

The background of the page is a vibrant red. It is decorated with several abstract geometric shapes: a large white circle with a blue border in the upper right; a smaller white circle with a blue border in the lower left; a large teal shape with a white border in the bottom right; and various other shapes in blue, green, and white scattered throughout the corners and edges.

**Appendix J2**  
Preliminary Design Report  
- Structure 02

# Preliminary Design Report – Consultation

STA-1b

Categories 1, 2 & 3

## Scheme

Name and Location: Busconnects Infrastructure Delivery – Project D

## Structure(s)

Name and nature of the Structure(s): Ballymun 02 bridge

Preliminary Design Report

Reference BCIDD-ROT-STR-ZZ-0003-XX-00-RP-CB-0016

Revision L02

Date May 2022

## Submitted by

Signed:



Name: Fernando Fernandez

Position: (Structures Team Leader)

Organisation: Roughan & O'Donovan – TYP SA Consulting Engineers

Date: 23/05/2022

## Structures Section confirmation of consultation:

Signed: \_\_\_\_\_

Name: \_\_\_\_\_

Position: \_\_\_\_\_

Date: \_\_\_\_\_

# BUSCONNECTS INFRASTRUCTURE DELIVERY – PROJECT D

## PRELIMINARY DESIGN REPORT – BALLYMUN 02

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## 1. INTRODUCTION

### 1.1 Brief

Roughan & O'Donovan-TYP  
SA have prepared this report for the National Transportation Authority (NTA) for the design of the Ballymun 02 bridge as part of the Busconnects Infrastructure Delivery – Project D.

### 1.2 Background Information

The proposed scheme for Ballymun/Finglas to City Centre aims to provide enhanced walking, cycling and bus infrastructure, which will enable and deliver efficient, safe and integrated sustainable transport movement to this corridor.

Priority for buses is provided along the entire route consisting primarily of dedicated bus lanes in both directions, with alternative measures proposed at particularly constrained locations along the scheme. Cycle tracks and footpaths will also be provided separated from the bus lanes. At constrained points, it is necessary to build new structures or widen the existing ones to provide adequate space for the new road layout.

This document relates to the Preliminary Design Report in respect of the Ballymun 02 bridge in accordance with DN-STR-03001 (April 2019). A location drawing of this structure within the scheme is provided in the Appendices, as well as a general arrangement drawing of the proposed bridge.

This structure is being proposed to accommodate a proposed high-quality cycling and footpath route along Prospect Road, sin it is not practicable to fit cycle and pedestrian facilities in addition to bus facilities through the existing bridge (OBD222) over the railway at Prospect Road.

Photographs of the structure taken during a site visit are included in Appendix 1.

### 1.3 Previous Studies

Reports prepared and published for this structure to date include:

- BCIDD-ROT-STR-ZZ\_0003-XX\_00-RP-CB-0012 – Ballymun02 Structures Options Report
- BCID-ROT-ERW-GI\_0304-RP-CR-0001 – Geotechnical Interpretive Report: Ballymun/Finglas Corridors

## **2. SITE & FUNCTION**

### **2.1 Site Location**

The Ballymun 02 bridge is situated nearby the existing bridge (OBD222) over the railway at Prospect Road. The site location plan is included in Appendix 2.

### **2.2 Function of the Structure**

The objective of the new bridge is to provide a new cycle and pedestrian route, which spans over the railway. A gap separates the proposed structure from the existing bridge (OBD222).

### **2.3 Choice of Location**

The location of the structure was chosen to facilitate the proposed Ballymun / Finglas to city centre corridor taking into account the layout and roadway requirements in terms of space for proposed lanes, footpaths, maximum slopes, etc.

### **2.4 Site Description and Topography**

The site of the proposed structure is located in an urban area, close to Dublin's city centre. Consequently, there are existing buildings and infrastructure in the direct vicinity of the new structure.

The level of the existing carriageway at the centreline of the bridge is at 24.80m and at 24.37m at the west and east abutments, respectively.

### **2.5 Vertical and Horizontal Alignments**

Horizontal and vertical road alignments at the bridge location are described below. The proposed general arrangement drawings can be seen in Appendix 2.

#### Horizontal Alignment

The bridge connects Whitworth Road with the north Royal Canal towpath.

#### Vertical Alignment

The proposed vertical road alignment at the location of the bridge follows the alignment of the existing road, falling between the north and south abutment at a constant gradient of 3%.

### **2.6 Cross-Sectional Dimensions on the Alignments**

The proposed mainline cross section at the structure location is shown in Table 2.1.

**Table 2.1: Ballymun 02 Cross-Section**

| Parameter               | Value          |
|-------------------------|----------------|
| Parapet Upstand         | 0.25 m         |
| Footway                 | Varies         |
| Cycle lane              | 3.00 m         |
| Footway                 | Varies         |
| Parapet Upstand         | 0.25 m         |
| <b>Out-to-Out Width</b> | <b>10.63 m</b> |

## 2.7 Existing Underground and Overground Services

A list of the existing services located in close proximity to the Ballymun 02 bridge is outlined below.

### Low and Medium Voltage Electricity Lines

ESB low voltage underground lines are present at the structure's location. These may need to be diverted following discussions with ESB.

### High Voltage Electricity Lines

Desktop services tracking to date indicate low and medium voltage underground lines in the vicinity of the structure which may need to be diverted following discussions with the ESB. There appear to be no high voltage lines, however, these will need to be verified by the Contractor on site.

### Telecommunications

Desktop services tracking to date indicate some telecommunication cables in the vicinity of the structure which may need to be diverted following discussions with the provider. Exact locations will need to be verified by the Contractor on site.

### Water Supply

Desktop services tracking to date indicate watermains at the structures location which may need to be diverted following discussions with Irish Water. Exact locations will need to be verified by the Contractor on site.

### Gas Networks

Desktop services tracking to date indicate gas mains at the structures location which may need to be diverted following discussions with Gas Networks Ireland. Exact locations will need to be verified by the Contractor on site.

## 2.8 Geotechnical Summary

The existing site investigation information for the area has been taken from the Geological Survey of Ireland (GSi) website and the British Geological Survey (BGS) website, including the Quaternary and Bedrock Geology of Dublin and Depth of Bedrock digital maps.

At the date of this report there is a GI contract available that aims to assess the geology of the site and determine the ground properties and conditions to enable the design of Bus Connects Core Bus Corridors.

## **2.9 Hydrology and Hydraulic Summary**

The bridge will have minimal effect on the hydrology in the area and is not crossing a watercourse.

## **2.10 Archaeological Summary**

An Environmental Impact Assessment Report (EIAR) is currently being prepared that considers archaeological impacts along the mainline alignment.

## **2.11 Environmental Summary**

An Environmental Impact Assessment Report (EIAR) is currently being prepared and it considered the mainline alignment at the structure location and its impact on the environment and local communities. All likely significant environmental effects are assessed, and mitigation is proposed as necessary in the Environmental Impact Assessment Report.

### **3. STRUCTURE & AESTHETICS**

#### **3.1 General Description of Recommended Structure**

The Ballymun 02 bridge shall be a single span fully integral portal frame bridge. The bridge deck consists of infilled precast concrete TY beams with a cast in situ reinforced concrete deck slab. Superstructure will be supported by pile caps and reinforced concrete piles.

#### **3.2 Aesthetic Considerations**

The structural form is typical for bridges and is a straightforward form of construction. The depth of the deck has been minimised to keep the headroom requirements of railway.

The width of the bridge meets the intention to design a cycle track and a comfortable walking area. The level of the existing carriageway has been kept, maintaining the overall aesthetic to the area while providing continuity to the cycle lane and footpath to Prospect Road.

The parapets will require aesthetic approval from the Employer's Representative to ensure an appropriate solution is employed in construction.

#### **3.3 Proposals for the Recommended Structure**

##### **3.3.1 Proposed Category**

The proposed bridge is a Category 2 structure.

##### **3.3.2 Span Arrangements**

The structure is a single span bridge of 13.32m length (c/c bearings) with a deck straight in plan and has a skew angle of approximately 4 degrees.

##### **3.3.3 Minimum Headroom Provided**

A minimum vertical clearance between the deck soffit and the proposed finished ground level is set at 4.99m.

##### **3.3.4 Approaches (incl. Run-on Arrangements)**

The approaches are generally on a suitable formation or using a compacted acceptable material finished with a capping layer. Footpath construction is used over the embankment fill up to the back of the end abutments. It is not proposed to use run on slabs.

##### **3.3.5 Foundation Type**

The substructure comprises of embedded foundations, formed by bored in-situ reinforced concrete piles and in-situ reinforced concrete pile cap, where the precast beams will be supported. 4No Ø0.50m piles are proposed per abutment.

##### **3.3.6 Substructure**

The precast beams will be supported on the embedded foundations. Integral connection between superstructure and substructure will be made at both abutments.

##### **3.3.7 Superstructure**

The bridge deck will be formed from precast TY beams with an infilled cast in situ reinforced concrete slab.

### 3.3.8 Articulation Arrangements (Joints and Bearings)

The structure will be designed to be a fully integral frame. There will be no requirement for any articulation of the structure; the precast beams will be tied into the abutments with full monolithic connections. Longitudinal forces acting on the frame due to temperature strains and vehicle loads will be resisted through soil-structure interaction and flexure of the frame. Saw cut joints will be provided in the pavement and footpath at the back of each abutment.

