Appendix J4
Preliminary Design Report
Ringsend 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): Ringsend 02 Walkway

Preliminary Design Report

Reference BCIDD-ROT-STR-ZZ_0016-XX_00-RP-CB-0016

Revision L01

Date Feb-2022

Submitted by

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Position: (Structures Team Leader)

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Date: 23/05/2022

Structures Section confirmation of consultation:

Signed: ______________________________

Name: ______________________________

Position: ______________________________

Date: ______________________________

RINGSEND TO CITY CENTRE CORE BUS CORRIDOR SCHEME

PRELIMINARY DESIGN REPORT – RINGSEND 02

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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 Ringsend 02 bridge as part of the Busconnects Infrastructure Delivery – Project D.

1.2 Background Information

The proposed scheme for Ringsend 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 Ringsend 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 increase the available space for pedestrians on North Wall Quay, near the Samuel Beckett cable-stayed bridge.

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_0016-XX_00-RP-CB-0012 – Structures Options Report: Ringsend 02
- BCID-ROT-ERW-GI_0016-RP-CR-0001 – Geotechnical Interpretive Report: Ringsend Corridor

2. SITE & FUNCTION

2.1 Site Location

The Ringsend 02 walkway is situated on North Wall Quay, near the Samuel Beckett cable-stayed bridge, where the available footpath space is constraint by the presence of 2No. buildings. The site location plan is included in Appendix 2.

2.2 Function of the Structure

The objective of the new structure is to increase the available space for pedestrians on North Wall Quay, creating an interesting and attractive space over the River Liffey.

2.3 Choice of Location

The location of the structure was chosen to facilitate the proposed Ringsend 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.

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 new structure is a cantilever walkway at the North Wall Quay.

Vertical Alignment

The proposed vertical road alignment at the location of the bridge follows the alignment of the existing road, which is relatively flat.

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: Ringsend 02 Cross-Section

Parameter	Value
Parapet Upstand	0.25m
Footpath	2.95 m
Out-to-Out Width	**3.20 m**

2.7 Existing Underground and Overground Services

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

Low and Medium Voltage Electricity Lines

ESB low voltage underground lines are present in the vicinity of the structure's location. It is not envisaged any disruption/affection to these services. Ongoing discussions with ESB will be in place.

High Voltage Electricity Lines

No conflicts were found in the vicinity of the structure; however, these will need to be verified by the Contractor on site.

Telecommunications

No conflicts were found in the vicinity of the structure; however, these will need to be verified by the Contractor on site.

Water Supply

Water mains are present in the vicinity of the structure's location. It is not envisaged any disruption/affection to these services. Ongoing discussions with Irish Water will be in place.

Gas Networks

No conflicts were found in the vicinity of the structure; however, these 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. Although it is a cantilever footpath over River Liffey, it will not be affected.

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 Ringsend 02 structure shall be a steel elevated cantilever walkway with a wooden surface.

3.2 Aesthetic Considerations

The structure form is a cantilever walkway similar to other structures upstream of the site and is therefore perfectly integrated into its surroundings and matching existing structures within the area.

The width of the bridge meets the intention to design a comfortable footpath, increasing the available space for pedestrian at North Wall Quay.

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 structure is a Category 2 structure.

3.3.2 Span Arrangements

The walkway has 58.33m length with a deck straight in plan without skew.

3.3.3 Minimum Headroom Provided

Not applicable.

3.3.4 Approaches (incl. Run-on Arrangements)

Not applicable.

3.3.5 Foundation Type

The cantilever walkway is supported by compression steel beams anchored to the front face of the existing quay wall and with reinforced concrete back-span counterweight blocks with micropiles at the back of the quay wall.

3.3.6 Substructure

The walkway structure is supported by the compression steel beams and on the counterweight blocks.

3.3.7 Superstructure

The walkway deck will be formed by longitudinal and transversal steel beams with a wooden surface finished.

3.3.8 Articulation Arrangements (Joints and Bearings)

The structure will be designed to avoid the use of joints and elastomeric bearings. There will be no requirement for any articulation of the structure. The steel deck is integrally connected to the substructure.

