DART+ South West

Volume 3F – Technical Optioneering Report – Memorial Road

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
CIE	Córas Iompair Éireann
Contact wire	Carriers the electricity which is supplied to the train by its pantograph.
CPO	Compulsory Purchase Order
Cross overs	A set of railway parts at the crossing of several tracks which helps trains change tracks to other directions.
CRR	Commission for Rail Regulation (formerly RSC – Railway Safety Commission)
CSM RA	Common Safety Method for Risk Evaluation and Assessment
CSS	Construction Support Site, Interchangeable with Construction Compound

Reference	Description
CTC	Central Traffic Control
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

Reference	Description
GI	Ground Investigation
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

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

Reference	Description
STC	Single Track Cantilever
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 that were 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 in the vicinity of Memorial Road Bridge (OBC3). 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, Electrical and Telecommunications
- Overhead Line Equipment (OHLE)
- Environment
- Highways
- Geotechnical
- 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 (GDA). It will provide a sustainable, electrified, reliable and more frequent rail service, improving capacity on rail corridors serving Dublin.

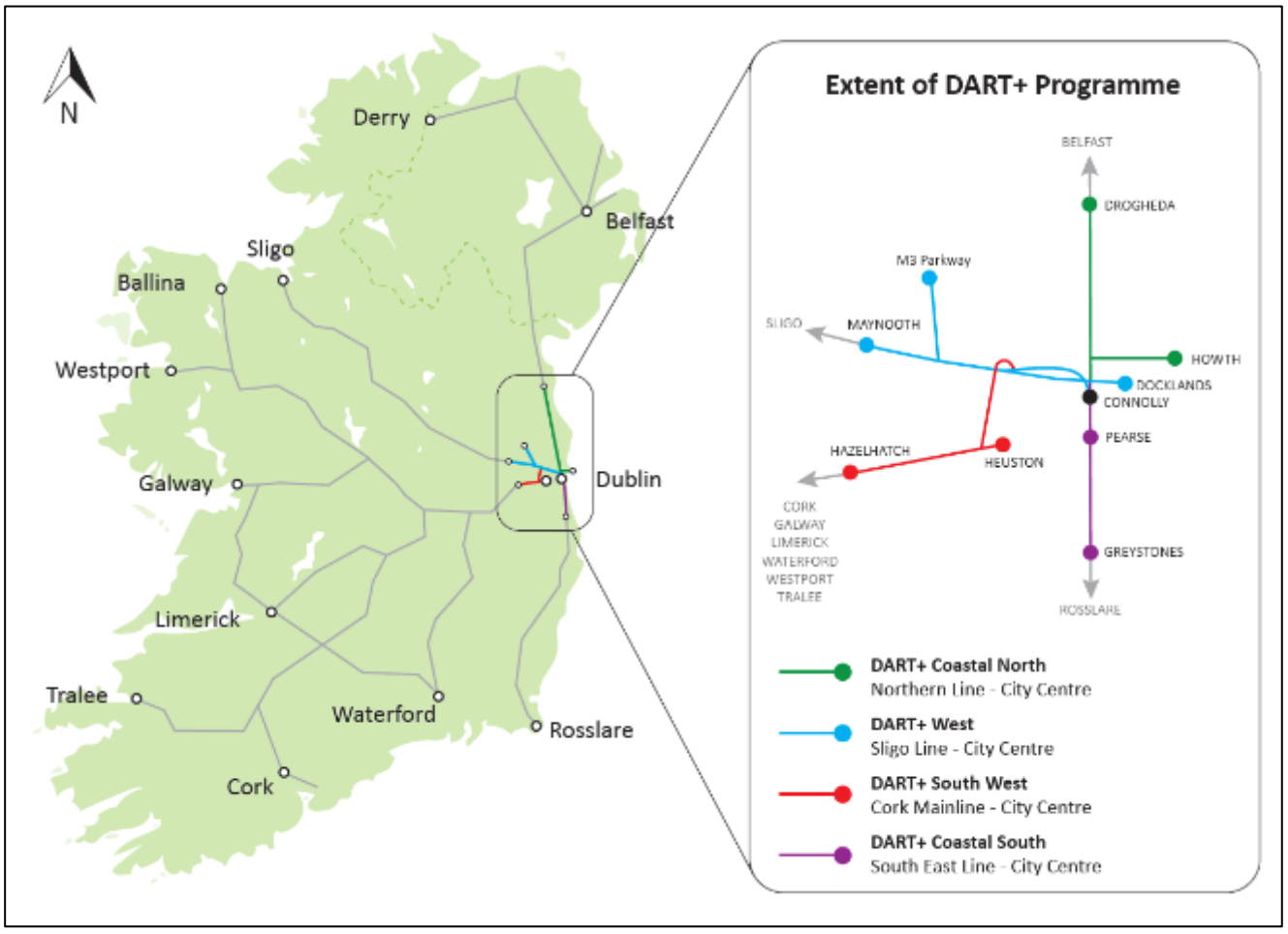

Figure 1-1 Schematic of Overall DART+ Programme

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

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

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

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

The Programme has also been prioritised as part of Project Ireland 2040 and the National Development Plan 2021-2030 as it is integral to the provision of an integrated, high-quality public transport system.

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

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

1.3. DART+ South West Project

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

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

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

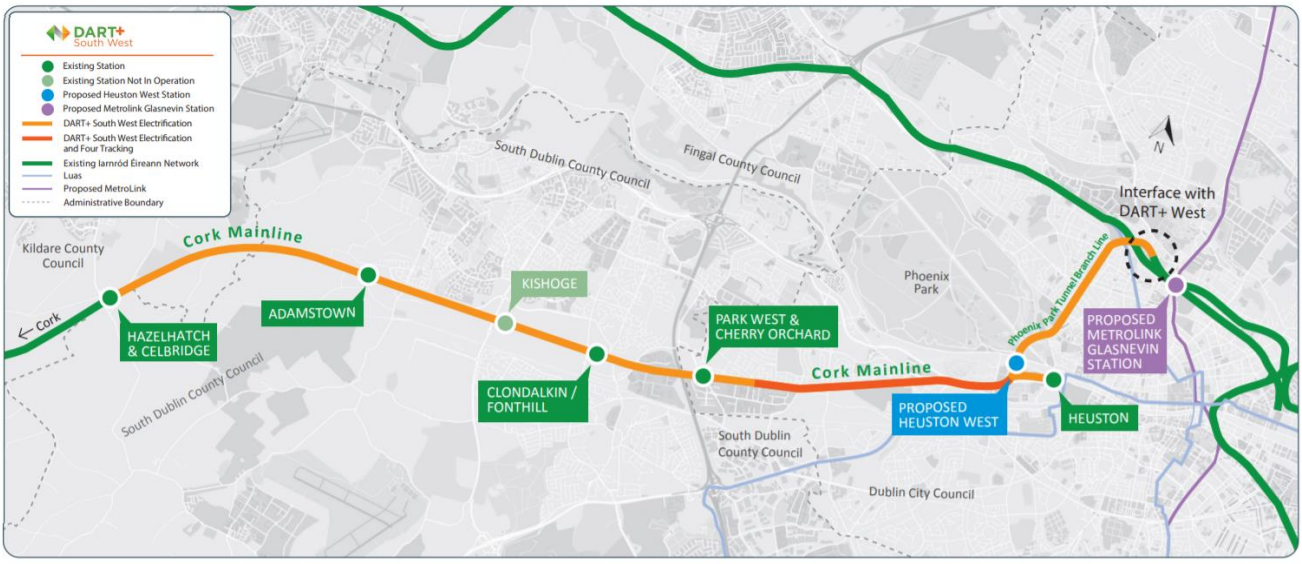

Figure 1-2 DART+ South West Route Map

1.4. Capacity Improvements Associated with DART+ South West

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

1.5. Key Infrastructural Elements of DART+ South West Project

The key elements of DART+ South West include:

- Completion of four-tracking from Park West & Cherry Orchard Station to Heuston Station, extending the works completed on the route in 2009.
- Electrification of the line from Hazelhatch & Celbridge Station to Heuston Station and also from Heuston Station to Glasnevin Junction, via the Phoenix Park Tunnel Branch Line, where it will link with the proposed DART+ West.
- Undertaking improvements / interventions of bridges to achieve vertical and horizontal clearances.
- Remove rail constraints along the Phoenix Park Tunnel Branch Line.
- Delivery of a new Heuston West Station[1].

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

Table 1-1 Route Breakdown

Area Name	Sub-area Description	Extents	Main Features
Hazelhatch to Park West	Area from Hazelhatch to Park West (Volume 3A)	West side of Hazelhatch & Celbridge Station to 50m to west of Cherry Orchard Footbridge (OBC8B)	Hazelhatch & Celbridge Station Adamstown Station Clondalkin/Fonthill Station

[1] For PC1 the scope of the project involved feasibility of a new Heuston West Station. As a result of stakeholder feedback, the new station will now be brought forward to Railway Order.

Area Name	Sub-area Description	Extents	Main Features
			Park West & Cherry Orchard Station
Park West to Heuston Station	Area from Park West to Le Fanu (Volume 3B)	West of Cherry Orchard Footbridge (OBC8B) to the East of the proposed Le Fanu Road Bridge (OBC7)	Cherry Orchard Footbridge (OBC8B) Le Fanu Road Bridge (OBC7)
	Area from Le Fanu to Kylemore (Volume 3C)	East of the proposed Le Fanu Road Bridge (OBC7) to the East of IE700B (i.e. the points for the Inchicore headshunt turnout)	Kylemore Road Bridge (OBC5A)
	Area from Kylemore to Sarsfield (Volume 3D)	East of IE700B (i.e. the points for the Inchicore headshunt turnout to the west of Sarsfield Road Bridge (UBC4)	Inchicore Works Depot Khyber Pass Footbridge (OBC5)
	Area from Sarsfield to Memorial (Volume 3E)	West of Sarsfield Road Bridge (UBC4) to the West of Memorial Road Bridge (OBC3)	Sarsfield Road Bridge (UBC4)
	Memorial Road (Volume 3F)	Area around Memorial Road Bridge	Memorial Road Bridge (OBC3)
	Area from Memorial Road to South Circular Road Junction (Volume 3G)	East of Memorial Road Bridge (OBC3) to East of St John's Road Bridge (OBC0A)	South Circular Road Junction South Circular Road Bridge (OBC1) St Johns Road Bridge (OBC0A)
	Area around Heuston Station and Yard (Volume 3H)	Area at the South side of the Heuston Station Yard (non-DART+ tracks)	Heuston Station Sidings around Heuston Station
Heuston West Station	New Heuston West Station (Volume 3I)	Area to the West of Heuston Station, adjacent to Liffey Bridge (UBO1)	Heuston West Station
St John's Road Bridge (Islandbridge) to Glasnevin Junction	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel (Voume 3J)	East of St John's Road Bridge (OBC0A) (Islandbridge) to North of Phoenix Park Tunnel	Liffey Bridge (UBO1). Conyngham Road Bridge (OBO2)

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

1.7. Stakeholder Feedback

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

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

Stakeholder feedback was in the main limited to concerns about potential increase construction, operational and maintenance noise; as well and construction traffic impact

Stakeholders also enquired as to the impact that works to Memorial Bridge will have on private lands.

Submissions noted the need for the bridge to be expanded to cater for a two-way cycle track to align with future cycle path developments in the area. The submissions state that improvements to this bridge will improve the access for those using sustainable and public transport.

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 section is 65m (approx.) in length and extends from the east side of Memorial Road Bridge (OBC3) to 50m west of Memorial Road Bridge (OBC3). The Permanent Way currently consists of 3 No. tracks. The tracks fall in level from west to east towards Heuston Station. There is currently no longitudinal drainage system installed along the Permanent Way.

Memorial Road Bridge (OBC3) is a major feature of this area; and it carries 2 No. lanes of northbound traffic over the rail corridor. There are currently no southbound lanes in Memorial Road. The junction of Memorial Road and the Chapelizod Bypass is immediately north of the bridge, and it is signalised. The junction of Memorial Road and Inchicore Road is 75m (approx.) south of the bridge. Con Colbert House is located on the south-east and south-west sides of the structure. These buildings house data centres.

The rail corridor is in cutting (i.e. the rail level is below the surrounding ground level). The corridor is formed by retaining walls along the south side of the trace and earthwork cutting slopes along the north side. The south side of the rail corridor is retained with a battered masonry retaining wall. The north side of the rail corridor is formed with a cutting slope. The major infrastructure features are illustrated in **Figure 2-1** below.

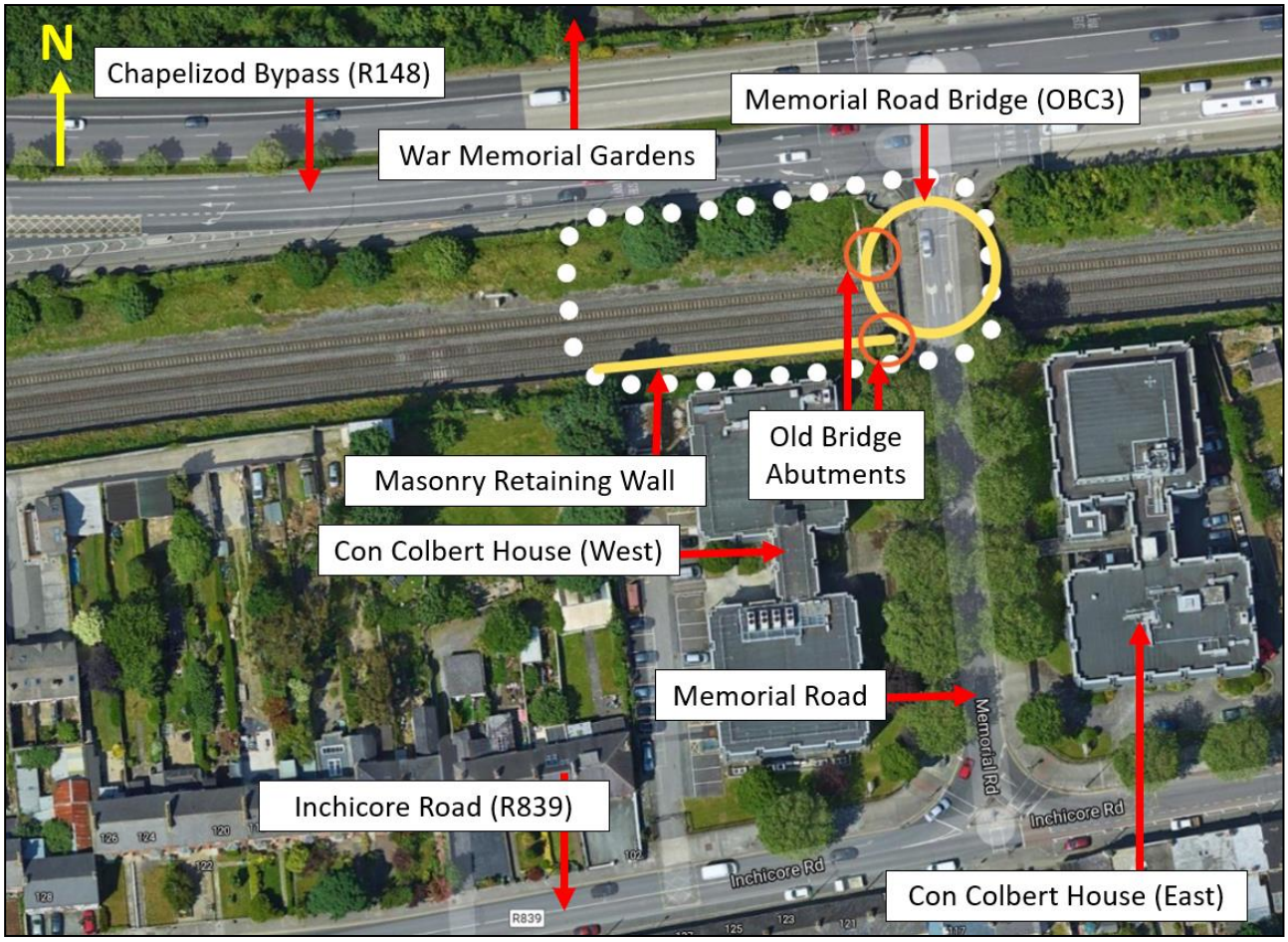

Figure 2-1 Aerial view of the area (white dotted outline)

The main Environmental features are described in **Section 2.8** below.

2.2. Challenges

The project objective is to increase the number of tracks between Park West & Cherry Orchard Station and Heuston Station to 4 No. tracks and to electrify 2 No. tracks from Hazelhatch & Celbridge Station to Glasnevin Junction. There are significant challenges that constrain the options available to achieve the Permanent Way and Overhead Line Electrification (OHLE) project requirements.

It is not practically feasible to add an additional track on the south side of the rail corridor due to the density and proximity of commercial and residential properties. As such, all options include widening the corridor to the north, where Con Colbert Road/Chapelizod Bypass (R148) exists as the only constraint but is located sufficiently away to allow for the widening to the north. The existing tracks will also be realigned to meet design standards. The additional track can be placed on the north side by installing a retaining structure along the cutting slope between South Circular Road Bridge (OBC1) and Memorial Road Bridge (OBC3). The track would be placed between the existing rail line and the Chapelizod Bypass which runs parallel to the permanent way corridor.

The existing Memorial Road Bridge (OBC3) structure, which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for 4 tracks. The intervention options proposed involve reconstructing the bridge with a new structure that has sufficient horizontal and vertical clearance for 4 No. tracks and overhead line electrification (OHLE).

Due to the existing road profiles and proximity of the Chapelizod Bypass on the north side of the bridge, even relatively minor road level increases would require a significant extent of highly disruptive roadworks to tie back into the existing levels. Therefore, track lowering forms the basis of feasible options considered. These issues are discussed further throughout the report.

2.3. Structures

Memorial Road Bridge (OBC3)

Memorial Road Bridge (OBC3) is a single span structure carrying road traffic from south to north over the rail corridor (see **Figure 2-2**). The bridge consists of pre flexed cast iron concrete encased beams supported on reinforced concrete abutments. The clear span of the structure is 12m (approx.). The bridge carries a 6m (approx.) wide carriageway and 2 No. footways of 4m (approx.) width on both sides of the carriageway. The existing footpaths are not suitable for vehicular traffic.

There are currently 3 No. tracks beneath the existing structure. The minimum vertical clearance beneath the existing structure is 4.358m (from top of track to bridge soffit). The bridge has insufficient horizontal clearance to construct an additional 4th track and insufficient vertical clearance for OHLE.

Figure 2-2 Memorial Road Bridge (OBC3) - East Elevation

Retaining Walls

There is 1 No. Continuous existing retaining wall along the boundary of the corridor (see **Figure 2-3**). The battered masonry retaining wall on the south side of the corridor extends along the full length of the area, except at Memorial Road Bridge (OBC3) itself. The wall is typically 3.5m (approx.) high. This increases to 4.5m high (approx.) on the south-west side of the bridge. The existing southern track is in close proximity to the face of the wall.

Other Structures

There are disused masonry bridge abutments immediately adjacent to the west side of Memorial Road Bridge (OBC3), north and south (see **Figure 2-4**). The abutments (now defunct) previously supported a steel pedestrian bridge which has been removed. Options that proposed replacing Memorial Road Bridge (OBC3) with a wider structure (to the west) would clash with these abutments.

Figure 2-3 Masonry Retaining Wall south-west side of Memorial Road Bridge (OBC3)

Figure 2-4 Disused masonry abutments to the west of Memorial Road Bridge (OBC3)

2.4. Permanent Way and Tracks

There are currently 3 No. tracks in this area. These are named from north to south as ‘Up Main’, ‘Down Main’ and ‘Relief Line’. The maximum speed under Memorial Road Bridge (OBC3) in the Up direction (i.e. towards Heuston

Station) is 25mph/ 40kph for the Up Main and Down Main and 40mph/ 64kph for the Relief Line. In the Down direction (to Inchicore) the maximum speed in is 40mph/ 64kph for all tracks. (refer to **Figure 2-5**).

