surveys have been carried out to characterise and identify bat roosting at the Phoenix Park Tunnel.

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 i.e. 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.

The River Liffey crosses under the railway line near Heuston Station. The ECFRAM maps indicate the risk of fluvial and coastal flooding. The ECFRAM maps indicate the River Liffey is impacted by river and coastal flooding in the 0.1% fluvial and 0.1% tidal Annual Exceedance Probability (AEP). The location is also influenced by the River Camac catchment, a tributary of the River Liffey.

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

Conyngham Road traverses over the railway by means of Conyngham Road Bridge (OBO2). The southern road corridor boundary consists of boundary walls/fences and entrance driveways as well as building facades, along with the bridge parapet. In contrast the northern boundary to the road corridor is the Phoenix Park boundary retaining wall that is 2.8-3.2m high (approx.). See **Figure 4.1** below.

Immediately south west of Conyngham Road Bridge (OBO2) is the Sunnybank apartment building facade and to the south east of the bridge is the 0.65m (approx.) high retaining wall of the Riverpark apartment complex, with its vehicular and pedestrian entrances. These are physical limits to potential temporary traffic management solutions that would otherwise require provision of pedestrian overbridges or alternatively diversions through Phoenix Park.

These adjacent apartment complexes have vehicular accesses within the immediate vicinity of the bridge and pedestrian accesses within 20m of Conyngham Road Bridge (OBO2). These too provide a constraint as to the extent to which the road could be raised to accommodate a bridge replacement in order to improve OHLE clearances.

In addition the proposed quality bus corridor (with its footpath and cycle track upgrades could further constrain an proposals particularly a localised customisation of the non-vehicular areas will be required to accommodate the critical utility diversions.

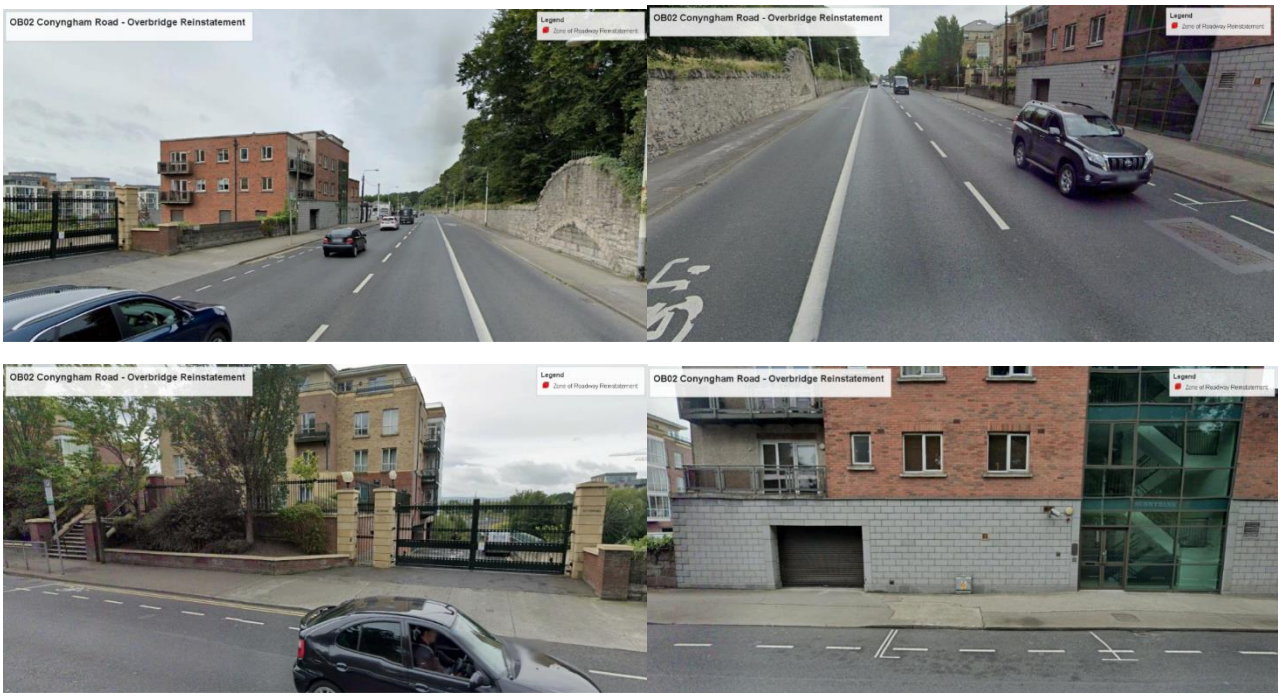


**Figure 4-1 Constraints on Road Design**

## 4.3 Permanent Way

The vertical and horizontal alignment is constrained by the elements summarised in the Table and Figure below.

**Table 4-1 Permanent Way Geometrical Constraints**

| ID | Name | Description |
|---|---|---|
| 1 | Existing Liffey Bridge (UBO1) | Liffey Bridge (UBO1) features a fixed track system which is to be retained and is a major constraint in terms of the horizontal and vertical Permanent Way alignment. |
| 2 | Existing Conyngham Road Bridge (OBO2) | Conyngham Road Bridge (OBO2) is a major constraint in terms of the horizontal and vertical Permanent Way alignment in that the height beneath the existing bridge is limited. |
| 3 | Existing Phoenix Park Tunnel – Lateral Clearances | Phoenix Park Tunnel has limited clearances to the arch and is a major constraint in terms of the horizontal and vertical Permanent Way alignment.<br>The tunnel lining has a kink in its alignment (approx. 170 m from the south entrance). |
| 4 | Existing Phoenix Park Tunnel – Invert slab level | The existing ballast depth under the sleepers is known to be reduced through the tunnel. The scope for track lowering that would improve lateral passing clearances due to the shape of the cross section of the tunnel is then limited. |

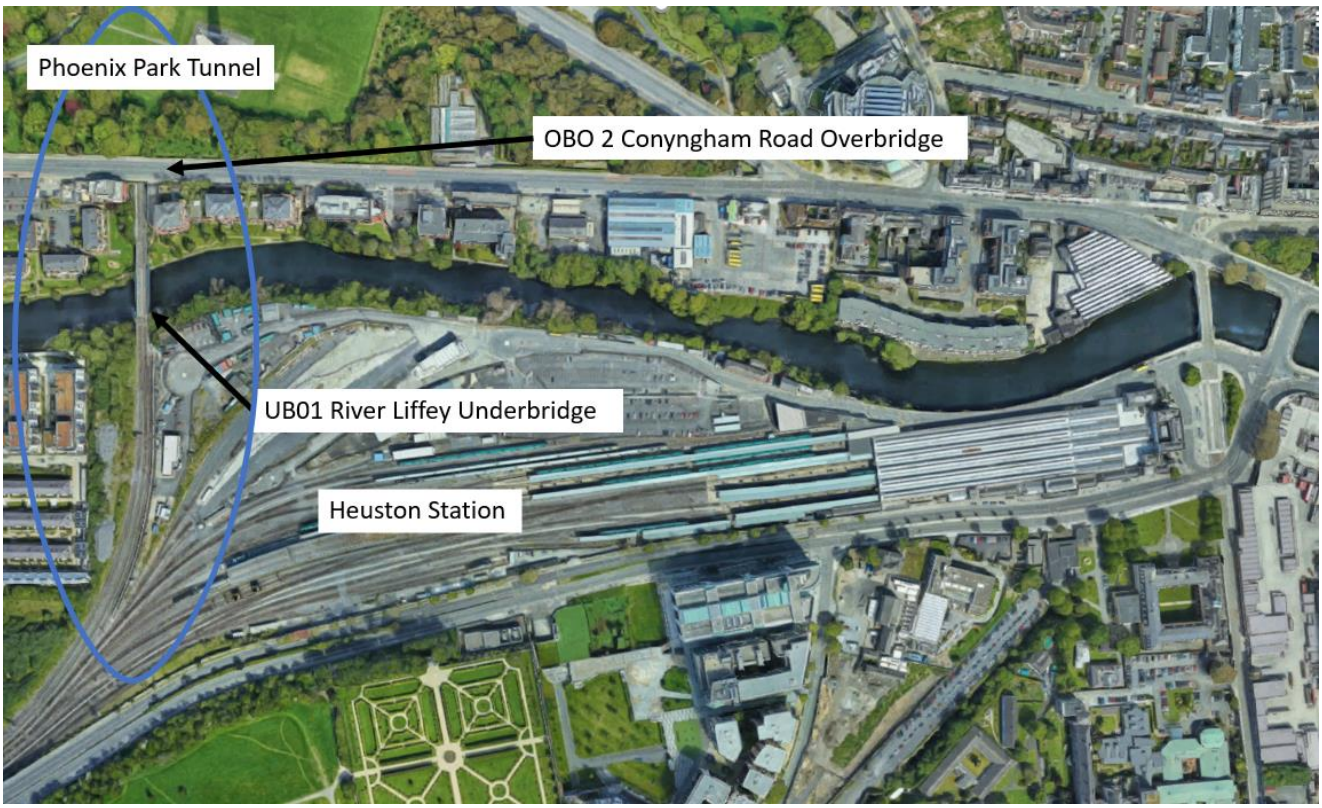


**Figure 4-2 Constraints of permanent way design**

The main constraint for the alignment on the Up Branch and Down Branch lines on the Glasnevin route in this area are the existing structures – namely Liffey Bridge (UBO1), Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel.

In addition to the structural constraints that will have an effect on the track alignment, there is an existing track drainage system installed in Phoenix Park Tunnel. The track realignment would require the reconstruction and integration of the track drainage system.

## 4.4 Existing Structures

The Phoenix Park Tunnel has limited clearances to the arch, particularly constraining horizontal realignment of tracks. The tunnel however has sufficient vertical clearance for the installation of electrification. As such no structural interventions are anticipated.

The existing Conyngham Road Bridge (OBO2) does not have adequate vertical clearance for implementation of electrification, requiring track or structural intervention. Due to the existing track drainage system under the Phoenix Park Tunnel, and the proximity between Conyngham Road Bridge (OBO2) and the Liffey Bridge (UBO1), track lowering needs to be minimized to avoid further interventions to the Phoenix Park Tunnel and the Liffey Bridge (UBO1) over the River Liffey as well as the arches section immediately north of the River Liffey.

Electrification of the existing track over the Liffey Bridge (UBO1) is possible, since this structure is an underbridge. The bridge features a fixed track system which is proposed to be retained and is a major constraint in terms of the horizontal and vertical track alignment changes leading up to Conyngham Road Bridge (OBO2). Should OHLE need to be supported from the bridge structure, bridge strengthening may be required.

Gantry HN331/HN332 will need to be removed to facilitate the installation of the electrification system.

## 4.5 Geotechnical

Ground Investigation works are ongoing and no onerous ground or groundwater conditions have been encountered in this area . Hazardous material has been identified in soil samples close to the proposed National Train Control Centre, at Heuston Station, l which is adjacent to this area.

Preliminary results from the foundation and track bed investigation pits carried out at the tunnel southern portal entrance indicate the invert depth of the tunnel align with the existing historic cross section of the tunnel profile and should not constrain track lowering at this location.

It is considered that the existing retaining walls in this area will remain unaffected by the current proposals.