3.3.9 Vehicle Restraint System

All parapets will comply with TII DN-STR-03034 (historical ref. NRA TD19) and EN 1317. The parapet proposed for this footbridge is a pedestrian parapet, where a cycleway is adjacent to the parapet. The parapets shall be provided with infilling such that the parapet will not have footholds.

3.3.10 Drainage

Due to the nature of the deck, timber planks, it is not necessary to provide additional drainage system as the rainwater will discharge through the planks directly into the river.

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);
- Buried concrete surfaces to be waterproofed in accordance with the TII Specification for Road Works.
- Contract Documents should make allowance for impregnation and coating of steel beams to prevent corrosion.
- The timber planks for the deck will have a shorter service life than the structure. Therefore, it will need to be replaced during the whole service life of the structure.

3.3.12 Sustainability

Life cycle sustainability assessment (LCSA) has been considered for the detailed design of the proposed bridge to enable a cost-effective and sustainable solution since the construction until the end of service life, with a minimal impact on the surrounding environment.

The proposed structure is integral with its substructure, removing the needs for expansion joints and elastomeric bearings. The bridge deck consists of steel structure with a wooden finished deck which is considered a more sustainable solution than a similar concrete structure for the following reasons:

- Due to the lightness of steel structures, it will transmit lower load to the foundation, which means it can be anchored to the existing river wall, removing the need for piling in the river.
- At the end of the structure's service life, the fact that it is made of steel means that it can be 100% recycled, whereas concrete structures need to be taken to a landfill site.

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 structure can be done from deck level. Inspection of the soffit of the proposed walkway shall be carried out from the River Liffey.

Superstructure

Structural steelwork will require regular inspection and maintenance, with major maintenance (paint system) required every 20 years.

Substructures

The substructures consist of in situ reinforced concrete, which should not incur any substantial maintenance costs.

Parapets

The parapet design is yet to be agreed with the Client. Nevertheless, it shall employ materials with low to none maintenance requirements (i.e. glass, galvanised steel parapets, etc.).

4. SAFETY

4.1 Traffic Management during Construction

Traffic management will be required during construction. Pedestrian diversions will be needed in order to build the proposed walkway.

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

Walkway parapets will be designed as pedestrian and cyclist parapets 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. COST

5.1 Budget Estimate in Current Year (incl. Whole Life Cost)

The estimated cost for the construction of the bridge is 585,000€

Basis of Cost Estimate

The cost estimate has been produced on the following basis:

- Figures are given in Euro and are based on 2019 rates (excluding VAT) – TII Schedule of Rates 2019 (CC-GMP-00054);
- Excludes land acquisition and rights of way;
- Excludes preliminaries;
- The Construction Cost Estimate does not include for fees associated with the following:
    - Additional SI and Topo;
    - Environmental Assessment;
    - Detailed Design and Checking;
    - Contract Administration;
    - Site Supervision during Construction.

6. DESIGN ASSESSMENT CRITERIA

6.1 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.

6.1.1 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

6.1.2 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.

6.1.3 Actions relating to Normal Traffic

None.

6.1.4 Actions relating to Abnormal Traffic

None.

6.1.5 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.

6.1.6 Provision for Exceptional Abnormal Loads

None.

6.1.7 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.

6.1.8 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.

6.1.9 Any Special Loading not Covered Above

None.

6.2 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;
- Irish Water.

6.3 Proposed Departures from Standards

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

6.4 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.

7. GROUND CONDITIONS

7.1 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”.

7.2 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 7.1: Encountered bedrock in the vicinity of Ringsend 02

Borehole Ref.	Depth to Encountered Bedrock (Expected)	Depth to N SPT Values of Refusal
R16-CP03	15-20 m	12.5m
R16-CP04	15-20 m	12.5m

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-0016-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 micropiles. This will allow to transfer the loads to the ground below the existing Quay wall foundation.