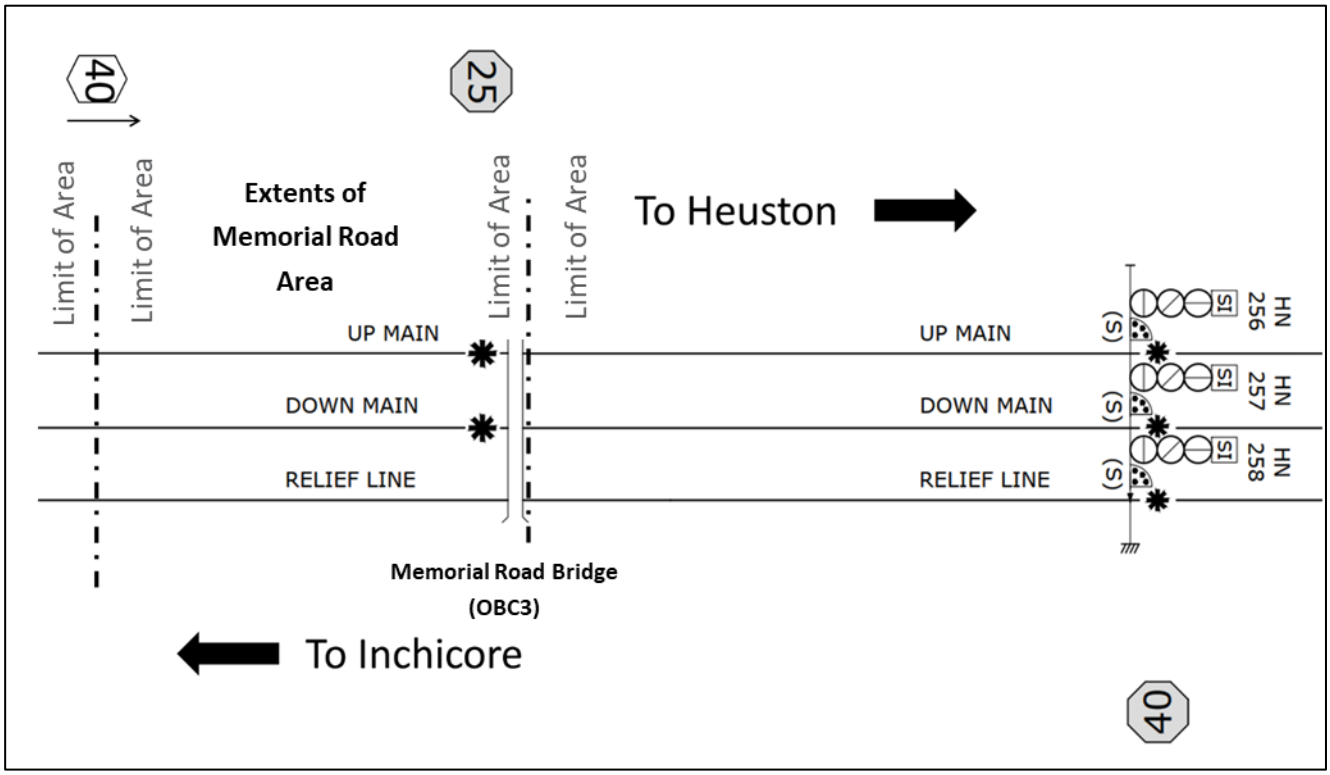

Figure 2-5 Track Layout

As mentioned above, the tracks are in a cutting, with a retaining wall on the south side. The area is marked as a limited clearance area as the relative offset of rail to abutments is considered below the current standards. To enter a position of safety in order to pass through the structure requires specific IE control measures to be initiated. The relative offsets of the nearest Relief Line and Up Main rails from the southern and northern abutment retaining walls can be seen in **Figure 2-6** and **Figure 2-7**; and measure 1.7m and 1.3 m respectively. .

The track gradient through the area is around 1.3%, with the gradient falling towards Heuston. The track-form is comprised of ballasted track with 54E1 rail and concrete sleepers.

No piped track drainage network currently exists in this area. Storm water runoff naturally percolates into the subsoil layers.

Figure 2-6 Nearest Relief Line rail from southern bridge abutment wall - Facing East

Figure 2-7 Nearest Up Main rail from northern bridge abutment wall - Facing West

2.5. Other Railway Facilities

There are no other facilities (such as access points) in this area which only covers and area of 65m (approx.); 50m from west side of the bridge. A location case is visible in the **Figure 2-7** but is described in the Sarsfield to Memorial Section Report.

2.6. Road Network

Memorial Road is a unidirectional 2-lane carriageway that runs perpendicular to and connects traffic from Inchicore Road (R839) to Con Colbert Road/Chapelizod Bypass (R148). Traffic enters Memorial Road from the single lane one-way Inchicore Road from the east and from a 2-lane bi-directional single carriageway from the west.

Vehicles entering Memorial Road (R839), proceed 75m (approx.) to its junction with the Con Colbert Road/Inchicore Bypass (R148) while crossing Memorial Road Bridge (OBC3). There is a single access off Memorial Road for the Con Colbert House (East) carpark, 20m from Inchicore Road.

From the nose of the 'fishtail' splitter island, at the southern end of the Memorial Road, to the kerb line on the south side of the R148 is 105m (approx.).

The lane widths along Memorial Road (R839) are 3.65m (approx.). The road then tapers down to lanes width of 2.75m in an area 5m (approx.) before the southern bridge abutment. This arrangement of 2.75m lanes continues over the bridge with parapets becoming the new footpath boundary limits. The existing footpaths widths are 4.5m (approx.) on both sides of the carriageway on the southern approach to Memorial Road Bridge (OBC3). The palisade fences of Con Colbert House form the outer boundary of the (boulevard).

The Memorial Road junction intersection with Con Colbert Road / Inchicore Bypass (R148) is signalised with the approach lane on the east being a dedicated right turn towards South Circular Road Junction located 560m to the east of the junction. The western approach is a dedicated left turn onto westbound carriageway of Con Colbert Road / Inchicore Bypass (R148), in the direction of the N4. Con Colbert Road / Inchicore Bypass (R148) is a 3-lane dual carriageway road, of which the outer lanes are dedicated bus lanes. The westbound and eastbound lanes carriageways are separated by a 2.5m (approx.) wide grassed median, which forms the crest of the dual carriageway. Its lanes crossfalls at 2% (1 in 50), from the median outwards (north and south), in the vicinity of Memorial Road (R839).

Memorial Road (R839), is a key transport node providing one of the limited access points across the rail corridor, connecting traffic from Inchicore (south of the rail corridor) to the R148/N4 (north of the rail corridor). In addition, is it is a highly trafficked pedestrian route providing access between Memorial Park, the Kilmainham Gaol historical sector and one of the limited safe R148 crossing points for children attending the St John of Gods (Special School); some of whom would be deemed mobility impaired. See **Figure 2-8** for a view of the areas that would be impacted temporarily during the construction works.

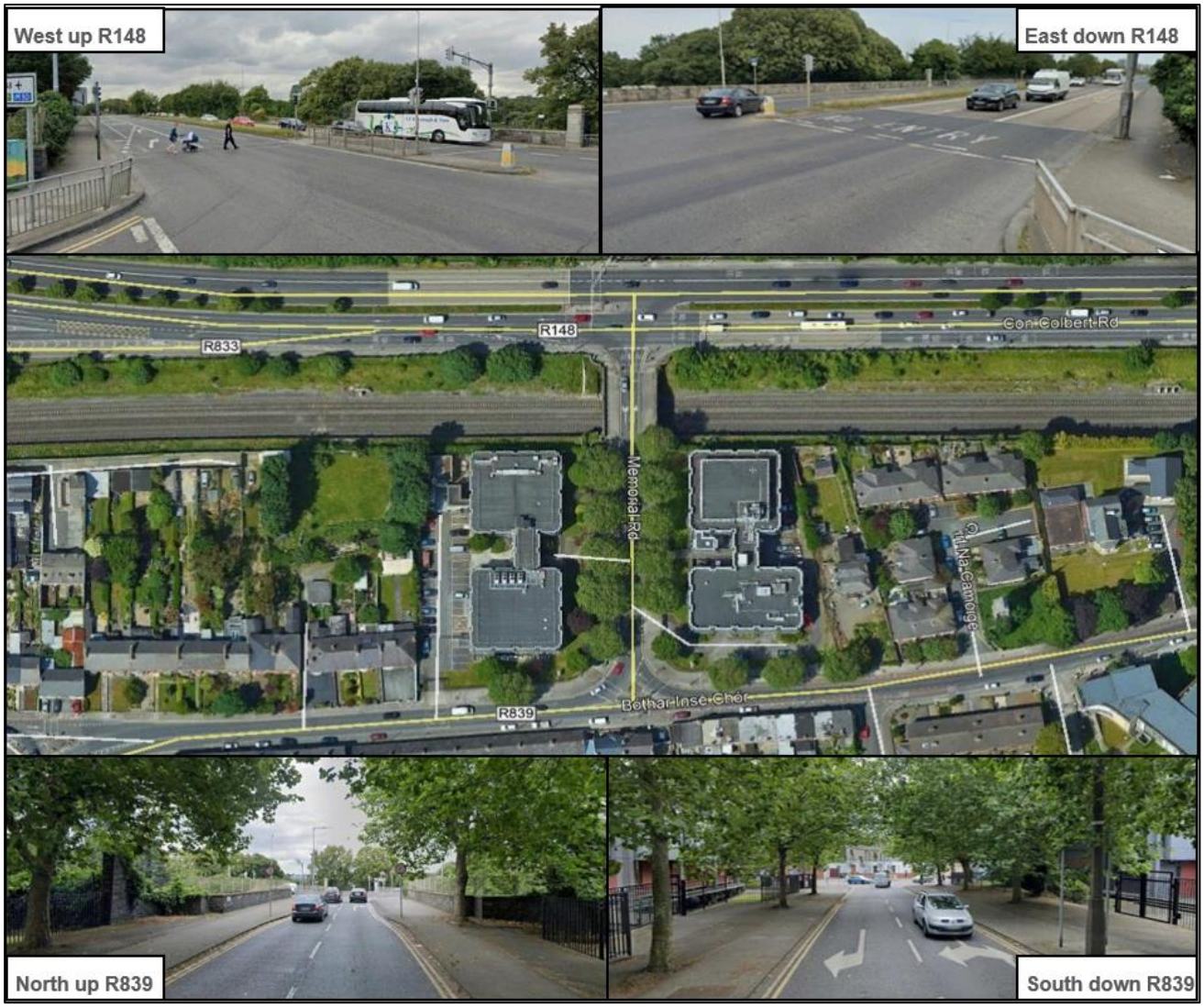

Figure 2-8 View of areas that would be impacted temporarily during the construction works.

2.7. Ground Conditions

The railway is located within a deep cutting in this area. The northern boundary cutting slope gradually increases in height from the western boundary of the area on to Memorial Road Bridge (OBC3) where it is at its highest. The southern boundary of the railway is supported by a battered masonry retaining wall. The area adjacent to the bridge generally is flat in topography, however further north, the ground slopes north towards the River Liffey.

The general superficial geology in this area is anticipated to comprise urban (made ground) deposits. It is anticipated that a layer of till will be underlying these urban deposits. Till deposits encroach into the southern boundary of the railway within the area. A pocket of gravel encroaches into the southern boundary of the railway at Woodfield Cottages (to the west of the area). Underlying the superficial deposits, bedrock deposits comprise limestone and shale.

Ground conditions in a borehole located 20m south of Memorial Road Bridge (OBC3) comprised made ground between ground level and 1.2m below ground level (bgl), at 23.17m AOD, underlain by deposits of clay and gravel to 5m bgl (19.37m AOD). Firm to stiff clay overlying the bedrock was encountered between 5m bgl (19.37m AOD)

and 18.50m bgl (5.87m AOD). Bedrock was described as very strong to strong limestone with moderately strong to weak mudstone and shale. Ground water was not recorded during drilling.

Ground conditions in a borehole located 100m east of Memorial Road Bridge (OBC3) comprised made ground between ground level and 1.2m bgl (21.94m AOD) which was underlain by gravelly clay. Bedrock was encountered described as strong to moderately strong limestone with moderately strong to weak mudstone and shale. Ground water was not recorded during drilling.

A Ground Investigation is currently ongoing to verify the data obtained in the historical investigations.

2.8. Environment

Directly opposite Memorial Road and north of the rail corridor is the Con Colbert Road / Chapelizod Bypass (R148) and beyond that the War Memorial Gardens which is listed on Dublin City Council's Record of Protected Structures (RPS). In addition to their role as a garden of remembrance, they are also considered to have architectural heritage interest. There is a designated conservation area of note related to the War Memorial Gardens. The Memorial Road (tree lined boulevard) with the stone masonry parapets and curved approach walls are considered an extension of the central axis through Memorial Gardens, which is now separated from the park by Con Colbert Road.To the south and straddling Memorial Road there are 2 No. office blocks understood to be government data centres which are considered sensitive receptors in relation to noise and vibration. West of these are residential houses and some commercial properties associated with Woodfield. These properties are within 100m of the existing rail corridor.

2.9. Utilities

The existing utility networks in the area consist of varied services which is typical of an urban environment such as this. Service providers with network assets in this area include the following:

- EIR
- ESB Networks
- Dublin City Council / Irish Water (Foul Water Sewers)
- Dublin City Council / Irish Water (Water Supply)
- Dublin City Council Traffic Department (Traffic Signals & Communications)
- Dublin City Council Public Lighting

Data in the form of utility service records have been gathered from all providers in the area. The majority of services are located within the existing streets and rail line bridge crossing. Hence, where modifications are required to the existing bridge and/or to the adjacent road network, impacts on utilities will be inevitable.

A number of services are also present at track level, crossing the railway corridor below the tracks, see **Figure 2-9**. Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

A number of key network infrastructure elements for particular utility providers are present and will be challenging to deal with given that only limited-service outage time (if any) will be permissible to the service and its customers. Significant forward planning and coordination will be necessary for such instances.

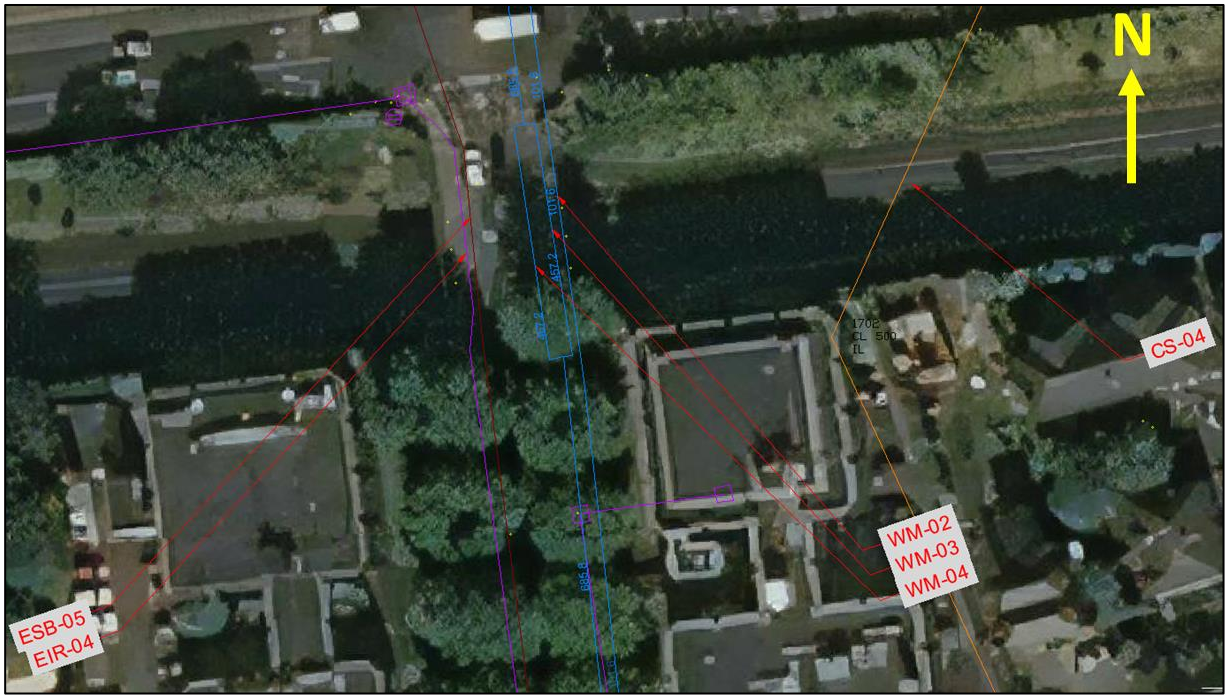

Figure 2-9 Existing Utilities at Memorial Road Bridge (OBC3)

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:

- Increase the number of tracks from 3 No. tracks to 4 No. tracks
- Electrification of 2 No. tracks for DART+ South West
- Provide vertical electrical clearance through existing structures or amend or reconstruct structures to provide the required clearance.
- Maintain functionality of existing 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. 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.

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 a typical OHLE arrangement in a four track open route.

In 4 No. track areas, Two Track Cantilevers (TTCs) will generally be placed on the north side of the line, to support OHLE on the northern two tracks. The project aims to achieve a minimum contact wire height of 4.4m throughout to ensure compliance with the relevant design standards, localised special conditions may be required. For contact wire details under Memorial Road bridge, see **Section 7.3.3. Signalling, Electrical and Telecommunications (SET)**.

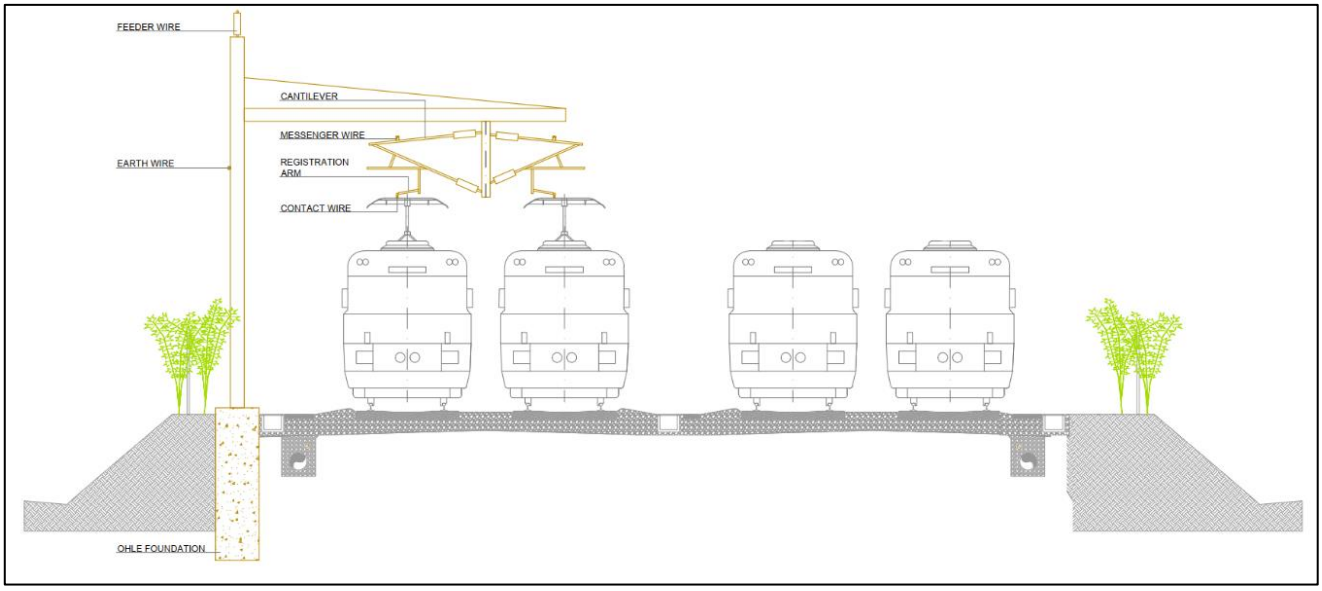

Figure 3-1 Typical OHLE arrangement in four track open route - Facing East

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

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

At intervals of up to 1500m the OHLE wires will be anchored at an arrangement known as an overlap, and a new set of wires will take over. The anchors provide the mechanical tension that the wires need to perform reliably and safely. In areas of crossovers and junctions, additional wiring will be provided for the extra tracks, and these will also be provided with anchors. See **Figure 3-2** for a typical anchor structure.

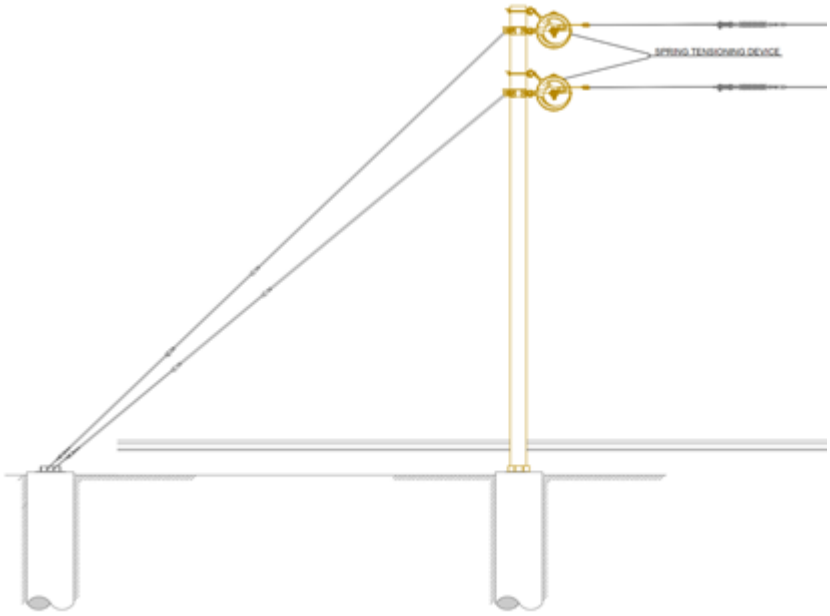

Figure 3-2 Typical anchor structure

The OHLE configuration through the overbridges for each track or civils option is being assessed using a clearance assessment tool derived from the System Wide Functional Requirement Specification (FRS) relating to Overhead Line Equipment (OHLE) and a set of configurations agreed with Irish Rail Signalling and Electrification Department through the Interface Coordination Document (ICD) process. This includes level and graded free running options, as well as level and graded options with elastic bridge arms fitted to the bridge. See **Figure 3-3** for a typical arrangement on approach to a low bridge.