## 4.6 Existing Utilities

The majority of utilities that cross the rail corridor in this area are concentrated in Conyngham Road Bridge (OBO2). Thus, any option that would require minor / major bridge intervention works would cause major disruption to the services and warrant temporary / permanent diversions. Any proposed works would be heavily constrained by such services. Track lowering beneath Conyngham Road Bridge (OBO2) to achieve sufficient clearances for OHLE would not adversely affect utilities in the road bridge.

There are 2No. combined sewers and 1No. Virgin Media duct that cross underneath the tracks south of Conyngham Road located underground, significantly below the Liffey Bridge (UBO1). As such, these do not pose any major constraints to track lowering for Conyngham Road Bridge (OBO2). Likewise, all utilities located in Phoenix Park cross above the tunnel and do not pose major constraints to design.

There are also 2 no. services located in the area of the proposed new Heuston West Station that will require diversions. The BT fibre optic cables (utility ID: BT-01a) run through Heuston Yard, cross under the tracks and remain parallel to the tracks until Hazelhatch and Celbridge. These cables contain signalling and communication data used by Irish Rail to monitor and manage the rail network. As such, they will be diverted with the other Irish Rail trackside utilities within the rail corridor.

The combined sewer (utility ID: CS-02) is located west of the tracks, adjacent to Clancy Quay. This area is the same area planned for the proposed attenuation tank and Heuston West Station. As such, this service will require a diversion. Temporary diversions will be required for both services to maintain service to customers and Irish Rail.

## 4.7 Property

All works in this section are proposed within the railway corridors on Irish Rail land. No third party lands are affected by the works directly.

The closest third party land is the Clancy Quay Development which is visually buffered in areas by its own retaining walls and separated from this Heuston Yard Works area by the railway to/from Glasnevin.

While the remaining lands adjacent to this section of the project are Heuston Station operational areas/buildings. The lands are bounded by the River Liffey (to the North) and St John's Road West (to the south). In between St John's West Road and Kilmainham Lane to the south are the grounds of the Royal Hospital Kilmainham The Royal Hospital Kilmainham is a designated conservation area and has a designated landscape protection objective (Z9) "to preserve provide for and improve recreational amenity and open space/ green networks. Adjacent to the South Circular Road is Bully's Acre, an area of archaeological potential in the grounds of the Royal Hospital Kilmainham.

Along the corridor boundary (between the River Liffey and Conyngham Road) are Riverpark Apartments, Sunnybank Apartments and Bridge Water Quay development lands. These properties are constraints on the proposed OHLE solutions in the area; temporary land take will be required as a minimum local to the OHLE masts to aid installation of the same.

## 4.8 Drainage

The existing Ø300mm perforated pipe, that runs along Phoenix Park Tunnel, also conveys runoff flows collected by the existing upstream drainage system from Cabra Station, and the Ø500mm pond overflow pipe that connects with the pipe drain at tunnel station 90.

Therefore, the proposed drainage solution will require an integration between the slab track section and the need of conveying the upstream flows to the existing outfall at Liffey River.

An addition to the above, any potential seepage arriving into the tunnel will also need to be intercepted by the drainage network and discharged into the existing outfall, as it is currently undertaken by the existing perforated pipe.

# 5 Options

This section presents the options associated with the following elements on the rail corridor between East of St. John's Road Bridge (Islandbridge) and North of the Phoenix Park Tunnel:

- Civil and OHLE infrastructure solutions
- Substations
- Construction Compounds

While the proposed new Heuston West Station falls within the same locality as this section, its description and optioneering is covered in **Volume 3I Technical Optioneering Report – Heuston West Station**.

## 5.1 Civil and OHLE

### 5.1.1 Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel

Permanent way options comprise realignments to provide standard clearances, both vertically and horizontally.

A total of 3 no. 'Main Options' have been developed for this area of the scheme and were presented at PC1. Main Options are divided into 'Option Variations' where only small differences exist between proposed solutions (e.g. different vertical clearance dimensions at Conyngham Road Bridge (OBO2)), but the broader option remains unchanged. The Main 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 the Main Options presented at PC1 as part of the Emerging Preferred Option Selection process is presented in **Table 5-1**. Note that the Liffey Bridge (UBO1) and adjacent arch viaduct are underbridges and hence are not constrained by height clearance for the electrification. It also has adequate width for the proposed Dart infrastructure. Therefore, no interventions are required for Liffey Bridge (UBO1) and adjacent arches.

**Table 5-1 Main Options Summary**

| Option | Description | |
|---|---|---|
| | **Conyngham Road Bridge (OBO2)** | **Phoenix Park Tunnel** |
| Option 0: Do Nothing | The existing infrastructure remains unchanged. There are no interventions. | The existing infrastructure remains unchanged. There are no interventions. |
| Option 1: Do Minimum | This option endeavours to achieve the electrification project requirements without widening the existing rail corridor and provides additional vertical clearance at Conyngham Road Bridge (OBO2) by track lowering only. | New track alignment and slab track, with OHLE.<br>Tunnel may require improvement works. |
| Option 2 | This option combines track lowering with structural intervention of Conyngham Road Bridge (OBO2) and lifting of Conyngham Road in order to provide sufficient vertical clearance to accommodate electrification by providing room for the OHLE – albeit with a reduced contact wire height. | New track alignment and slab track, with OHLE.<br>Tunnel may require improvement works. |

Option Variations are elaborated within the Main Option text. 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

Conyngham Road Bridge and Phoenix Park Tunnel 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 in the end of the Option description section.

#### 5.1.1.1 Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing road or rail infrastructure at the Conyngham Road Bridge. The vertical clearance at Conyngham Road Bridge (OBO2) would not be resolved. As such, this option would not facilitate the installation of an OHLE system. The project requirements would not be achieved.

The Do-Nothing Option proposes no changes to the existing rail infrastructure at the Phoenix Park Tunnel. The tracks would not be realigned or modified. The lateral clearance issue at PPT would not be resolved. As such, this option would not comply with the project requirements.

#### 5.1.1.2 Option 1: Do-Minimum

This Option seeks to achieve the electrification of the DART Slow lines by means of minor interventions only – specifically, the implementation of the maximum possible track lowering at Conyngham Road Bridge (OBO2).

A review of the constraints has concluded that a maximum track lower of circa 370mm under Conyngham Road Bridge (OBO2) would achieve a structural vertical clearance of 4.566m, which would require approval of the localised OHLE system solution within the North and South Portals of the Phoenix Park Tunnel.

A slab track system is also proposed for this option to limit the depth of construction particularly as this essentially the south portal of the Phoenix Park Tunnel.

At the Pheonix Park Tunnel, this Option seeks to achieve improved clearances by a realignment of the track and the installation of a slab track system. The proposed alignment improves the lateral passing clearances to structure and between passing trains.

#### 5.1.1.3 Option 2

This Option seeks to achieve the electrification of the railway in this section by means of a combination of interventions – track lower, bridge intervention and requiring road raising at Conyngham Road. The existing track horizontal alignment will be retained throughout this area, whilst the vertical alignment would remain as per the existing over Liffey Bridge (UBO1).

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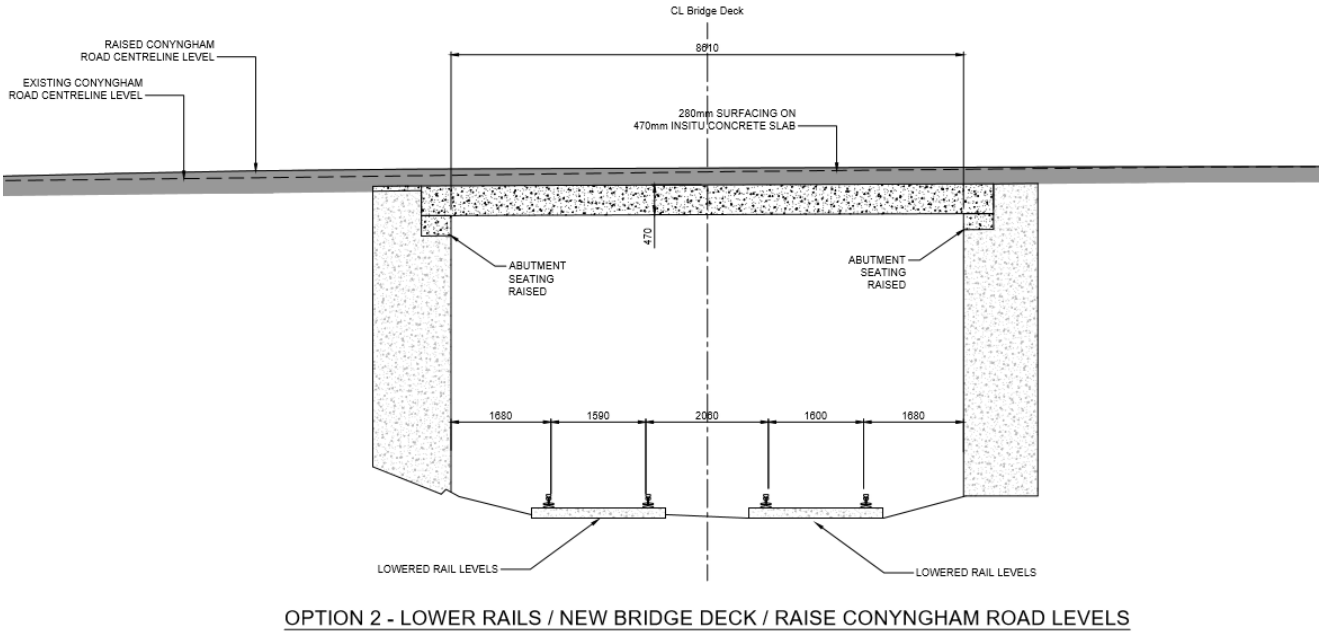


**Figure 5-1 Cross Section at Conyngham Road Bridge (OBO2) - Facing North**

Due to the constraints on road design solutions (previously mentioned in **Section 4**), the road and adjacent footpaths could only be raised by approx. 100-120mm local to the bridge. This minimal benefit is as a result of the requirement to tie back into existing footpaths without severely impacting the adjacent apartments' accesses.

As noted, the required vertical levels would require track lowering (around 150mm) plus a road level increase (around 100mm) and the reduction of the bridge deck thickness, when compared to the existing bridge.

Approval for non-standard localisation of the footpaths and cycle tracks with high kerbs a ramping (to include pedestrian railing) would also be required in order to provide sufficient clearance for all the utility diversions.


**Figure 5-2 Extent of Roadworks Reinstatement at Conyngham Road Bridge (OBO2)**

Regarding the Phoenix Park Tunnel, as with the Do-minimum option, this Option seeks to achieve improved clearances by a realignment of the track and the installation of a slab track system. The proposed alignment improves the lateral passing clearances to the tunnel and between passing trains.

## 5.1.2 OHLE Arrangement – All Do-Something Options

The Phoenix Park Tunnel is directly adjacent to the Conyngham Road Bridge (OBO2), and so these two structures have been considered together when defining the OHLE solution for each option.

Two OHLE options for this location exist and are applicable to both Option 1 and 2 above.

**Table 5-2 OHLE options**

| Option | Conyngham Road Bridge (OBO2) Solution | Phoenix Park Tunnel Solution |
|---|---|---|
| OHLE1 | Flexible OHLE | Flexible OHLE |
| OHLE2 | Rigid Overhead Bar | Rigid Overhead Bar |

### 5.1.2.1 Option OHLE 1

This option is the least visually intrusive at the open sections of route south of Conyngham Road Bridge (OBO2) and north of the tunnel.