8. DRAWINGS & DOCUMENTS

8.1 List of All Documents Accompanying the Submission

Appendix 1 – Photographs:

(3No. of photos)

Appendix 2 – Site Location and Drawings

- BCIDD-ROT-STR_KP-0016_XX_00-DR-SS-0001 – CBC 16 Ringsend to City Centre Core Bus Corridor Scheme – Bridges and Retaining Structures - Key Plan
- BCIDD-ROT-STR_ZZ-0016_XX_00-DR-SS-0003 – Ringsend 02 General Arrangement.
- BCIDD-ROT-STR_ZZ-0016_XX_00-DR-SS-0004 – Ringsend 02. Sections

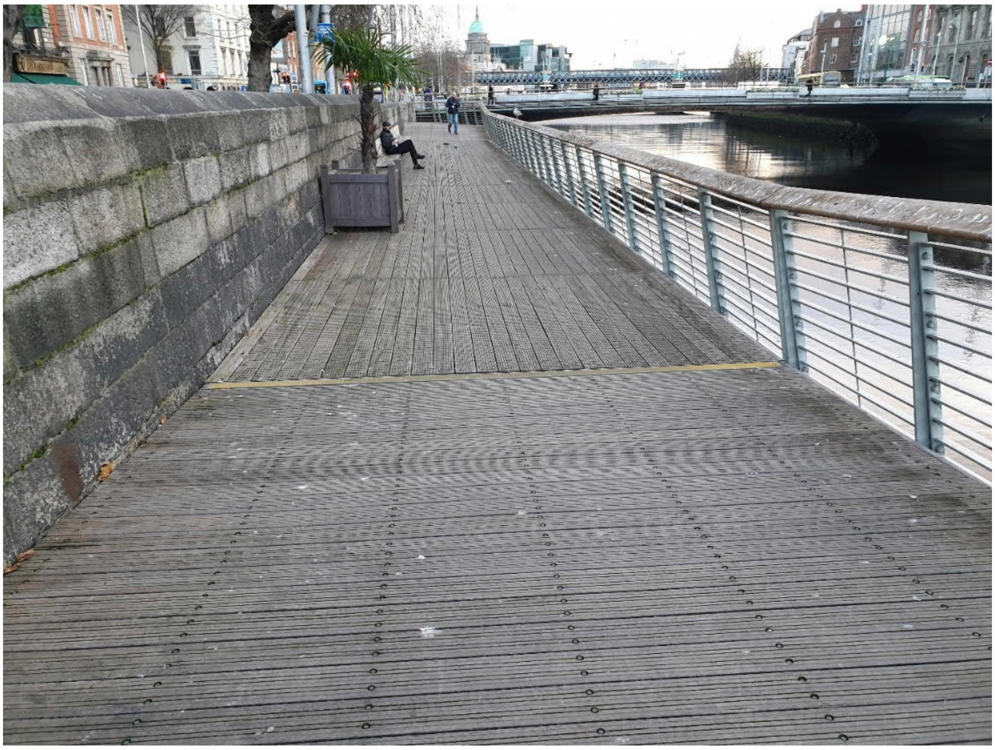
Appendix 3 – Relevant Extracts from Ground Investigation Report

(6No. of pages)

