Appendix J1
Preliminary Design Report
– Structure 01

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 01 bridge

Preliminary Design Report

Reference	BCIDD-ROT-STR-ZZ-0003-XX-00-RP-CB-0015
Revision	L02
Date	May 2022

Submitted by

Signed:	______________________
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Date:	23/05/2022

Structures Section confirmation of consultation:

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Name:	______________________
Position:	______________________
Date:	______________________

BUSCONNECTS INFRASTRUCTURE DELIVERY – PROJECT D

PRELIMINARY DESIGN REPORT – BALLYMUN 01

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1. INTRODUCTION

1.1 Brief

Roughan & O'Donovan-TYPSA have prepared this report for the National Transportation Authority (NTA) for the design of the Ballymun 01 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 01 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, since it is not practicable to fit cycle and pedestrian facilities in addition to bus facilities through the existing bridge (OBO11) 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-0011 – Ballymun01 Option Report
- BCID-ROT-ERW-GI_0304-RP-CR-0001 – Geotechnical Interpretive Report: Ballymun/Finglas Corridors

2. SITE & FUNCTION

2.1 Site Location

The Ballymun 01 bridge is situated next to the existing bridge over the railway (OBO11) at Prospect Road. The site location plan is included in Appendix 2.

2.2 Function of the Structure

The objective of the new bridge next to the existing one is to increase the width of the carriageway at this particular location. This allows the unimpeded passage of the cycle lane and footpaths at Prospect Road.

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 24.30m and at 24.11m at the north and south 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 are shown in Appendix 2.

Horizontal Alignment

The Prospect Road is straight across the bridge.

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 1.2%.

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 01 Cross-Section

Parameter	Value
Parapet Upstand	0.25 m
Footpath	3.00 m
Cycle track	3.00 m
Out-to-Out Width	**6.25 m**

2.7 Existing Underground and Overground Services

A list of the existing services located in close proximity to the Ballymun 01 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

There appear to be no telecommunications lines, however, these 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 01 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.

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 follow the requirements of IÉ to increase the existing vertical clearance under bridge OBO11.

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 bridge is a single span bridge of 16m length (c/c bearings) with a deck straight in plan and has a skew angle of approximately 7 degrees.

3.3.3 Minimum Headroom Provided

A minimum vertical clearance between the deck soffit and the proposed finished ground level is set at 4.90m. IÉ requested to increase the existing clearance under OBO11 of 4,45 metres as much as possible.

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. Full 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 caps, where the precast beams will be supported. 3No. 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 portal 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-REQ-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 OBO11 bridge.

3.3.10 Drainage

The proposed longitudinal gradient of the road is a 1.20% 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 water.

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".

As it is considered as an extension of the existing bridge, temporary edge protection will be required on the existing bridge.

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^3
- Structural steelwork 77 kN/m^3
- Pavement 23 kN/m^3
- Backfill to structures 20 kN/m^3

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

The structure will be designed for IS EN 1991-2 live load models LM1, LM2 and LM4 as defined in TII IAN 02/11 (including Amendment No. 1 February 2012). Traffic surcharge loading to be applied behind the bridge abutment and wingwalls will be calculated in accordance with IS EN 1991-2.

Ballymun 01 is bridge designed for pedestrian and cyclist. However, due to it is a widening of an existing road bridge. It has been considered appropriate to design it for normal traffic load as there is not any physical barrier between the existing bridge and the proposed Ballymun 01.

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/m² 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.

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

Fatigue Load Model - Fatigue load models shall be in accordance with IS EN 1991-2:2003 Cl. 4.6 and specifically Load Models 1 & 2. Fatigue Load Models 3, 4 and 5 will not be used.

Fatigue loading shall not be less than the requirements of NA to IS EN 1991-2, Table NA.4 for the type of road.

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”.