The existing Conyngham Road Bridge (OBO2) has a 4.26m minimum soffit height. Therefore, no OHLE solution is possible for Option 0

For bridge Options 1 and 2, it is proposed that the OHLE through the bridge will be fitted, with elastic bridge arms supported from the bridge at multiple locations due to its length. Two pocket location will be designed within the bridge deck to position the bridge arm between bridge support beams and so utilise to reduce the intervention requirement. This is an essential requirement to provide sufficient clearance for OHLE in all the options. Slab track will be used through Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel, so no upward track movement allowance has been provided.

This will provide minimum contact wire height of 4.2m under all conditions.

The Phoenix Park Tunnel is configured such that the OHLE can pass through the tunnel, but due to its length it will be connected to the tunnel at multiple locations. This option provides a continuation of the flexible OHLE through the tunnel. The opportunity exists to begin grading the contact wire up within the tunnel; and the opportunity will also be taken to open up a system height within the tunnel, removing the need for elastic bridge arms which can create dynamic resonance problems when used in multiples. The support and registration through the tunnel in this option is likely to comprise a small system height cantilevers supported from the centre of the tunnel roof. Electrical clearances will be 150mm static and 100mm passing.

Due to the shape of the tunnel and restricted clearance between the OHLE live equipment and the tunnel face in areas, compression arms will be used where necessary to keep all the registration from the centre of the tunnel. Due to the low line speed at the location (30kph) it will be possible to use compression arms at multiple locations without affecting the dynamic performance of the system.

The length of the tunnel is approximately 700m, and so the mid point anchor will be placed within the tunnel.

Overlaps will be placed at both end of the tunnel.

Mast spacings to the south of Liffey Bridge (UBO1) will be dependent on the design of OHLE at the Heuston west station throat, which will follow at a later stage of the design development.

#### 5.1.2.2 Option OHLE 2

This option offers some robustness advantages over OHLE 1 but is more expensive and will result in a minor increase in visual intrusion at the Southern Portal end and a significant increase at the Northern Portal. This option will only be pursued if the tunnel condition requires it.

This option provides ROCL throughout the bridge and tunnel section. This option offers some advantages in terms of robustness, which can be advantageous in tunnels with a corrosive environment. However, this option is likely to be more expensive, due to the requirement for more frequent tunnel supports than with the flexible OHLE option. This option also requires transition arrangements at each end of the ROCL section where the flexible OHLE takes over. At these transitions, the OHLE tension must be transferred into the Conyngham Road Bridge (OBO2) deck (at the Southern transition) and into the ground (at the North transition outside the tunnel, where a conventional anchor structure can be used). The ROCL will also unavoidably need a midpoint anchor within the tunnel. Anchor points will need to be regularly inspected. For these reasons, the ROCL option is only likely to be pursued if the further design development demonstrates that option OHLE1 is not feasible, either due to tunnel conditions or another constraint.

### 5.1.3 Permanent Way

In the two main options, the permanent way solutions follow the existing rail corridor footprint, being constrained by existing structures - Liffey Bridge (UBO1), Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel. In order to improve the maintainability of the clearances to the structure a slab track system is proposed from Liffey Bridge (UBO1) to the north portal of Phoenix Park Tunnel. Because of this, the minimum lateral passing clearances to the tunnel may be reduced as well as the required vertical clearances at Conyngham Road Bridge (OBO2). This is further aided by the reduced maintenance allowances associated with slab track.

### 5.1.4 Design Speed, Track Spacing and Lateral Clearance Criteria

Phoenix Park Tunnel is very constrained in terms of the interval between tracks, the clearance between the train and the tunnel and the tight horizontal curvature that limits the speed within its extents. Consequently, the existing line speed will be retained – 25mph (40 km/h). The proposed track layout will strike a balance to ensure a best-fit alignment that ensures adequate clearances between rolling stock and tunnel infrastructure, as well as vehicles passing one another on adjacent lines (the Up Slow and Down Slow tracks).

To ensure that the new electrified rolling stock fits through the tunnel a clearance analysis will be undertaken using what is called a reference profile – in this case called IRL2A. This represents the maximum cross section of any vehicle that will pass through the tunnel, so will prove safe passage of any actual rolling stock using the tunnel.

### 5.1.5 Drainage

An upgrade to slab track is being proposed in the Phoenix Park Tunnel, which will require a dedicated drainage system. Therefore, an integrated drainage solution has been proposed to ensure a safe and reliable operation of the infrastructure.

The current catchment area at the tunnel and its approaches will not be modified by the proposed track works, and the aim is to retain the existing drainage strategy along the track but adjusting the current water collection system to the proposed slab section.

Based on the above, the existing discharge rate and outfall location of this drainage network can be retained, with the only difference that the current collection system (perforated pipe) will not work on a track slab and will need to be replaced by a channel drain located in the 6-foot area.

This drainage strategy will be re-assessed at a later stage so the approach can be validated, and the different elements defined (cover and invert levels, channel and pipe alignments, outfall location, inspection chambers, etc.). Consultations with the consenting authority will be carried out in order to ensure agreement with this approach.

In case a new outfall to the Liffey River is required, additional consultations will be carried out and OPW Section 50 requirements shall be considered.

### 5.1.6 Geotechnical (All Do-Something Options)

New track alignments and electrification interventions will require detailed geotechnical design for the following elements:

- Earthworks and track bed formation design for new slews and vertical alignment changes for the proposals. Due to the Phoenix Park Tunnel invert being potentially close to the base of the existing track bed, a slab track is required to achieve the require vertical and lateral clearances.
- Overhead Line Equipment foundation design.

### 5.1.7 Roads (Only Option 2)

The only road works anticipated are associated with option 2.

The level of road carriageway raising noted under the option summary could be achieved with an asphalt overlay but the footpaths would require local reconstruction to facilitate the road raising as well as to accommodate the reinstatement of utilities. The extent of the works would be between 50-70m in length across the entire width of the road ‘right of way’.

A localised low point would be introduced on the eastern side of the bridge and consequently new double gullies would be required to replace the gully currently located adjacent to the bridge.

If the bus corridor upgrades commence prior to rail scheme, then the extent of reinstatement will be nominally more costly primarily owing to the aesthetic finishes to defined segregated cycle lanes.

### 5.1.8 Cable and Containments (All Do-Something Options)

Existing containment routes consist of buried duct, surface troughing and ladder rack/tray. With the exception of Option 0, all other engineering options will require the relocation of various cables and containments.

Where new containment is required to interface with proposed SET installations, these shall be interfaced appropriately with the existing containment runs. Where cable ducts are required to pass under the railway track they shall be contained by a suitable under track crossing

Where there is a required change of direction for cabling draw-chambers shall be installed (surface or otherwise). Draw-pits will be of adequate size to enable cables to be drawn in without damage and accommodating the cable bending radius.

These containment solutions shall be utilised for all SET cabling requirements with services separated as far as is reasonably practical.

## 5.2 Heuston West Station

It is proposed that a new station, located at Heuston West will be delivered as part of the DART+ South West Project, the proposed location of the station is adjacent to platform 10 and the Clancy Quay development. Details of the station are included **Volume 3I Technical Optioneering Report – Heuston West Station**.

## 5.3 Substations (All Do-something Options)

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 this section at:

- Islandbridge

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.

### 5.3.1 Islandbridge Substation

The power study determined the requirement for an electrical substation in Islandbridge. The area is a densely populated urban environment, close to Dublin city centre, to the north is the River Liffey, to the south is the R148 & Royal Hospital Kilmainham, to the east is Heuston Station and to the west is mix of residential and office space. The study area in Islandbridge primarily focuses on IÉ-owned land, and the potential of utilising existing land to construct a new substation. See **Figure 5-3.**

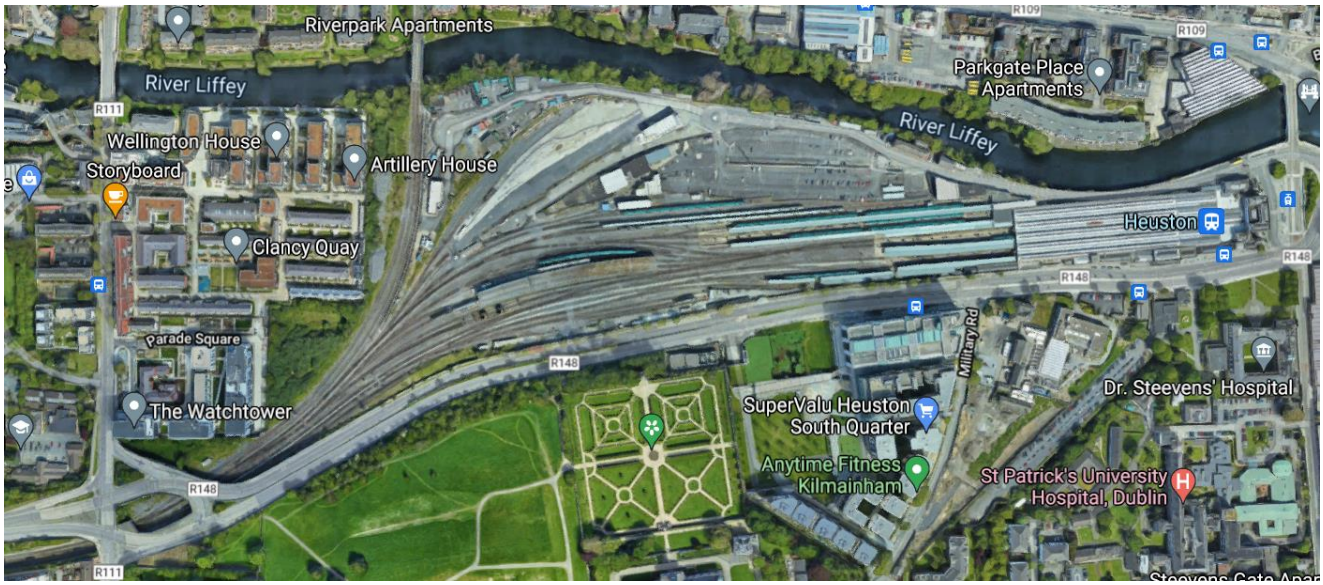


**Figure 5-3 – Islandbridge Substation Site Location**

#### 5.3.1.1 Constraints and Challenges

The study area includes the greater area of Heuston Station for consideration. The main constraints for this location are as follows:

- Existing and proposed land use – the urban / city centre setting and presence of the adjacent Heuston Station means that the local area is dominated by railway yard / infrastructure and residential/commercial developments. IÉ have also noted a future development plan for the area and to maximise potential for commercial property development. Further competing land use needs arise through the requirements of the DART+ South West project in terms of space needed for proposed drainage attenuation and/or infiltration tanks and space proofing for the Heuston West Station.
- Grid connections – ESB infrastructure is located nearby along the R148. This is a busy arterial route into the city and hence is sensitive to traffic disruption. 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, in particular at the junction with Con Colbert Road / Chapelizod Bypass and South Circular Road. 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 South Circular Road. This level difference diminishes further to the east.
- Environmental / Other - lands to the south of the R148 include the Royal Kilmainham Hospital and Bully's Acre. All lands and features associated with these areas are environmentally sensitive.
- Power simulation – The original location for the proposed substation per Section 5.3.2 of the Power Study is specified as 4.03km from Datum. This would require the substation to be located along the railway corridor between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). This is a very constrained area, the rail line runs in a deep cutting with Colbert Road / Chapelizod Bypass dual carriageway running parallel to the railway to the north and existing residential development all along the southern railway boundary, there are no feasible locations available in this area. Therefore, the proposed location per the power simulation study has been relocated eastwards towards Heuston Yard noting that

by reducing the distance between the proposed Islandbridge substation and the DART+ West substation at Glasnevin, the outputs of the power simulation will remain acceptable. Hence, the proposed location is positioned on the first available suitable site which is immediately adjacent to St John's Road Bridge (OBC0A).