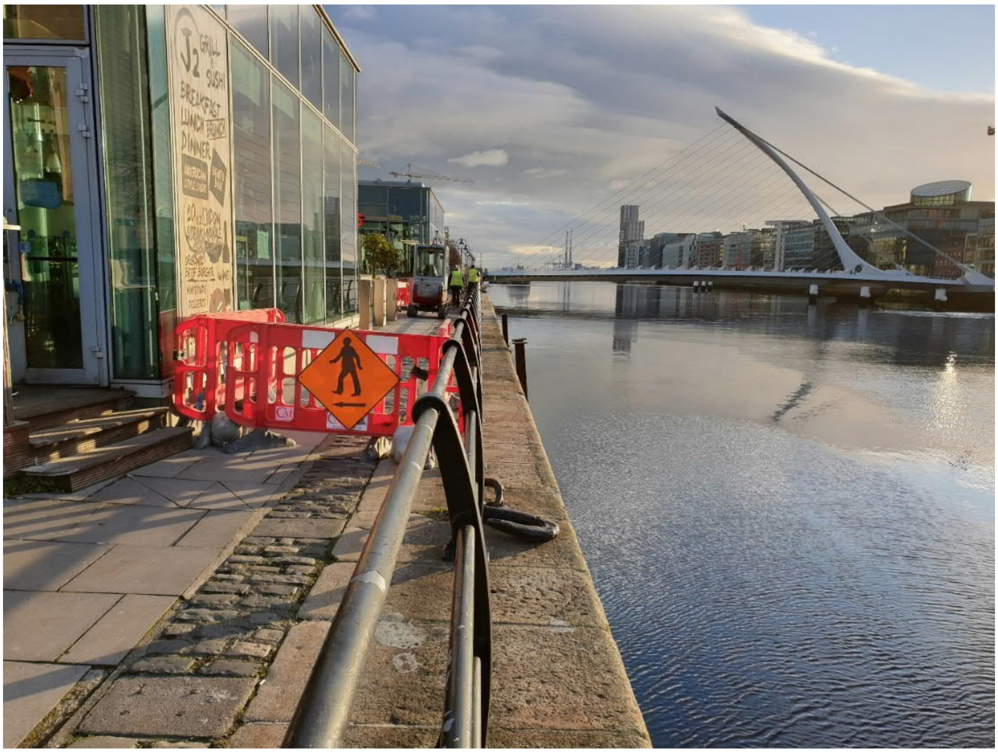
Appendix 4 – Other Relevant Documentation/Reports

(Not Used)

APPENDIX 1
PHOTOGRAPHS



Existing wooden deck similar to proposed Ringsend 02 at River Liffey



Location of new Ringsend 02 footbridge

Existing footbridge similar to Ringsend 02 upstream the proposed site – Looking from south river bank

APPENDIX 2
DRAWINGS

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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
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Rev	Date	Drn	Chk'd	App'd	Description
M01	06/04/2022	JGE	EFD	SMG	ISSUE FOR PHASE 4: PLANNING

Client: NTA — Údarás Náisiúnta Iompair — National Transport Authority

Engineering Designer: ROD ROUGHAN & O'DONOVAN — TYPSA

Date	06/04/2022
Scale	1:10000 @ A1, 1:20000 @ A3
Drawn	JGE
Checked	EFD
Approved	SMG
Project Code	BCIDD
Originator Code	NTA
QMS Code	

Programme Title

BUSCONNECTS DUBLIN
CORE BUS CORRIDORS INFRASTRUCTURE WORKS

Drawing Title

CBC 16
RINGSEND TO CITY CENTRE CORE BUS CORRIDOR SCHEME
BRIDGES & RETAINING STRUCTURES
KEY PLAN

Drawing File Name	Sheet Number	Status	Rev
BCIDD-ROT-STR_KP-0016_XX_00-DR-SS-0001	01 of 01	A	M01