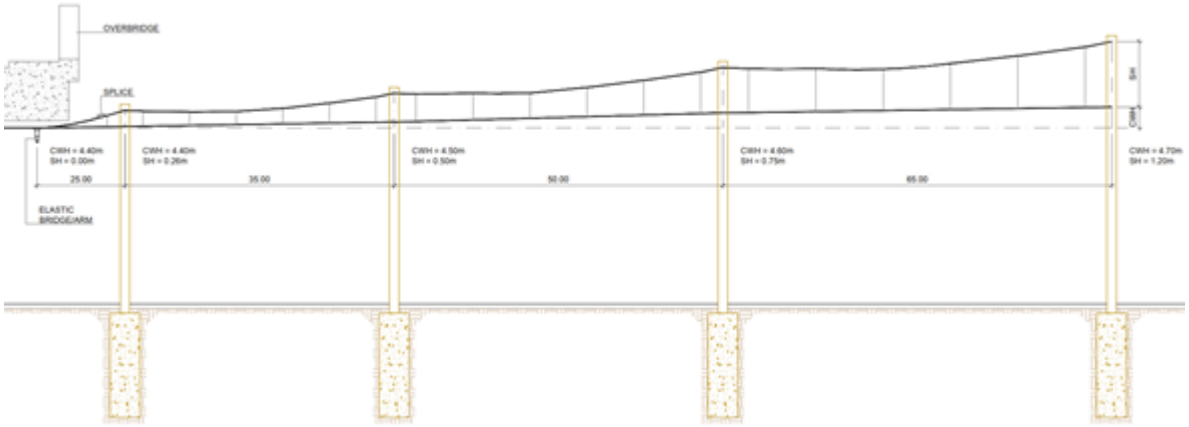

Figure 3-3 Typical arrangement on approach to a low bridge

3.2.2. Substations

In order to facilitate the introduction of the new OHLE scheme across the DART+ network a power supply study has been carried out. There is a requirement to provide six new substations on the DART+ South West scheme, but none of them fall within this section of the route.

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

Following fieldwork and desktop assessment, additional environmental constraints have been considered in addition to those identified in **Section 2.8 Environment**.

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, and birds and terrestrial and freshwater habitats have been carried out to date.

In relation to Built Heritage, a comprehensive desktop assessment of built heritage assets within 50m either side of the railway centreline has been undertaken by a Heritage Specialist. This assessment confirmed the designated status of the features of heritage interest i.e. Protected Structure status and/or inclusion in the NIAH record, and/or inclusion in the Industrial Heritage Record. Stakeholder feedback from PC1 noted that the superstructure of the Memorial Bridge was designed and built as an integral part of the Lutyens designed ceremonial entrance to the National War Memorial Gardens (which is listed on the Dublin City Council's Record of Protected Structures). The respondent noted that the Memorial Road and Bridge clearly form part of the Lutyens designed War Memorial and should be treated as within the curtilage of the protected structure.

A meeting with Dublin City Council noted that a new City Development Plan for 2022-2028 is being prepared. The new City Development Plan for 2022-2028 may contain modifications (additions/deletions) to the Record of Protected Structures (RPS). A structure must be listed on the planning authority's RPS to qualify for protected status under the Planning and Development Act 2000 (as amended). The RPS will be monitored on an on-going basis by the Heritage Specialist.

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

4.2. Roads

The existing road network poses significant constraints in terms of achieving the project requirements of providing an additional 4th track and electrifying 2 No. tracks. The existing vertical clearance at Memorial Road Bridge (OBC3) is also insufficient to accommodate the OHLE infrastructure required to electrify the rail line.

The Chapelizod Bypass (R148) is almost directly adjacent and parallel to the top of the cutting slope along the length of this project area. This removes the option to provide the additional track on the north side of the corridor by means of a standard earthwork widening solution along and through the existing cutting on the north side of the corridor. A retaining structure is therefore required to create space for the additional track. In addition, the road falls towards Inchicore Road (R839) south of the bridge, which lengthens the tie-in chasing potential for every Option that proposes to increase the road level. Options to reconstruct the bridge at this location would likely have a severe impact on the traffic in the area.

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

- The proximity of the junction of Chapelizod Bypass (R148) and Memorial Road to the existing and proposed north abutment (for bridge replacement Options) is a major constraint in terms of reconstructing Memorial Road Bridge (OBC3) to provide the clearances needed.
- The structural depth of beam/slab options (all listed in this report).
- The depth of track lowering reasonably achievable.
- TII and DMURS (Design Manual for Urban Roads and Streets) requires a maximum of 3% gradient for the first 15m of road at junctions. Limiting the ability to chase levels back to existing road levels.
- On Memorial Road, the back of footpath edge is at the top of an embankment upon which is the Con Colbert House plot boundary fences. A raising of the road would require changing the embankments within the grounds of Con Colbert House or constructing a low-level retaining wall (upstand) along the boundary.

4.3. Property

The density and proximity of the residential properties along the south side of the rail corridor is a major constraint in terms of achieving the 4-tracking requirements by adding the additional track to the south side of the corridor. Please refer to Property Boundary lines on the Bridge and Permanent Way Options Drawings in **Appendix C Supporting Drawings**. See **Figure 4-1** for the residential and commercial property locations in the area.

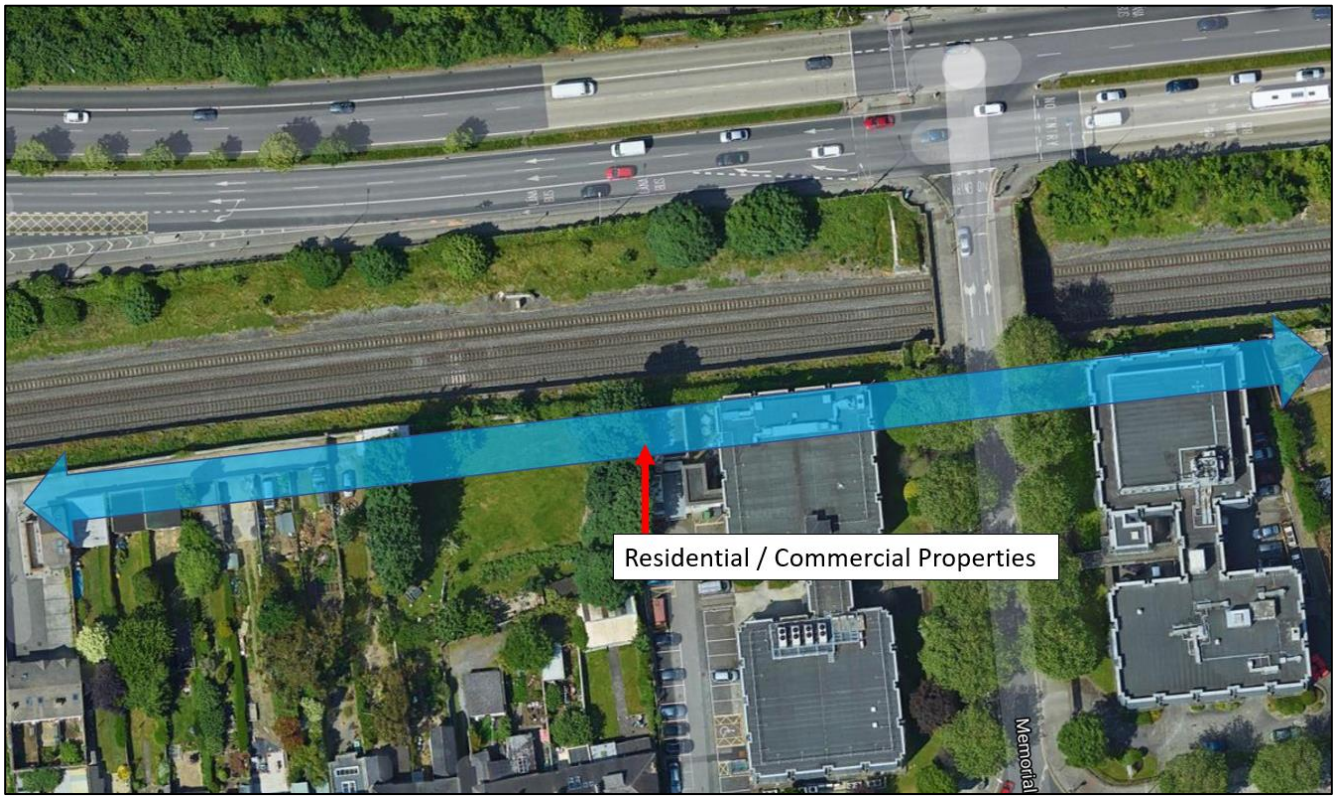

Figure 4-1 Residential and Commercial Property Locations in the area

4.4. Permanent Way

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

Table 4-1 Permanent Way Geometrical Constraints

ID	Name	Description
1	Existing width of the railway corridor	The existing width of the railway corridor is not adequate for the installation of an additional track. The corridor should be widened.
2	Existing masonry retaining wall	Any modification to the existing retaining wall on the south would potentially impact the stability of the properties along the south side of the corridor and must be carefully assessed.
2	Chapelizod Bypass	The widening of the railway corridor to the north for an additional fourth track could potentially impact the functionality of this road.
4	Safety and Maintainability	There are substandard safety clearances on the south side of the tracks to the masonry retaining wall and to the abutments of Memorial Road Bridge (OBC3). Any permanent way solution should improve the existing situation.
5	Track Alignment in area to the east and around South Circular Road	The track levels may need to be significantly modified in the section to the east, under South Circular Road Bridge (OBC1) to achieve the required vertical clearance for the OHLE equipment unless the Double Track Buried Portal Structure is used. The vertical alignment design must consider the proposals for section running under South Circular Road and into Heuston Station. The vertical alignment will be further constrained by the crossovers that are proposed on the east side of Memorial Road to provide access to Heuston station.
6	Track alignment in the area west of Memorial Road Bridge (OBC3) up to Inchicore Works	In the area, at Inchicore Works, there are two main permanent way options: widening of the railway corridor to the north or to the south. The horizontal alignment must tie-in with these designs.
7	Vertical Clearances at proposed Memorial Road Bridge (OBC3).	The proposed vertical alignment must provide adequate vertical clearances for OHLE installation through the new Memorial Road Bridge (OBC3).

The clearance requirements for the positioning of new/renewed track from property boundaries is shown in the **Figure 4-2**. The space required for the installation of new property walls, OHLE masts and walkways are considered. **Figure 4-3** shows the rail corrdior width.

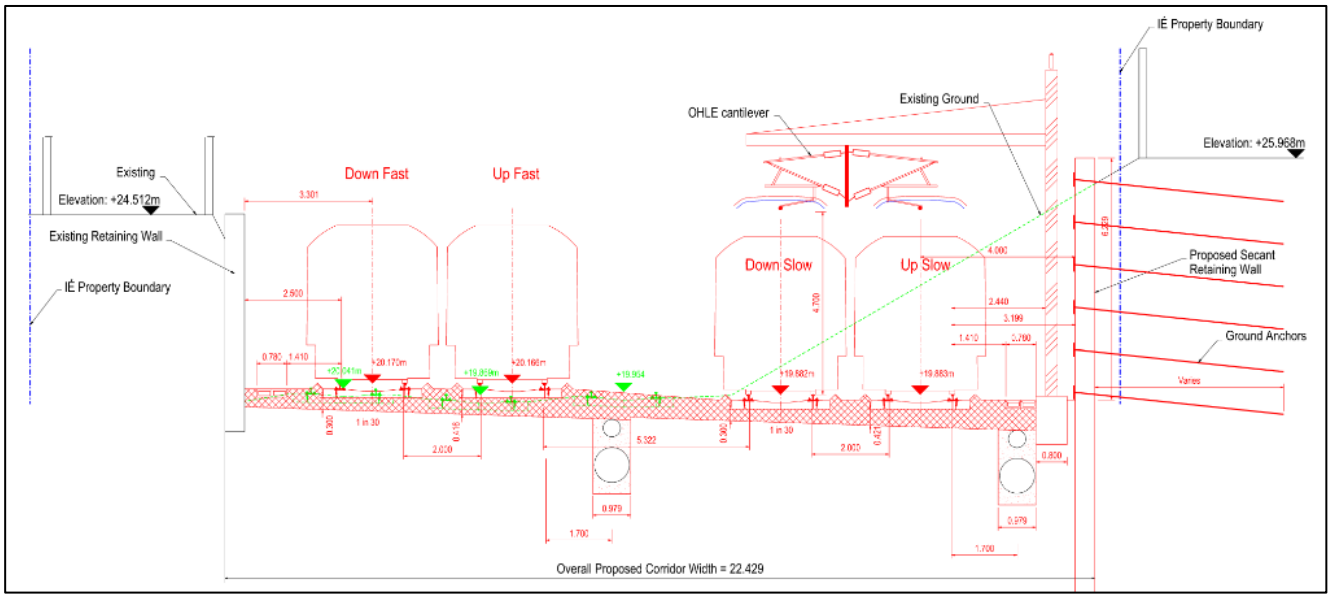

Figure 4-2 Minimum distance from property boundary to nearest track - Facing West

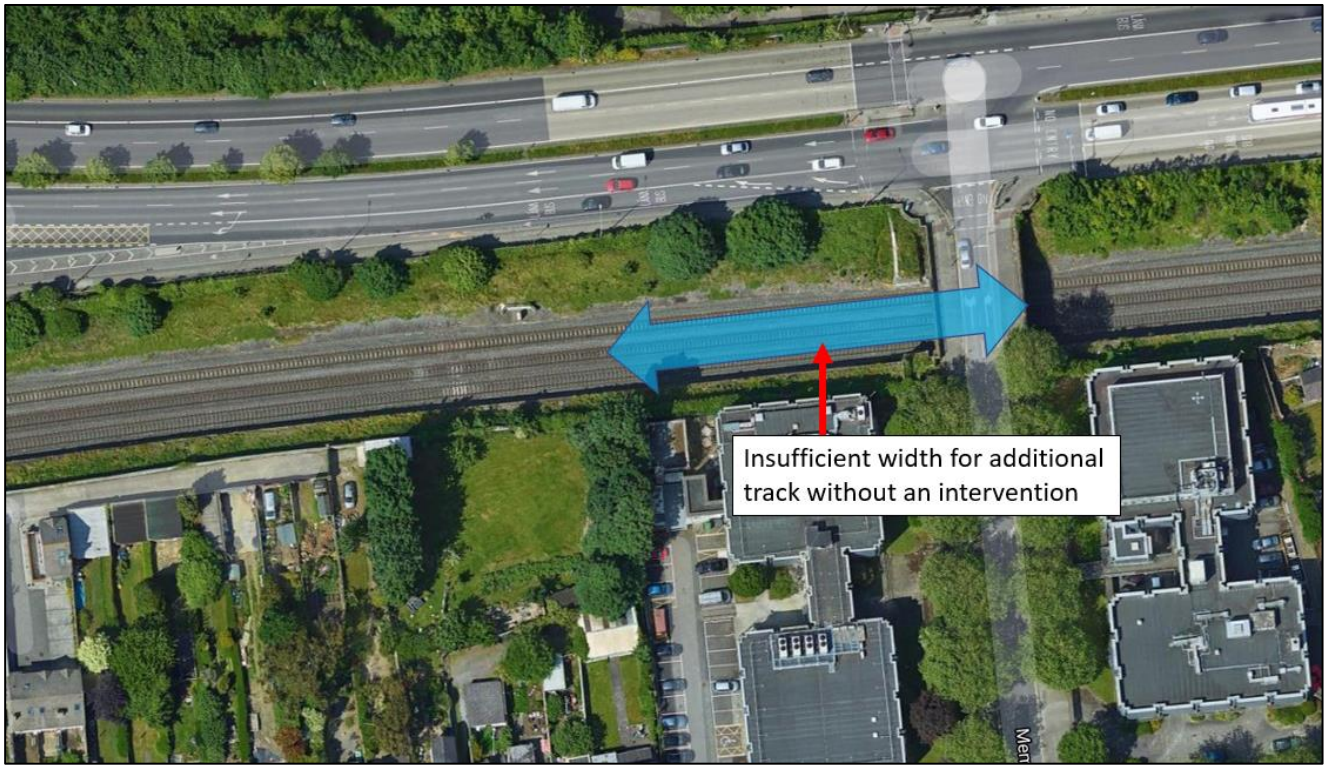

Figure 4-3 Rail Corridor Width

4.5. Existing Structures

The existing Memorial Road Bridge (OBC3) has insufficient horizontal clearance to accommodate an additional track beneath the structure. An initial bridge electrical clearance assessment has been carried out to determine whether an OHLE solution is possible without structural intervention or track lowering. The assessment found that an OHLE solution is not possible without intervention.

Proposed interventions include replacement of the road bridge with a new structure of sufficient horizontal and vertical clearance to facilitate 4-tracking and OHLE. Replacement bridge interventions consider various combinations of track lowering and increasing road levels to achieve the vertical clearance.

Iarnród Éireann standard requirement for structural clearance is 5.3m at new bridges and 4.83m at reconstructed bridges, with a minimum contact wire height of 4.4m. In this case either track lowering, an increase to road levels or a combination would be required to achieve these compliant clearances required for electrification. The track and road levels would also take account of the greater structural depth needed for an increased span (four tracks) and the horizontal clearances required from the new edge of outer rails to abutments in accordance with design standards.

Where track lowering would be required for an Option, the existing masonry retaining wall could potentially be destabilised. Options discussed below include the requirement for a stabilising intervention where required.

4.6. Geotechnical

Where significant track lowering is required, the stability of the existing retaining wall along the southern boundary could be affected.

Bored pile and trench walls are considered to be suitable at this stage of development, and conservative sizing will be used until such stage that detailed ground investigation data becomes available.

Existing nearby walls, buildings, structures and earthworks may require monitoring (e.g. vibration monitoring) during piling of any new structures to ensure no structural damage is caused during construction to the proposed foundation construction works. Con Colbert House (on Memorial Road) houses a government data centre and as such may be particularly sensitive to vibration.

4.7. Existing Utilities

The significant number of utilities in the area, particularly crossing the overbridge itself, will be constraints during both the design and construction phases. As such, their treatment in the temporary and permanent situations has been carefully considered during the development of options. There are a large number of services crossing the rail corridor via Memorial Road Bridge (OBC3). Irrespective of the option selected, the services in the existing bridge would need to be maintained or outage durations absolutely minimised.

A number of services are also present at track level, crossing the railway corridor below the tracks. Where track lowering is proposed, consideration of the impacts on these services will also be necessary.

All existing utilities pose constraints to the area-wide options. Where utility conflict arises, potential treatments are being discussed with the utility providers. Discussions are ongoing with DCC regarding the significant watermain trunk pipes located within the bridge. Temporary and permanent diversions have been agreed upon in principal, which will minimise the effect bridge reconstruction will have on the service. Similarly, an agreement has been made with Eir; key fibre optic cables which pass through the bridge, used by the adjacent data centres, which will undergo temporary and permanent diversions to minimise disruption. Temporary diversions will be housed in the temporary bridge during construction.

5. Options

This section presents the options associated with the following elements at the Memorial Road area:

- Civil and OHLE infrastructure solutions
- Construction Compounds locations

5.1. Civil and OHLE Options

5.1.1. Memorial Road Bridge (OBC3)

The existing Memorial Road Bridge (OBC3) structure, which currently has 3 No. tracks beneath it, has insufficient horizontal clearance for 4 tracks. The existing vertical clearance beneath Memorial Road Bridge (OBC3) is also insufficient for electrification.

The potential intervention options are to either reconstruct the bridge (with sufficient clearances for 4-tracking and OHLE) with various combinations of track lowering and/or road level increases.

A total of 6 No. Options were developed for the area and presented at PC1. The Options included a 'Do-Nothing' Option and a 'Do-Minimum' Option.

- A Do-Nothing option means that the design endeavours to achieve the project requirements without any intervention to the existing infrastructure.
- A Do-Minimum option means that the design endeavours to achieve the project requirements with only minor intervention to the existing infrastructure.

A summary of Options presented at PC1 as part of the Emerging Preferred Option Selection process is presented in the table below. Refer to **Section 5.1.3 Permanent Way (All Do-Something Options)** for a description of the permanent way Options for the area (that are compatible with the bridge Options referred to in **Table 5-1**).