#### 5.3.1.2 Options

A total of five options for substation locations were identified. These options are outlined as follows and illustrated in **Figure 5-4**.


**Figure 5-4 - Islandbridge Proposed Substation Options**

**Option 1**

Option 1 is located to the north of the Chapelizod Bypass / South Circular Road junction and to the south of the existing Clancy Quay residential development. It is a brown field Option in the possession of IÉ adjacent to the railway.

**Option 2**

Option 2 is located to the east of Clancy Quay development. It is a brown field Option in the possession of IÉ adjacent to the railway.

**Option 3**

Option 3 is also located to the east of Clancy Quay development on the southern bank of the River Liffey. It is a brown field Option site in the possession of IÉ adjacent to the railway bridge across the river.

**Option 4**

Option 4 is located within the Heuston Yard area along the R148 (St John's Road). It is a brown field Option in the possession of IÉ on the southern side of the railway yard.

**Option 5**

Option 5 is located within Heuston Yard, next to the old Guinness sidings and existing CCE Maintenance Depots. It is a brown field Option in the possession of IÉ.

## 5.4 Construction Compounds

One Construction Compound is required between East of St John's Road Bridge and North of Phoenix Park Tunnel:

- Heuston West

### 5.4.1 Heuston West

A construction compound is required to the west of Heuston Station, adjacent to the existing platform 10, for works to be undertaken to the Phoenix Park Tunnel and the construction of the new Heuston West Station. A construction compound will need to be constructed on both sides of the existing railway as access on the western side is also required for the installation of an underground attenuation tank which is to be located in this area. Equipment and material will need to be stored on this side of the railway due to the extent and type of work involved.

Due to the proximity of the proposed new underground drainage attenuation tanks on the western side of the tracks, the compound will need to be split and works phased to allow the construction of the station, Phoenix Park tunnel works and the construction of the new Heuston West station.

Outbound access to the main road network would be via the Heuston Station access road to Parkgate Street, Conyngham Road, Islandbridge Road and on to Chapelizod Bypass (Con Colbert Road) and onwards to the M50. Inbound traffic could use the Chapelizod Bypass (Con Colbert Road and St John's Road West) and access directly to the Heuston Station Access Road.

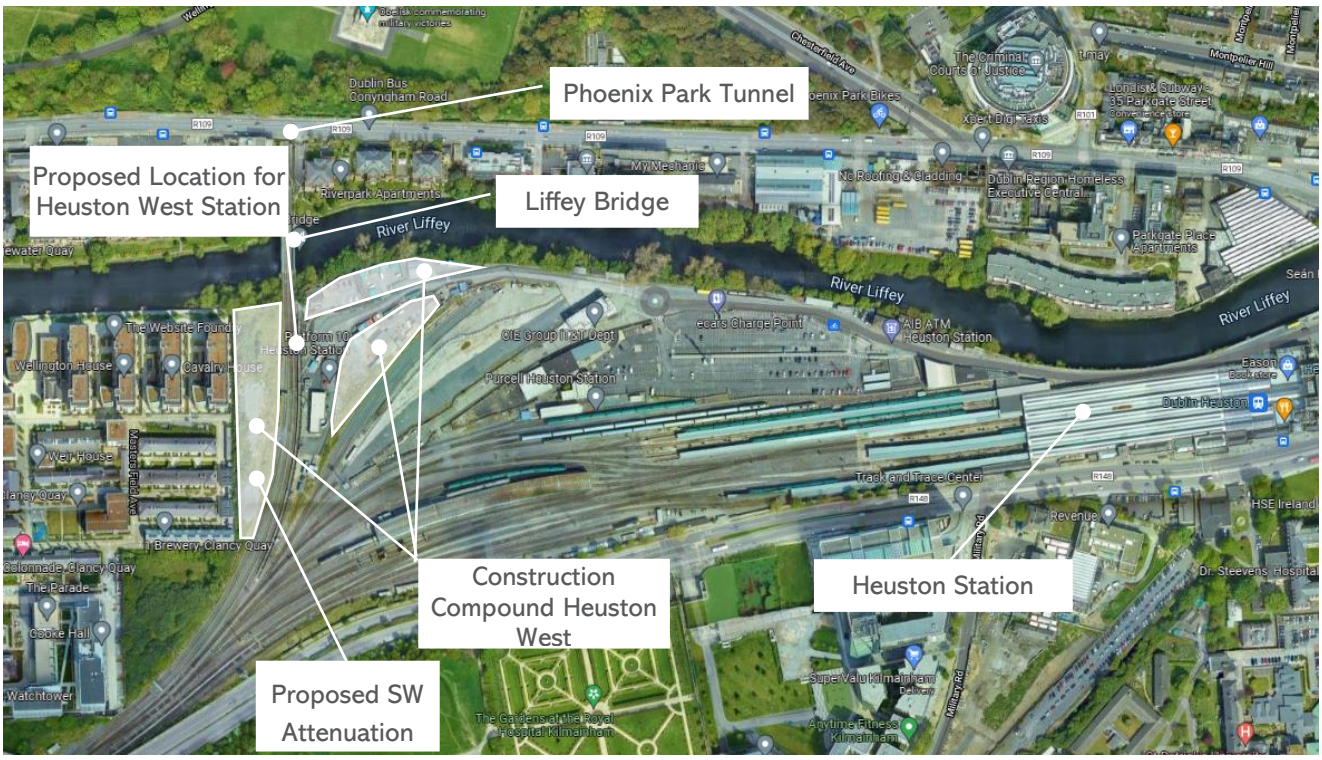


**Figure 5-5 Construction Compound Heuston West Site Location**

The proposed construction compound is located on Irish Rail property adjacent to platform 10 and the Clancy Quay residential development. Due to the proposed location of the new station and the presence of existing rail lines to the east and south, no other suitable construction compound locations were identified in this very constrained area of the route. As a result, the selected construction compound location did not require multi-criteria analysis.

# 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, 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 (if / as appropriate):

- 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 assess the options associated with the following elements on the section from the East of St. John's Road Bridge to East of the Phoenix Park Tunnel:

- Conyngham Road Bridge and Phoenix Park Tunnel
- Substations
- Construction Compounds

The sifting and MCA process is slightly different for each of these elements; each process is described in detail under each element subsection.

### 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, Economic 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.

The options assessed for selecting the Preferred Option for the Project, 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.

This process has been used separately to assess the Corridor Preferred Option, the Substation Site Preferred Option and the Construction Compounds Preferred Option.

Where the sifting results in only one feasible option, a multi-criteria analysis (MCA) is not required for that one option.

### 6.1.2 Stage 2 Multi Criteria Analysis (MCA)

Stage 2 of the optioneering process comprises a detailed multi-disciplinary comparative analysis of the feasible options that 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). These parameters were split into a number of sub-criteria considered relevant to the DART+ South West Project.

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 Emerging Preferred Option will be assessed in the environmental impact assessment report (EIAR) 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 Emerging Preferred Option.
- The envelope around each Option was used to spatially represent environmental constraints within / proximate to the options.

The options which were brought forward from the Preliminary Screening were developed further to facilitate the more detailed Stage 2 Multi Criteria Analysis.

The MCA Process 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 Conyngham Road Bridge and Phoenix Park Tunnel Option Selection

### 6.2.1 Stage 1 Sifting

**Table 6-2** and **Table 6-3** provide details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process for Conyngham Road Bridge. **Table 6-4** and **Table 6-5** provide details for the sifting for Phoenix Park Tunnel. Options which were assessed as feasible and fulfilled the project requirements were brought forward to Stage 2 MCA for a more detailed assessment. See **Appendix A Sifting Backup Process** for details.

**Table 6-2 Sifting Process – Conyngham Road Bridge (OBO2)**

| 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. |
| | | OHLE to be installed | FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved. |
| | | Electrical clearance for electrification | FAIL. No intervention proposed. Vertical electrical clearance at structures not achieved. |
| | | Safe rolling stock passing clearances | PASS. No intervention proposed. |
| | | Compliant road design | PASS. No intervention proposed. |
| | | Track alignment and drainage (standards) | PASS. No intervention proposed. |
| | **Economy** | | Compatible with the investment guidelines and programme for DART+ |
| | **Environment** | | No impact on Environmental sites of National of International significance. |
| | **SIFTING OUTCOME** | | **FAIL. Do not progress to Stage 2 Assessment** |
| 1 | **Engineering** | Constructability | PASS. Proposal requires slab track installed in Phoenix Park Tunnel. |

| Option | Requirements | | Description |
|---|---|---|---|
| | | | Unknown ground conditions and the presence of an existing drainage channel in Phoenix Park Tunnel may make construction difficult. |
| | | Geometrical fitness for intervention | PASS. This would require a minimum track lowering of circa 388mm, which is difficult to achieve (Per Way Variation 3) in technical terms as GI and existing drainage channel through Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel unknown and steep gradients exceeding 1.5% feature in the vertical alignment design (Max. 1.859% in PPT). |
| | | Safety | PASS. No issues. |
| | | OHLE to be installed | PASS. Reduced contact wire height achieved will require a derogation (OHLE equipment to be installed between bridge beams). |
| | | Electrical clearance for electrification | PASS. This option achieves a reduced electrical clearance of 4.566m at Conyngham Road Bridge (OBO2). |
| | | Safe rolling stock passing clearances | PASS. Horizontal alignment maintained as existing. |
| | | Compliant road design | PASS. No intervention proposed. |
| | | Track alignment and drainage (standards) | PASS. |
| | **Economy** | | Compatible with the investment guidelines and programme for DART+. |
| | **Environment** | | No impact on Environmental sites of National of International significance. |
| | **SIFTING OUTCOME** | | **PASS. Proceed to Stage 2 Assessment** |
| 2 | **Engineering** | Constructability | PASS. Re-construction of Conyngham Road Bridge (OBO2) would be difficult but is considered feasible. |
| | | Geometrical fitness for intervention | PASS. This would require a minimum track lowering of circa 200mm. |
| | | Safety | PASS. No issues. |
| | | OHLE to be installed | PASS. Reduced contact wire height achieved will require a derogation. |
| | | Electrical clearance for electrification | PASS. This option achieves electrical clearance in structures (with derogations). |
| | | Safe rolling stock passing clearances | PASS. Horizontal alignment maintained as existing. |
| | | Compliant road design | PASS. Option is in accordance with derogated standards. |
| | | Track alignment and drainage (standards) | PASS. |
| | **Economy** | | Compatible with the investment guidelines and programme for DART+ |
| | **Environment** | | No impact on Environmental sites of National of International significance. |
| | **SIFTING OUTCOME** | | **PASS. Proceed to Stage 2 Assessment** |

Conyngham Road Bridge (OBO2) has Do Minimum and a Do Something (Option 2) options that pass the sifting process. The Do Minimum Option is preferred over the Do Something Option and will be brought forward as the Preferred Option. See **Table 6-3** for a summary of the sift process results for Conyngham Road Bridge.