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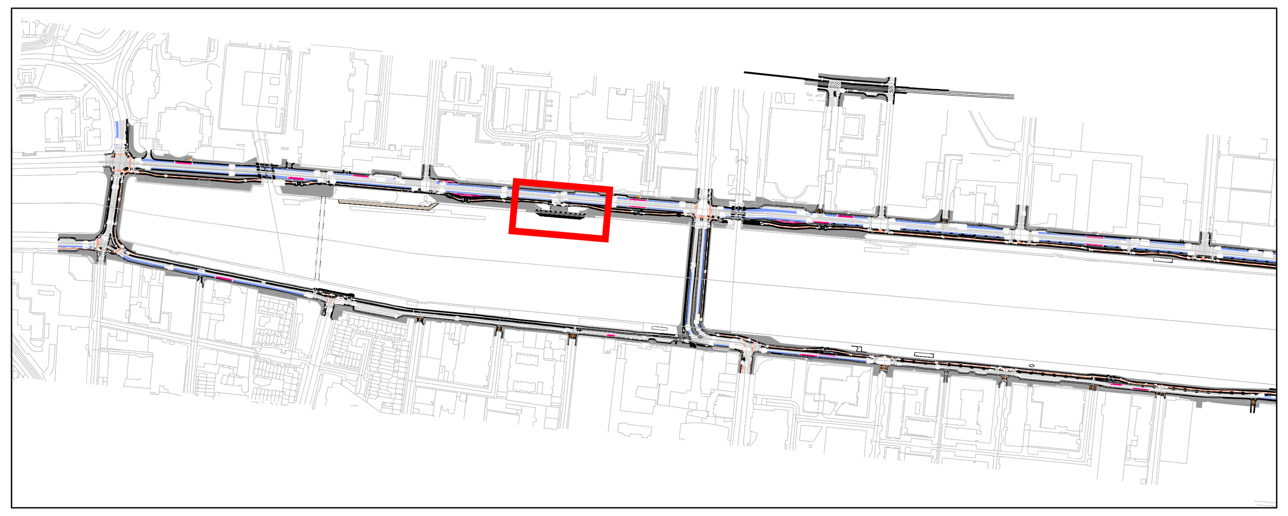
GENERAL PLAN
SCALE 1:100

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. THE GENERAL ARRANGEMENT IS INDICATIVELY ONLY.
3. 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 PRIOR 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 SAFETY BARRIER IN ACCORDANCE WITH DN-REG-03034
7. STRUCTURAL STEEL ELEMENTS:
   - STEEL S355
8. SERVICES SHOWN INDICATIVELY ONLY. THE CONTRACTOR SHALL IDENTIFY THE SERVICES ON SITE PRIOR COMMENCING CONSTRUCTION WORKS.



KEY PLAN

Project Ireland 2040
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Rev	Date	Drn	Chk'd	App'd	Description
M01	02/07/2021	JGE	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:
RINGSEND TO CITY CENTRE CORE BUS CORRIDOR SCHEME
STRUCTURES
RINGSEND 02. GENERAL ARRANGEMENT