### 3.3.9 Vehicle Restraint System

All parapets will comply with TII DN-STR-03034 (historical ref. NRA TD19) and EN 1317. The parapet containment level as well as the approaches / departures and transitions shall be H4a unless otherwise specified by the road authority. The parapet proposed is of solid concrete appearance and they will be tied into existing walls adjacent to the OBD222 bridge.

### 3.3.10 Drainage

The proposed longitudinal gradient of the road is a 3% fall from south to north along the carriageway. Due to the short span, it is not proposed to install combined kerb drains across the bridge; instead, bridge deck drainage will be provided by gullies on the southern approach to the bridge. Gullies will also be provided on the northern approaches to collect surface.

### 3.3.11 Durability

The proposed structure will be designed to achieve the required 120 years design life.

In addition, the specification of suitable materials will enhance durability and reduce the maintenance liability. The following measures are proposed:

- Durable concrete to be provided in accordance with TII DN-STR-03012 (formerly BD 57);
- Exposed concrete to be surface impregnated and buried concrete surfaces to be waterproofed in accordance with the TII Specification for Road Works;
- Stainless steel reinforcement to be provided in elements that are subject to de-icing salts and that are particularly vulnerable;
- Bridge deck to be waterproofed with a spray applied system that has a current BBA / IAB Certificate;
- Exposed formed concrete surfaces to be F4 / F3;
- Provision of a fully maintainable bridge deck drainage system

### 3.3.12 Sustainability

Sustainable development has been considered for the detailed design of the proposed bridge to enable a cost-effective and sustainable solution which has a minimal impact on the surrounding environment.

The proposed structure is an integral concrete beam and infill slab type deck bridge which is considered a more sustainable solution than a similar steel structure for the following reasons:

- Concrete is manufactured in Ireland while steel is imported;
- Local cement and aggregates are used in the production of concrete;
- It avoids the requirement for elastomeric bearings and expansion joints (replaceable elements) due to its integral nature;

- Concrete typically requires less ongoing maintenance work than steelwork.

It is proposed to adopt 50% ground granulated blast furnace slag (GGBS) as cement replacement in the mix design for all in-situ concrete which reduces CO2 emissions.

### **3.3.13 Inspection and Maintenance**

The inspection of bridges shall be carried out in accordance with TII procedures by suitably qualified personnel who shall be responsible for providing the relevant equipment and establishing traffic management appropriate to the type of inspection being carried out.

Inspection of most parts of the bridge can be done from finish road level. Inspection of the soffit of the proposed bridge and abutments shall be carried out at nights' possession of the railway tracks.

The proposed structure is an integral bridge therefore maintenance requirements will be minimal.

#### **Superstructure**

All external concrete surfaces will be visible for inspection. Structural steelwork and bearings are not proposed therefore maintenance is expected to be minimal.

#### **Substructures**

The substructures consist of in situ reinforced concrete mostly buried into the ground, which should not incur any substantial maintenance costs.

#### **Parapets**

Reinforced concrete parapets are proposed, which are virtually maintenance free within their working life.

## **4. SAFETY**

### **4.1 Traffic Management during Construction**

Traffic management will be required during construction. The bridge can be constructed without the need of falsework over the railway, the beams are the permanent formwork. This will allow railway service to be maintained during construction. Nights' possession will be needed during lifting and pouring operations.

### **4.2 Safety during Construction**

The Designer will comply with the General Principles of Prevention (of accidents) as specified in the First Schedule of the Safety, Health and Welfare at Work (General Application) Regulation and liaise with the Project Supervisor for the Design Stage (PSDP) appointed by the Client and the Project Supervisor appointed for the Construction Stage as required by the "Safety, Health and Welfare at Work (Construction) Regulations, 2013".

### **4.3 Safety in Use**

Bridge parapets will be designed for collision loading in accordance with IS EN1317, the headroom and cross section will be designed in accordance with TII DN-GEO-03036 (historical ref. TD 27).

### **4.4 Lighting**

Lighting under the bridge is not required. Lighting over the bridge will be provided in accordance with BS-5489-1.



## 5. DESIGN ASSESSMENT CRITERIA

### 5.1 Actions

The structure will be designed in accordance with IS EN 1991 Eurocode 1: Actions on Structures and, in particular, Part 1-1: General Actions, Part 1-3: Snow Loads, Part 1-4 Wind Loads, Part 1-5 Thermal Actions, Part 1-6 Execution, Part 1-7 Accidental Actions and IS EN 1991 Part 2 Traffic Loads on Bridges as amended by the relevant Irish National Annexes.

#### 5.1.1 Permanent Actions

The following nominal densities will be adopted:

- Reinforced concrete 25 kN/m<sup>3</sup>
- Structural steelwork 77 kN/m<sup>3</sup>
- Pavement 23 kN/m<sup>3</sup>
- Backfill to structures 20 kN/m<sup>3</sup>

#### 5.1.2 Snow, Wind and Thermal Actions

Snow action may be ignored due to the geographical location as outlined in IS EN 1990:2002 + NA:2010. Thermal actions Approach 2 will be used in accordance with clause NA.2.3 of the Irish National Annex to IS EN 1991-1-5. Wind load will be assessed in accordance with IS EN 1991-1-4:2005 and the associated National Annex.

#### 5.1.3 Actions relating to Normal Traffic

Traffic surcharge loading to be applied behind the bridge abutment and wingwalls will be calculated in accordance with IS EN 1991-2.

#### 5.1.4 Actions relating to Abnormal Traffic

None.

#### 5.1.5 Footway Live Loading

The structure will be designed for footway loading in accordance with IS EN 1991-2 load model LM4 (crowd loading). This consists of a uniformly distributed load ( $q_{fk}$ ) of 5kN/m<sup>2</sup> and a concentrated load ( $Q_{fwk}$ ) of 20kN as defined in section 5 of IS EN 1991-2 and the Irish National Annex.

#### 5.1.6 Provision for Exceptional Abnormal Loads

None.

#### 5.1.7 Accidental Actions

Accidental actions will be considered in accordance with I.S. EN 1991-1-7. Accidental presence of vehicles on the bridge in accordance with IS EN 1991-2.

#### 5.1.8 Actions during Construction

The design shall take account of any adverse loading during construction as outlined in IS EN 1991-1-6 and its National Annex. Specifically, the design shall take account of required construction vehicles and the actions will be applied as described in section 6.1.3 above.

#### 5.1.9 Any Special Loading not Covered Above

None.

## **5.2 Authorities Consulted**

The following is a list of Authorities to be consulted as part of the scheme:

- Local Authorities – Dublin City Council;
- ESB;
- Gas Networks Ireland;
- Iarnród Éireann – Irish Rail;
- Irish Water.

## **5.3 Proposed Departures from Standards**

There are no existing departures applied for at this stage of the design process.

## **5.4 Proposed Methods of Dealing with Aspects not Covered by Standards**

Agreed departures to be incorporated into the design – however at this stage no departures have been applied for.

## 6. GROUND CONDITIONS

### 6.1 Geotechnical Classification

The existing site investigation information for the area has been taken from the Geological Survey of Ireland (GSI) website and the British Geological Survey (BGS) website, including the Quaternary and Bedrock Geology of Dublin and Depth of Bedrock digital maps.

A GI contract has recently been completed which aims to assess the geology of the site and determine the ground properties and conditions to enable the design of Bus Connects Core Bus Corridors. The GI includes boreholes, trial pits, dynamic probes, standpipes/piezometer installation and monitoring, in-situ testing, geotechnical and environmental laboratory testing and preparation of a factual report, all in accordance with the “Specification and Related Documents for Ground Investigation in Ireland”.

### 6.2 Description of the Ground Conditions and Compatibility with Proposed Foundation Design

The following table shows the expected depth to bedrock, based on the data from the Desktop Review, as well as the depth of the encountered bedrock in the GI undertaken. Note that some of the boreholes were terminated at a shorter length, before encountering the bedrock strata.

**Table 6.1: Encountered bedrock in the vicinity of Ballymun 02**

| Borehole Ref. | Depth to Encountered Bedrock | Depth to N SPT Values of Refusal |
|---------------|------------------------------|----------------------------------|
| R3-CP03       | -                            | 5m                               |

Additional information regarding the geological profile and location of the boreholes can be found on the Geotechnical Interpretation Report, document No. BCID-ROT-ERW\_GI-0304-RP-CR-0001. An extract of the Geotechnical Interpretation Report is included in Appendix 3.

Based on the current site investigation information provided, it is proposed to use piled foundations to support the bridge abutments.