Due to the proximity between Ballymun 01 & 02, it was decided to carry out just the site investigation at Ballymun 02. 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)

Appendix 2 – Site Location and Drawings

- BCIDD-ROT-STR_KP-0304_XX_00-DR-SS-0001 – CBC 03- Ballymun/Finglas to City Centre Core Bus Scheme – Bridges and Retaining Structures – Key Plan
- BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0001 – Ballymun 01 General Arrangement.
- BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0002-O1 – Ballymun 01. 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

Existing Bridge (OBO11) and Parapet to be removed for bridge widening – Looking from North side

Existing Bridge (OBO11) and Parapet to be removed for bridge widening – Looking from South side

Footpath and east bridge parapet

Existing retaining wall to be partially demolished due to the new bridge

APPENDIX 2
DRAWINGS

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Project Ireland 2040
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Rev	Date	Drn	Chk'd	App'd	Description
M01	13/05/2022	JVG	EFD	SMG	ISSUE FOR PHASE 4: PLANNING

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: ROD ROUGHAN & O'DONOVAN TYPSA

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

Project Code	Originator Code	QMS Code	Drawing File Name	Sheet Number	Status	Rev
BCIDD	NTA		BCIDD-ROT-STR_KP-0304_XX_00-DR-SS-0001	01 of 01	A	M01

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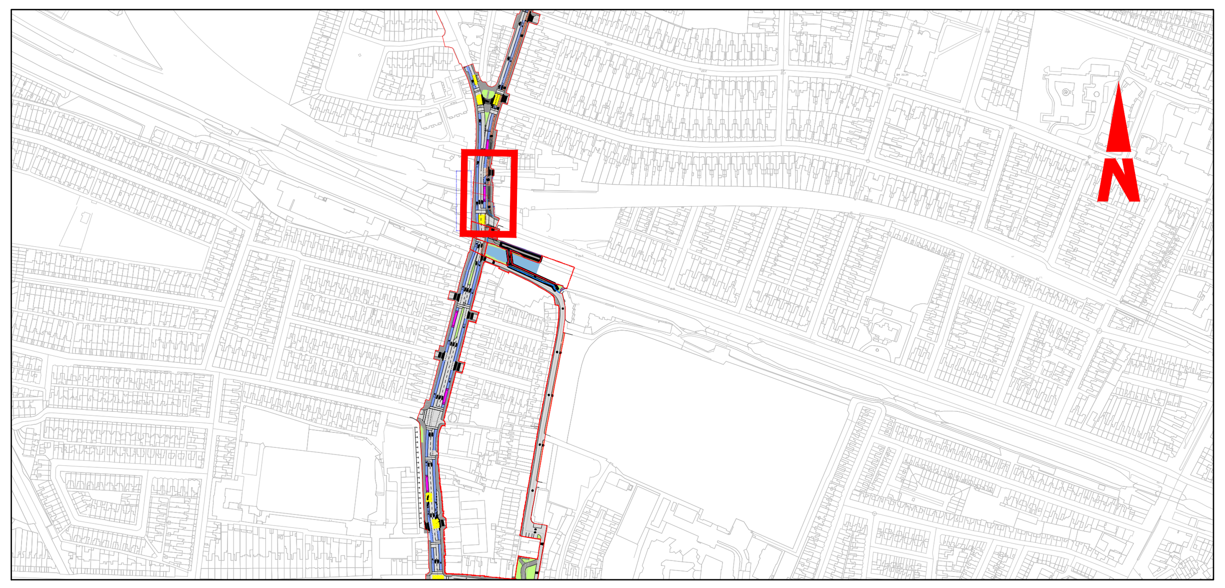
GENERAL PLAN
SCALE 1:50

*INFORMATION AND DIMENSIONS DRAWN FROM AVAILABLE DRAWINGS PROVIDED BY IANROD EIRANN.

- GASNEVIN ROAD OVERBRIDGE DRAWINGS (SEPT 1894)
- RENEWAL OF PARAPET CROSSGUNS BRIDGE DRAWINGS (26-OCT-1978)

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:
   - C45/55 @ TRANSFER
   - C57/70 @ 28 DAYS
8. SERVICES SHOWN INDICATIVELY ONLY. THE CONTRACTOR SHALL IDENTIFY THE SERVICES ON SITE PRIOR COMMENCING CONSTRUCTION WORKS.