Date	Scale	Drawn	Checked	Approved
06/04/2022	1:100 @ A1 1:200 @ A3	JGE	EFD	SMG

Project Code	Originator Code	QMS Code	Drawing File Name	Sheet Number	Status	Rev
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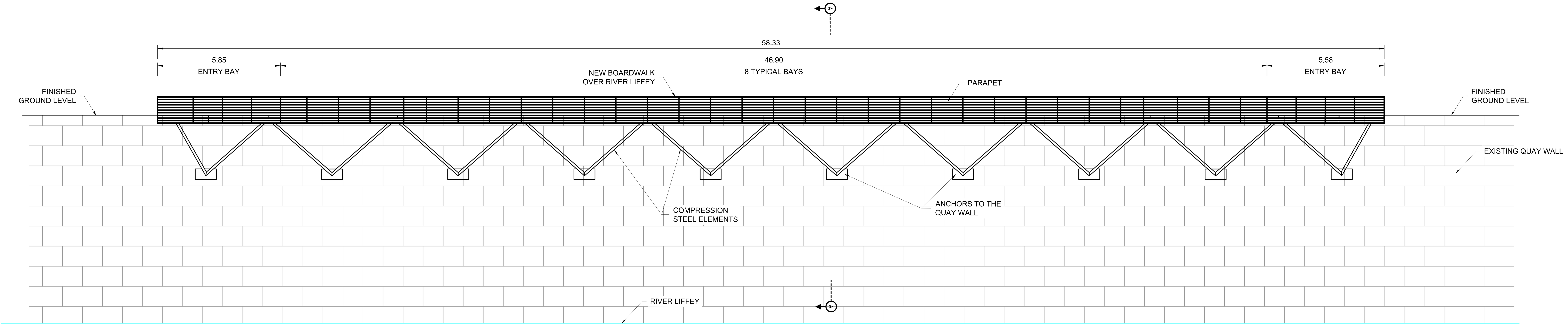
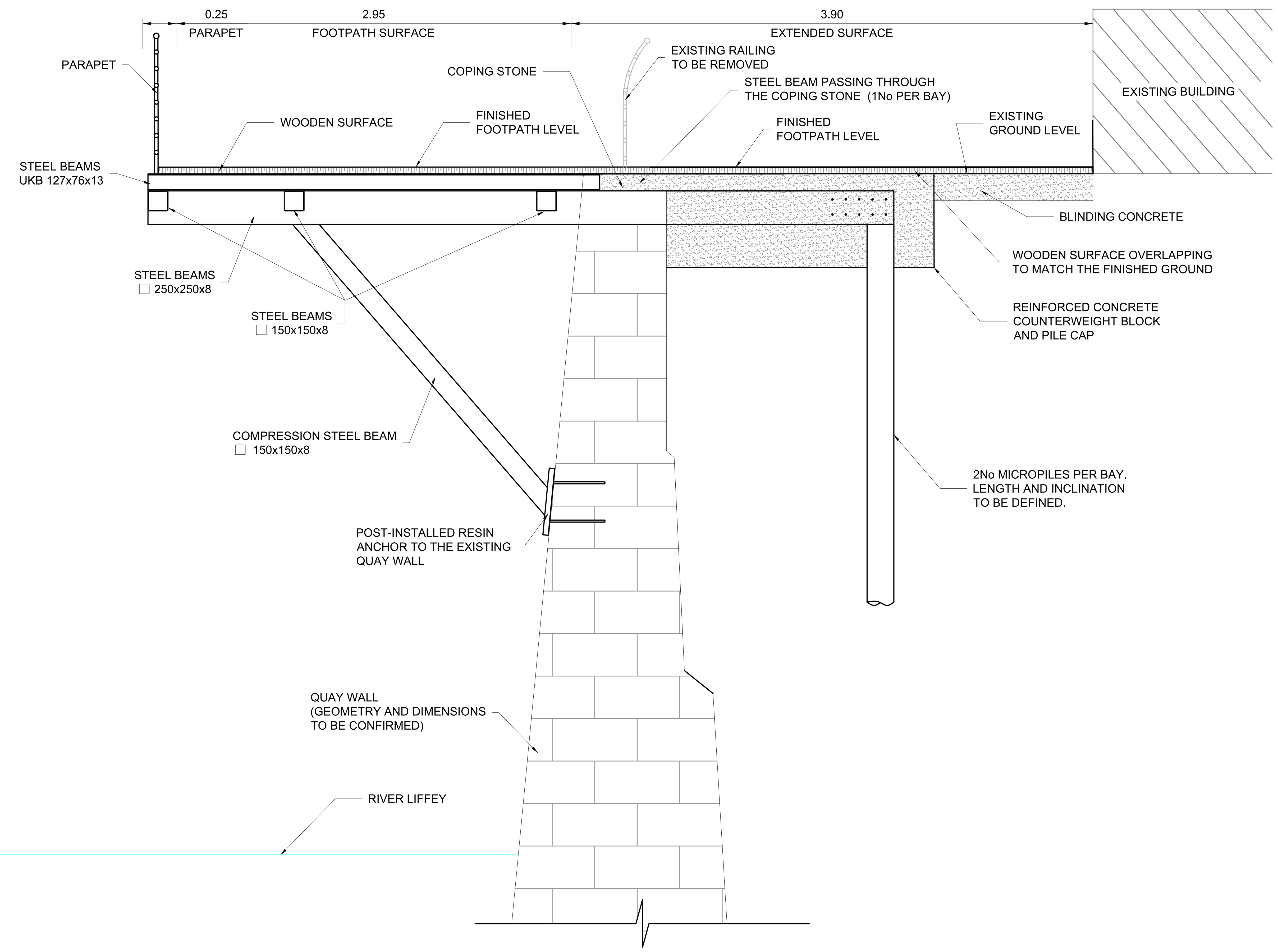


ELEVATION VIEW
SCALE 1:100



SECTION A-A. TYPICAL SECTION
SCALE 1:25

NOTES:

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2. THE GENERAL ARRANGEMENT IS INDICATIVELY ONLY.
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Project Ireland 2040
Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
M01	06/04/2022	JGE	EFD	SMG	ISSUE FOR PHASE4: PLANNING

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: ROD TYPSA

Date	Scale	Drawn	Checked	Approved
06/04/2022	AS SHOWN	JGE	EFD	SMG

Project Code: BCIDD
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QMS Code:

Programme Title: BUSCONNECTS DUBLIN
CORE BUS CORRIDORS INFRASTRUCTURE WORKS

Drawing Title: RINGSEND TO CITY CENTRE CORE BUS CORRIDOR SCHEME
STRUCTURES
RINGSEND 02. SECTIONS

Drawing File Name	Sheet Number	Status	Rev
BCIDD-ROT-STR_ZZ-0016_XX_00-DR-SS-0004	02 of 02	A	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.

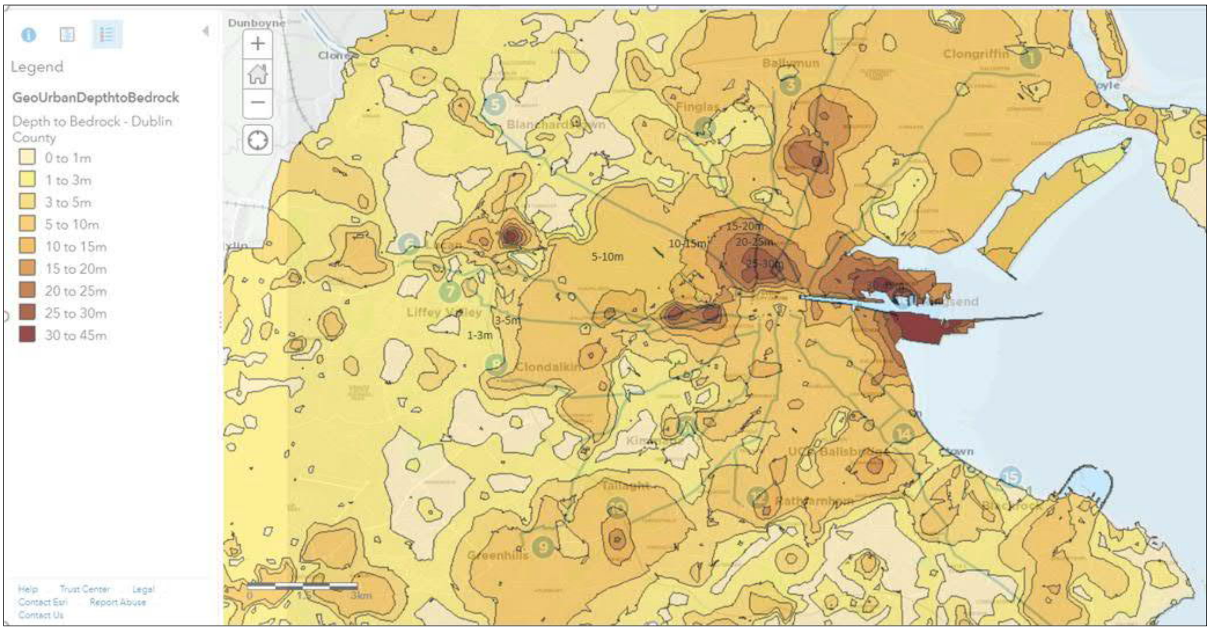
The Lower Brown Dublin Boulder Clay (LBrBC) exists as a 5 m to 9 m thick hard, brown, silty clay, with gravel, cobbles and boulders. It has previously been called the “sandy boulder clay” as it is similar to but siltier than the UBkBC above.

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. 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
R16-CP01	10-15m	15	-
R16-CP02	10-15m	15	-
R16-CP03	15-20m	15	-
R16-CP04	15-20m	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 16. June 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
Ringsend 01	R16-CP01	10-15m	5.0	-	
	R16-CP02	10-15m	9.1	-	
Ringsend 03	R16-CP03	15-20m	12.3	-	
	R16-CP04	15-20m	13.5	-	

The GI works undertaken comprise 4 No. Cable Percussion Boreholes to a maximum depth of 13.5m BGL; 22 SPT tests at 1 metre intervals alternating with disturbed samples and 6 GWL recordings.