## **7. DRAWINGS & DOCUMENTS**

### **7.1 List of All Documents Accompanying the Submission**

#### **Appendix 1 – Photographs:**

(4No. of photos)

#### **Appendix 2 – Site Location and Drawings**

- BCIDD-ROT-STR\_KP-0304\_XX\_00-DR-SS-0001 – Ballymun/Finglas to City Centre Core Bus Scheme – Bridges and Retaining Structures – Key Plan
- BCIDD-ROT-STR\_ZZ-0304\_XX\_00-DR-SS-0003 – Ballymun 02 General Arrangement
- BCIDD-ROT-STR\_ZZ-0304\_XX\_00-DR-SS-0004 – Ballymun 02. Sections

#### **Appendix 3 – Relevant Extracts from Ground Investigation Report**

(8 Pages) Extract GIR - BCID-ROT-ERW\_GI-0304-RP-CR-0001

#### **Appendix 4 – Other Relevant Documentation/Reports**

(Not Used)

## **APPENDIX 1 PHOTOGRAPHS**



*Overview of existing OBD222 bridge*



*Existing parapet to be partially demolished*





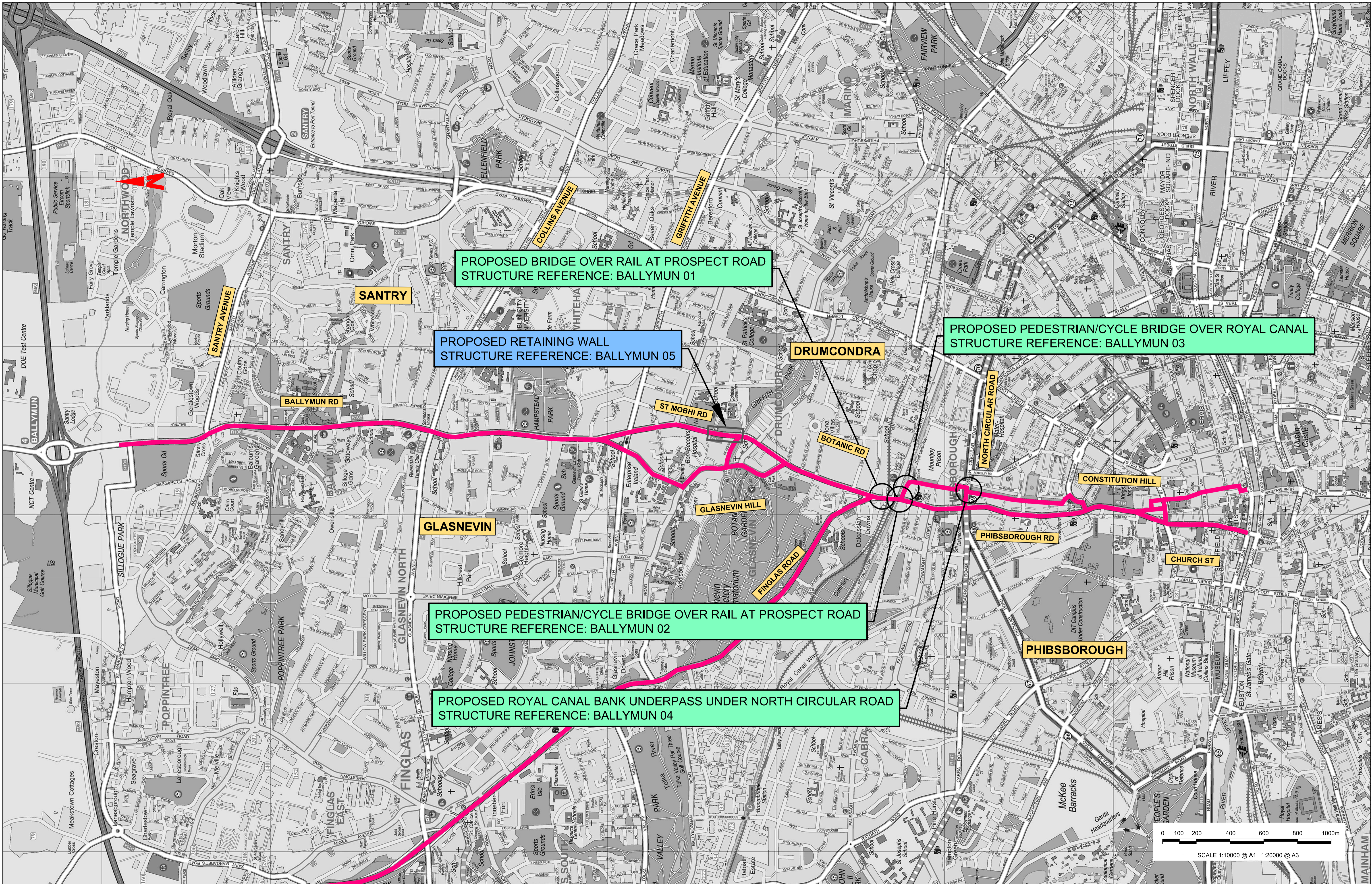
*View of railway tracks – location of proposed Ballymun 02*



*Existing retaining wall at the location of proposed Ballymun 02*

## **APPENDIX 2 DRAWINGS**





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| M01 | 13/05/2022 | JVG | EFD  | SMG   | ISSUE FOR PHASE 4: PLANNING |

**Client**  
**NTA**  
 Údarás Náisiúnta Iompair  
 National Transport Authority

**Engineering Designer**  
**IROD**  
 IROD & O'DONOVAN  
 TVPSA

**Programme Title**  
**BUSCONNECTS DUBLIN**  
**CORE BUS CORRIDORS INFRASTRUCTURE WORKS**

**Drawing Title**  
 CBC 03  
 BALLYMUN / FINGLAS TO CITY CENTRE CORE BUS CORRIDOR SCHEME  
 BRIDGES & RETAINING STRUCTURES  
 KEY PLAN

**Date** 13/05/2022 **Scale** 1:10000 @ A1  
 1:20000 @ A3 **Drawn** JVG **Checked** EFD **Approved** SMG

**Project Code** BCIDD **Originator Code** NTA **QMS Code**

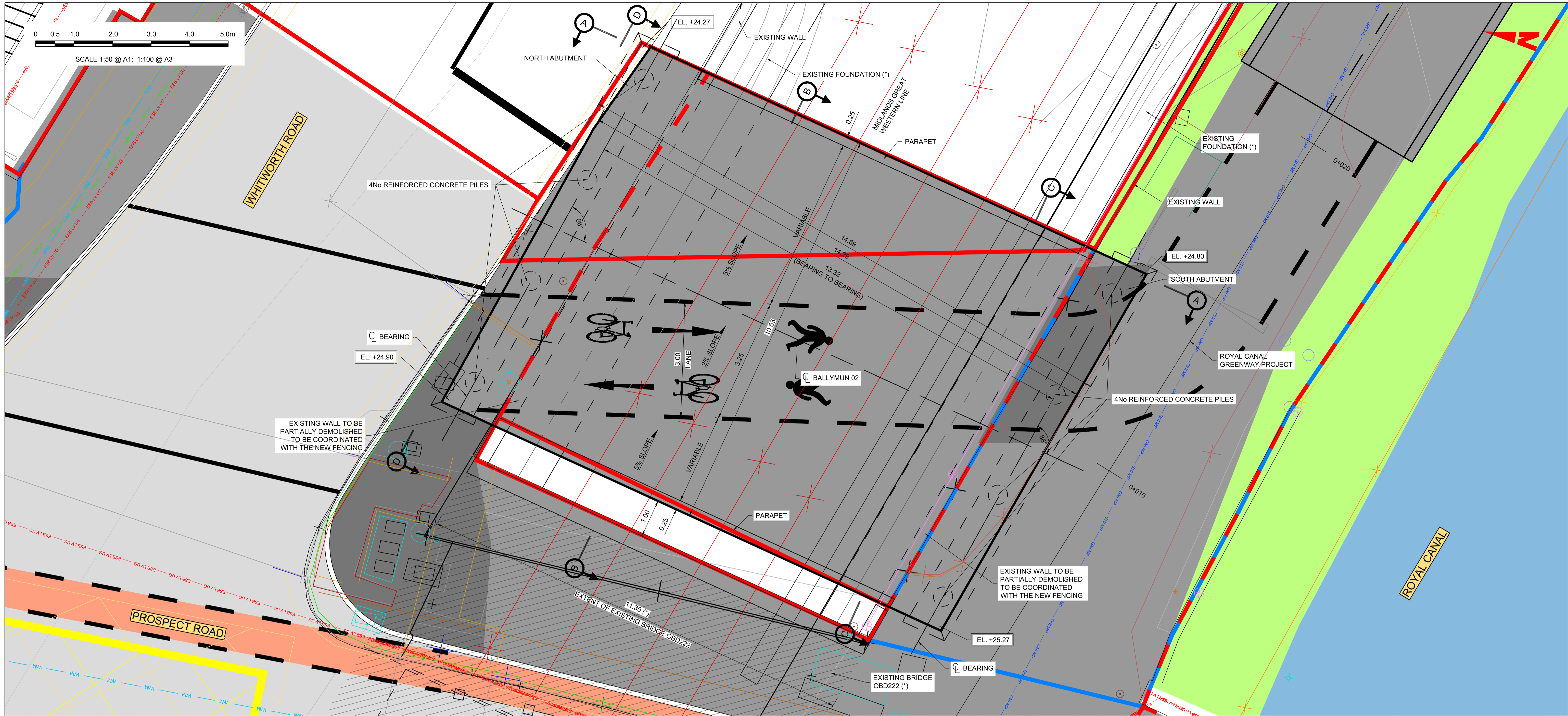
**Drawing File Name** BCIDD-ROT-STR\_KP-0304\_XX\_00-DR-SS-0001 **Sheet Number** 01 of 01 **Status** A **Rev** M01

| Rev | Date       | Dm  | Chkd | App'd | Description                 |
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|-----|------------|-----|------|-------|-----------------------------|
| M01 | 13/05/2022 | JVG | EFD  | SMG   | ISSUE FOR PHASE 4: PLANNING |