**Table 6-3 Summary of Sift Process Results – Conyngham Road**

| Main Option | Sifting Process Result |
|---|---|
| Option 0: Do Nothing | FAIL |
| Option 1: Do Minimum | PASS |
| Option 2 – Do Something | PASS |

**Table 6-4 Sifting Process – Phoenix Park Tunnel**

| 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. |
| | | OHLE to be installed | FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved. |
| | | Electrical clearance for electrification | PASS. No intervention proposed. |
| | | Safe rolling stock passing clearances | FAIL. Existing lateral clearances are not compliant with standards. |
| | | Track alignment and drainage (standards) | PASS. No intervention proposed. |
| | **Economy** | | Compatible with the investment guidelines and programme for DART+ |
| | **Environment** | | No impact on Environmental sites of National of International significance. |
| | **SIFTING OUTCOME** | | **FAIL. Do not progress to Stage 2 Assessment** |
| 1 | Engineering | Constructability | PASS. Proposal requires slab track installed in Phoenix Park Tunnel. Associate tunnel improvement works may be necessary.<br>Unknown ground conditions and the presence of an existing drainage channel in Phoenix Park Tunnel may make construction difficult. |
| | | Geometrical fitness for intervention | PASS. Localised tunnel structural intervention may be needed. |
| | | Safety | PASS. No issues. |
| | | OHLE to be installed | PASS. |
| | | Electrical clearance for electrification | PASS. Vertical clearance will allow for electrification in the tunnel. |
| | | Safe rolling stock passing clearances | PASS. Horizontal is improved. |
| | | Track alignment and drainage (standards) | PASS. |
| | **Economy** | | Compatible with the investment guidelines and programme for DART+. |
| | **Environment** | | No impact on Environmental sites of National of International significance. |
| | **SIFTING OUTCOME** | | **PASS. Proceed to Stage 2 Assessment** |

The Phoenix Park Tunnel is limited in terms of possible interventions and the Do minimum is realistically the only feasible option. It will therefore be taken forward to the Preferred Route. See **Table 6-5** for a summary of sift process results for Phoenix Park Tunnel.

**Table 6-5 Summary of Sift Process Results – Phoenix Park Tunnel**

| Main Option | Sifting Process Result |
|---|---|
| Option 0: Do Nothing | FAIL |
| Option 1: Do Minimum | PASS |

No MCA process is therefore deemed required through this area. As the Do Minimum options are feasible (subject to validation in terms of Conyngham Road Bridge (OBO2), these minimal interventions will be taken through to the Preferred Route.

### 6.2.2 Stage 2 Multi Criteria Analysis (MCA)

No MCA was required for Conyngham Road Bridge and Phoenix Park Tunnel. The preferred route (option 1) will therefore comprise lowering of the track through Conyngham Road Bridge (OBO2), the addition of Electrification infrastructure through the whole area and a new slab track and realignment of the track will be required through the tunnel.

## 6.3 Substations

A total of six substations are required for the DART+ South West Project, one of them is located in the section from Hazelhatch to Park West at the following locations:

- Islandbridge

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 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 6-6**. 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 6-6 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.<br>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 | Estimated risk of maintenance cost associated with the improvement or deterioration of the condition of the substation. |

| CAF Parameters | Criteria | Basis for Comparative Analysis | Qualitative and/or Quantitative Considerations (as appropriate) |
|---|---|---|---|
| | | greater risk of long-term maintenance issues. | |
| 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).<br>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<br>Buildability of the solution during operation.<br>Potential to impact rail service / IR operations during construction. |
| | 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:<br>Changing character of area (future urban regeneration proposals, extant planning permission etc).<br>The extent to which an option provides / supports opportunity for regeneration - |

| CAF Parameters | Criteria | Basis for Comparative Analysis | Qualitative and/or Quantitative Considerations (as appropriate) |
|---|---|---|---|
| | | | 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.<br>Potential to impact on external links during operation.<br>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 | 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 |
| | Air quality and Climate | | |
| | Landscape and Visual | | |
| | Biodiversity (flora and fauna) | | |

| CAF Parameters | Criteria | Basis for Comparative Analysis | Qualitative and/or Quantitative Considerations (as appropriate) |
|---|---|---|---|
| | Cultural Heritage, archaeological and architectural heritage | | whether potential effects can be mitigated. |
| | 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.<br>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 | |

| CAF Parameters | Criteria | Basis for Comparative Analysis | Qualitative and/or Quantitative Considerations (as appropriate) |
|---|---|---|---|
| | | operational phase not construction. | |

## 6.3.2 Islandbridge Substation

### 6.3.2.1 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. A summary of the findings of the sifting assessment is provided in **Table 6-7**. Full details of the initial sifting assessment are provided at **Appendix A Sifting Backup Process** of this report.

**Table 6-7 Sifting Assessment Summary**

| Islandbridge Sifting | Result | Comments | Brought forward to MCA |
|---|---|---|---|
| **Option 0: 'Do Nothing'** | **FAIL** | Electrification not achieved | **No** |
| **Option 1** | **PASS** | Feasible | **Yes** |
| **Option 2** | **PASS** | Feasible | **Yes** |
| **Option 3** | **PASS** | Feasible | **Yes** |
| **Option 4** | **PASS** | Feasible | **Yes** |
| **Option 5** | **PASS** | Feasible | **Yes** |

### 6.3.2.2 Stage 2 Multi Criteria Analysis (MCA)

Full details of the assessment matrix are available at **Appendix B MCA Backup Process** of this report. **Table 6-8** provides a summary of the MCA findings.

**Table 6-8 Islandbridge MCA Summary**

| CAF Parameters | Option 1 Assessment | Option 2 Assessment | Option 3 Assessment | Option 4 Assessment | Option 5 Assessment |
|---|---|---|---|---|---|
| **1. Economy** | Significant Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Significant Comparative Advantage over Other Options | Some Comparable Advantage over Other Options |
| **2. Integration** | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Advantage over Other Options | Some Comparative Disadvantage over Other Options |
| **3. Environment** | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Advantage over Other Options | Some Comparative Disadvantage over Other Options |
| **4. Accessibility and Social Inclusion** | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Disadvantage over Other Options | Some Comparative Advantage over Other Options | Some Comparative Advantage over Other Options |
| **5. Safety** | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral |
| **6. Physical Activity** | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral | Comparable to Other Options / Neutral |
| **Conclusion** | | | | **Preferred Option** | |

Option 4 is the preferred option for the proposed Islandbridge traction power substation. In terms of Economy, Option 4 performs favourably due to ease of access and constructability due to close proximity to the R148 St John's Road. It is assumed that any permanent access track would require work to effectively separate it from the permanent way and thus permit access by ESB Networks personnel (unaccompanied by IÉ TSC's). ESB grid connection is likely to be comparatively simple when compared to other options.

All Options are comparative in terms of integration with Option 4 offering a slight comparative advantage over other options due to the ease of access to the adjacent road network. With regard to environmental criteria, Option 4 performs marginally better due to an expected lesser noise impact as this Option is located further away from existing residential developments when compared to the other options.

Similarly, as distance to neighbouring residences is maximised, Option 4 offers a slight comparable advantage over other options regarding Integration and Social Inclusion. All Options are comparable in terms of Safety. See **Appendix C Drawings** for a drawing of the Islandbridge proposed substation location.

## 6.4 Construction Compounds

As there are no other suitable alternative locations for the Construction Compound in this area, multi-criteria analysis was not required. Please refer to **Section 8** for further details in relation to the Construction Compounds

# 7 Preferred Option Design Development

## 7.1 Review of Corridor 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 1 (do minimum) as the Preferred Option for Conyngham Road Bridge and Phoenix Park Tunnel.

In light of the above, the Option has been further validated, and its design progressed as the Preferred Option.

## 7.2 Review of Stakeholder Feedback

Stakeholder feedback from PC1 has noted concerns about the proposed line and its possible impact on the Phoenix Park with respondents stating that they do not want the line to infringe on the park, “environmentally or physically”. Further issues or concerns raised during PC1 are described in the **Public Consultation No. 1 Findings Report, Volume 4.1**.

## 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

Further geotechnical site investigation and P-Way alignment design has been undertaken and currently no existing bridge reconstruction works are proposed for this section. The track lowering currently is not deemed to impact the River Liffey Bridge (UBO1) and the arches immediately north of the River Liffey nor Conyngham Road Bridge (OBO2) refer to the OHLE and P-Way Sections for references pertaining to P-Way composition and lowering as well as novel OHLE supports proposals.

#### 7.3.1.2 Retaining Walls

There are currently no new retaining walls proposed for this section of track.

### 7.3.2 Permanent Way

The proposed layout comprises 4 tracks at the start of the section to the east of St John’s Road Bridge (OBC0A) - the 3 existing tracks being realigned on the south side of the corridor plus the addition of a new track on the north side. The 2 northern tracks tie-in to the existing GSWR branch lines and become the electrified Slow lines, whilst the Fast lines to the south approach Heuston Station. There are also other connections from the Slow lines

into Heuston Station, as well as the Slow lines passing through new Heuston West Platforms 10 and 11; both of these items are the subjects of their own separate reports.

The proposed track layout is shown in the figure below. See **Appendix C Supporting Drawings** for additional drawings for this area.