Table 5-1 Options Summary

Option	Description
Option 0: Do Nothing	The existing infrastructure remains unchanged. There are no interventions.
Option 1: Do Minimum	This option endeavours to achieve the 4-tracking and electrification project requirements without widening the existing rail corridor or providing additional vertical and horizontal clearance at Memorial Road Bridge (OBC3).
Option 2	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by increasing the road level only.
Option 3	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering only.
Option 4	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering (50%) and increasing road levels (50%).
Option 5	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance requirements are achieved by track lowering and increasing road levels (other than a 50% split). This Option includes the original Concept Design (ARUP, 2018).
Option 6	This Option proposes to replace the existing Memorial Road Bridge (OBC3) with a new road bridge that has sufficient vertical and horizontal clearance. The vertical clearance

Option	Description
	requirements are achieved by increasing the road level to a point above which works would be required to the Chapelizod Bypass.

With the exception of Option 0 (Do-Nothing) and Option 1 (Do-Minimum), there are some design disciplines that have technical features that are common to all Options (e.g. OHLE and Cable & Containment). Similarly, there are technical aspects that have been considered but are determined to have no (or insignificant) bearing on the development or selection of Options for the area. To remove repetition among the Option descriptions, these issues are addressed as separate subsections of section **5.1 Civil and OHLE Options**. Options 2 through to Option 6 propose to incorporate cycle paths in the footways.

5.1.1.1 Option 0: Do-Nothing

The Do-Nothing Option proposes no changes to the existing road or rail infrastructure. The rail corridor would not be widened (inside or outside the Iarnród Éireann property boundary). The horizontal and vertical constraints at Memorial Road Bridge (OBC3) would not be resolved. As such, this option would not facilitate the inclusion of the additional 4th track or the installation of an OHLE system. The project requirements would not be achieved.

5.1.1.2 Option 1: Do-Minimum

This Option seeks to achieve the 4-tracking and electrification by means of minor interventions only. A review of the area constraints has concluded that there are no minor interventions that by themselves alone could achieve the project requirements.

5.1.1.3 Option 2

This Option proposes to achieve 4-tracking and electrification by replacing the existing Memorial Road Bridge (OBC3) with a new reinforced concrete (RC) beam-and-slab integral bridge. The proposed bridge would be 17m wide (approx.) and carry a 7.5m wide carriageway with 4.5m footpaths at each side. The bridge would have no or negligible skew.

In this option the vertical clearance requirements would be achieved by raising the road levels only, while the rail tracks would be kept at their existing levels.

Roads Analysis:

- Due to the proximity of the bridge abutment to the R148, any road raising at the bridge greater than 500mm would require the full reconstruction of the R148 dual carriageway (all lanes, as well as median and footpaths). This would also require the plot boundary walls to Memorial Park and the rail corridor to be reconstructed to retain the raised footpaths, by a level similar to that of the road raising. This road and wall reconstruction would be between 100m and 150m in length either side of the junction, but the replacement of the wall would likely be required in any event for all Options due track piling requirements. The level of road raising would also require the relaying of all utilities in the area and beyond (depending on the depth to cover requirements for each utility company).
- This would also limit the ability to carry out advance diversion works.
- The entire length of Memorial Road would need to be reconstructed with new retaining walls built along the Con Colbert House (East and West) boundaries; along with amended stairways constructed to tie-in to the building footbridge to the eastern plot and full stairway reconstruction to the western plot.
- It would also extend the level of traffic management complexity into the Con Colbert Road / Chapelizod Bypass (R148) rather than just that resulting from Memorial Road itself.

- The Lucan Bus Connects Scheme proposes amendments to the Con Colbert Road / Chapelizod Bypass (R148) along this section, it is not currently part of the scope of this project to include for reconstruction of the same. This would result in a larger proportion of abortive works if the scheme was not finalised.

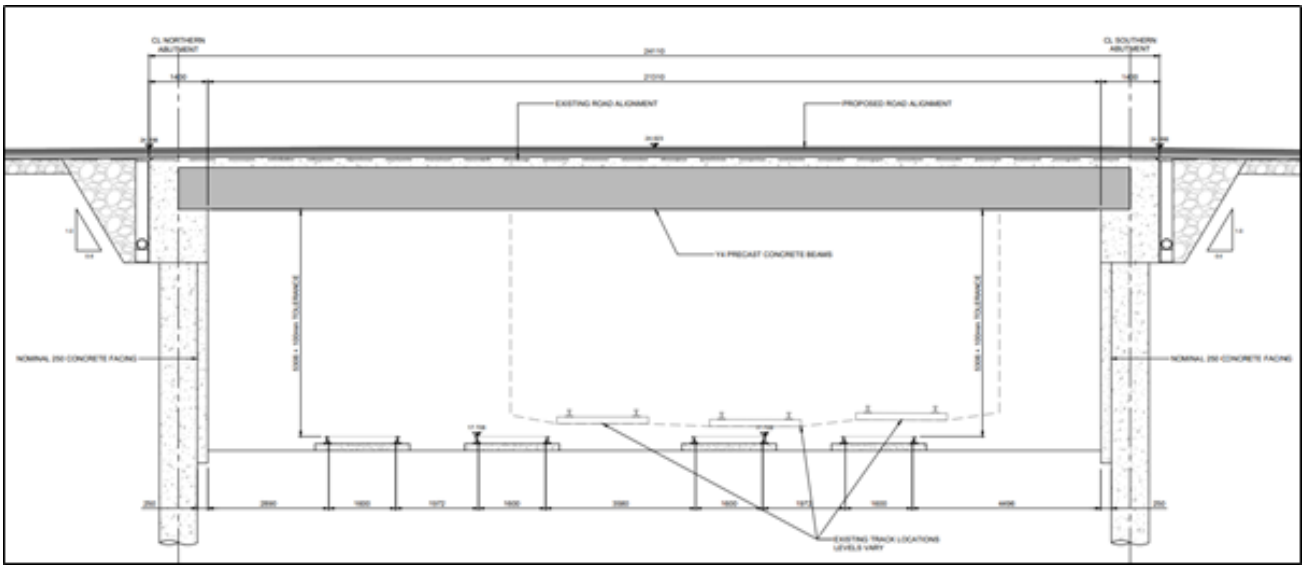

Figure 5-1 Typical longitudinal section - Facing East

5.1.1.4 Option 3

This Option is the same as Option 2, but all the vertical clearance requirements would be achieved through track lowering, while the road levels would be kept at their existing levels.

This would add additional risk to the long term integrity of adjacent stone masonry walls and 3rd party plots and enhanced complexity of the structural works potentially required to mitigate the risk.

Roads Analysis:

- As this would be an at grade reinstatement, the tie-in would likely be limited to the 7m north of the bridge, up to and including the kerb line of the Con Colbert Road / Chapelizod Bypass (R148).
- As the tie-in carriageway cross-section is wider (5.5m to 7.5m), the walls to the north at the junction would need to be reconstructed as H4A containment retaining walls transitioning into the existing rail corridor boundary wall along the Con Colbert Road / Chapelizod Bypass (R148). In addition, the bell mouth radius would be locally modified resulting in an amended footpath and kerb line (east and west of the Memorial Road intersection with the Con Colbert Road / Chapelizod Bypass (R148).
- The carriageway to the south of the bridge would need to be reconstructed for at least 15m to remove the existing taper in the kerb line and provide the revised segregated footpath/cycle track facility over the bridge.
- The Lucan Bus Connects Scheme proposes amendment to the Con Colbert Road (R148) in the area of the Memorial Road junction with Con Colbert Road / Chapelizod Bypass (R148). However it is not currently part of the scope of this project to include for reconstruction of the of any BusConnects planned works. The additional cost to reinstate the proposed Bus Connects Scheme layout, if it were programmed for implementation in advance of DART+ South West, would not be significant..

5.1.1.5 Option 4

This Option is similar to both Option 2 and Option 3, only in that it requires amendment to both track and road levels but not to the same extent. The Memorial Road Bridge (OBC3) is proposed to be replaced but the vertical clearance requirements would be achieved through changes to both the road and track levels. In this Option the additional vertical clearance required would be split evenly between road level increases (50%) and track lowering (50%). For example, if an adjustment of 0.7m is required to achieve the vertical clearance, the road would be raised by 0.35m and the tracks would be lowered by 0.35m.

Roads Analysis:

- The impact on roads, walls and utilities would be similar to that described for Option 3; requiring full width reconstruction of Con Colbert Road /Chapelizod Bypass (R148) but for a length of 50-75m (approx.) either side of the Junction.
- Any increase of road levels between 0.050m (50mm) and 0.35m (approx.) would require full reconstruction of the west bound carriageway of the Con Colbert Road /Chapelizod Bypass (R148), including footpaths and median, for approximately 110m either side of the junction. This would require commencing a super-elevation transition 100m in advance of the junction on the Con Colbert Road /Chapelizod Bypass (R148), using the median kerb as the swivel point. The resultant effect would be to a change the crossfall characteristics from 2% crossfall to the carriageway edge, to one which crossfalls from the southern carriageway edge to the central median (achieved just prior to Memorial Road junction with Con Colbert Road /Chapelizod Bypass (R148). This revised crossfall towards the median would continue 100m (approx.) to the west of the Memorial Road junction; at which point it would merge with existing super-elevation of the highway (located at the slip- lane where Con Colbert Road diverges from the Chapelizod Bypass). Tie-ins within Memorial Road would be achievable without affecting the pedestrian entrances to the 2 No. Con Colbert House buildings (east and west). Most of the mature trees could perceivably be accommodated without being removed through boxing areas around them as part of a formal landscaping scheme.

5.1.1.6 Option 5

This Option is similar to Option 4 such that the bridge is replaced, and the vertical clearance requirements would also be achieved through changes to road and track levels. However, with this Option the additional vertical clearance required would not be split evenly between road level increases and track lowering. It also does not limit road level to increases to a level above which would require Departures from Standards. This Option is based on the original Concept design (ARUP, 2018).

Roads Analysis:

- The Option would require a similar extent of re-construction works to the Con Colbert Road / Chapelizod Bypass (R148), as would be required for Option 4.
- The difference would be a reduction in the extent of reconstruction works required in Memorial Road (south of the bridge).

5.1.1.7 Option 6

This Option requires that the bridge be replaced, and the vertical clearance requirements be achieved by changes to road and track levels. The additional vertical clearance required would be split between road level increases and track lowering. The road level would be increased to a level of 50mm above the existing road. This level is

one that can be achieved without requiring the reconstruction of the carriageway within Con Colbert Road / Chapelizod Bypass (R148).

Roads Analysis:

- The required road reconstruction would be similar to that of Option 3. The intention would be to avoid any carriageway works to the Con Colbert Road / Chapelizod Bypass (R148), only requiring the junction 'bell-mouth' tie-in works. The tie-in between edge of bridge and the Con Colbert Road / Chapelizod Bypass (R148) would be close to the gradient limit of 3% typically accepted at junctions.
- The aim would be to limited reconstruction to within 7m of the bridge (to the north), including the kerb line of the Con Colbert Road / Chapelizod Bypass (R148). An additional 15-20m would need to be reconstructed south of the bridge to remove the existing taper in the kerb line; and provide the revised footpath/cycle track over the bridge with its transition tie-ins to existing footpaths and kerb lines.
- The proposed new carriageway cross-section is wider (5.5m to 7.5m) across the bridge and as such will require the walls to the north of bridge to be reconstructed as H4A containment walls, transitioning into the rail corridor boundary wall that runs along Con Colbert Road / Chapelizod Bypass (R148).
- In addition, the bell-mouth radius would be locally modified due to the requirement to amend the junction bell-mouth radius. This would result in an amended footpath and kerb line, east and west of the Memorial Road junction intersection with the Con Colbert Road / Chapelizod Bypass (R148), for up to 10-15m in either direction.
- The Lucan Bus Connects Scheme proposes amendments to the Con Colbert Road / Chapelizod Bypass (R148), it is not currently part of the scope of this project to include for reconstruction of the same, unless implemented prior to DART+ South West Project.

5.1.2. OHLE Arrangement (All Do-Something Options)

Memorial Road Bridge (OBC3) has insufficient vertical clearance to be electrified with OHLE. Therefore Options 0 and 1 would not be feasible.

For Options where the minimum soffit clearance of 4.91m would be achievable, OHLE will be connected to the bridge at multiple locations with minimum contact wire height of 4.4m under all conditions. Either side of the bridge, the contact wire shall be graded up and mast heights shall be designed accordingly.

For Options where the minimum soffit clearance of 5.306m achievable, the OHLE would pass beneath the bridge without being connected to it with contact wire height of 4.7m.

OHLE masts would be positioned at 20m from each side of the bridge.

5.1.3. Permanent Way (All Do-Something Options)

The differences between the Perway Options are related to the potential treatments at Inchicore (i.e. widening to the north or to the south) with minimal differences between them in this short section. In both cases, the railway corridor is widened to the north to create space for the additional track. Widening the corridor to the south is not considered feasible due to the proximity of office buildings - as such this has not been considered further.

The Permanent Way Options have considered a standard 10-foot dimension between the Slow and Fast lines and realignment of the existing tracks to remove areas of limited clearance and improve safety.

The vertical alignment has been analysed and track lowering ranging from 0.4m to 1.1m is achievable. The track gradient would need to be increased from 1.3% to 1.7%. Final adjustments in the vertical level would be realised

in Stage 3 Preliminary Design. The track lowering may require underpinned the foundation of the existing retaining wall.

For all intervention Options the track formation would be completely renewed. It is proposed that a new track drainage system would be installed and connected to a proposed attenuation facility adjacent to the proposed Heuston West Station before discharging to the Liffey. The drainage design would be developed in Stage 3 Preliminary Design.

5.1.4. Geotechnical (All Do-Something Options)

The retaining walls required in this area, to create space in the existing cutting slope on the north side of the corridor, would be bored pile retaining walls (or similar). The general superficial geology in this area is anticipated to comprise a thin layer of made ground underlain by a significant thickness of Glacial Till overlying bedrock. From an assessment of the available historical ground investigation summarised in this report, no onerous ground or groundwater conditions are expected that would significantly impact any of the Options proposed based on the available ground investigation information at the time of writing. Therefore, the ground and groundwater conditions currently do not pose any significant concerns from a geotechnical design perspective (e.g. selection of shallow foundations or piling).

Note that the bridge width for all bridge replacement Options would partially clash with the disused abutments on the north-west and south-west sides of Memorial Road Bridge (OBC3). All Options propose to remove the disused abutments fully.

Where significant track lowering is required, the stability of the existing retaining wall along the southern boundary could be affected. All bridge replacement Options propose an intervention to stabilise the wall as required. This may necessitate below ground ties, anchors or walls which for the purposes of this stage of scheme development should be assumed to be required for a track lowering Option.

5.1.5. Roads (All Do-Something Options)

All Options will ensure vulnerable user connectivity is provided to Memorial Park. The extent of utility infrastructure relay requirements is often relative to the level of increase over the utility (subject to confirmation by specific utility companies for given locations).

All Options require the bell-mouth to be widened at the junction with the Con Colbert Road / Chapelizod Bypass (R148); as well as tie-ins requiring reconstruction of road between north abutment and the Con Colbert Road / Chapelizod Bypass (R148) and south for a minimum of 15m. The extent of roadworks in a southerly direction from the bridge would be almost directly proportional to the level of bridge raising.

The difference however with Option 2 and 4 is that they would require a disproportionate amount of roads and drainage works and would also result in higher track side retaining walls, ultimately not feasible.

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

All Options would require the relocation of a variety of service cables, utilities and containments throughout, as well as new containment routes to accommodate all new railway systems cabling throughout These will be migrated in accordingly at each stage of construction.

5.2. Construction Compounds

One Construction Compound is required in the vicinity of Memorial Road Bridge (OBC3):

- Memorial Road Bridge (OBC3)

5.2.1. Memorial Road Bridge

Memorial Road Bridge is being replaced with a wider structure and there is no space for temporary diversion of the road traffic on to a temporary adjacent bridge, so Memorial Road will be closed for a period of time. It is therefore proposed to utilise the remainder of Memorial road as a construction compound. This site will accommodate offices, parking for workers vehicles and site vehicles and a materials storage and laydown area. See **Figure 5-2 and 5-3** for construction compound Site Location and Indicative Site Layout respectively.

The first lane (bus lane) of Con Colbert Road will be required to excavate soil and construct the new wall. It is therefore proposed to close the first lane of this road from the South Circular Road junction to beyond Memorial road and to utilise this space as a construction compound.

Figure 5-2 Memorial Construction Compound Site Location

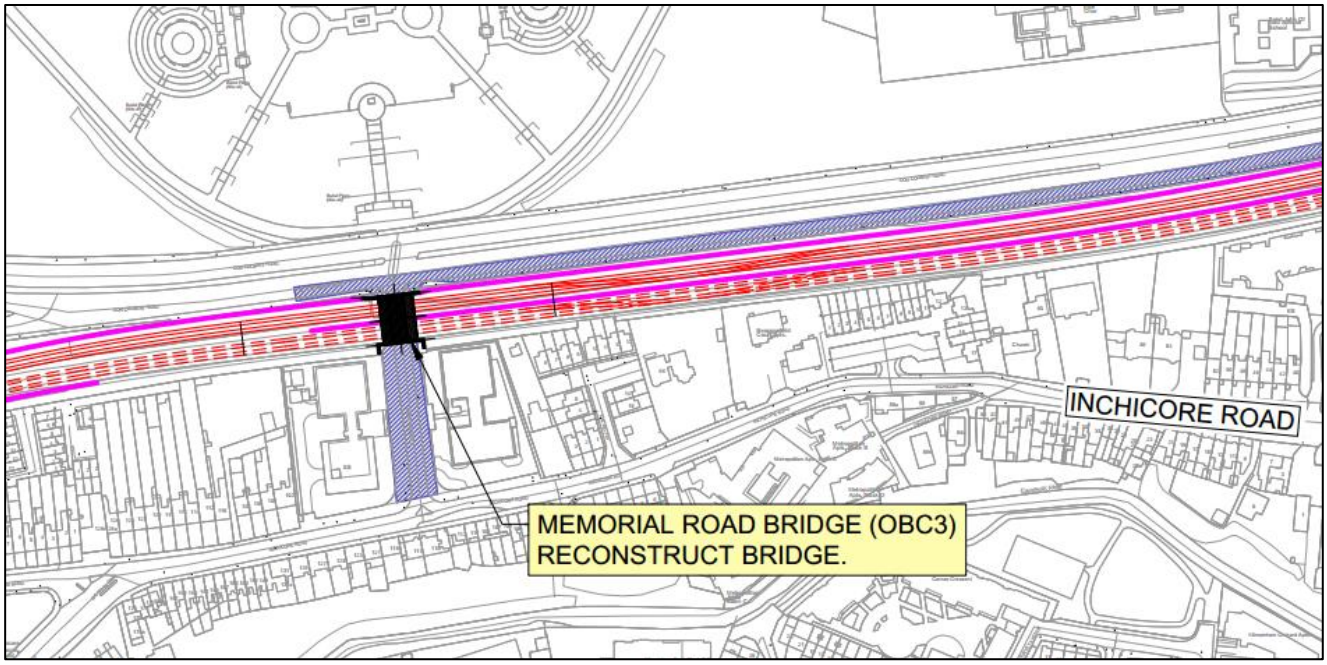

Figure 5-3 Memorial Construction Compound Indicative Site Layout

The site does provide good access to the road network, located adjacent to Con Colbert Road which leads directly to the M50 by means of a dual carriageway.

Options north of Con Colbert road were explored but due to a lack of access to the railway due to the presence of the main road itself, no other options were considered feasible. Other options would also require land purchase as no other viable sites owned IÉ in close proximity to Memorial road have been identified.

This location will also be used for the adjacent section for the construction of the Memorial Road Bridge but will be expanded to include Memorial Road itself when a full road closure is eventually required for that section of the works.

6. Options Selection Process

6.1. Options Selection Process

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

The Option Selection Process involves a two-stage approach (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 asess the options associated with the following elements:

- Civil and OHLE at Memorial Road Bridge (OBC3)
- Construction Compounds

6.1.1. Stage 1 Preliminary Assessment Process (Sifting)

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

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

A total of six (6 No.) Options were initially developed for this area regarding civil and OHLE; and one option was developed regarding construction compounds locations.

The options assessed for selecting the Preferred Option for the corridor regarding civil and OHLE, 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. Where the sifting results in only one feasible option being retained, it is not required to complete a multi-criteria analysis (MCA) on that one option.

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

Stage 2 Multi-Criteria Analysis (MCA) comprises a detailed multi-disciplinary comparative analysis of those options which passed through Stage 1: Preliminary Assessment (Sifting).

The options are assessed against the criteria of Economy, Safety, Environment, Accessibility and Social Inclusion, Integration and Physical Activity in line with the criteria required for multi-criteria analysis under the Department of Transport, Tourism and Sport (DTTAS), Common Appraisal Framework (CAF) for Transport Project and Programmes (March 2016). 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 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 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. See **Table 6-1**.