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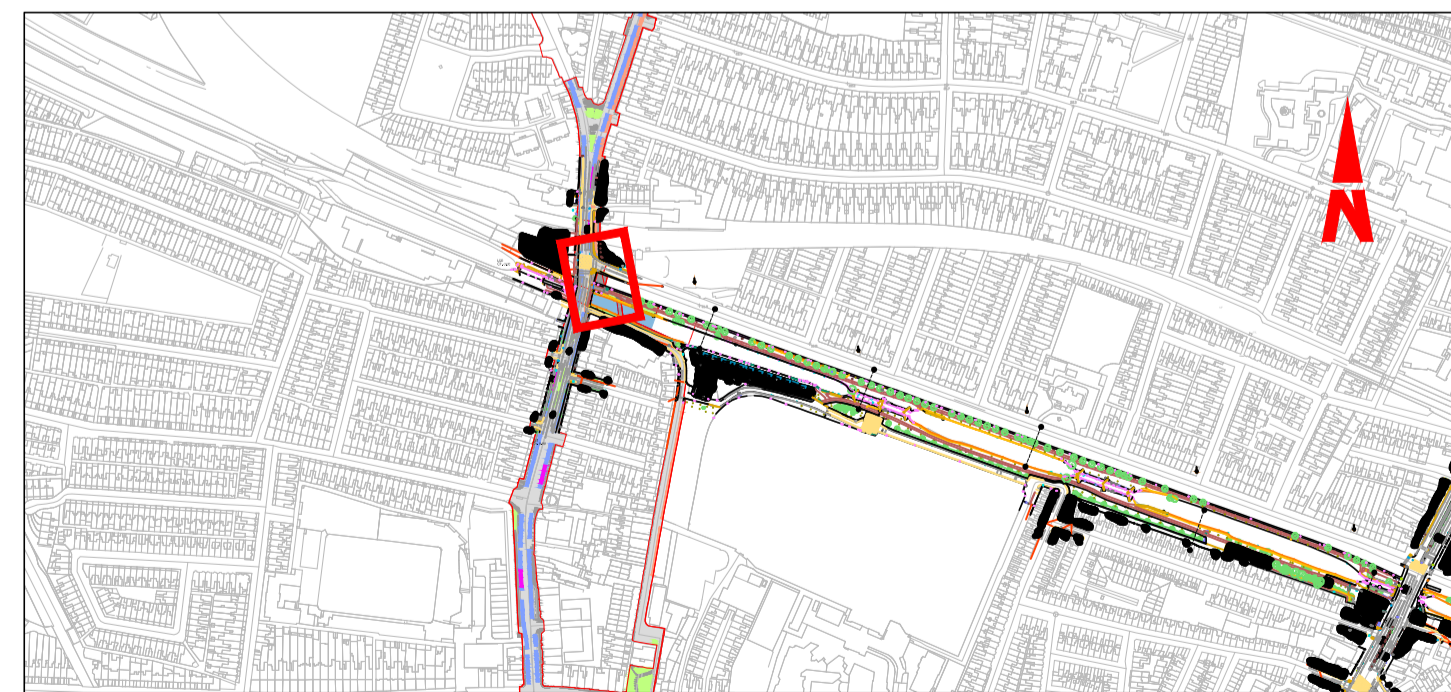


**GENERAL PLAN**  
SCALE 1:50

\*INFORMATION AND DIMENSIONS DRAWN FROM AVAILABLE DRAWINGS PROVIDED BY IANROD EIRANN.  
- OBD222 CROSS GUNDS BRIDGE DECK EXTENSION REPLACEMENT (SEPT 11)

**NOTES:**

- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
- THE GENERAL ARRANGEMENT IS INDICATIVELY ONLY.
- PRIOR TO THE EXECUTION OF THE WORKS, THE CONTRACTOR MUST CHECK ON SITE THE GEOMETRY AND DIMENSIONS OF THE EXISTING STRUCTURAL ELEMENTS. SHOULD THE CONTRACTOR FIND ANY DISCREPANCY WITH THOSE INDICATED IN THE DRAWINGS, THEN IT SHALL BE COMMUNICATE IMMEDIATELY TO THE PROJECT DIRECTOR BEFORE COMMENCING CONSTRUCTION WORKS.
- ALL BURIED SURFACES TO BE WATERPROOFED IN ACCORDANCE WITH THE TII SPECIFICATION FOR ROAD WORKS.
- FOUNDATION DETAILS SUBJECT TO CONFIRMATION OR RECEIPT OF G.I.
- SAFETY BARRIER IN ACCORDANCE WITH DN-REG-03034 .
- PRECAST BEAM STRENGTH:  
- C32/40 @ TRANSFER  
- C50/60 @ 28 DAYS
- SERVICES SHOWN INDICATIVELY ONLY. THE CONTRACTOR SHALL IDENTIFY THE SERVICES ON SITE PRIOR COMMENCING CONSTRUCTION WORKS.



**KEY PLAN**

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| M01 | 13/05/2022 | JVG | EFD   | SMG   | ISSUE FOR PHASE 4: PLANNING |

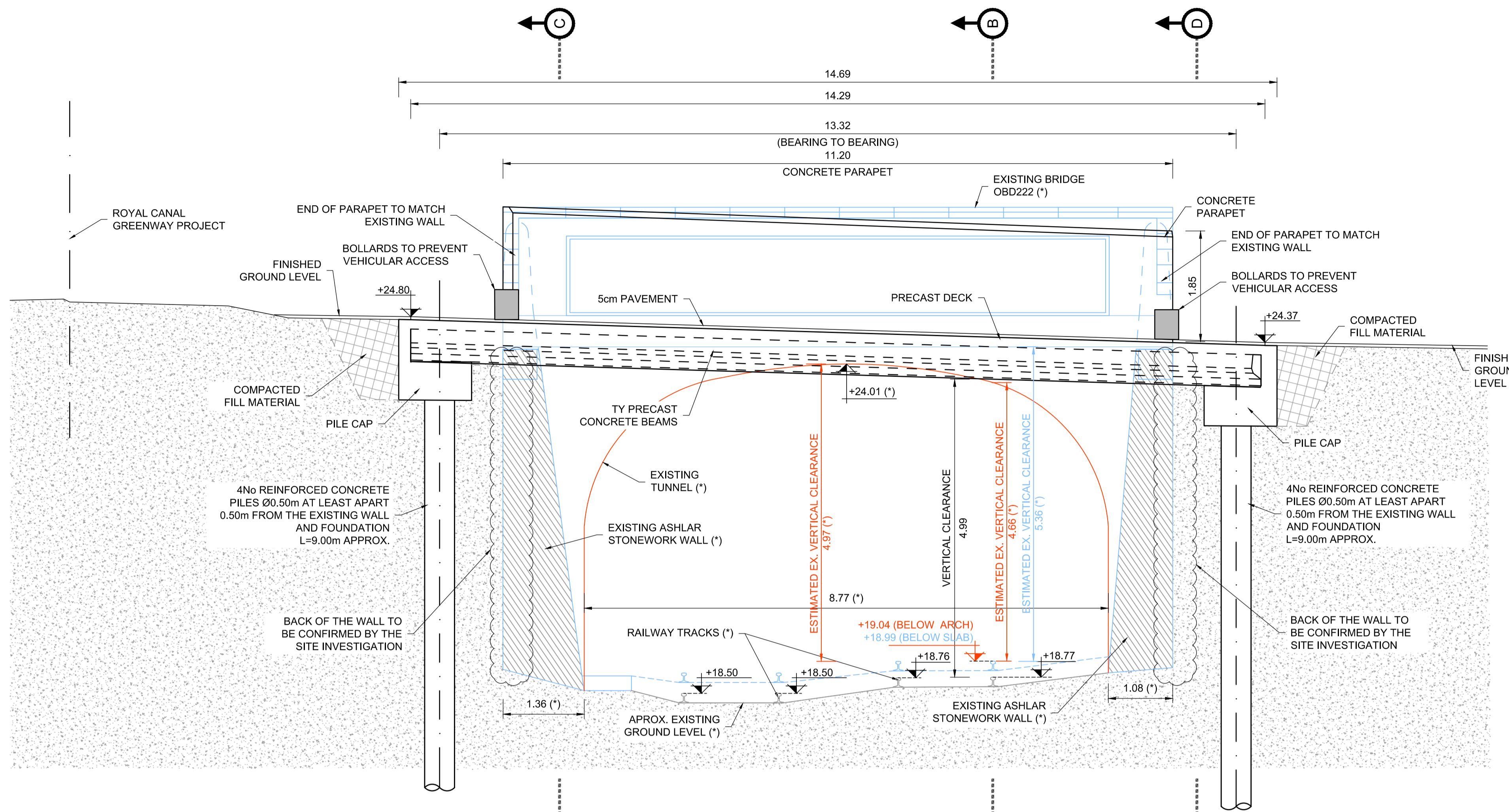
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|--|----------------------------------|--|----------------|-----------------|
| Client<br><b>NTA</b><br>Udarás Náisiúnta Iompair<br>National Transport Authority |                                  | Engineering Designer<br><b>IROD</b><br>TYPSA |                |                 |
| Date<br>13/05/2022   | Scale<br>1:50 @ A1<br>1:100 @ A3 | Drawn<br>JVG                                 | Checked<br>EFD | Approved<br>SMG |
| Project Code<br>BCIDD  | Originator Code<br>ROT           | QMS Code                                     |                |                 |

|   |                          |             |            |  |
|---|--------------------------|-------------|------------|--|
| Programme Title<br><b>BUSCONNECTS DUBLIN<br/>CORE BUS CORRIDORS INFRASTRUCTURE WORKS</b>                                      |                          |             |            |  |
| Drawing Title<br>BALLYMUN / FINGLAS TO CITY CENTRE CORE BUS CORRIDOR SCHEME<br>STRUCTURES<br>BALLYMUN 02. GENERAL ARRANGEMENT |                          |             |            |  |
| Drawing File Name<br>BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0003   | Sheet Number<br>01 of 02 | Status<br>A | Rev<br>M01 |  |