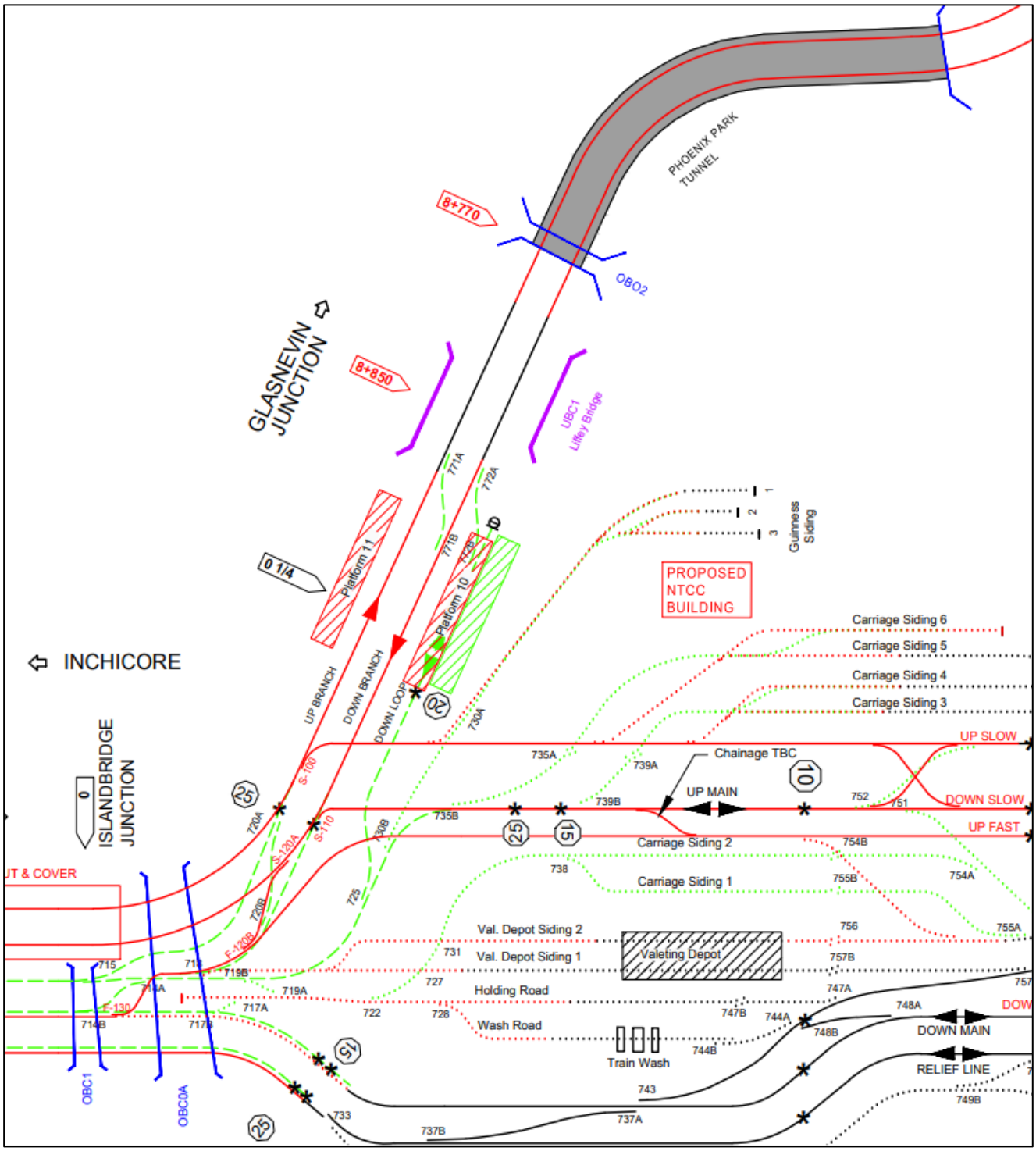


**Figure 7-1 St. John's Road Bridge (OBC0A) to East of Phoenix Park Tunnel – Track Plan Layout**

The horizontal alignment on the Slow lines emerges from the new OBC1 cut and cover structure before converging onto the existing Branch line alignment, to tie-in prior to Liffey River Bridge (UBO1) - being a fixed

track system on the bridge deck there is no track work proposed here. On the approach to Conyngham Road Bridge (OBO2) the slow lines are lowered by approximately 300mm in order to achieve clearance to install OHLE equipment.

The track alignment through Phoenix Park Tunnel has been realigned horizontally and vertically to ensure that structural and passing clearances are achieved, whilst providing the necessary headroom for the installation of new OHLE equipment required to electrify the lines. Due to the constrictive nature of the tunnel a careful balance has been struck to optimise the outcome of fitting the track with the new OHLE equipment. It is proposed to install slab track from Conyngham Road Bridge (OBO2) through Phoenix Park Tunnel, in order to provide improved restraint and positioning of the rails and maintain structure and passing clearances. There is an additional benefit in that slab track offers a shallower "track form" compared to ballasted track that will aid the provision of drainage through the tunnel, whilst facilitating the track lowers required to install the OHLE system.

Horizontally, to the east of Phoenix Park Tunnel, the tracks need to be widened in some areas where a sub-standard (less than 1970mm) track interval has been identified, to ensure passing clearance for the new DART+ rolling stock.

Vertically, the section is on a falling 0.9% gradient heading east from St. Johns Road Bridge (OBCOA) before levelling out at 0% through Heuston West Station, Platforms 10 and 11. The alignment then continues east towards a local high point (crest on a vertical curve) over Liffey Bridge (UBO1) prior to a low point at Conyngham Road Bridge (OBO2). Upon entering Phoenix Park Tunnel the gradient climbs at an average 1.2% heading east until the end of the section at the north portal.

The existing line speed in the section has been maintained for the proposed layout – i.e. 25mph (40km/h).

The following cross sections illustrate the proposed slab track and OHLE arrangements through Conyngham Road Bridge (OBO2) and Phoenix Park Tunnel.

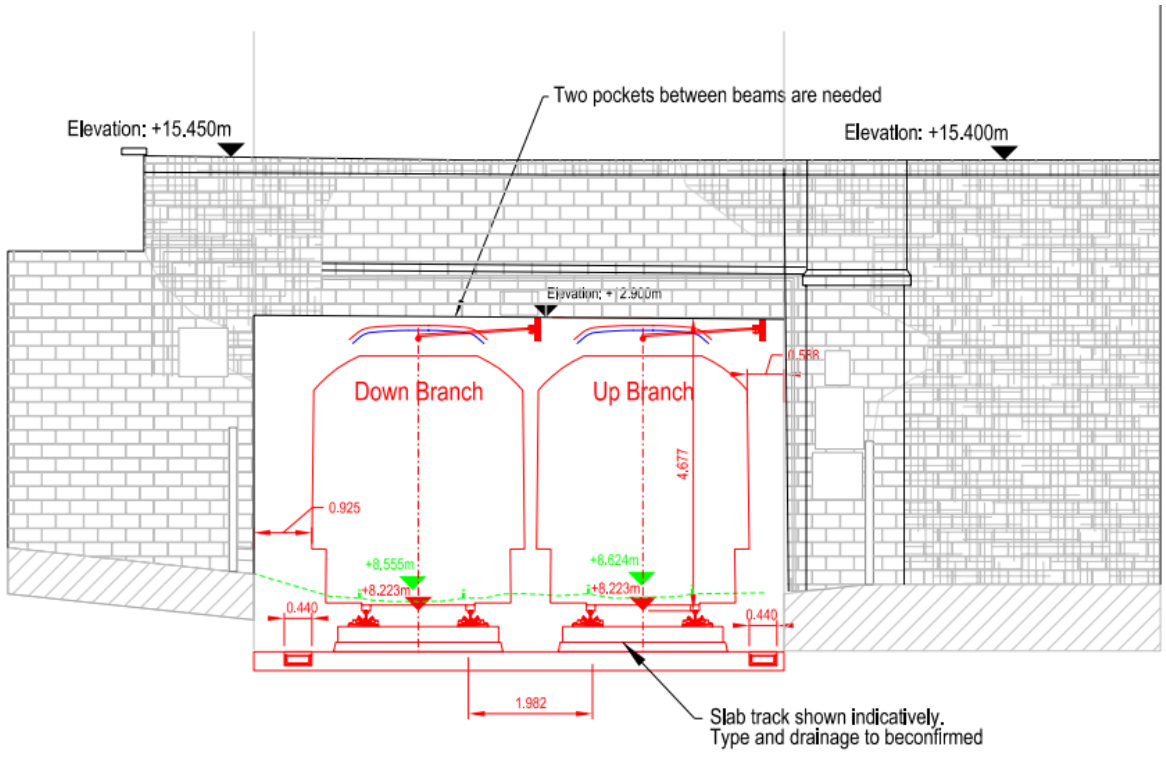


**Figure 7-2 Conyngham Road Bridge (OBO2) – Cross section at Ch 8+771, view towards Heuston West**

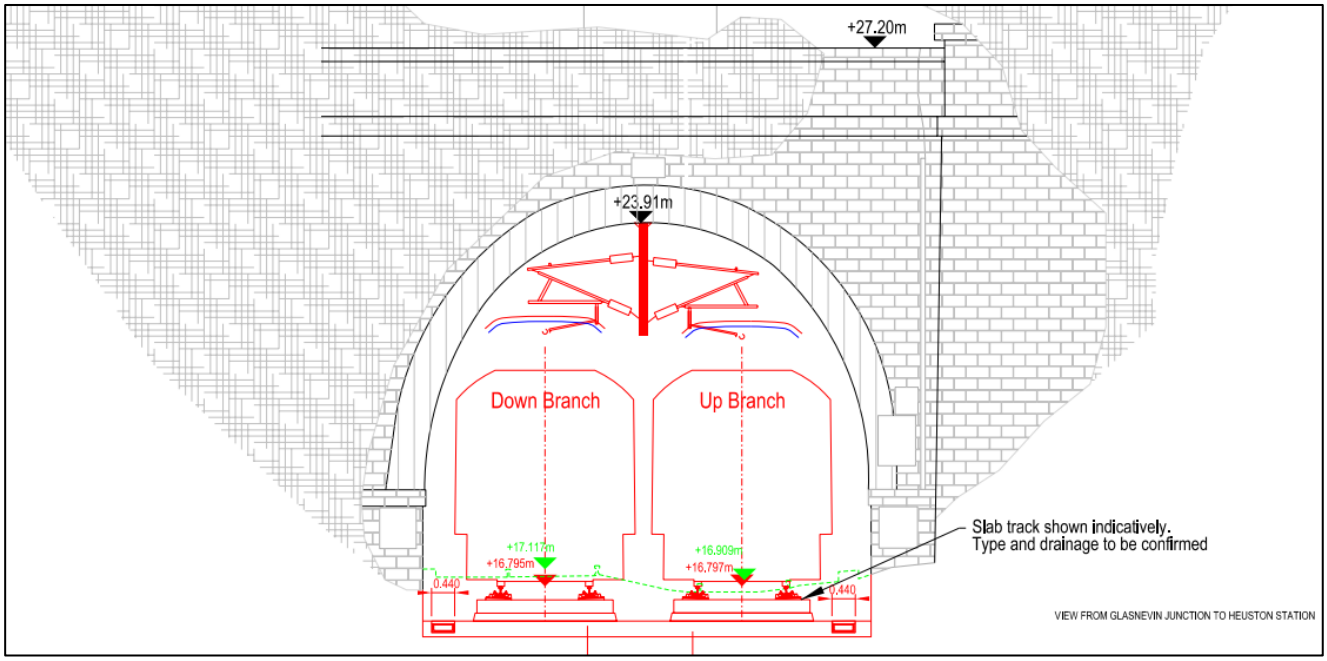


**Figure 7-3 Phoenix Park Tunnel – Cross section at Ch 8+056 – view from Glasnevin Junction**

## 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 **Volume 2 Option Selection – Technical Report.**

### 7.3.3.1 Signalling

No equipment has been considered within this section.

### 7.3.3.2 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 and secure anti-slip walkways (see **Figure 7-4**), with ladder rack being used on the tunnel walls. Secure troughing occupies the same footprint as 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 providing easy maintenance going forward.

**Figure 7-4 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 shown at the permanent way cross section drawings. See **Appendix C Drawings**.

#### 7.3.3.3 Telecommunications

According to the current design, a Telecom Equipment Building (TER) is not proposed for this area.

#### 7.3.3.4 Electrification

In this two track section, the electrification equipment will be supported by TTC structures on the north side of the lines to support OHLE on both tracks, and STC structures where the OHLE to be terminated with anchor arrangement required in limited space as detailed in **Section 3.2.1. Electrification System**.

An Electrical section break (a special 4 no. span insulated overlap) is required at the south exit of Phoenix Park Tunnel. Due to the restricted space between Phoenix Park Tunnel, Heuston West station and Liffey Bridge (UBO1), this cannot be moved towards the Heuston.

OHLE masts required 2m away from the Conyngham Road Bridge (OBO2) with a short anchor span to terminate the OHLE coming out of the tunnel. TTC type OHLE masts shall be positioned to support the OHLE between the tunnel and Liffey River bridge, due to the limited space at east side of the track.