Table 6-1 Comparison Criteria

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

6.2. Civil and OHLE Option Selection

6.2.1. Stage 1 Sifting

The 'Do-Something' Options for civil and OHLE in this area involve the widening of the existing rail corridor to accommodate the required four tracks. Widening of the rail corridor is proposed on the north side of the existing tracks to minimise impact on the private residential and commercial properties located on the southern side of the existing rail corridor. Existing structures in this area were analysed to determine if they could accommodate the additional tracks and installation of the new Overhead Line Electrification (OHLE) system. The existing road network also poses significant constraints in terms of achieving the project requirements of providing an additional 4th track and electrifying 2 No. tracks in this area.

Table 6-2 provides details of the assessment undertaken as part of the Stage 1 Preliminary Assessment (Sifting) Process, used in the selection of the Preferred Option for the civil and OHLE elements at Memorial Road area (see **Appendix A Sifting Process Backup**).

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

Table 6-2 Sifting Process for the selection of the Preferred Option for the project corridor

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.
		4-tracking Park West-Heuston	FAIL. No intervention proposed. 4-tracking is not achieved.
		Electrification of DART+ tracks	FAIL. No intervention proposed. Electrification of the DART+ tracks not achieved.
		Vertical electrical clearance in structures	FAIL. No intervention proposed. Vertical electrical at structures would not be achieved.
		Bridge Design Standards	Not applicable. No intervention proposed.
		Keep current functionality of roads	PASS. No intervention proposed.

Option	Requirements		Description
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
1	**Engineering**	Constructability	PASS. Minor interventions to the rail corridor are possible.
		Geometrical fitness for intervention	PASS. Minor interventions without geometrical fitness concerns are possible.
		Safety	PASS. Minor interventions that pose no safety concerns are possible.
		4-tracking Park West-Heuston	FAIL. Minor interventions only cannot achieve 4-tracking.
		Electrification of DART+ tracks	FAIL. Minor interventions only cannot achieve electrification of the DART+ tracks.
		Vertical electrical clearance in structures	FAIL. Minor interventions only cannot achieve vertical electrical clearance requirements at structures.
		Bridge Design Standards	PASS. Minor interventions to the rail corridor in accordance with standards are possible.
		Keep current functionality of roads	PASS. Minor interventions to rail corridor that do not affect road functionality are possible.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
2	**Engineering**	Constructability	PASS. It would be possible to construct this option.
		Geometrical fitness for intervention	PASS. No issues.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve the electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.7m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
3	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would be difficult to construct in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.

Option	Requirements		Description
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve the electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	PASS. Road levels would be unchanged.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**
4	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would present issues in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.35m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
5	**Engineering**	Constructability	PASS. It would be possible to construct this option.
		Geometrical fitness for intervention	PASS. This Option would require a minimum track lowering of 0.2m.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	FAIL. The original Concept design would provide a 4.690m vertical clearance only.
		Bridge Design Standards	FAIL. The original Concept design would provide a 4.690m vertical clearance only.
		Keep current functionality of roads	FAIL. This Option would require a minimum road level increase at the bridge of 0.4m (approx.). This road level increase at Memorial Road Bridge (OBC3) would require extensive works to a significant length of the westbound carriageway of the Chapelizod Bypass which is immediately adjacent to the structure on the north side.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible

Option	Requirements		Description
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**FAIL**
6	**Engineering**	Constructability	PASS. This Option would be difficult to construct but it is considered feasible.
		Geometrical fitness for intervention	PASS. This Option would be difficult to construct in terms of gradient and longitudinal drainage, but it is considered feasible.
		Safety	PASS. No issues.
		4-tracking Park West-Heuston	PASS. This option would achieve the 4 tracking.
		Electrification of DART+ tracks	PASS. This option would achieve the electrification of DART+ tracks.
		Vertical electrical clearance in structures	PASS. This option would achieve electrical clearance in structures (with derogations).
		Bridge Design Standards	PASS. Pass this option would achieve horizontal clearance to abutments (with derogations and derailment impact design).
		Keep current functionality of roads	PASS. Current road functionality maintained. This Option would require a road level increase of 50mm only.
	Economy	Compatible with the investment guidelines and programme for DART+	Compatible
	Environment	No impact on Environmental sites of National or International significance.	No impact
	SHORTLISTED FOR STAGE 2 MCA		**PASS**

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

- **Option 0** - The Do-Nothing Option proposes no changes to the existing road or rail infrastructure, as such, this option would not facilitate the inclusion of the required 4 tracks or the installation of the OHLE system. The project requirements would not be achieved as such this option was not brought forward.
- **Option 1** - This Option seeks to achieve the 4-tracking and electrification by means of minor interventions only. Due to the constraints in this area, minor interventions would not be sufficient to achieve the project requirements, as such this option was not brought forward.
- **Option 2** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height, it would require the road level to be increased no less than 0.7m to avoid track lowering. This option was not brought forward due to the required road level increase, which would require full reconstruction of both the eastbound and westbound carriageways of the Con Colbert Road / Chapelizod Bypass (R148) for more than 100m in either direction of the junction as well as the length of memorial road, posing significant disruption during construction and greater risk due to heavy engineering works along the length of the data centres.
- **Options 4** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height and require the road level to be increased no less than 0.35m, while also lowering the track and equivalent depth. This option was not brought forward due to the required road level increase, which would require full reconstruction of the westbound carriageway of the Con Colbert Road / Chapelizod Bypass (R148) (100m approx. in either direction of the junction); as well as a significant proportion of memorial road, posing significant disruption during construction and greater risk due to heavy engineering works along the length of the data centres.

- **Option 5** - This option involves the reconstruction of the Memorial Road Bridge (OBC3) with a greater span, width, and height and require the Con Colbert Road / Chapelizod Bypass (R148) level to be increased no less than 0.4m, while also lowering the track by at least 0.2m. This option was not brought forward as it requires a road level increase, which would require full reconstruction of the westbound carriageway of the Con Colbert Road / Chapelizod Bypass (R148), for 100m (approx.) in either direction of the junction. This would also include a significant proportion of Memorial Road, posing significant disruption to vehicular and vulnerable users during construction. The risks associated with heavy engineering works along the length of the data centres would also be increase. In addition, the Option does not achieve the accepted OHLE minimum clearance standards.

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

Option 3 and Option 6 propose to achieve 4-tracking and electrification by replacing the existing bridge with a new beam-and-slab bridge. Vertical clearance requirements would be achieved mainly by track lowering with no or insignificant increases to road levels. The difference between the two options lies on the methodology used for adjusting the road and track levels:

- **Option 3** – This option involves the replacement of the Memorial Road Bridge (OBC3), with a greater span and width; the works would involve the entire burden of achieving OHLE clearance through track lowering; in order to limit impact on road users and adjacent land holdings. The aim being to limit impact on vehicular and vulnerable road users and adjacent land holdings. It is proposed to lower track levels by up to 1.15m to achieve a desirable OHLE contact wire clearance of 4.7m. Alternatively, reducing track lowering to 0.7m if the prior is deemed unachievable. In either case the road levels would be reinstated to their existing levels.
- **Option 6** – This option involves the replacement of the Memorial Road Bridge (OBC3), with a greater span and width; the works would involve almost the entire burden of achieving OHLE clearance through track lowering with a nominal increase to road level on. The aim being to limit impact on vehicular and vulnerable road users and adjacent land holdings. It is proposed to increase the road level to a maximum level, above which works to the Chapelizod Bypass would be required, in addition to lowering the track levels as needed to achieve the additional required vertical clearance. The road raising at the bridge would only be 50mm (approx.); thereby reducing the track lowering required under Option 3 by the equivalent depth.

Table 6-3 summarizes the assessment completed as part of the Sifting Process. A total of two 2 No. Options were shortlisted and progressed to Stage 2 (MCA) of the assessment process.

Table 6-3 Summary of Sift Process Results

Main Option	Result	Brought forward to MCA

Option 0: 'Do Nothing'	FAIL	No
Option 1: Do Minimum	FAIL	No
Option 2	FAIL	No
Option 3	PASS	YES
Option 4	FAIL	No
Option 5	FAIL	No
Option 6	PASS	YES

After completing the Stage 1 Preliminary Assessment (Sifting) it was noted that there was a distinct choice in routing and/or spatial variation in the options for around Inchicore and South Circular Road, which would lend themselves well to the MCA process. However, in respect of this area of Memorial Road Bridge (OBC3) the spatial difference in the feasible options was much less clear. In this case, only two feasible options progressed through the Stage 1 Preliminary Assessment (Sifting) process and the differences between the options were focused on technical design matters.

6.2.2. Stage 2 MCA

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

Table 6-4 MCA Summary

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

Across the CAF Parameters of Economy, Integration, Accessibility and Social inclusion, Safety and Physical Activity there was no comparative advantage or disadvantage between the two options.

In terms of the Environment, despite the slight advantage recorded under the landscape and visual factor for Option 3, the overall findings for the MCA for Environment are assessed as neutral. The point of difference between the options related to construction stage impacts to the road surface, including potential to impact trees which form the 'avenue vista' of the road; however, these potential impacts can be addressed through detailed construction stage planning and alone would not be reasonable to evaluate the MCA above neutral finding.

In order to streamline and simplify the reporting from the MCA results, it was considered appropriate at this stage to combine the two feasible options into a single option which would be the preferred option. The detailed design differences will remain as a potential design variation to be further explored through the future design process. Therefore, Option 3 is brought forward, with Option 6 as a design variation / comparator to be further explored through the future design process. **Section 7 Preferred Option Design Development** describes in detail the preferred option.

6.3. Construction Compounds Option Selection

The works are taking place in a spatially constrained location, the proposed location for the Construction Compound is the only one available space in this area. The construction compound is required to serve the localised works in this area. As no other suitable alternative locations in the area were identified through the option development process, the selected construction compound location did not require multi-criteria analysis.

7. Preferred Option Design Development

7.1. Review of Preferred Option

The baseline information or outcomes of design development since PC1 (inclusive of stakeholder input) have not materially impacted the optioneering and MCA outcomes that resulted in the selection of Option 3 as the Preferred Option.

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

This change did not materially affect any of the previously assessed options outlined in **Section 5 Options** and **Section 6 Options Selection Process,** but resulted in a raising of the track to reduce the impact on adjacent sensitive masonry retaining walls to the south of the corridor and reduction in earthworks haulage and construction duration associated with the proposed electrified slow tracks.

The Preferred Option requires the reconstruction of the existing bridge with a slightly wider cross-section and longer span and with a different beam/deck arrangement to accommodate OHLE clearances and reinstatement of utilities, and so limit negative impact on road users.The Preferred Option widens the rail corridor to the north (adding a fourth track) and replaces the existing bridge with a longer span. In addition, the rail tracks will be lowered to facilitate the electrification infrastructure beneath the new bridge. The masonry wall on the southern side would need to be strengthened due to the lowering of the track and a new wall would be required along the northern side. It is envisaged that some of the works could be completed at night-time and under traffic management. It is also envisaged that a temporary pedestrian bridge would be provided, during the bridge closure phase.

The proposed new Slow tracks alignment will be provided on the northern side of the corridor, with the lowering of the track commencing east of Sarsfield Road Bridge (UBC4) to allow for the necessary OHLE clearances at Memorial Road Bridge (OBC3). The track levels of both the Slow and Fast tracks will be significantly lower than the existing rail levels to achieve the required vertical clearance for the electrification along the new structure. The proposed vertical profile shows a track lowering of 1.15m at the western edge of the structure to achieve the nominal contact wire clearance of 4.7m. This is as a result of the constraint imposed by the proximity to Con Colbert Road / Inchicore By-Pass (R148), as well as adjacent data centres and existing utilities. If the geotechnical investigation (coupled with drainage design development) indicate that this depth of lowering is not achievable; then a derogation will be sought for an alternative track lowering depth of no less than 0.7m to achieve the minimum acceptable OHLE contact wire clearance of 4.4m.

7.2. Review of Stakeholder Feedback

In terms of the noise and traffic impact from construction; there will be adequate noise monitoring provision across the entire scheme with restrictive construction and material delivery hours being considered (off-peak and limited long duration night works.In order to provide continuous vulnerable user crossing during the bridge closure, a portion of temporary land take will be required from the Department of Social Welfare DataCentre sites to accommodate the temporary bridge pad foundation and temporary footpath to connect to the existing footpath. No other private lands are anticipated to be directly impacted by physical works in this short section of track.

There is nominal bridge widening provision to ensure that sufficient width is available for vertically and horizontally segregated footpaths from cyclelanes and to provide carriageway lane widths conducive to a bus route. It also includes for aesthetic finishes to the bridge parapet and an increased road safety impact containment class.

The proposed Footpaths and Cycle Tracks/lanes are being designed in accordance with the prevailing national standards. In the event that the National Cycle Manual is revised, prior to the project receiving approval for implementation, due consideration will be given to the same. The current design is compatible with the Bus Connects proposals to date at this the interface of the Liffey and Lucan Schemes.

7.3. Design Development

The minimum 4.4m contact wire height is the standard requirement for electrification. Design has been developed to meet this requirement.

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

- Structures
- Permanent Way
- Signalling, Electrical and Telecommunications (SET)
- Roads
- Drainage

7.3.1. Structures

7.3.1.1. Bridges

As noted earlier in the report, electrifying the line requires the installation of overhead electrical lines along the railway. The lines pass under existing bridges. In many instances the existing bridges are too low to accommodate the overhead lines at their normal heights and special measures are warranted to facilitate the electrification. In relation to Memorial Road Bridge, a total of six (6 No.) options were initially developed; following the selection process, Option 3 was identified as the Preferred Option for this area. This Option requires the reconstruction of the existing bridge with a slightly wider cross-section and longer span and with a different beam/deck arrangement to accommodate OHLE clearances and reinstatement of utilities, and so limit negative impact on road users. In addition, the rail tracks will be lowered to facilitate the electrification infrastructure beneath the new bridge. See **Figure 7-1** and **Figure 7-2** for a general arrangement and longitudinal section. See **Appendix C Supporting Drawings** for additional drawings of this bridge.

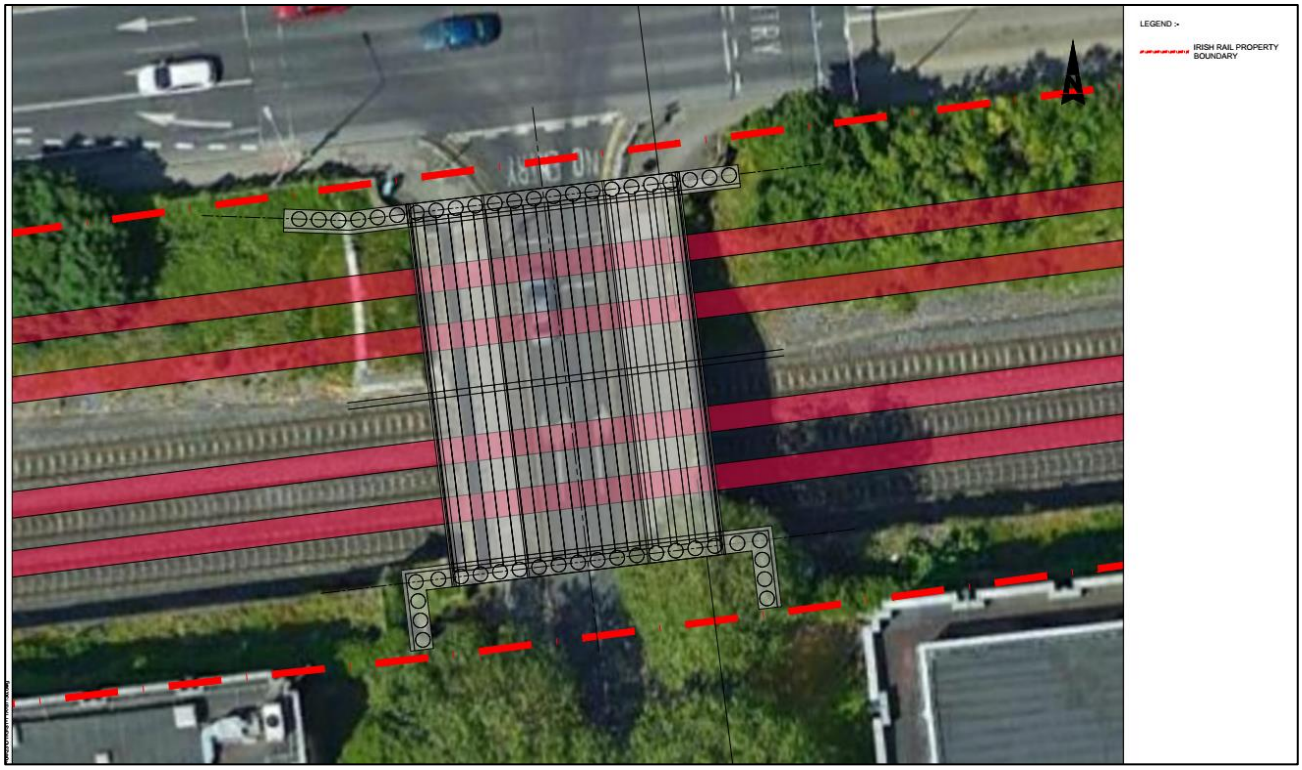

Figure 7-1 Memorial Road Bridge (OBC3) General Arrangement

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

- Proposed Bridge Type = Prestressed Beams and In-situ Deck seated on Secant Piles Abutment.
- Proposed Bridge Span (incl. Abutment Length) = 25.573m
- Proposed Bridge Width (incl. Parapets) = 16.6m
- Proposed Bridge Slab Depth = 0.25m
- Proposed Bridge Beam Depth = 1.0m
- Proposed Parapet = H4A containment walls 1.8m higher than adjacent footpath
- Proposed Utility Space Proofing = include duct and pipe containment for the reinstatement of the watermain and data centre fibre optics between the beams.

See **Figure 7-2** for a Bridge Deck Longitudinal Section of Memorial Road Bridge.

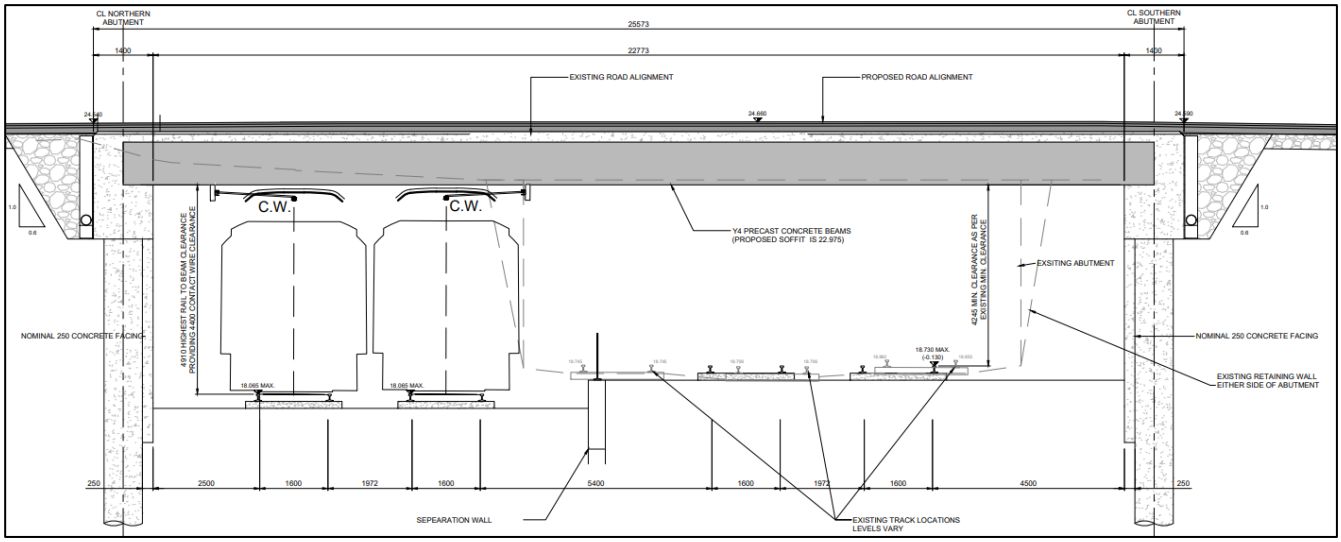

Figure 7-2 Memorial Road Bridge (OBC3) Bridge Deck Longitudinal Section - Facing East

There are currently a number of options being evaluated for parapets and approach road containment walls for the new bridges. The main criteria for the parapet is that they achieve an overall height of 1,8m above deck level. The options under consideration include full height precast reinforced concrete parapets, full height steel parapets, and 1200m high RC parapets with perforated or glazed sections to the remaining 600mm to achieve the min height requirement. All parapets will have a H4a containment level. More information on parapets and approach on road containment walls will be available at Railway Order stage.