KEY PLAN

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Rev	Date	Drn	Chk'd	App'd	Description
M01	13/05/2022	JVG	EFD	SMG	ISSUE FOR PHASE 4: PLANNING

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: ROD TYPSA

Programme Title: BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS

Drawing Title: BALLYMUN / FINGLAS TO CITY CENTRE CORE BUS CORRIDOR SCHEME STRUCTURES BALLYMUN 01. GENERAL ARRANGEMENT

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

Project Code	Originator Code	QMS Code	Drawing File Name	Sheet Number	Status	Rev
BCIDD	ROT		BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0001	01 of 02	A	M01

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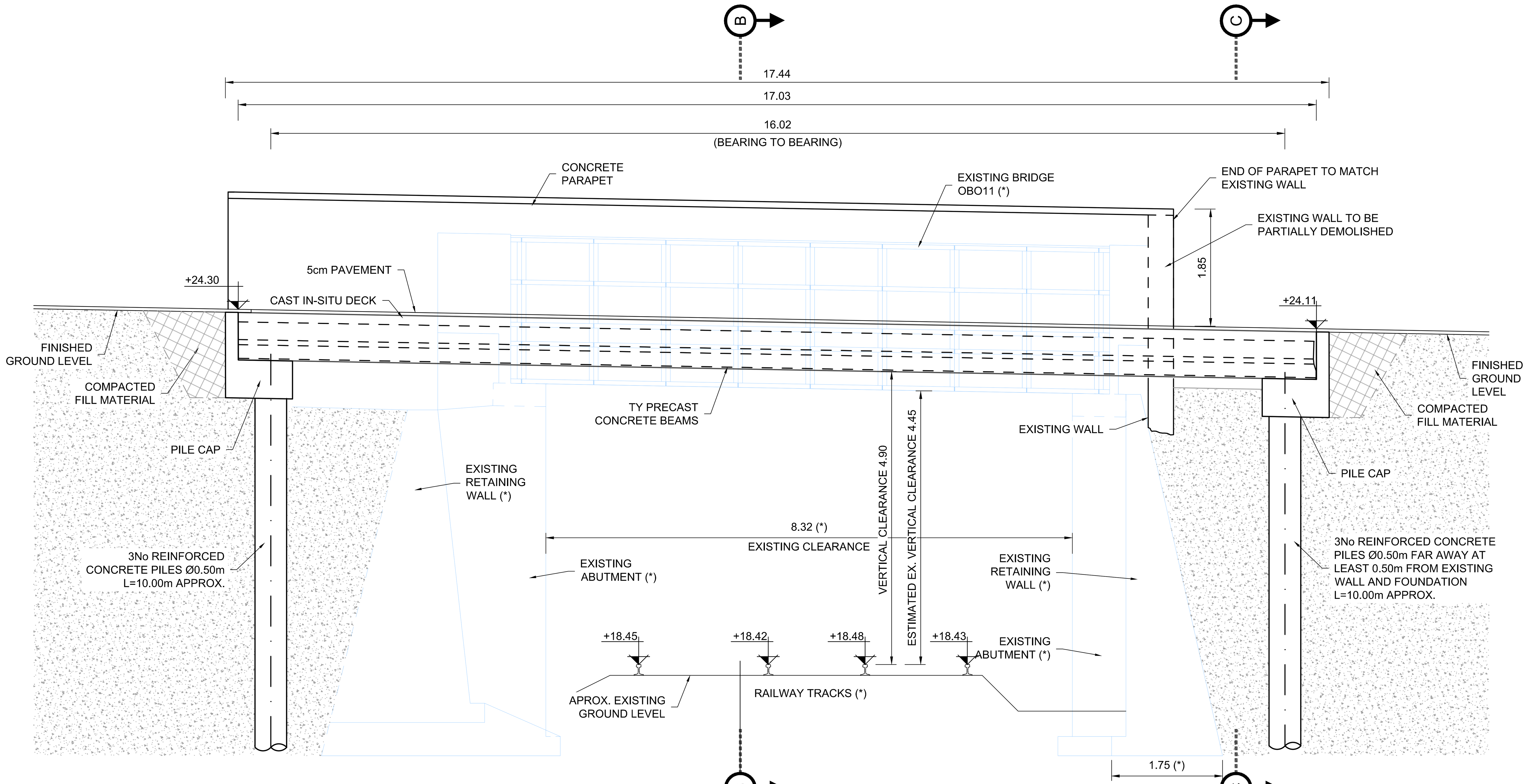