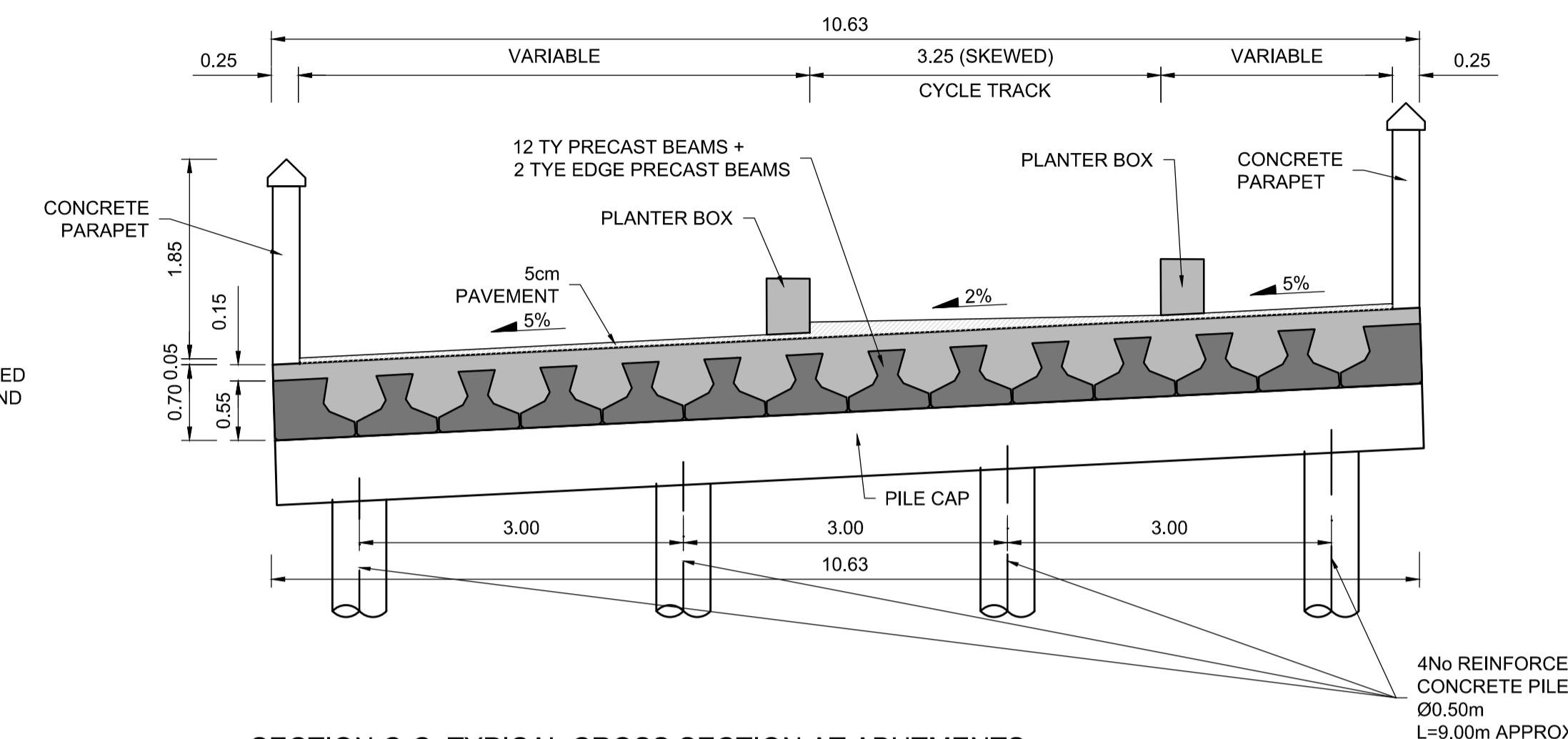
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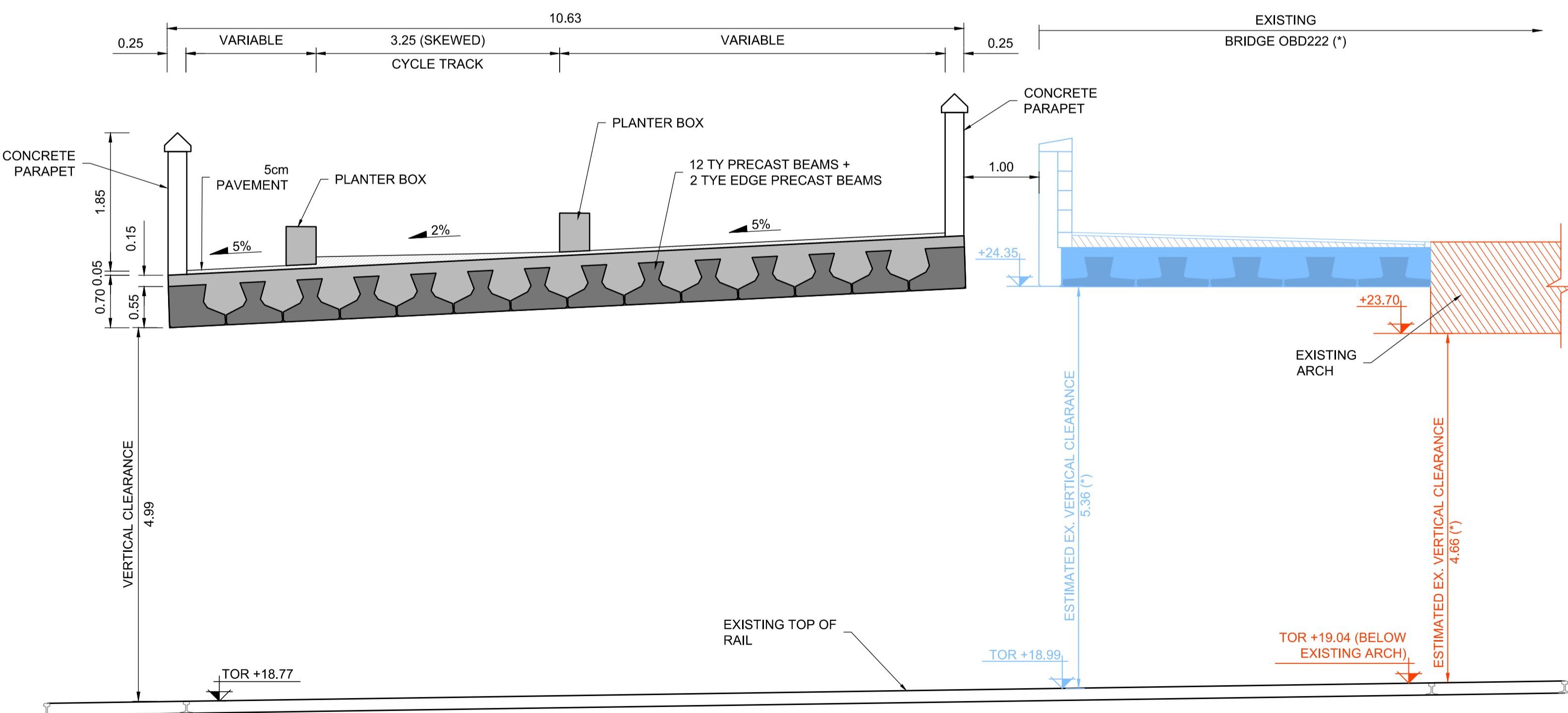




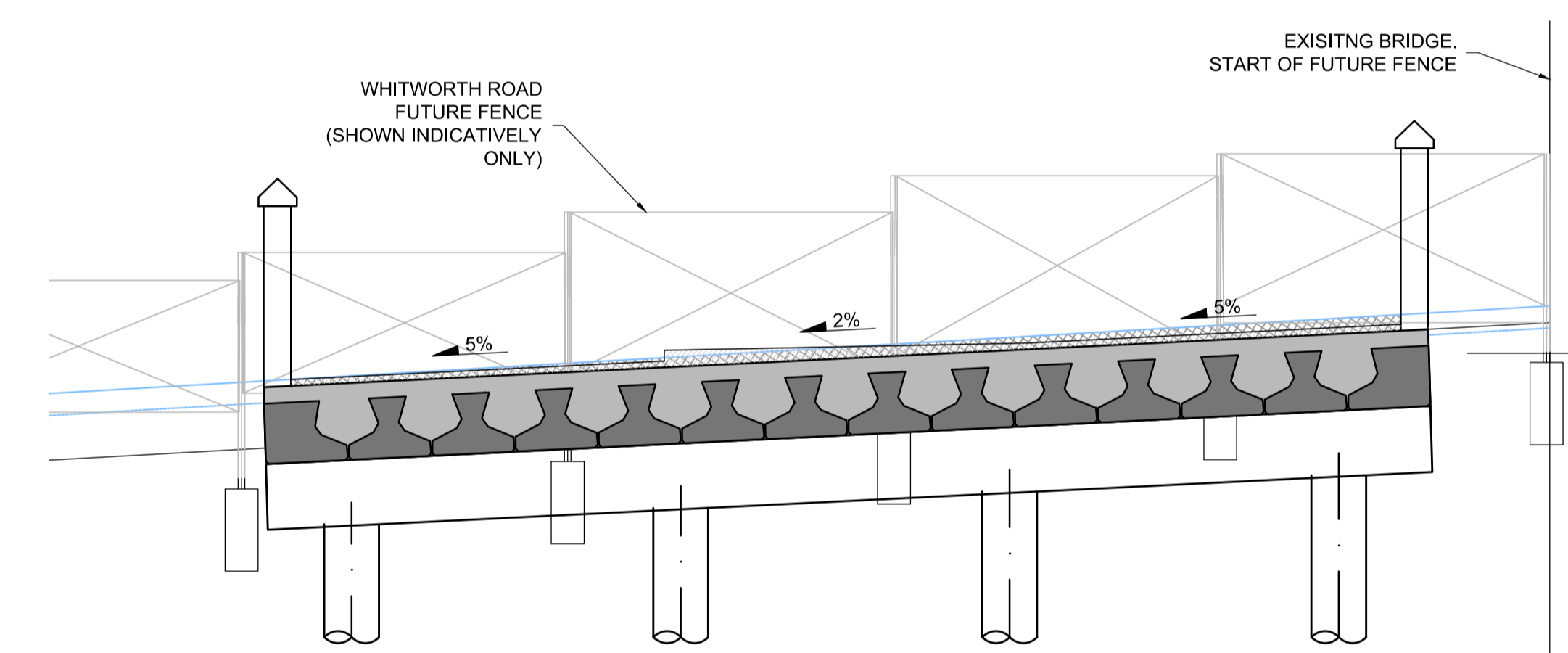
SECTION A-A. LONGITUDINAL SECTION  
SCALE 1:50