As the aesthetic is an important factor a number of finishes are being considered for the precast concrete options. These include introducing patterned concrete formers to replicate the existing masonry parapets currently in place, see **Figure 7-3**. There a many different finishes available to use and the panels can be coloured. See below some examples.

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

Other options are to fully clad the precast panels with masonry cladding to match the exiting parapets, see **Figure 7-4**, or to retain and repurpose the existing masonry in the parapets to be used as cladding to the new precast parapets. Other options being considered take into account landscape and visual considerations where a desire has been expressed to retain views of the Dublin mountain skyline from some of the structures.

Figure 7-4 Precast panels fully cladded with masonry

7.3.1.2. Retaining Walls

Retaining Walls are proposed for 2no. functions in the Memorial Road Bridge section:

- To retain the change in level between slow and fast tracks: In this area close to Memorial Road Bridge (OBC3) the retained ballast height (above track cess level) would vary between 0.5m and 1m. While in the adjacent section to the west the height retained would progressively increase to 2.6m (approx.) at the western face of the South Circular Road Buried Portal (proposed OBC1A cut and cover structure). These will be piled walls.
- To retain Con Colbert Road: The Con Colbert Road retaining wall height (above track cess level) will vary between 4.5m and 7m along this section and a bored secant pile wall solution will be adopted for this section of retaining wall along the northern perimeter to form the northern (slow) tracks cess edge. Due to the over steepened nature of the existing cutting slopes, proximity of the adjacent Con Colbert Road and height of the cutting slope to be retained, necessitates a piled wall solution with the inclusion of soil nails or ground anchors.

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

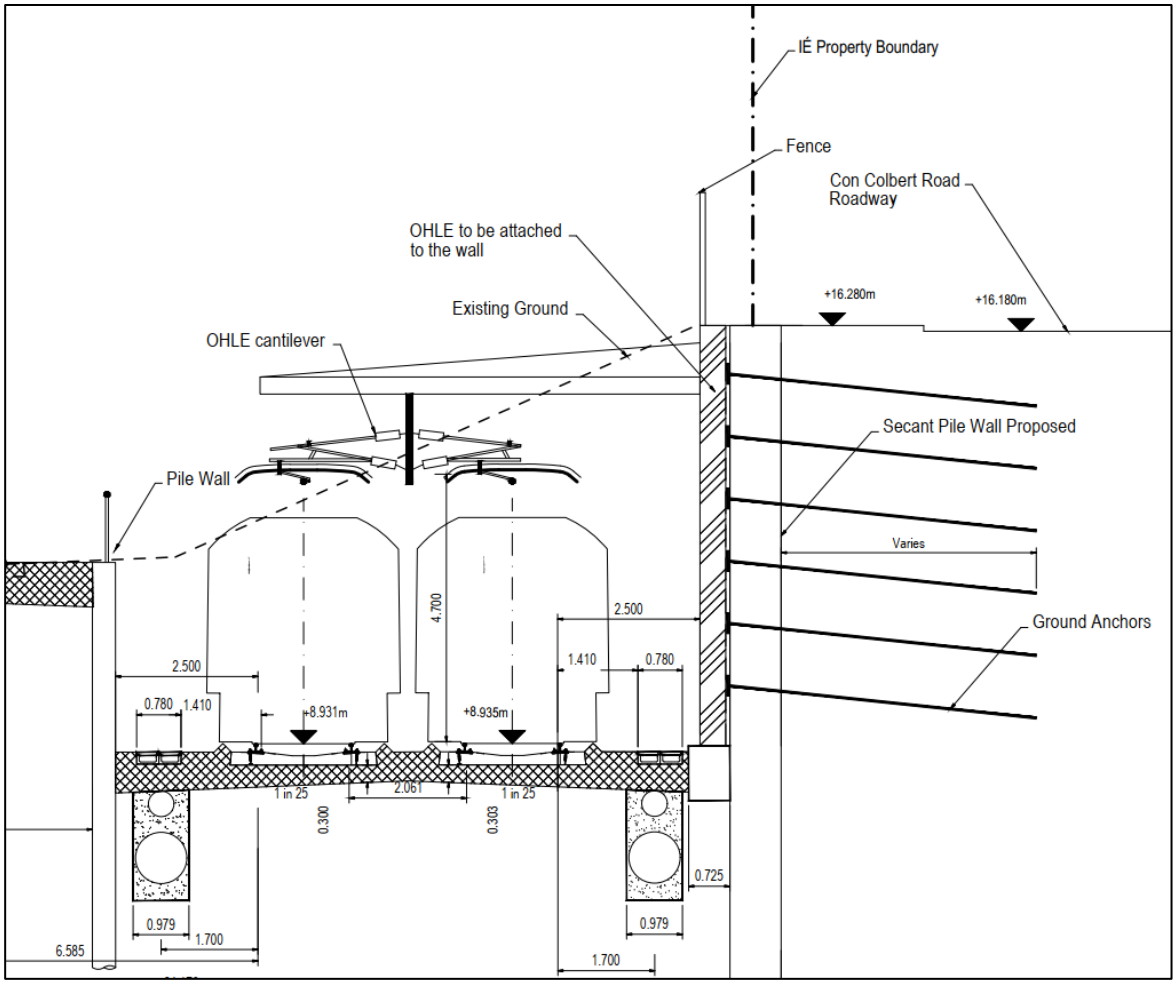

Figure 7-5 East of Memorial RoadCon Colbert Road Retaining Wall & Ground Anchors - Facing West

Figure 7-6 Example of a Secant Wall

Figure 7-7 Examples of Retaining Walls

7.3.1.3. Signalling Cantilevers

Where possible, signalling infrastructure will be located within IE existing land; however in areas where the track encroaches into adjacent land, then consideration will be given to nominal additional land take for signalling structure access. Where space for foundations in the cess is not available, consideration will be given to integrating the signalling cantilevers into the retaining wall structural design locally.

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

No additional permanent landtake is envisaged within the section of track in the vicinity of Memorial Road Bridge (OBC3).

7.3.2. Permanent Way

The Slow and Fast tracks begin vertically diverging at CH10+200, 200m west of Memorial Road Bridge (OBC3) which is at CH10+000, to achieve the minimum structural clearance to facilitate a minimum acceptable contact wire height of 4.4m for the slow tracks.

- The resultant Slow Tracks lowering = 0.680m (approximately) western parapet Memorial Road Bridge (OBC3)
- The resultant Fast Tracks lowering = 0.050m (approximately) eastern parapet Memorial Road Bridge (OBC3)

Fast tracks lowering has been limited to a maximum of 200mm in order to reduce the potential impact on the existing stone masonry retaining walls on the southern side of the rail corridor. The level segregation between Slow and Fast tracks changes from 0m on the western end, through to a maximum of 2.6m (approximately) at the low point on the Slow lines in the adjacent section of track (CH9+550); west of South Circular Road Buried Portal (proposed OBC1A cut and cover structure).

- Slow Track Gradient through the Section = 1.674%
- Fast Track Gradient Through the Section = 1.285%

Figure 7-8 shows the track plan layout at the Memorial Bridge area.

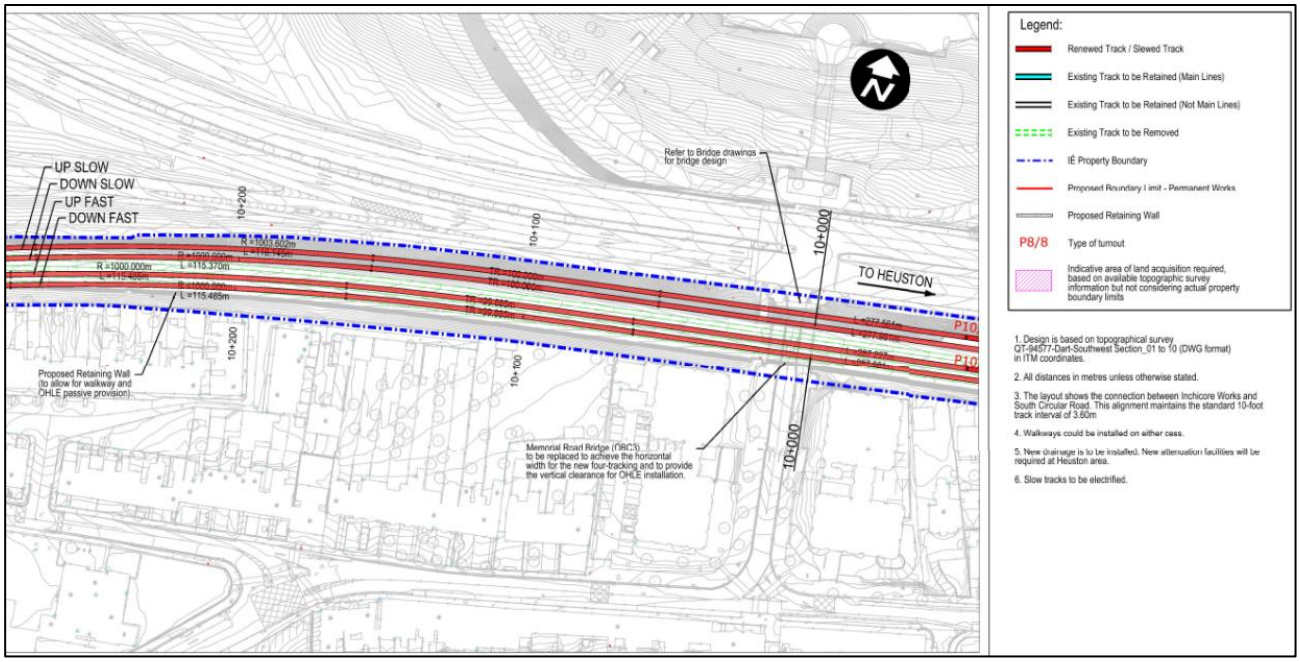

Figure 7-8 Memorial Road Bridge (OBC3) – Track Plan Layout

A retaining wall is required to facilitate the difference in ground level between the Slow and Fast lines on the easterly approach to the proposed OBC1 cut and cover structure that will accommodate the Slow lines and their associated OHLE equipment. As such, the ten-foot track interval has been increased between OBC3 and OBC1 from the standard 3.4m up to 5.4m – this provides compliant clearances between the face of the structure (the retaining wall) and the running edge of the adjacent line (Down Slow line on north side of wall, Up Fast line on south).

Figure 7-9 shows a cross section of the corridor within the extents of the section covered by this report.

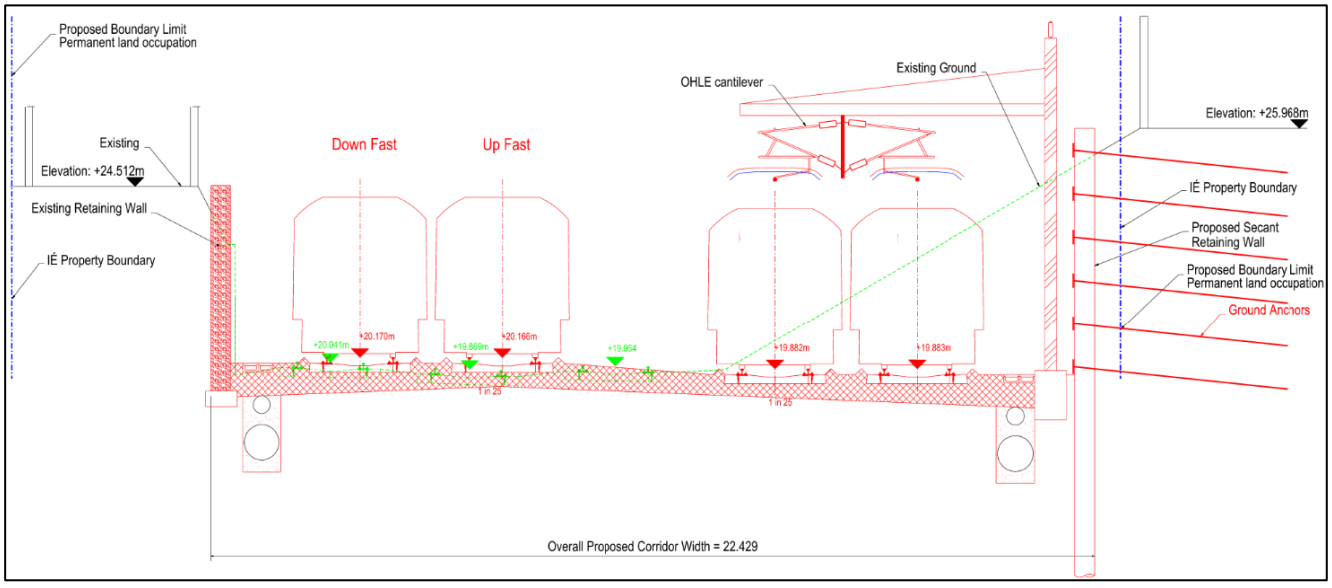

Figure 7-9 Cross section at Ch 10+103 - West of Memorial Road Bridge (OBC3) - Facing West

7.3.3. Signalling, Electrical and Telecommunications (SET)

This section provides detail on the proposed SET equipment and components which will be distributed along this section of the railway. More information on the typical SET equipment is included in **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, direct buried cable routes and secure anti-slip walkways (see **Figure 7-10**), with ladder rack being used on the tunnel walls. Secure troughing occupies the same footprint as concrete troughing but is of a lighter more manageable construction. As this trunking also acts as a designated non-slip walkway it will help to mitigate space constraint issues along the route as well as minimise the aesthetic impact to the public. It also has the added advantage that it provides security of cabling from theft and damage as well as providng easy maintenance going forward. This has no impact to the public domain.

Figure 7-10 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

No new Telecom Equipment Building (TER) is required for this area.

7.3.3.4. Electrification

Memorial Road Bridge (OBC3) will be designed to provide a soffit height of 4.91m. In this configuration the OHLE will be graded down with a minimum contact wire height of 4.4m through the bridge under all conditions. OHLE through the bridge will be fitted, with elastic bridge arms supported from the bridge at a single location in the middle of the bridge due to its length. Electrical clearance from the live OHLE to the bridge will be 100mm static and 80mm dynamic. These connections would not be visible from road level. Typically, OHLE masts would be positioned between 20m and 40m on each side of the bridge before reverting to normal spacings. The contact

wire will be graded up. **Figure 7-11** shows an indicative OHLE arrangement for passing under Memorial Road bridge (OBC3).

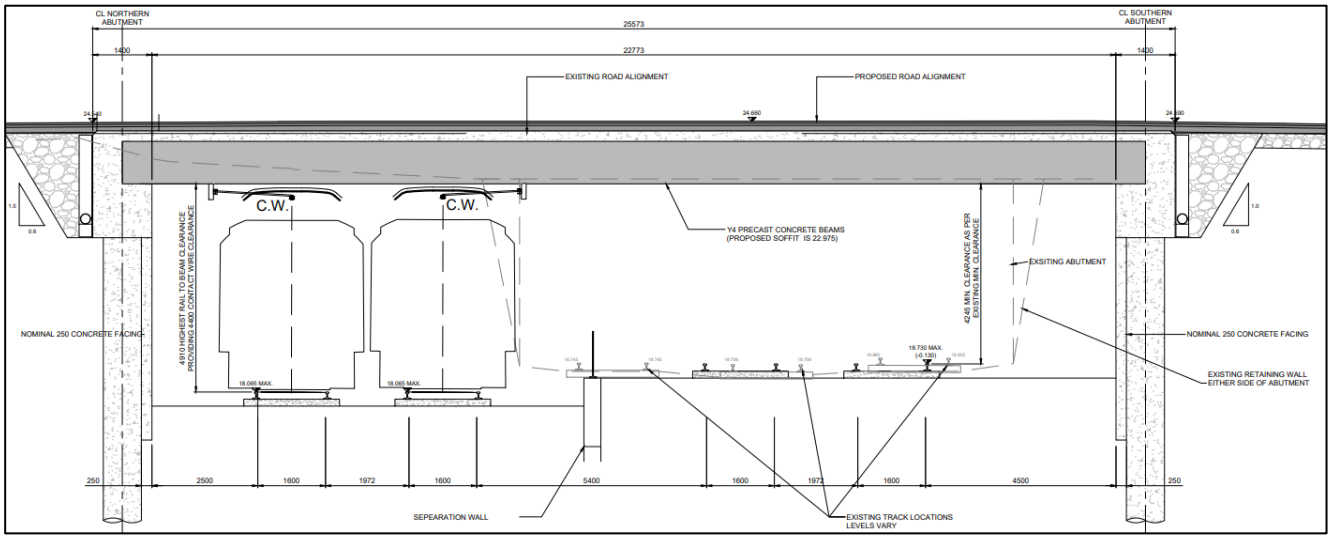

Figure 7-11 Indicative cross section for fitted OHLE system in four tracking area - Facing East

7.3.4. Roads

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

The project will provide a combination footpath/cycle track that is equal in width to the current shared use footpath width (as a minimum), except where carriageway widening has been requested by Bus Connects.

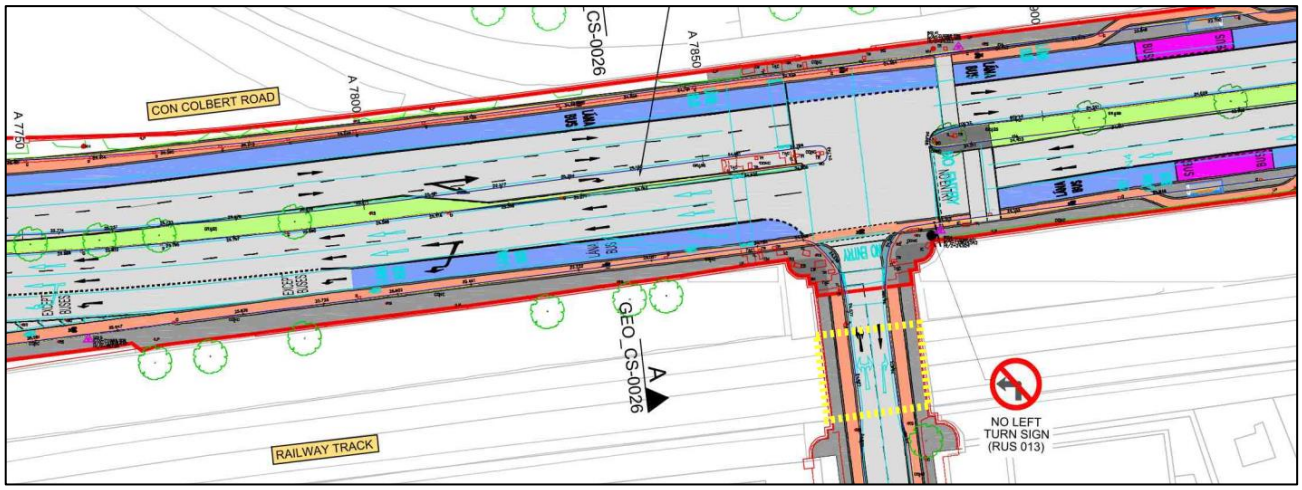

Figure 7-12 BusConnects (Interface of Lucan and Liffey Schemes)

BusConnects' proposals (refer to **Figure 7-12**), for both the Liffey and Lucan Schemes, cover the area around the bridge. The proposals include changing Memorial Road from a one-way system to provide bi-directional flow. This would include a dedicated right turn slip lane being provided on the eastbound carriageway of the Chapelizod Bypass (R148) to facilitate southbound turns into Memorial Road (R839). See **Figure 7-13** for a Plan and section of Memorial Road Bridge.