SECTION A-A. LONGITUDINAL SECTION

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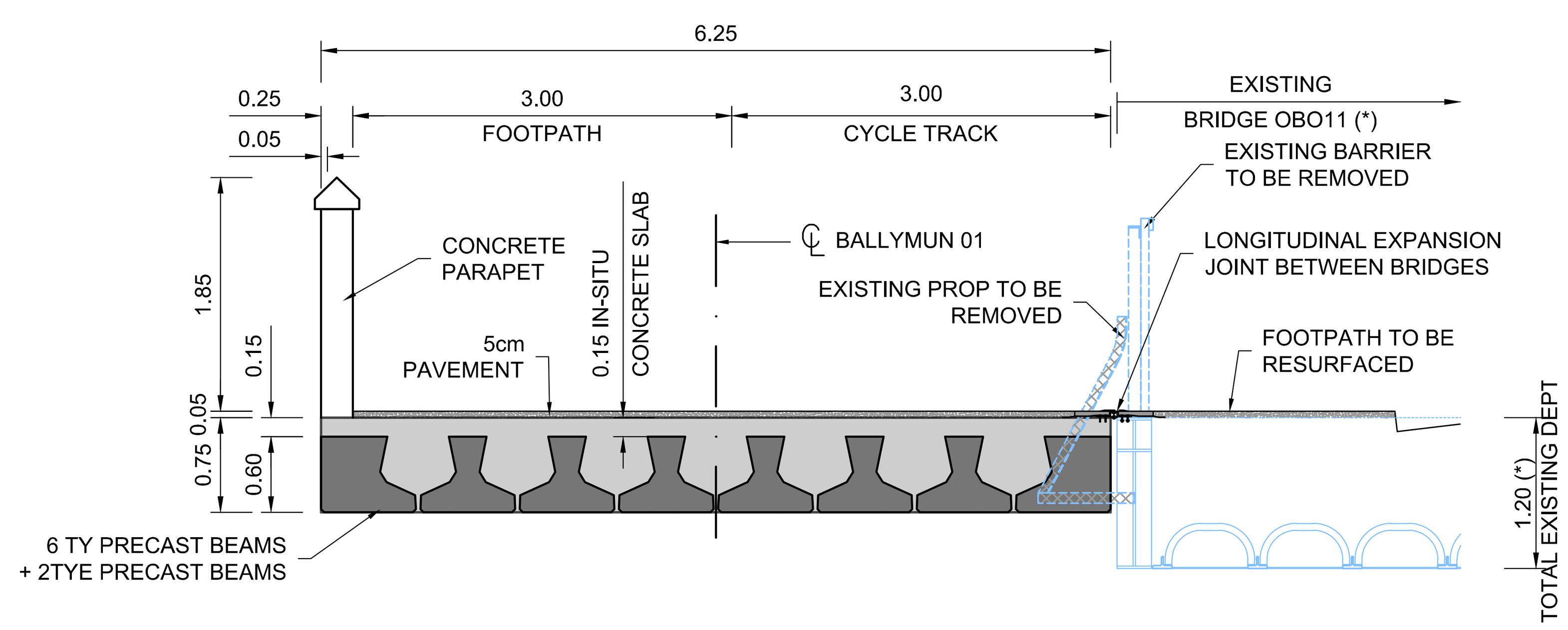