OHLE switching shall be mounted on these structures. A hard standing surface will be required for switch operation.

Due to the reduced space between the track and retaining wall between Liffey Bridge (UBO1) and Conyngham Road Bridge (OBO2), the OHLE masts in this area may need to be positioned outside of the railway boundary as shown below.


**Figure 7-5 OHLE Mast position for Liffey Bridge and OBO2**

Then 4No. STC type OHLE masts shall be positioned to support the anchor span at the south end of the overlap. These four STCs will be attached to the Liffey Bridge (UBO1) at each end. This may require bridge strengthening to accommodate the tension and loading from OHLE structure.

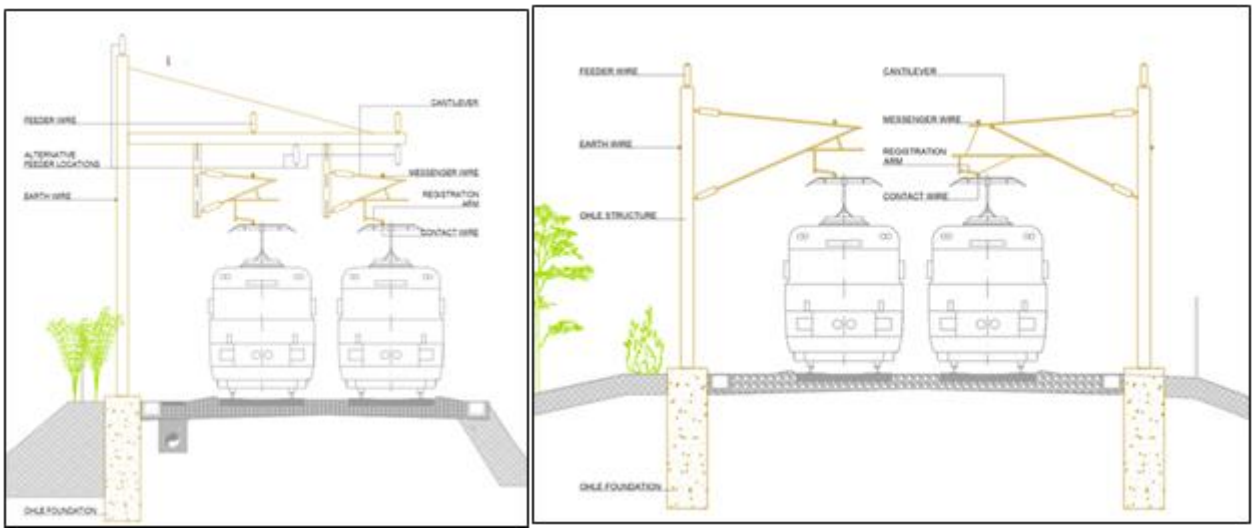


**Figure 7-6 Typical OHLE arrangement in two track open route - Facing North**

Heuston West Station

Electrical sectioning (insulated overlap) shall be positioned at each side of the station for Isolation and maintenance purpose. The anchor structure of the insulated overlap at the north end of the station has been designed to terminate the OHLE before the station platform to mitigate the tripping hazard due to tie in the station area. TTC type OHLE masts shall be positioned through station area to minimise the OHLE masts on one platform. The OHLE masts shall be placed to avoid clashing with station footbridge and shelter.

With OHLE configuration as stated above with graded down contact wire, the required safety clearance of 3m for 1500V to the passengers standing on the future station is achievable. However, for any high voltages such as 25kV, the required clearance may not be achievable due to the height of the bridge. See **Volume 3I – Technical Optioneering Report – Heuston West Station** for more details.

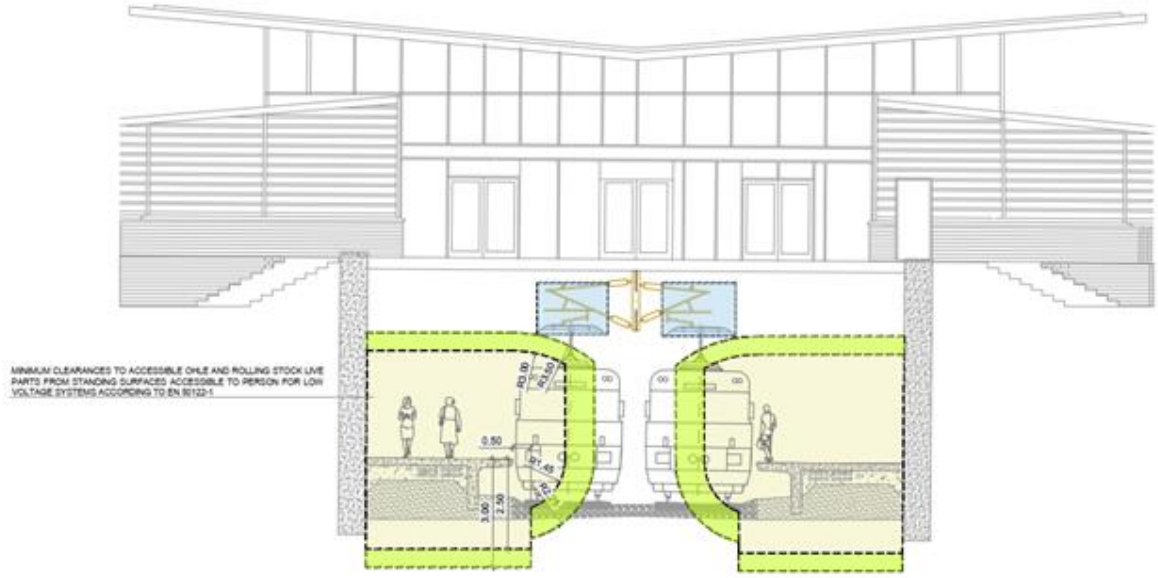


**Figure 7-7 Example OHLE system in station area with clearance.**

Bridge and Tunnel

The Phoenix Park Tunnel is directly adjacent to the Conyngham Road Bridge (OBO2) and therefore, these two structures have been considered together when defining the OHLE solution for each option

The OHLE through Conyngham Road Bridge (OBO2) will be fitted, with elastic bridge arms supported from the bridge at multiple locations due to its length. These connections would not be visible from road level. Slab track will be used through Conyngham Road bridge and Phoenix Park tunnel and therefore, no upward track movement allowance has been provided.

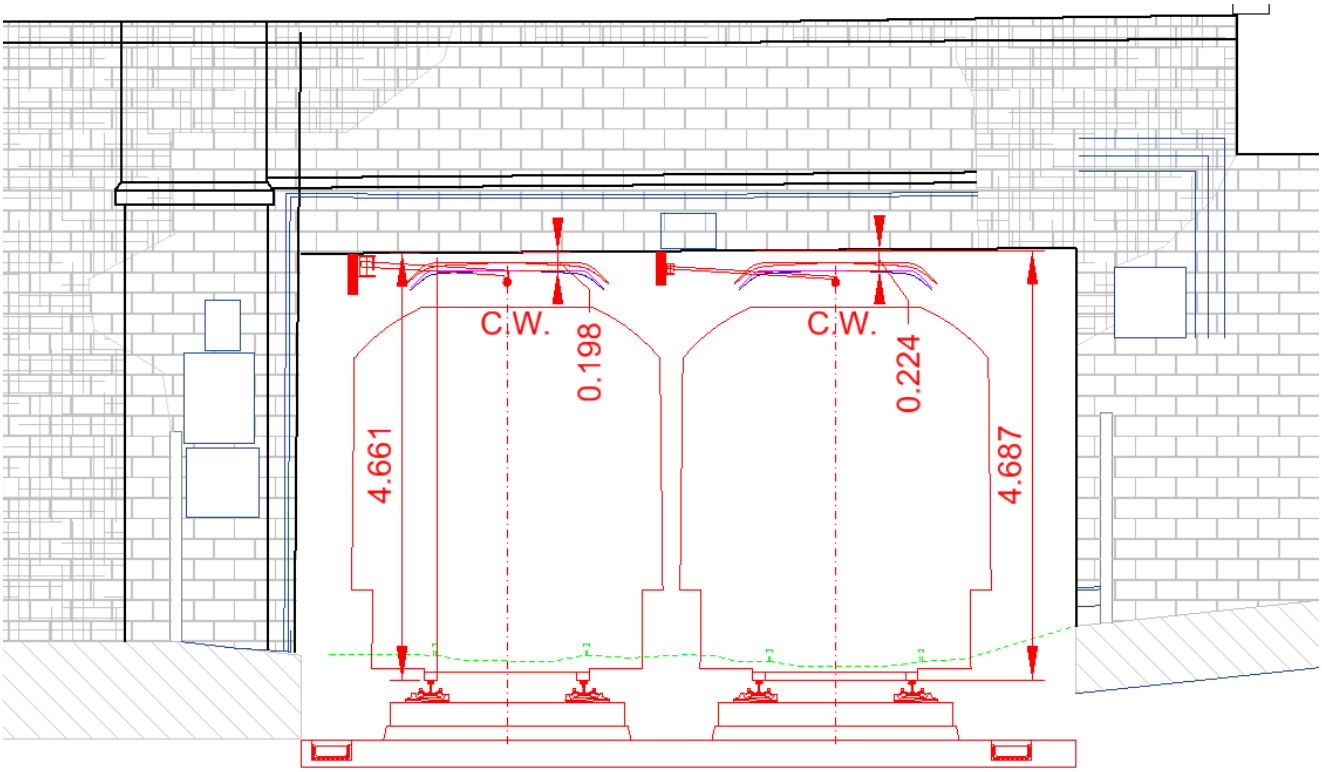


**Figure 7-8 Example cross section for fitted OHLE system in twin area - Facing North**

Phoenix Park Tunnel is sufficiently high that the OHLE can pass through the tunnel, but due to its length the OHLE will be connected to the tunnel at multiple locations. This option provides a continuation of the flexible OHLE through the tunnel. The OHLE shall be graded up from 4.2m to a greater value within the tunnel. Where the tunnel is high enough, the OHLE within the tunnel shall be designed with larger system height and removing the need for elastic bridge arms to reduce the dynamic resonance problems within the tunnel. The support and registration through the tunnel in this option is likely to comprise a small system height cantilever supported from the centre of the tunnel roof. Electrical clearances will be 150mm static and 100mm passing.

Due to the shape of the tunnel and restricted clearance between the OHLE live equipment and the tunnel face in this option, compression arms will be required where necessary to keep all the registration from the centre of the tunnel. Due to the low line speed at the location (30kph) it will be possible to use compression arms at multiple locations without affecting the dynamic performance of the system.

The length of the tunnel is around 700m, with the overlap at each end of the tunnel, the total tension length for this section will be more than 800m. Therefore, a Mid-point Anchor is required in the middle of the tunnel.