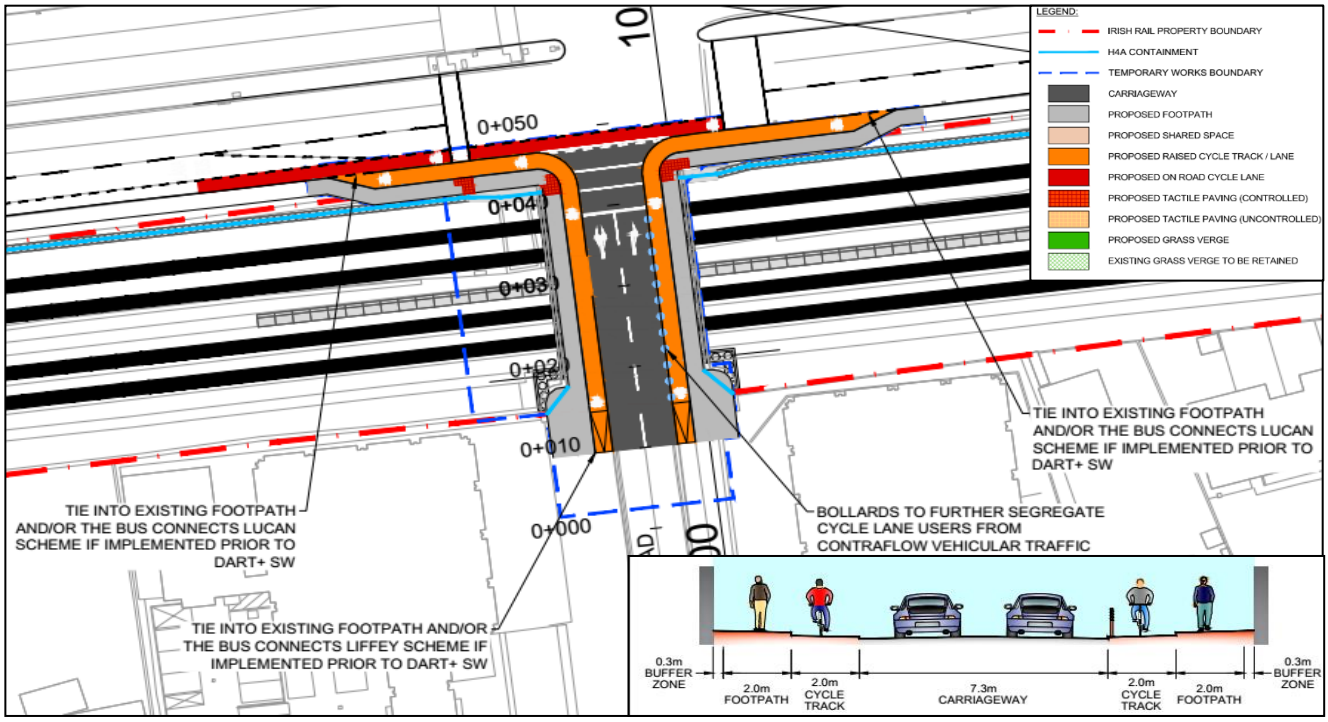

Figure 7-13 Memorial Road Bridge (OBC3) - Plan & Section

After consulation with Bus Connects, it was agreed that the proposal to reinstate a widened carriageway would be preferable for their design intent. This would remove the existing carriageway narrowing that exists over the bridge and would align the new cylelane kerbline over the bridge with existing kerb line along the remainder of Memorial Road to the south.

The carriageway lane widths would be increased to 3.65m, also preferrable for bus routes, and would be in accordance with proposals of the Liffey BusConnects Scheme.

With the removal of the existing curvilinear wall currently defining back of footpath at the abutments and the required location of the track retaining wall, the proposed future reinstatement of the walls to the north (with H4A level containment atop the track retaining walls) would facilitate further space to assist the interfacing of the 2No. Bus Connects routes by providing sufficient width of 4m to provide a uniform transition between the schemes at the Con ColbertRoad/Memorial Road Junction.

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

- 2m wide cycle track segregated from the carriageway with a 50mm kerb height
- 2m wide footpath with 75mm kerb height adjacent separating it from the cycle track
- An additional 0.3m buffer strip to the parapet face for potential fixings.
- Appropriate drop kerbs and tactile paving would be provided for vulnerable users at crossing points.

The cycle lanes would tie in with the existing lanes running west along Con Colbert Road. As the road works length would only extend approximately 10-15m south of the bridge, the proposal will be curtailed accordingly at this same location.

Memorial Road would remain unidirectional (northbound traffic only) with the eastern lane being right turn only and the western lane being left and right turn; until such time that the approved BusConnects Schemes are implemented. In the interim the eastern cycle lane coming from Con Colbert Road would be a contra-flow (southbound) arrangement. Consequently, additional temporary surface mounted segregation (PVC bollards and/or mounted rubber upstand kerb) is proposed atop the 50mm kerb. These safety mechanisms will provide additional warning to oncoming vehicles as well as control cycle movements until such time that Memorial Road reverts to bi-directional (north and southbound) flow. Traffic would generally be slowing in the current state as it approaches the current T-junction with Con Colbert Road (R105)/ Inchicore By-pass.

7.3.5. Drainage Requirements

7.3.5.1. Road Drainage

A the road is being reinstated to line and level of the existing road as well as the bridge itself is the crest of the road. It is only anticipated to reinstate the gullies immediate to the junction belmouth kerbline where this is intended to also be reconstructed to accommodate the transition of Cycle track through to Con Colbert Road (R105)/ Inchicore By-pass.

7.3.5.2. Track Drainage

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

The drainage network for this track section consists of two main branches running parallel to the track beneath the ballast layer. As the slow and fast track depart in level between chainage 10+120 and 9+500 (approx.) the Fast track drainage will be located at the back of the central retaining structure (between the fast and slow tracks); the formation will crossfall in a northerly direction to achieve this. This will also serve to limit the excavation for track drainage adjacent to the existing stone mansonry wall, south of the track in this section. No track drainage attenuation structures are proposed in this section as the retention tank and outfall point for the network draining this track length are located adjacent to the proposed Heuston West Station. See **Figure 7-14**.

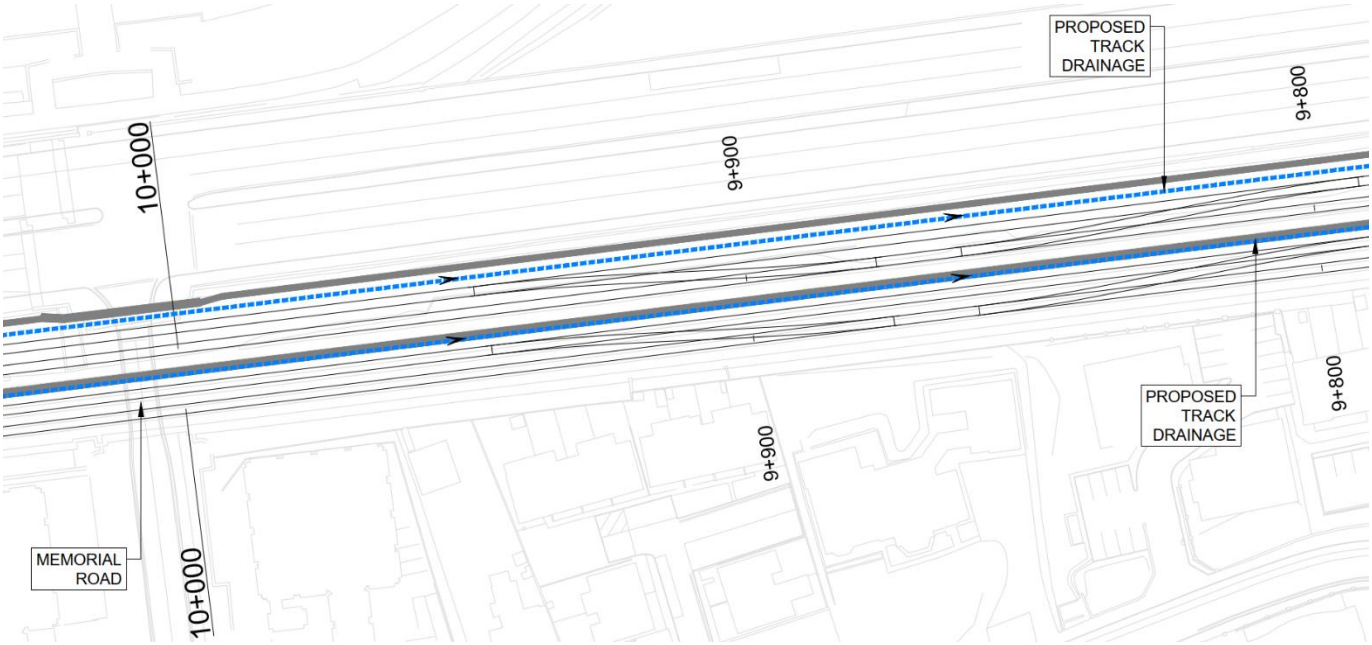

Figure 7-14 Memorial Road Bridge (OBC3) – Proposed Drainage System

8. Construction

This section of the report sets out the approach in relation to the construction methodology for the works in the area around Memorial Road Bridge.

8.1. Summary of the Proposed Works

The section of the railway corridor between Parkwest Station and Heuston Station must be widened to accommodate the additional 2No. tracks for the new DART+ service. The cross section varies through this area but is predominantly in cutting, with property boundaries close to the top of the cut slopes. The widening operation is further complicated by the need to lower the slow tracks through much of the 4-tracking area so that roads that cross the corridor on bridges are not raised too much (creating significant impact on local properties and road infrastructure); this is particularly relevant to this section, as it is linked to the adjacent section to its east (the approach to the South Circularl Road Buried Portal (OBC1A).

8.2. Retaining Structures

To achieve the widened cross section, to limit the impact of the construction works on Con Colbert Road, it is proposed to construct retaining walls along the northern corridor boundary where there will be a level difference between the proposed tracks and the adjacent land (Con Colbert Road Corridor).

Several different wall types and /or earth retaining methodologies are proposed across the project depending on the height of the retained soil, the soil conditions and the proximity of buildings to the corridor. Refer to **Section 7.3.1 Structures** for typical examples of the types referred to below.

8.2.1. Secant piled walls and contiguous bored piled walls

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

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

Large cantilever walls can be constructed using trench shields using the following methodology. The working area is first prepared so that a min 3m bench is cut into the side slope. To achieve this on the existing slope, small temporary sheet piles are pushed into position to create a temporary retaining wall on the upslope of the bench. The trench shields are then excavated into the ground using excavators from the top. A reinforced concrete base and wall is then poured. For long term slope stability, the cantilever wall will require an additional toe to be added to the wall once the trench shield and remaining soil in the front of the wall is removed.

8.2.2. Soil Nailing

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

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

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

8.2.3. Memorial - Embankments and Retaining Walls Design

It is proposed that a bored secant pile wall solution will be adopted for the section of retaining wall along the northern perimeter to form the northern (slow) tracks cess edge. The retaining wall will be approximately 4.5 to 7 m in height and will be constructed utilising access from track side within Irish Rail lands.

The over steepened nature of the existing cutting slopes, proximity of the adjacent Con Colbert Road and height of the cutting slope to be retained, necessitates a piled wall solution with the inclusion of soil nails or ground anchors.

To minimise the pile size and associated lateral movement of the upper portion of the walls and to maintain the integrity of the infrastructure beyond the crest of the retained slope along Con Colbert Road, the retaining wall along this section shall be anchored using soil nails extending into the existing slope substratum beneath Con Colbert Road. The length of the soil nails/ground anchors will vary based on the height of the cutting slope to be retained and are anticipated to be approximately 15 to 20m in length.

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

8.3. Bridges

The Memorial Road Bridge (OBC3) is required to be reconstructed to enable a greater span over the railway, with the number of tracks going from 2No. to 4No.

The Memorial Road Bridge (OBC3) will require full closure over the duration of its construction, estimated to be 14 months. The road works required are limited and it is expected that they will only extend 10-15m from the bridge abutments, by way of tie ins. A temporary bridge will be provided in advance of said works to provide an uninterrupted direct access (at this location) between Inchicore/Kilmainham and Memorial Park and St John of Gods special needs school for vulnerable road users (Pedestrians, cyclists and mobility impaired road users) (Refer to **Section 8.7 – Temporary Traffic Management**). The same temporary bridge will include the watermain and critical data centre fibre optic diversions. Unless an alternative arrangement is sought for the watermain.

It is preferable that Memorial Road Bridge (OBC3) is not constructed at the same time as South Circular Road Buried Portal (OBC1A) or Sarsfield Road Bridge (UBC4) embankment retaining structures. Memorial Road itself will also be closed to allow construction of the new bridge in addition the Con Colbert Road Bus Lane will need

localised closure to allow removal of material from track side to road level, piling and cranage (Refer to **Section 8.6 – Construction Compounds**).

Following demolition of the existing bridge within a track possession, bored piled walls will be constructed along both sides to form abutments. Abutting precast concrete beams will be placed on each side using a crane. A deck slab will be poured over the beams and at the end diaphragms to tie the walls into the deck. It is envisaged that boring the piles for the south side abutment will be done under possession from an enhanced safety perspective, but piles on the north side should be far enough away from the live carriageway to enable daytime safe zone working. Craning of precast beams would also be undertaken under a track possession, but deck slab and diaphragm stitches could possibly be done during live operations.

Both abutments and piers are currently assumed to be piled. Alternatives might be proposed by contractor. Works will focus on the North side and material will be moved using the transfer conveyors.

8.4. Permanent Way

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

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

Between Memorial Bridge and Heuston West, a retaining wall separating the existing tracks and the new DART tracks will be required. Due to the proximity of this wall to the existing track, it is probable that a few staging phases may be required to facilitate construction. Alternatively, the supporting wall will need to be constructed during night-time possession.

8.5. OHLE Infrastructure

OHLE 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. The phasing of the works will endevour to keep a minimum of 2No. working railway tracks through the Cork line. it is envisaged that a safe zone will be possible for construction in this area.

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 also distributed along the scheme by geographical features. For example, compounds will be required at each of the bridge reconstruction locations as well as 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.

Layouts have been developed for each compound, but final layouts will be developed by the contractors at construction stage. 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 requires minimal modification, if any, over the duration of the construction programme. The compound will consist of areas of hardstanding for vehicles and materials and therefore the water runoff with be managed and treated as required.

Construction compunds 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 requirement that the construction compunds are located close to and ideally with direct access to the various work sites and have good access to the public roads network.

Some construction compounds are required at very specific geographic locations, in close proximity to specific work elements, for example, construction compounds will be required at each of the bridge reconstruction locations.

A number of potential geographic locations have been identified as construction compounds along the route to support the project construction; one of them has been identified at the vicinity of Memorial Road Bridge:

- Memorial Road Bridge

Section 5 Options outlines the preferred locations for the two construction compounds required for this area; **Section 6 Options Selection Process** provides a detail of the option selection methodology. **Figure 8-1** illustrates the preferred option indicative site layout for this construction compounds.

The section between Memorial Road and South Circular Road is generally geographically constrained, with options limited for materials handling and welfare facilities. Large sections of the westbound bus lane will require closure to facilitate access and egress to construction compounds as well as the works itself. Shorter sections have the potential to pose a greater hazard.

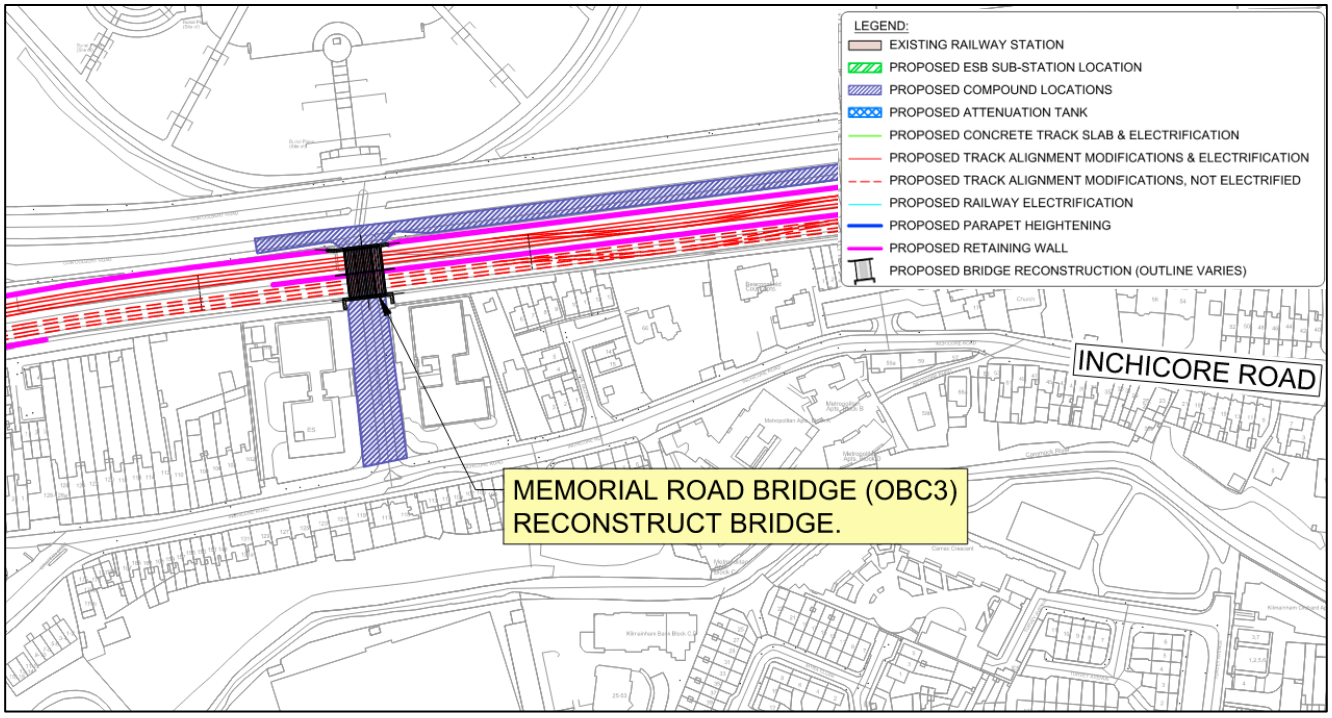

Figure 8-1 Construction Compound Memorial Road Bridge – Preferred Option Indicative Site Layout

The construction compound preferred option is proposed at the Memorial Road area that will be closed during the bridge replacement works. The first lane (bus lane) of Con Colbert Road will also be required to excavate soil and construct the new wall. It is therefore proposed to close the first lane of this road from the South Circular Road junction to beyond Memorial road and to utilise this space as a construction compound. The site provides good access to the road network, located adjacent to Con Colbert Road which leads directly to the M50 by means of a dual carriageway.

8.7. Temporary Traffic Management

8.7.1. Private and Commercial Vehicles

Memorial Road Bridge (OBC3) reconstruction requires a full closure of the crossing from Inchicore Road to Con Colbert Road. The temporary traffic management solutions being considered at this time are set out below:

Sarsfield Road's (westbound lane) currently is designated for bus use only, but traffic counts suggest it is already used regularly by other forms of transport. It is anticipated that these traffic patterns would be retained with no additional traffic as a result of the diversions. The R833 (Ballyfermot Rd) / Sarsfield Rd junction is restrictive (only allows a left-turn) and is therefore not anticipated to serve as a practical diversion route for Memorial Rd Traffic.

Traffic from Naas Road via Tyrconnell Road (all the R810) through Grattan Crescent that would typically use Memorial Road to head east into the City Centre or down South Circular Road would likely divert initially using Emmet Rd as well as the R111 (South Circular Rd) as represented by the yellow route in **Figure 8-2**.

Road users which originate from the areas surrounding Inchicore Rd, Sarsfield Rd and Grattan Crescent are anticipated to follow a similar routing to the vehicles originating from the south. Vehicles will travel northwards along Grattan crescent before making a left-turn onto Emmet Rd. They will then travel onto South Circular Rd and redistribute at the Chapelizod Bypass / South Circular Rd Junction. The routing is represented by Cyan in **Figure 8-2**.

It should however be noted that, based on the existing configuration of the Chapelizod Bypass / South Circular Rd Junction, eastbound vehicles will be required to travel into the city via Conyngham Rd. This is a relatively large detour for eastbound traffic and therefore not the preferred solution for motorists. As a result, it is recommended that a short-term right turn movement be added to the northbound direction on the South Circular Rd Bridge. This adjustment is consistent with the proposed configuration of the junction following the implementation of BusConnects. The preferred and alternative eastbound traffic diversions are shown in **Figure 8-3** while the proposed BusConnects layout is shown in **Figure 8-4**.

Owing to the lengthy anticipated duration of the closure of the Memorial Road Bridge (OBC3) crossing; vehicular users will undoubtedly find further alternatives to reach their destinations; some of which may well be longer in length but possibly with shorter journey times.