SECTION B-B. TYPICAL CROSS SECTION

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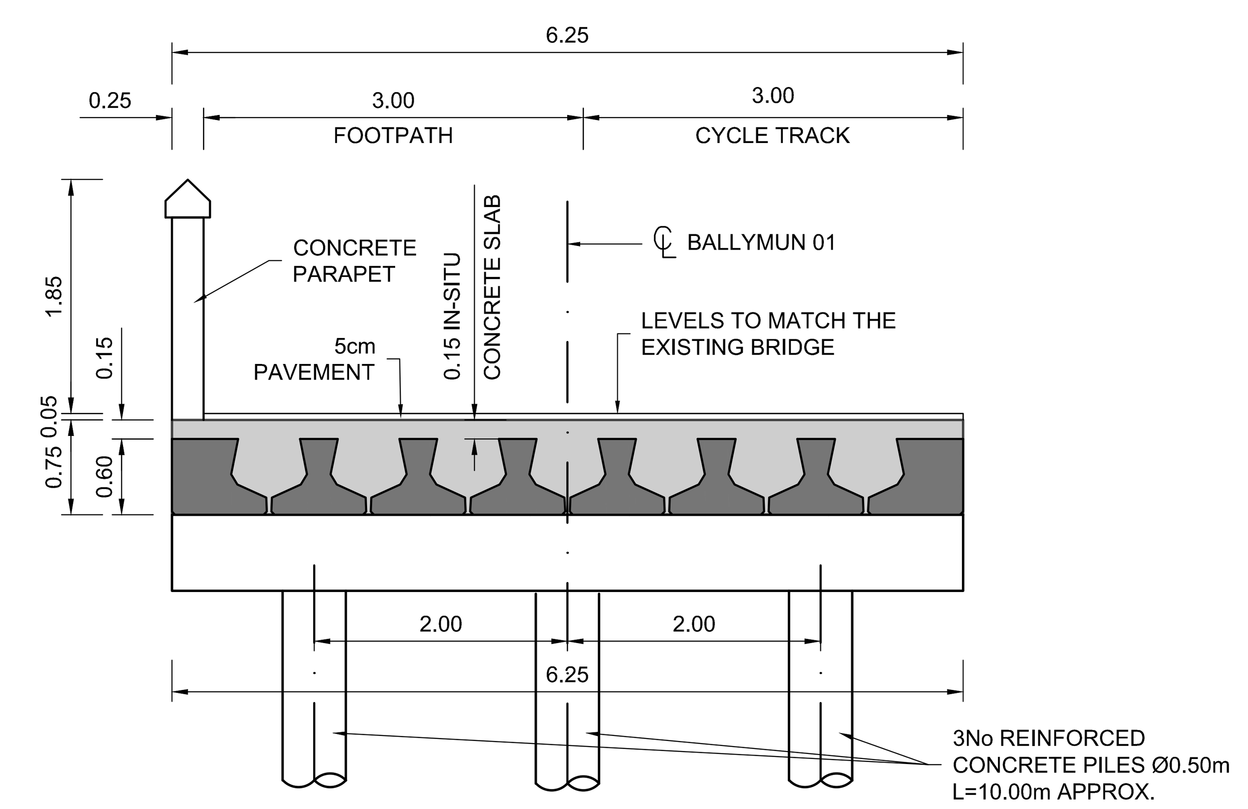
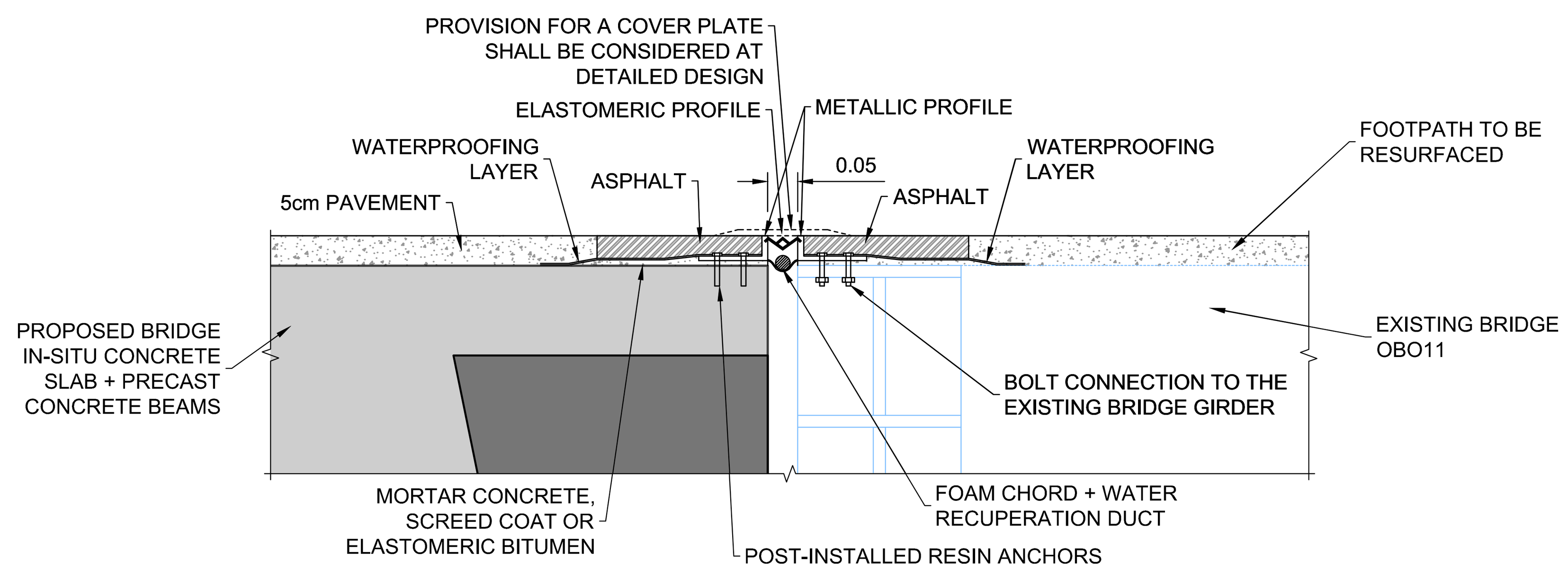