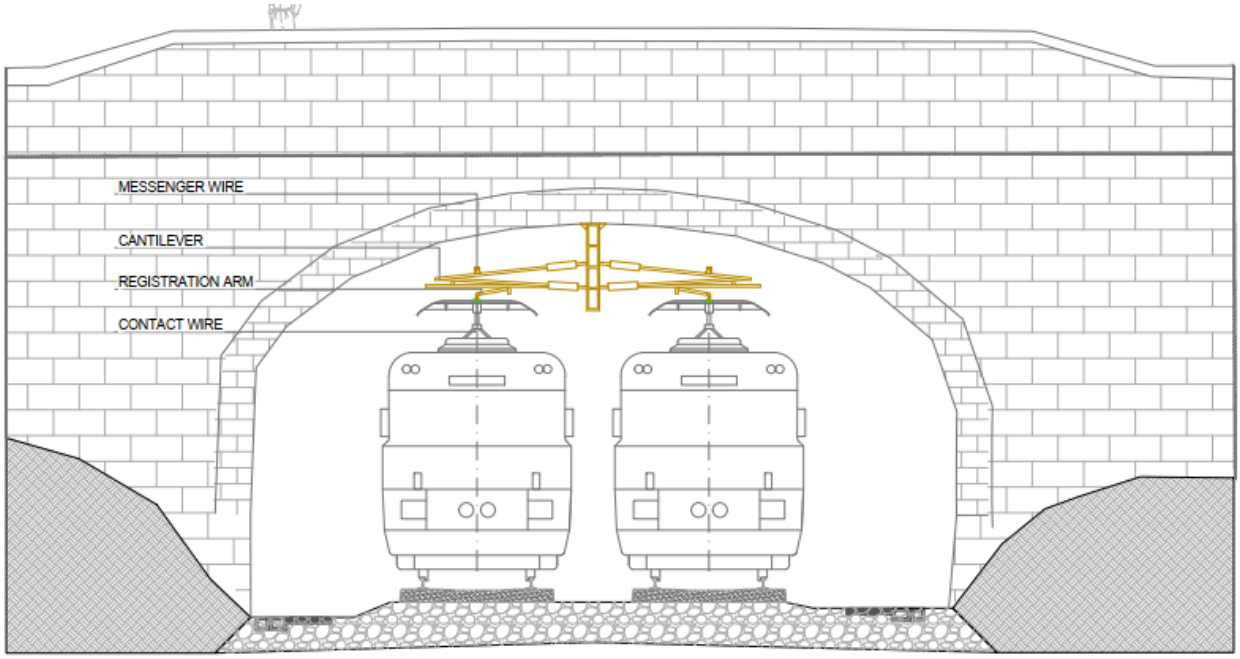


**Figure 7-9 Typical OHLE Tunnel Cantilever arrangement**

### 7.3.4 Roads

As the Conyngham Road Bridge (OBO2), Option 1 (Do Minimum) proposal for PC1, has been validated as the Preferred Option; no further road design development took place .

Storm water attenuation tanks however are to be provided west of Heuston Station in an isolated location; and as such controlled maintenance crossing is proposed immediately south of the Liffey River Bridge (UBC1) and north of the proposed Heuston West Station Footbridge. Access will be from the existing Heuston West roundabout in through the existing containerised office compound (north of the roundabout) and across the tracks. Safety systems of work will be interlocked into the proposed new signal control system along with physical barrier control. Due to the space constraints, only trucks with dimensions typical of 3.5tonne flatbed would be allowed access the area after the construction of the proposed Heuston West Station.

### 7.3.5 Drainage Requirements

The proposed drainage system for PPT includes a channel drain located in the 6-foot area to collect any surface water runoff on the track and convey flows from the upstream drainage network up to the existing outfall (potentially to Liffey River).

# 8 Construction

This section of the report sets out the approach in relation to the construction methodology for the works in the area between East of St. John's Road Bridge to North of the Phoenix Park Tunnel encompassing Liffey Bridge (UBO1) and Conyngham Road Bridge (OBO2).

## 8.1 Bridges

No bridge reconstruction works are required but currently it is proposed that the River Liffey Bridge (UBO1) will be used to provide access to construct the P-Way and OHLE works from the River Liffey as well as to including the Phoenix Park Tunnel Works.

## 8.2 Signalling Cantilevers

Signalling infrastructure in this section 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 manned access cantilevers will generally be from steps located within the Cess. However if space is available within adjacent IE land that is outside the cess access may also be considered.

## 8.3 Permanent Way

Track lowering will be limited where possible and is currently only envisaged that minor lowering will occur between St John's Road Bridge (OBC0A) and the Phoenix Park Tunnel to facilitate the provision of four tracking and electrification. The majority of the track work south of the River Liffey will be at grade.

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

It is probable that a number of staging phases may be required to facilitate construction due to the section being the junction the Greater Heuston Station Complex.

## 8.4 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 2No. 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.

Through the GSWR line from Heuston Station to Glasnevin there are only 2No. tracks and as such periodic short duration closures of the UP and DOWN tracks will be required to install all OHLE equipment (These closures are referred to as 'possessions'). Alternatively, it may be installed as part of an entire track possession subject to whether the tunnel will be closed or not during track lowering works.

## 8.5 Substations

One new substation will be constructed in this area. From a constructability perspective, the substation is relatively straightforward; the main consideration 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.

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 1000 m2.

## 8.6 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 construction 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 construction compounds are required at specific construction sub-sites and they are 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 construction 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 with be managed and treated as required.

**Section 5 Options** outlines the preferred location for the construction compounds required for this area; **Section 6 Options Selection Process** provides a detail of the option selection methodology.

The proposed location for the construction compound at Heuston West is required to facilitate the localised works, it is also the proposed location for the new Heuston West station. It is located on Irish Rail property adjacent to platform 10 and the Clancy Quay residential development. **Figure 8-1** shows the preferred indicative site layout for Heuston West construction compound.

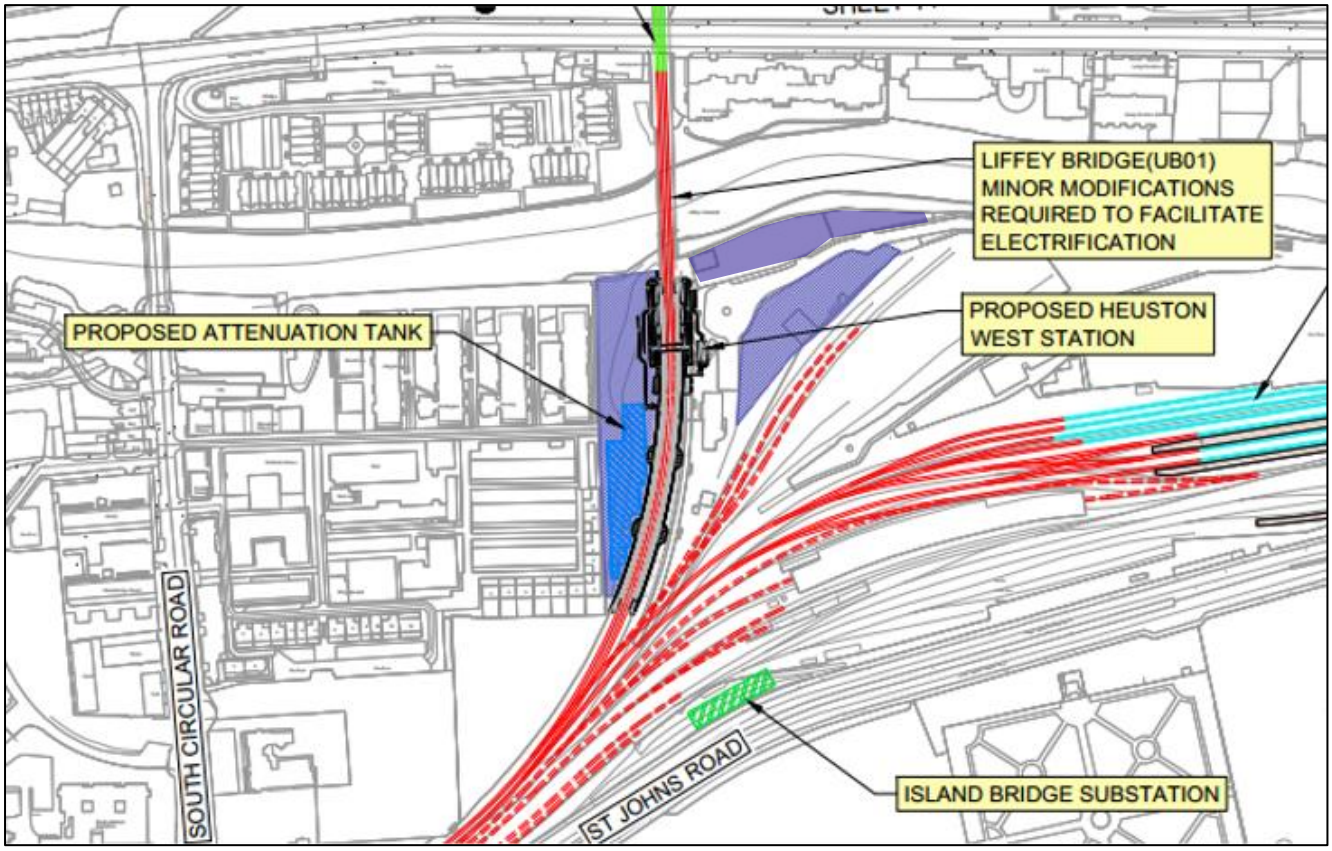


**Figure 8-1 Construction Compound Heuston West – Preferred Option Indicative Site Layout**

## 8.7 Temporary Traffic Management

There are no long duration public road closures currently proposed for this section of track construction. However, the section between Heuston Station and Conyngham Road Bridge (OBO2) as well as Phoenix Park tunnel are otherwise landlocked in terms of gaining access to support the construction works. It is proposed to either use the Liffey Bridge for access to the northern side of the River Liffey, assuming a complete closure of the Tunnel for a period of time or to construct a temporary bridge to the side of the Liffey bridge for use by construction vehicles. An appointed contractor may propose short duration off peak lane closures to too crane in materials occasionally from Conyngham Road Bridge (OBO2) down to the railway.

Access to the compounds will be via the existing Station Access Road used by current NTCC construction vehicles and IE operational HGV's.

## 8.8 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).

Materials delivery times will predominantly be outside peak traffic hours; particularly for construction HGV's known to restrict natural flow of traffic; this is also governed by the Dublin City HGV Cordon for vehicles about 5 axles for project areas east of South Circular Road. Special Permitting will be required for departures from this in accordance with the City Cordon conditions of access. In addition, where possible, long duration night works will be limited in areas close residential units 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 local 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 for Conyngham Road Bridge and Phoenix Park Tunnel

- Conyngham Road
- Phoenix Park Tunnel

A.2 Sifting Process Backup - Substations Site Location

- Islandbridge

# Appendix B – MCA Process Backup

## B.1 MCA Process Backup - Substations Site Location

- Islandbridge

# Appendix C – Supporting Drawings

The following drawings accompany this Technical Report:

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-36991: Conyngham Road (OBO2) – Cross Section @8+771

DP-04-23-DWG-PW-TTA-36992: Conyngham Road (OBO2) and Phoenix Park Tunnel – Track Plan Layout and Longitudinal Profile (sheet 1 of 2)

DP-04-23-DWG-PW-TTA-36993: Conyngham Road (OBO2) and Phoenix Park Tunnel – Track Plan Layout and Longitudinal Profile (sheet 2 of 2)

DP-04-23-DWG-PW-TTA-36994: Phoenix Park Tunnel – Cross Section @Ch 8+056

Substation Drawings

DP-04-23-DWG-EL-TTA-09421: Islandbridge IE Proposed Substation Location