SECTION C-C. TYPICAL CROSS SECTION AT ABUTMENTS  
SCALE 1:50



SECTION B-B. TYPICAL CROSS SECTION  
SCALE 1:50



SECTION D-D. TYPICAL CROSS SECTION SHOWING PROPOSED FENCE  
SCALE 1:50

- NOTES:**
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
  2. THE GENERAL ARRANGEMENT IS INDICATIVELY ONLY.
  3. PRIOR TO THE EXECUTION OF THE WORKS, THE CONTRACTOR MUST CHECK ON SITE THE GEOMETRY AND DIMENSIONS OF THE EXISTING STRUCTURAL ELEMENTS. SHOULD THE CONTRACTOR FIND ANY DISCREPANCY WITH THOSE INDICATED IN THE DRAWINGS, THEN IT SHALL BE COMMUNICATE IMMEDIATELY TO THE PROJECT DIRECTOR BEFORE COMMENCING CONSTRUCTION WORKS.
  4. ALL BURIED SURFACES TO BE WATERPROOFED IN ACCORDANCE WITH THE TII SPECIFICATION FOR ROAD WORKS.
  5. FOUNDATION DETAILS SUBJECT TO CONFIRMATION OR RECEIPT OF G.I.
  6. SAFETY BARRIER IN ACCORDANCE WITH DN-REG-03034 .
  7. PRECAST BEAM STRENGTH:  
- C32/40 @ TRANSFER  
- C50/60 @ 28 DAYS
  8. SERVICES SHOWN INDICATIVELY ONLY. THE CONTRACTOR SHALL IDENTIFY THE SERVICES ON SITE PRIOR COMMENCING CONSTRUCTION WORKS.

\*INFORMATION AND DIMENSIONS DRAWN FROM AVAILABLE DRAWINGS PROVIDED BY IANROD EIRANN.  
- OB222 CROSS GUNDS BRIDGE DECK EXTENSION REPLACEMENT (SEPT 11)

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Client: **NTA**  
Udárás Náisiúnta Iompair  
National Transport Authority

Engineering Designer: **IROD**  
TYPSA

Date: 13/05/2022  
Scale: 1:50 @ A1, 1:100 @ A3  
Drawn: JVG  
Checked: EFD  
Approved: SMG

Project Code: BCIDD  
Originator Code: ROT  
QMS Code:

|  |                          |             |            |
|--|--------------------------|-------------|------------|
| Programme Title<br><b>BUSCONNECTS DUBLIN<br/>CORE BUS CORRIDORS INFRASTRUCTURE WORKS</b>                           |                          |             |            |
| Drawing Title<br>BALLYMUN / FINGLAS TO CITY CENTRE CORE BUS CORRIDOR SCHEME<br>STRUCTURES<br>BALLYMUN 02. SECTIONS |                          |             |            |
| Drawing File Name<br>BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0004  | Sheet Number<br>02 of 02 | Status<br>A | Rev<br>M01 |

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## **APPENDIX 3**

### **RELEVANT EXTRACTS FROM GROUND INVESTIGATION REPORT**

# 1. INTRODUCTION AND DESKTOP REVIEW

The existing site investigation information for the area has been taken from the Geological Survey of Ireland (GSI) website and the British Geological Survey (BGS) website, including the Quaternary and Bedrock Geology of Dublin and Depth of Bedrock digital maps.

The following selection of published papers has found to be of relevance to estimate the lithology and geotechnical properties:

- “Geotechnical properties of Dublin boulder clay”. Authors: Long, Michael M and Menkiti, Christopher O. Sept 2007, Géotechnique 57 (7): 595-611. Published by the ICE.
- Ground Investigation Report of the National Pediatric Hospital Project, Dublin. Roughan & O’Donovan Consulting Engineers, January 2015.

## 1.1 Overview of geotechnical conditions along the Project.

Quaternary sediments cover up to 80% of the Dublin region. Quaternary thicknesses at the city area range from 5 to 20m. Maximum thicknesses are recorded along a Tertiary channel occurring on the north shore of the River Liffey valley, reaching 45m, and along a channel-like feature running along the south margin of the Dodder valley Quaternary sediments, with a thickness of 15 to 25 m.

The most commonly occurring Quaternary deposit in the area has been termed locally as the Dublin Boulder Clay. It is a glacial deposit derived from the Lower Carboniferous Limestone and it is classified by its two main members: the Black Boulder Clay (BkBC) and the Brown Boulder Clay (BrBC). The Brown Boulder Clay is less consolidated and since it overlies the Black Boulder Clay it has been interpreted as its weathered upper layer.

The Upper Brown Boulder Clay (UBrBC) is the outcome of the oxidation of the clay particles in the top 2m to 3m of the UBkBC, resulting in a change in colour from black to brown and a lower strength material. It is usually described as thick stiff to very stiff brown, slightly sandy clay, with rare silt / gravel lenses and some rootlets, particularly in the upper metre.

The Upper Black Dublin Boulder Clay (UBkBC) is a very stiff, dark grey, slightly sandy clay, with some gravel and cobbles. It is typically 4 m to 12 m thick.

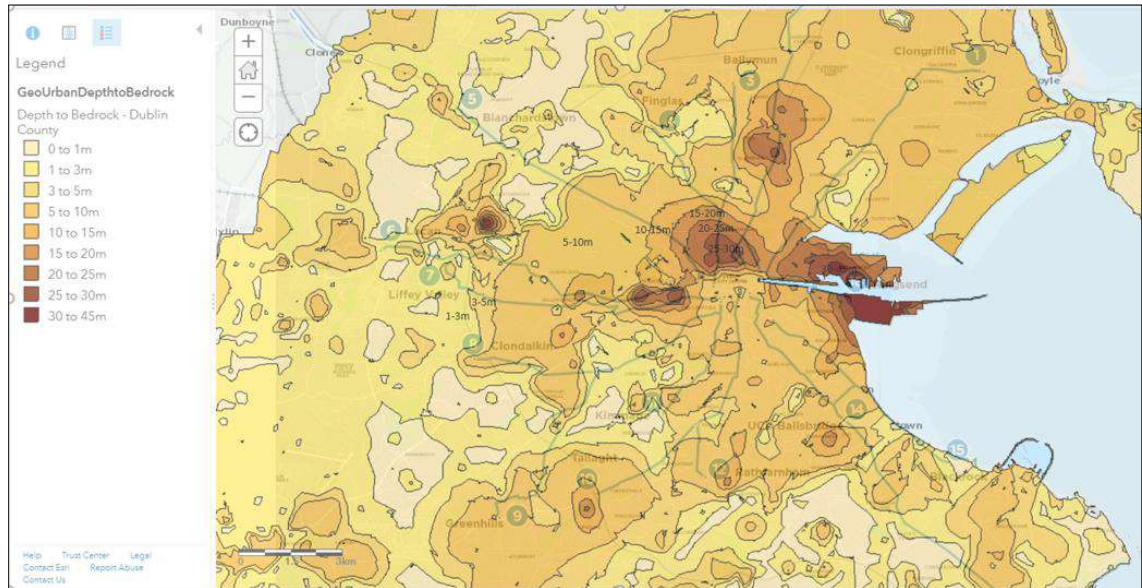
The Lower Brown Dublin Boulder Clay (LBrBC) exists as a 5 m to 9 m thick hard, brown, silty clay, with gravel, cobbles and boulders. It has previously been called the “sandy boulder clay” as it is similar to but siltier than the UBkBC above.

The Lower Black Dublin Boulder Clay (LBkBC) is a patchy layer of hard slightly sandy gravelly clay with an abundance of boulders. Its thickness does not exceed 4 m and is typically less than 2 m.

Note that not all four distinct formations of the Dublin Boulder Clay are always present. The upper two units though have been proven at all investigation sites across the city.

Bedrock close to the surface occurs mostly along the main riverbeds as well as the coastline and the higher ground areas of the Howth peninsula. The bedrock map of Ireland shows a wide variety of rock types which have originated at different periods of geological time. Underlying the project area consists of Lower Carboniferous Limestone of the Lucan Formation (Calp), which is typically described as a dark grey to black fine grained limestone.