SECTION C-C. TYPICAL CROSS SECTION AT ABUTMENTS

SCALE 1:50



DETAIL JOINT

SCALE 1:10

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:
   - C45/55 @ TRANSFER
   - C57/70 @ 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.

- GASNEVIN ROAD OVERBRIDGE DRAWINGS (SEPT 1894)
- RENEWAL OF PARAPET CROSSGUNS BRIDGE DRAWINGS (26-OCT-1978)

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b. This drawing is to be used for the design element identified in the titlebox. Other information shown is to be considered indicative only. The drawing is to be read in conjunction with all other relevant design drawings.

c. O.S. data used for plans are printed under © Ordnance Survey Ireland Government of Ireland. All rights reserved. Licence Number 2022/OSi_NMA_180 National Transport Authority. All elevations are in metres and relate to OSi Geoid Model (OSGM15) Malin Head. All Co-ordinates are in Irish Transverse Mercator Grid (ITM) as defined by OSi active local GPS station.

d. Information concerning the position of apparatus shown on this drawing is based on drawings supplied by the utility owners and/or the utility works contractor, whilst every care has been taken in the preparation of this drawing, positions should be taken as approximate and are intended for general guidance only and no representation is made by the NTA as to the accuracy, completeness, sufficiency or otherwise of this drawing and the position of the apparatus.The information contained herein does not purport to be comprehensive or final as the apparatus is subject to being altered and/or superceded. Recipients should not rely on this information. Any liabilities are hereby expressly disclaimed.

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Project Ireland 2040
Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
M01	13/05/2022	JVG	EFD	SMG	ISSUE FOR PHASE 4: PLANNING

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: ROD ROUGHAN & O'DONOVAN TYPSA

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

Drawing Title: BALLYMUN / FINGLAS TO CITY CENTRE CORE BUS CORRIDOR SCHEME STRUCTURES BALLYMUN 01. SECTIONS

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

Project Code	Originator Code	QMS Code	Drawing File Name	Sheet Number	Status	Rev
BCIDD	ROT		BCIDD-ROT-STR_ZZ-0304_XX_00-DR-SS-0002	02 of 02	A	M01

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

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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.