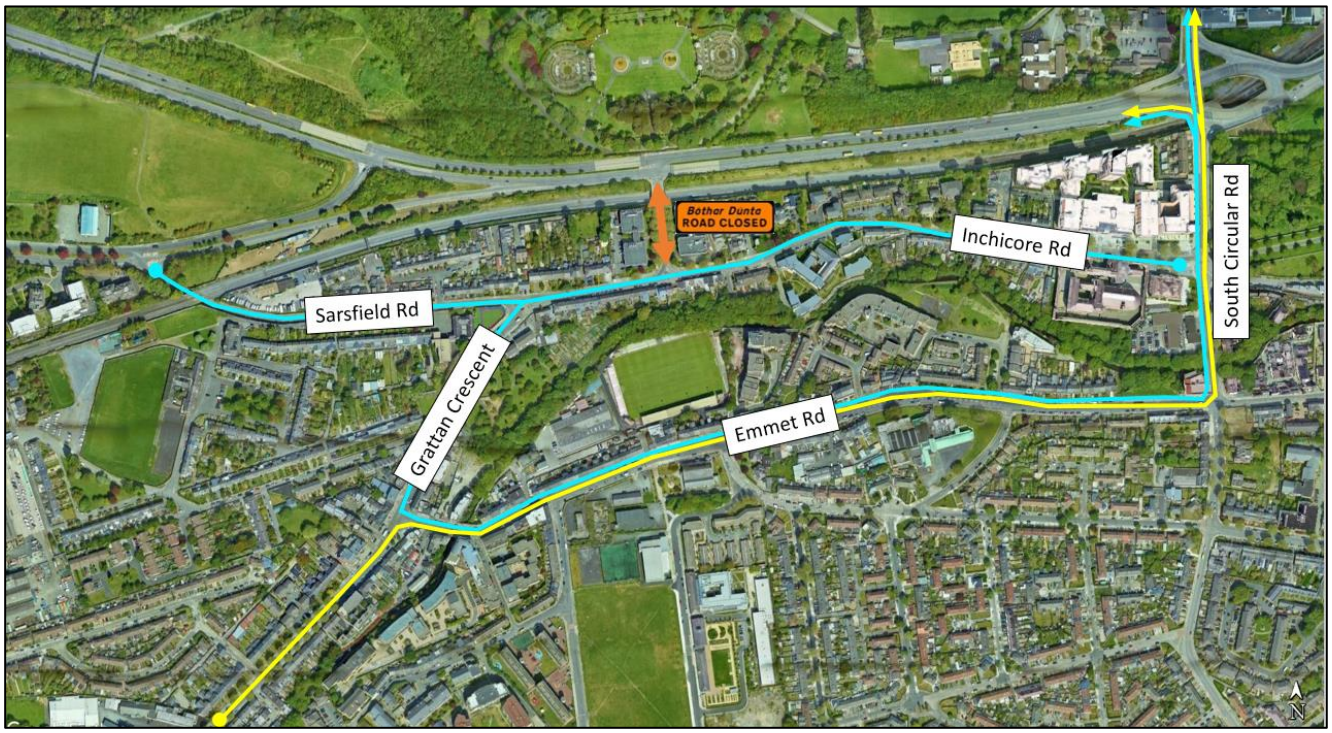

Figure 8-2 Proposed vehicular diversion routes and/or indicative dispersion patterns

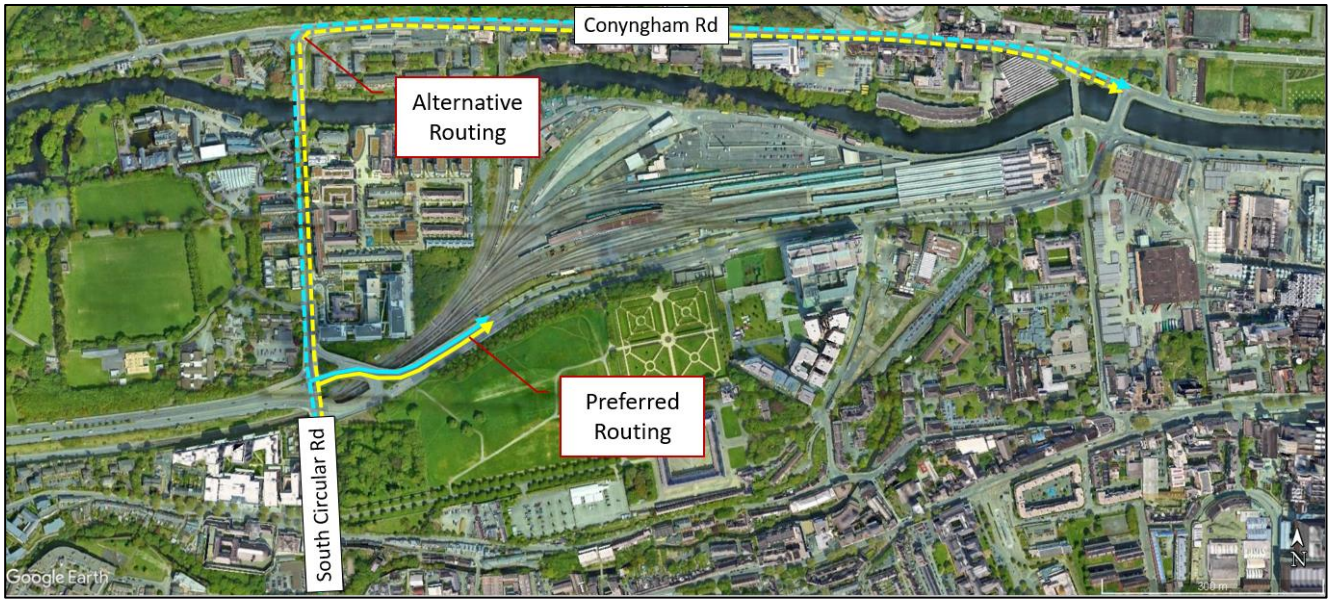

Figure 8-3 Eastbound Traffic Routing

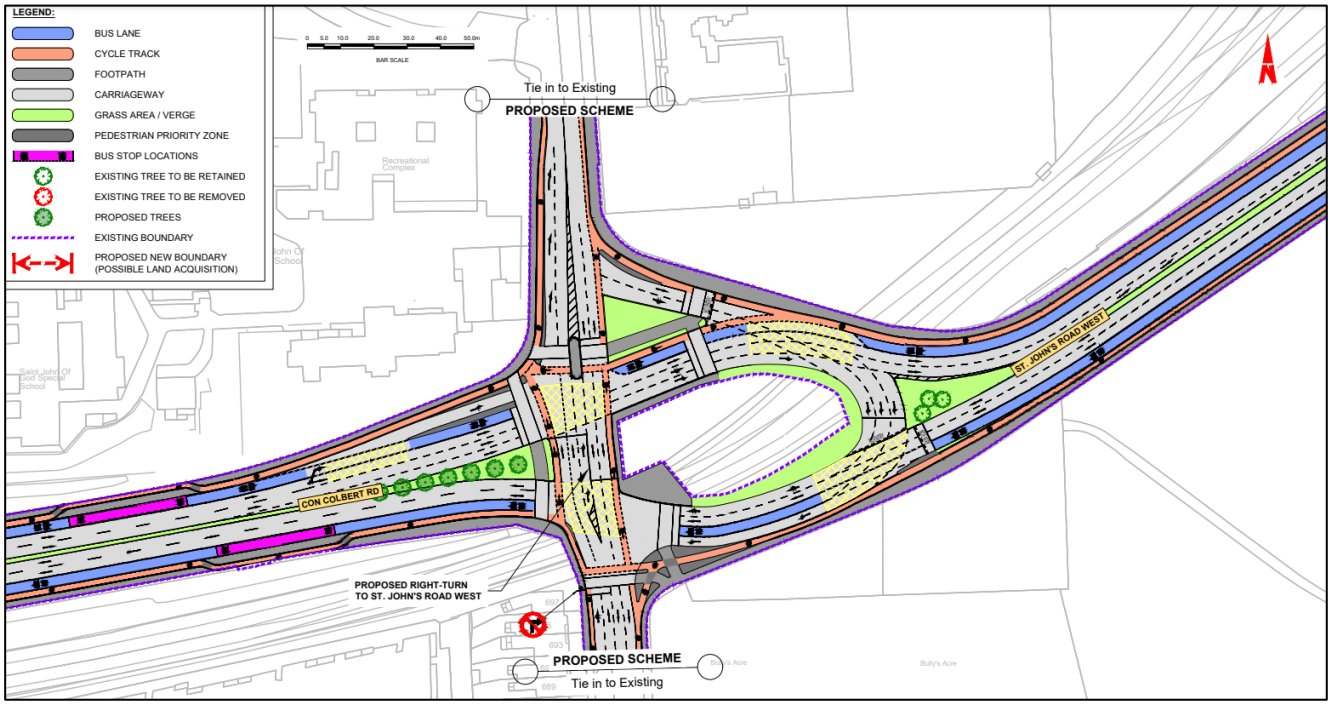

Figure 8-4 - Proposed Junction Layout - BusConnects

The right turn proposed in the temporary diversion proposal **Figure 8-3** would not be different to the latest published Bus Connects proposal for a permanent right turn, as evident in **Figure 8-4.**

8.7.2. Vulnerable Users (Pedestrians, Wheel Chair users and Cyclists)

Memorial Road is also a well-used pedestrian route providing connectivity between Memorial Park (north of Con Colbert Road) for those residing working or visiting Kilmainham and Inchicore areas. In addition, it provides a

safer and shorter route for vulnerable children attending the St John of God's special needs school (as opposed to crossing at South Circular Road junction).

The Con Colbert Road pedestrian crossing is currently only 2.1m wide (controlled by median pedestrian safety fencing) to the west of the junction. It is proposed to provide a 3.15m width temporary bridge (Maybey type segmental, fast erection) for continuous vulnerable user access to their original route. This would facilitate passing movements between wheelchair user (or cyclist walking a bicycle) and a pedestrian.

While this is not as wide as that currently available for use by pedestrians and cyclist but the area is space constrained.. In addition, as mentioned above, the footpath along Con Colbert Road and its crossing both have less width than the 3.15m proposed. The Con Colbert Road pedestrian crossing is currently only 2.1m wide (controlled by median pedestrian safety fencing) to the west of the junction.

The eastern footpath of Memorial Road will be closed for the duration of the works as well as the southern footpath of Con Colbert Road (east of Memorial Road), while the footpath to the west of the temporary bridge up to the slip road leading towards Sarsfield Road will also be closed until such time as the railway/road corridor boundary wall has been reinstated onto the new piled retaining wall. Those that would normally use this section of footpath to access Memorial Park will need to walk via Sarsfield Road and cross the temporary bridge referred to above (see in **Figure 8-6**).

While currently there are some that would walk the length of Con Colbert Road using the southern footpath; during the construction of this section of track and the structure, the southern footpath will be closed and they will need to choose one of the 2No. alternatives proposed below, in **Figure 8-5**.

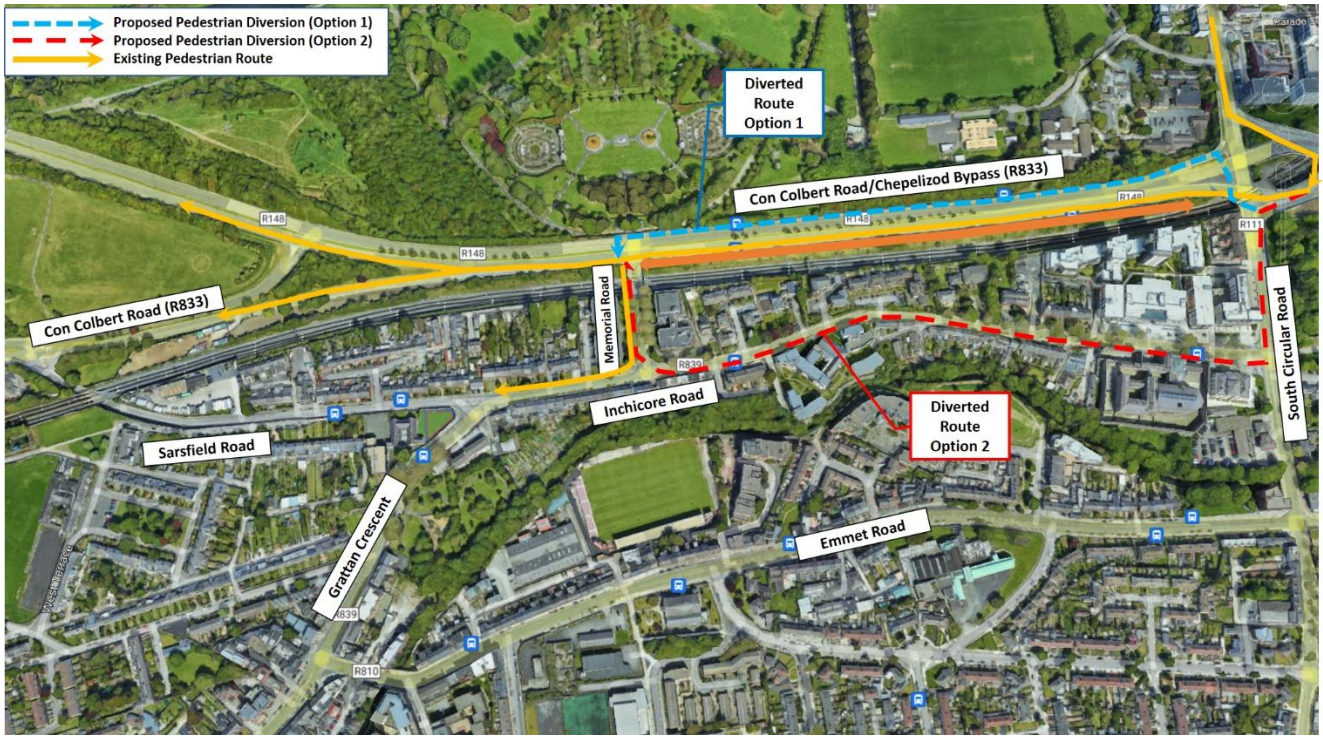

Figure 8-5 Proposed Pedestrian Diversion Routes (Westbound)

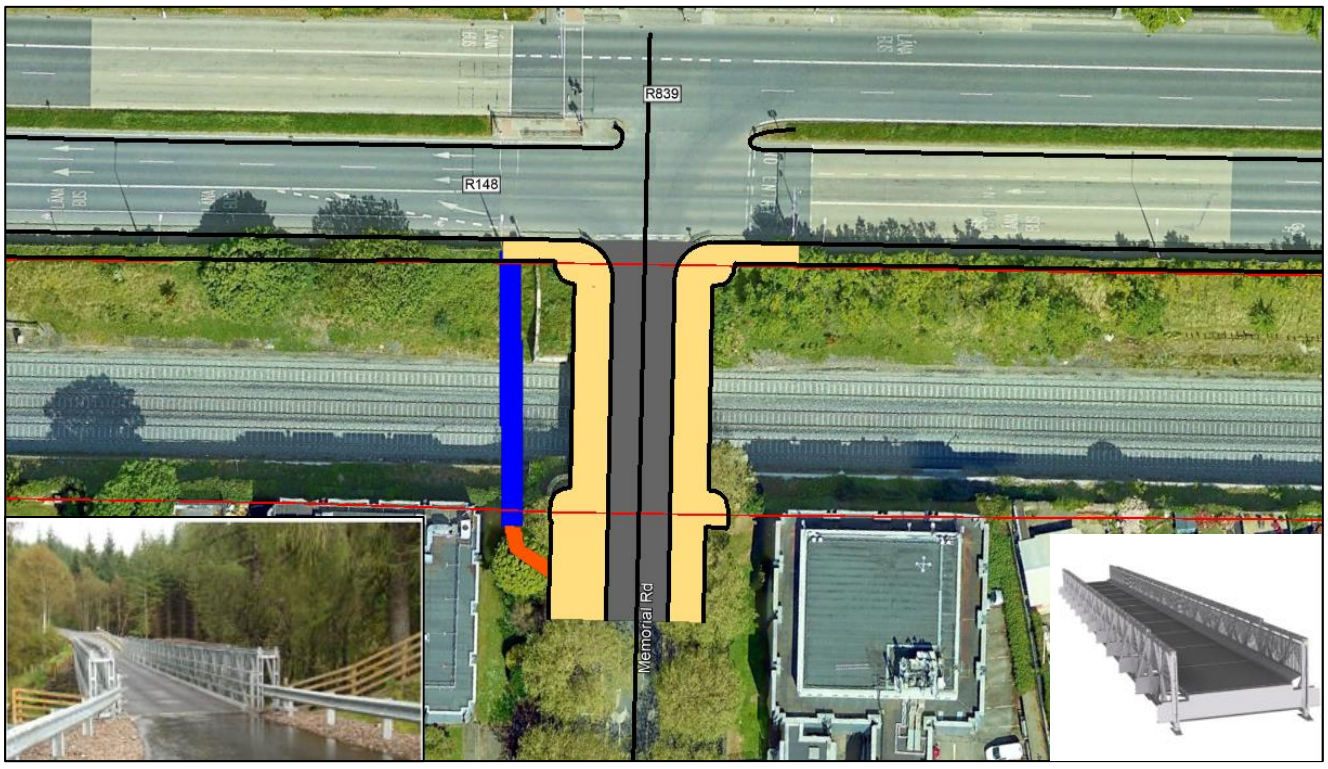

Figure 8-6 Proposed temporary vulnerable user diversion (incl. bridge)

8.7.3. Public Transport

The only bus route currently utilising Memorial Rd is Dublin Bus Route 69. The full closure of Memorial Rd is expected to require a diversion of Route 69 via Emmet Rd & South Circular Rd. The proposed diversion is shown in **Figure 8-7**.

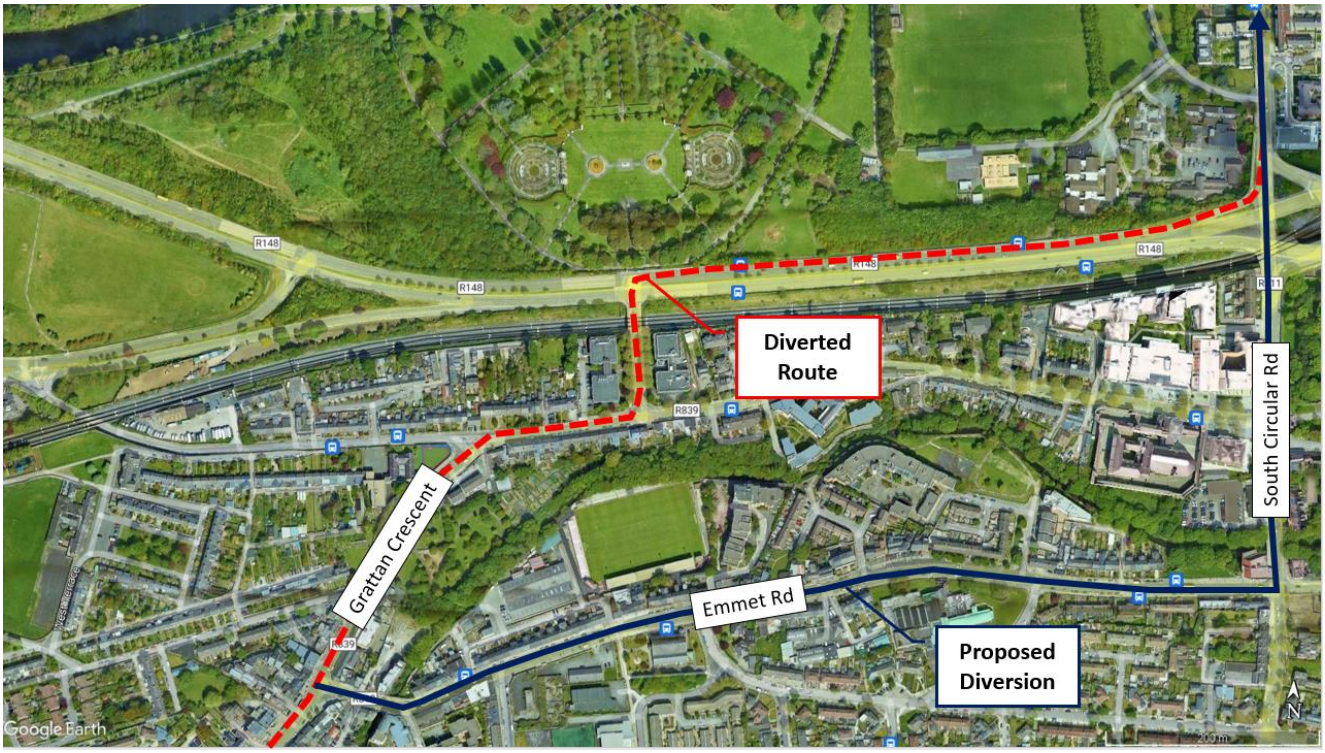

Figure 8-7 Proposed Bus Route Diversion - Dublin Bus Route 69

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).

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

A full methodology of the setup and construction methods will need to be sympathetic to both the railway operations, as well as 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 consulation phases as well as planning compliance criteria stipulated in the Railway Order).

Appendix A – Sifting Process Backup

A1. Sifting Process Backup – Memorial Road Bridge

Appendix B – MCA Process Backup

B.1 MCA Process Backup – Civil and OHLE at Memorial Road area

Appendix C – Supporting Drawings

The following drawings accompany the Technical Report:

Bridge Drawings

DP-04-23-DWG-ST-TTA-57130: Memorial Road Bridge (OBC3) – General Arrangement

DP-04-23-DWG-ST-TTA-57131: Memorial Road Bridge (OBC3) – Bridge Deck Plan

DP-04-23-DWG-ST-TTA-57132: Memorial Road Bridge (OBC3) – Bridge Deck Cross Section

DP-04-23-DWG-ST-TTA-57133: Memorial Road Bridge (OBC3) – Bridge Deck Longitudinal Section

Roads Drawings

DP-04-23-DWG-CV-TTA-56531: Memorial Road Overbridge (OBC3) – Plan and Profile

Permanent Way Drawings

DP-04-23-DWG-PW-TTA-56995: Sarsfield Road Bridge (UBC4) and Memorial Road (OBC3) – Track Plan Layout

DP-04-23-DWG-PW-TTA-56996: Sarsfield Road Bridge (UBC4) and Memorial Road (OBC3) – Cross Section CH 10+103