The following image from the Geological Survey Ireland website shows the expected depth to Bedrock.



Depth of Bedrock from the Geological Survey Ireland website

The water pressures correspond to hydrostatic conditions with a groundwater table about 2m below ground level.

- *Summary of Desktop Review.*

The following preliminary lithology and geotechnical properties has been assumed based on the Desktop Review:

| Layer                           | Depth      | Thickness | Undrained shear strength, $c_u$ (kPa) |
|---------------------------------|------------|-----------|---------------------------------------|
| Made ground / Urban / Alluvium  | 0 to 1 m   | 1         | 0                                     |
| Upper Brown Boulder Clay, UBrBC | 1 to 3 m   | 2         | 80                                    |
| Upper Black Boulder Clay, UBkBC | 3 to 10 m  | 7         | 200                                   |
| Lower Brown Boulder Clay, LBrBC | 10 to 18 m | 8         | 400                                   |
| Lower Black Boulder Clay, LBkBC | 18 to 22 m | 4         | 600                                   |
| Bedrock                         | >22 m      | N/A       | >600                                  |

The expected depth to bedrock has been included in Section 2.

## 2. SUMMARY OF GROUND INVESTIGATION CONTRACT

At the date of this document, there are two GI contracts underway. Lot 1, which includes projects C and D , and Lot 2, which covers A and B projects.

Proposed ground investigation works aim to assess the geology of the site and determine the ground properties and conditions to enable the design of Bus Connects Core Bus Corridors. The GI provides for boreholes, trial pits, dynamic probes, standpipes/piezometer installation and monitoring, in-situ testing, geotechnical and environmental laboratory testing and preparation of a factual report, all in accordance with the “*Specification and Related Documents for Ground Investigation in Ireland*”.

At the Project D schemes (Ballymun/Finglas to City Centre, Kimmage to City Centre and Ringsend to City Centre), there are 21 proposed investigation points, consisting of Cable Percussion (CP) and Rotary Core (RC) boreholes as well as few windowless dynamic samples (WS) in restricted space areas. The location of these points can be found in the form of drawings in the “*BusConnects Detailed Ground Investigation – Stage 1 – LOT 1*”, February 2020.

In situ tests mainly include standard penetration tests. Laboratory tests mainly include particle size distribution, Atterberg limits, density and moisture content to identify soils and direct shear strength, triaxial CU or UU and uniaxial compression to determine the strength of the soil/rock.

For more details see the “*BusConnects Detailed Ground Investigation – Stage 1 – LOT 1*”, February 2020.

For the Ringsend to City Centre Core Bus Corridor Scheme, the following investigation points have been proposed:

| <b>Borehole Ref.</b> | <b>Expected Depth to Bedrock</b> | <b>Borehole Depth (m) – Cable Percussion</b> | <b>Borehole Depth (m) – Rotary Core</b> |
|----------------------|----------------------------------|--|---|
| R3-CP01              | 15-20m                           | 15   | -                                       |
| R3-CP02              | 15-20m                           | 15   | -                                       |
| R3-CP03              | 15-20m                           | 15   | -                                       |
| R3-CP04              | 15-20m                           | 15   | -                                       |
| R3-CP05              | 15-20m                           | 15   | -                                       |
| R3-CP06              | 15-20m                           | 15   | -                                       |
| R3-CP07              | 15-20m                           | 15   | -                                       |
| R3-CP08              | 15-20m                           | 15   | -                                       |
| R3-CP09              | 20-25m                           | 15   | -                                       |
| R3-CP10              | 20-25m                           | 20   | -                                       |
| R3-CP11              | 20-25m                           | 20   | -                                       |
| R3-CP12              | 20-25m                           | 20   | -                                       |
| R3-CP13              | 20-25m                           | 20   | -                                       |
| R3-CP14              | 20-25m                           | 15   | -                                       |

### 3. SUMMARY OF FACTUAL REPORT

The following factual report was issued as part of the Lot 1 GI:

Detailed Stage 1 Lot 1 Route 3. July 2021 Completed investigation points are as summarised below:

| <b>Structure</b> | <b>Borehole Ref.</b> | <b>Expected Depth to Bedrock</b> | <b>Borehole Depth (m) – Cable Percussion</b> | <b>Borehole Depth (m) – Rotary Core</b> | <b>Notes</b> |
|------------------|----------------------|----------------------------------|--|---|--------------|
| Ballymun 01      | R3-CP01              | 15-20m                           | -  | -                                       | Cancelled    |
|                  | R3-CP02              | 15-20m                           | -  | -                                       | Cancelled    |
| Ballymun 02      | R3-CP03              | 15-20m                           | 7.1  | -                                       |              |
| Ballymun 02&03   | R3-CP04              | 15-20m                           | -  | -                                       | Cancelled    |
|                  | R3-CP05              | 15-20m                           | -  | -                                       | Cancelled    |
|                  | R3-CP06              | 15-20m                           | -  | -                                       | Cancelled    |
| Ballymun 03      | R3-CP07              | 15-20m                           | 6.0  | -                                       |              |

| Structure   | Borehole Ref. | Expected Depth to Bedrock | Borehole Depth (m) – Cable Percussion | Borehole Depth (m) – Rotary Core | Notes   |
|-------------|---------------|---------------------------|---------------------------------------|----------------------------------|---|
|             | R3-CP08       | 15-20m                    | 4.8                                   | -                                | Changed to WS03 (Drive-in Windowless Sampler) |
| Ballymun 04 | R3-CP09       | 20-25m                    | -                                     | 20                               | Changed to RC01                               |
|             | R3-CP10       | 20-25m                    | -                                     | 20                               | Changed to RC02                               |
|             | R3-CP11       | 20-25m                    | -                                     | 20                               | Changed to RC03                               |
|             | R3-CP12       | 20-25m                    | 1.5                                   | -                                | Changed to WS01 (hand window sample)          |
|             | R3-CP13       | 20-25m                    | 1.0                                   | -                                | Changed to WS02 (hand window sample)          |
|             | R3-CP14       | 20-25m                    | 9.0                                   | -                                |   |

In addition, the following reports have been received to complete the GI performed for Lot1:

- GIR New Metro North (Glasnevin). March 2018. This includes 2 boreholes located among performed boreholes in Route 3.
- MetroLink Phase 4 GI. October 2020. This includes 2 boreholes and 3 inspection pits located among performed boreholes in Route 3.

The GI works undertaken comprise 3 No. Cable Percussion Boreholes to a maximum depth of 9.0m BGL, 3 No. Window Samples and 3 No. Rotary Core Boreholes to a maximum depth of 20.0m BGL; 58 SPT tests at 1 metre intervals alternating with disturbed samples, 2 No. Dynamic probeholes and 4 GWL recordings.

18 disturbed samples were taken at each change of soil consistency or between SPT tests and 1 undisturbed sample (UT100) where ground conditions permit. Geotechnical testing consisted of 19 moisture content, 8 Atterberg limits and 10 Particle Size Distribution. Soil strength testing consisted of 1 UU Triaxial Test, 2 Vane tests and 2 Shear Box.

Environmental & Chemical testing consisted of 23 Suite E samples and 2 PH and Organic matter content tests.

From Glasnevin and MetroLink Phase 4 GI works, 3No. Inspection Pit, 2 No. Cable Percussion Boreholes followed by Rotary Core Boreholes to a maximum depth of 40m BGL, 2 No. Rotary Core Boreholes to a maximum depth of 35.4m BGL; 40 SPT tests at 1 metre intervals alternating with disturbed samples and 6 GWL recordings.

40 disturbed samples were taken at each change of soil consistency or between SPT tests. Geotechnical testing consisting of 40 moisture content, 25 Atterberg limits and 24 Particle Size Distribution. Soil strength testing consisted of 9 CU Triaxial Tests, 3 CU Triaxial Tests with PWP and 2 Shear Box. Rock strength testing included 12 Unconfined Compressive Strength (UCS) testing, 13 Point Load Tests and 3 Brazilian Tests.



## **4. OVERVIEW OF SOIL CLASSIFICATION**

### **4.1 Made ground**

Made Ground deposits were encountered either from the surface or beneath the Topsoil/Surfacing and were present to depths of between 1.40m and 6.50m BGL.

Made ground deposits were described generally as either dark grey / brown, sandy gravelly Clay with occasional cobbles or greyish brown clayey sandy Gravel. In some investigation holes the made ground contained occasional fragments of concrete, ceramic, red brick metal, rubber and wood.

Soil classifies as CLAY of intermediate to high plasticity, with a plasticity index ranging between 17% and 40%.

The Particle Size Distribution tests confirm percentages of sands and gravels ranging between 10% and 42% and 24% and 47%, respectively.

PH and total organic carbon (TOC) were determined at boreholes R03-CP03 and C03-CP08, at 1m and 0.5m depth respectively. Organic matter content (OMC) was estimated from TOC. Average values of PH 7.8, TOC 2.7 % w/w C and OMC 4.6 % w/w were obtained.

Samples R03-WS02 and R03-CP14 showed high values (>6% w/w C) of total organic carbon at Suite E tests. Asbestos was detected at 0.5m depth at borehole R03-CP08.

### **4.2 Cohesive deposits**

Cohesive deposits were encountered beneath the Made Ground and were described typically as brown sandy gravelly CLAY or grey / dark grey sandy gravelly CLAY with occasional cobbles and boulders.

The strength of the cohesive deposits typically increased with depth. In the majority of the exploratory holes, it was firm below 3.0m BGL, stiff below 5.0m BGL and very stiff below 7.0m BGL.