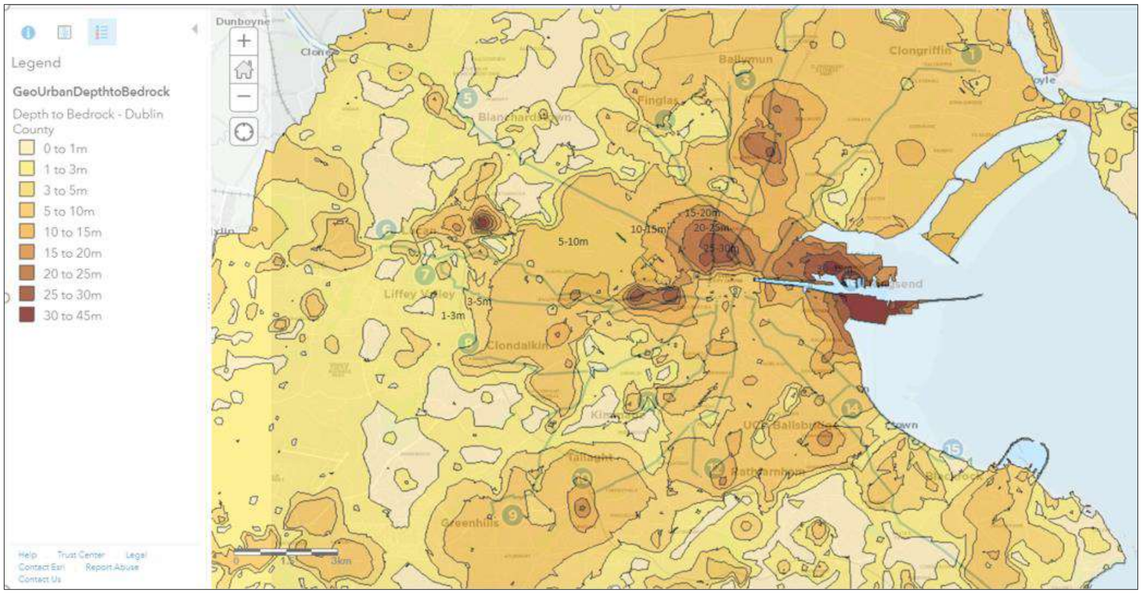
The Lower Brown Dublin Boulder Clay (LBrBC) exists as a 5 m to 9 m thick hard, brown, silty clay, with gravel, cobbles and boulders. It has previously been called the "sandy boulder clay" as it is similar to but siltier than the UBkBC above.

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. Underlaying 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:

Borehole Ref.	Expected Depth to Bedrock	Borehole Depth (m) – Cable Percussion	Borehole Depth (m) – Rotary Core
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:

Structure	Borehole Ref.	Expected Depth to Bedrock	Borehole Depth (m) – Cable Percussion	Borehole Depth (m) – Rotary Core	Notes
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

Date:	**9/2/18**	**14/2/18**
Glasnevin BH01	9.80	9.80
Glasnevin BH02A	10.10	11.25
Date:	**30/7/20**	**31/7/20**
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_{SPT} values of Refusal	Piles estimated length (m)
Ballymun 01 D=0.5m	454 / 120	-	15-20m	-	-	9.5
Ballymun 02 D=0.5m	424 / 179	R3-CP03	15-20m	-	5m	8.5
Ballymun 03 D=0.5m	82 / 169	R3-CP07	15-20m	-	5m	5.5
		R3-WS03	15-20m	-	5m	5.5
Ballymun 04 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 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.

Cu values have been derived from SPT values obtained in each borehole following the SPT-Cu 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 Ballymun 04	Depth (m)	Dry weight (KN/m^3)	Undrained shear strength, c_u (kPa)	Young's modulus E (MPa)	Undrained Young's modulus (MPa)	Friction angle φ' (º)	Cohesion c' (KPa)	Poisson's coefficient (-)	Earth pressure coefficient at rest K_0 (-)	Horizontal spring stiffness (KN/m^3)
Made Ground	0 to 4.5m	-	50	25	-	28	0	0.3	1	3,500 – 5,000
Grey Boulder Clay (UBkBC)	4.5 to 12.5	22.5	250	80	100	30	0	0.2	1.3	17,000 – 20,000
Brown Boulder Clay (LBrBC)	12.5 to 17.5	-	325	-	120	35	0	0.2	1.3	20,000 – 25,000
Mudstone	17.5 to 19.5	-	325	-	-	-	-	-	-	-
Limestone	>19.5	25	500	800	1000	45	0	.	-	35,000 – 37,500

APPENDIX 4
OTHER RELEVANT DOCUMENTATION/REPORTS

(Not used)