The geotechnical testing carried out on recovered soil samples generally confirm the descriptions on the logs and classified the deposits as CLAY of low, with a plasticity index ranging between 14% and 17%.

The Particle Size Distribution tests confirm generally well-graded deposits with percentages of sands and gravels ranging between 14% and 31% and 20% and 56%, respectively, with average values of 22% of sand and 34% of gravel.

### **4.3 Bedrock**

The rotary core boreholes recovered weak to medium strong thinly laminated to thickly bedded grey/dark grey fine-grained LIMESTONE locally interbedded with medium strong dark grey fine grained laminated MUDSTONE.

The depth to rock is of 18.5m BGL. RQD values are very poor but presumably because they belong to the upper weather zone.

## **5. SUMMARY OF GROUND INVESTIGATION INTERPRETATIVE REPORT**

For Ballymun/Finglas to City Centre CBC scheme, the following lithology and soil strength properties has been assumed based on the GI findings:

| Layer   | Depth (m)    | SPT   | Undrained shear strength, $c_u$ (kPa) |
|---|--------------|-------|---------------------------------------|
| Topsoil   | 0 to 0.5 m   | -     | -                                     |
| Made Ground: Gravel / Brown Clay (possibly UBrBC) / Grey Clay | 0.5 to 4m    | 8     | 50                                    |
| Stiff / Very stiff Grey or Dark Grey Boulder Clay (UBkBC)     | 4 to 12.5    | 20-50 | 250                                   |
| Very stiff Brown Boulder Clay (LBrBC)                         | 12.5 to 17.5 | 50    | 325                                   |
| Gravel  | 14 to 18.5   | 50    | 325                                   |
| Limestone   | >18.5        | -     | -                                     |

- 2 Vane tests at Made Ground layer UBrBC, defined as brown slightly sandy slightly gravelly Clay have shown Peak shear strength values of about 20 KPa.
- 1 undrained triaxial UU test at UBrBC layer, defined as stiff brown slightly sandy gravelly Clay, has given a shear strength of about 80 KPa.
- 2 Shear Box tests at UBkBC layer, defined as slightly sandy slightly gravelly Clay, shown angles of peak shearing resistant between 32 and 36 degrees and effective cohesion between 5 and 15 kPa.

From Glasnevin project 9 triaxial CU tests. Layers of UBkBC and LBrBC shown values between 600 and 700 kPa. Also 1 triaxial CU from Thameslink project on LBrBC showing a value of 800 kPa.

From Metrolink 2 Shear Box tests, one at Made Ground layer showing an angle of peak shearing resistant of 29 degrees and effective cohesion of 6 kPa, and another at the bottom Gravel layer with an angle of peak shearing resistant of 34 degrees and no effective cohesion.

The geological geotechnical ground profile can be found at Appendix 1.

Ground parameters from in situ and lab tests are shown in Appendix 2.

## 6. HIDROGEOLOGY

Groundwater was noted during the investigation although the exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime. However, standpipes were installed to allow the equilibrium groundwater level to be determined.

Groundwater levels recorded during the GI works are summarized below:

| Date:   | 20/4/21 | 16/6/21 |
|---------|---------|---------|
| R3-CP01 | -       | -       |
| R3-CP02 | -       | 10.03   |
| R3-CP03 | -       | -       |
| R3-CP04 | -       | -       |
| R3-CP05 | -       | -       |
| R3-CP06 | -       | -       |
| R3-CP07 | 1.29    | 1.27    |
| R3-CP08 | -       | -       |
| R3-CP09 | -       | -       |
| R3-CP10 | -       | -       |
| R3-CP11 | -       | -       |
| R3-CP12 | -       | -       |
| R3-CP13 | -       | -       |
| R3-CP14 | -       | 1.25    |

|                 |                |                |
|-----------------|----------------|----------------|
| <b>Date:</b>    | <b>9/2/18</b>  | <b>14/2/18</b> |
| Glasnevin BH01  | 9.80           | 9.80           |
| Glasnevin BH02A | 10.10          | 11.25          |
| <b>Date:</b>    | <b>30/7/20</b> | <b>31/7/20</b> |
| Metrolink GBH01 | 8.97-9.06      | -              |
| Metrolink GBH02 | -              | 10.47-11.2     |

## 7. GEOTECHNICAL INPUT TO STRUCTURES

The following table shows the expected depth to bedrock, based on the data from the Desktop Review, as well as the depth of the encountered bedrock in the GI undertaken.

Note that most of the boreholes were terminated at a shorter length, before encountering the bedrock strata. Therefore, the expected depth to bedrock could not be confirmed.

| Structure             | Permanent loads / Variable loads (KN) | Borehole Ref. | Expected Depth to Bedrock | Depth to encountered Bedrock | Depth to N <sub>SPT</sub> values of Refusal | Piles estimated length (m) |
|-----------------------|---------------------------------------|---------------|---------------------------|------------------------------|---|----------------------------|
| Ballymun 01<br>D=0.5m | 454 / 120                             | -             | 15-20m                    | -                            | -   | 9.5                        |
| Ballymun 02<br>D=0.5m | 424 / 179                             | R3-CP03       | 15-20m                    | -                            | 5m  | 8.5                        |
| Ballymun 03<br>D=0.5m | 82 / 169                              | R3-CP07       | 15-20m                    | -                            | 5m  | 5.5                        |
|                       |                                       | R3-WS03       | 15-20m                    | -                            | 5m  | 5.5                        |
| Ballymun 04<br>D=0.8m | 298 / 425                             | R3-RC01       | 20-25m                    | 18.5m                        | 9.5m  | 10.0                       |
|                       |                                       | R3-RC02       | 20-25m                    | 18.5m                        | 6.5m  | 7.0                        |
|                       |                                       | R3-RC03       | 20-25m                    | 18.5m                        | 8m  | 8.5                        |
|                       |                                       | R3-WS01       | 20-25m                    | -                            | -   | -                          |
|                       |                                       | R3-WS02       | 20-25m                    | -                            | -   | -                          |
|                       |                                       | R3-CP14       | 20-25m                    | -                            | 5m  | 6.0                        |
| Ballymun 04<br>D=0.5m | 298 / 425                             | R3-RC01       | 20-25m                    | 18.5m                        | 9.5m  | 14.5                       |
|                       |                                       | R3-RC02       | 20-25m                    | 18.5m                        | 6.5m  | 12.0                       |
|                       |                                       | R3-RC03       | 20-25m                    | 18.5m                        | 8m  | 12.0                       |
|                       |                                       | R3-WS01       | 20-25m                    | -                            | -   | -                          |
|                       |                                       | R3-WS02       | 20-25m                    | -                            | -   | -                          |
|                       |                                       | R3-CP14       | 20-25m                    | -                            | 5m  | 11.0                       |

A preliminary number of the characteristic compressive resistance of piles has been obtained following the alternative procedure in accordance with the Eurocode 7 and the Irish National Annex. This procedure makes use of the ground parameters (such as the undrained shear strength,  $c_u$ ) to estimate the shaft and base compressive resistance of piles.

$c_u$  values have been derived from SPT values obtained in each borehole following the SPT- $c_u$  relationship proposed by Stroud and Butler (1975). Calcs can be found at Appendix 3.

For 0.5m diameter driven piles embedded in the Dublin boulder clay (except for Ballymun 04, where piles diameters are 0.8m), the estimated piles length that satisfies the ULS is as detailed in the table above.

At Ballymun 04 a retaining wall is proposed, for which the following geotechnical parameters derived from the ground investigation works can be used for the design

| Route 3<br>Ballymun<br>04           | Depth<br>(m)       | Dry<br>weight<br>(KN/m <sup>3</sup> ) | Undrained<br>shear<br>strength,<br>c <sub>u</sub> (kPa) | Young's<br>modulus<br>E (MPa) | Undrained<br>Young's<br>modulus<br>(MPa) | Friction<br>angle<br>φ' (°) | Cohesion<br>c' (KPa) | Poisson's<br>coefficient<br>(-) | Earth<br>pressure<br>coefficient<br>at rest K <sub>0</sub><br>(-) | Horizontal<br>spring<br>stiffness<br>(KN/m <sup>3</sup> ) |
|-------------------------------------|--------------------|---------------------------------------|---|-------------------------------|--|-----------------------------|----------------------|---------------------------------|---|---|
| Made<br>Ground                      | 0 to<br>4.5m       | -                                     | 50  | 25                            | -  | 28                          | 0                    | 0.3                             | 1   | 3,500 –<br>5,000  |
| Grey<br>Boulder<br>Clay<br>(UBkBC)  | 4.5 to<br>12.5     | 22.5                                  | 250   | 80                            | 100                                      | 30                          | 0                    | 0.2                             | 1.3   | 17,000 –<br>20,000  |
| Brown<br>Boulder<br>Clay<br>(LBrBC) | 12.5<br>to<br>17.5 | -                                     | 325   | -                             | 120                                      | 35                          | 0                    | 0.2                             | 1.3   | 20,000 –<br>25,000  |
| Mudstone                            | 17.5<br>to<br>19.5 | -                                     | 325   | -                             | -  | -                           | -                    | -                               | -   | -   |
| Limestone                           | >19.5              | 25                                    | 500   | 800                           | 1000                                     | 45                          | 0                    | .                               | -   | 35,000 –<br>37,500  |

## **APPENDIX 4 OTHER RELEVANT DOCUMENTATION/REPORTS**

(Not used)