13 disturbed samples were taken at each change of soil consistency or between SPT tests and 4 undisturbed samples (UT100) where ground conditions permit. Geotechnical testing consisting of 13 moisture content, 2 Atterberg limits, 2 Bulk Density and 9 Particle Size Distribution. Soil strength testing consisted of 4 Vane tests and 4 Shear Box.

Environmental & Chemical testing consisted of 19 Suite E samples and 1 pH and organic matter content test.

4. OVERVIEW OF SOIL CLASSIFICATION

4.1 Made ground

Made Ground deposits were encountered beneath the Topsoil/Surfacing and were present to depths of between 2.50m and 5.30m BGL.

Made ground deposits were described generally as either brown, sandy gravelly Clay with cobbles or greyish brown clayey gravely Sand with occasional cobbles and contained occasional fragments of concrete, plastic, red brick and wood.

Note that a culvert was encountered in borehole R16-CP02 between 3.0 and 5.3m, which was noted as a void on the log.

The Particle Size Distribution tests confirm that generally the Made ground deposits are well-graded graded with percentages of sands between 22% and 53% and percentages of gravels between 31% and 69%.

PH and total organic carbon (TOC) were determined at R16-CP04 at 0.5m depth. Organic matter content (OMC) was estimated from TOC. PH, TOC and OMC values were 9.3, 1.6% w/w C and 2.8% w/w respectively.

Asbestos was detected at 0.5m depth at borehole R16-CP03.

4.2 Cohesive deposits

Cohesive deposits were encountered beneath the Made Ground or interbedded with Granular Deposits and were described typically as grey slightly sandy silty CLAY.

The strength of the cohesive deposits was typically very soft till depths of 11.7mBGL.

Cohesive deposits found to be a CLAY of high plasticity, with a plasticity index ranging between 29% and 31%. Particle Size Distribution tests confirm generally well-graded deposits with percentages of sands and gravels ranging between 11% and 15% and 2% and 5%, respectively.

4.3 Granular deposits

Granular deposits were encountered interbedded with cohesive deposits in the majority of holes and were typically described as either greyish sandy sub rounded to rounded fine to coarse GRAVEL with occasional cobbles or gravelly fine to coarse SAND.

Based on the SPT N values the deposits vary from loose to dense.

Particle Size Distribution tests confirm generally well-graded deposits with percentages of sands and gravels ranging between 18% and 58% and 33% and 69%, respectively.

5. SUMMARY OF GROUND INVESTIGATION INTERPRETATIVE REPORT

For RingsenD 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, Concrete	0 to 0.5	-	-
Made Ground: Brown Clay (possibly UBrBC) / Sand / Gravel	0.5 to 6	6	40
Very soft silty Grey Clay (only found in 2 out of 4 boreholes)	6 to 12	3.5	20
Gravel	Top level between 6 and 12m	50	325

- 2 Vane tests at Made Ground Sand layer, defined as brown very sandy Gravel or brown very gravelly Sand, have shown Peak shear strength values higher than 146 KPa.
- 2 Vane tests at soft silty clay layer, shown Peak shear strength values between 11 and 13 kPa.
- 2 Shear Box tests at Made Ground Sand layer, defined as brown silty (very) gravelly Sand, shown angle of peak shearing resistant values between 34 and 44 degrees and effective cohesion values between 4 and 13 kPa.

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
R16-CP01	4.46	4.72
R16-CP02	5.03*	-
R16-CP03	-	2.47
R16-CP04	3.73	4.40
* Water depth might be unrepresentative due to culvert		

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)
Ringsend 01 D=0.5m	294 / 623	R16-CP01	10-15m	-	5m	11.0
		R16-CP02	10-15m	-	6m	11.5
Ringsend 02 D=0.2m	50	R16-CP03	15-20m	-	12.5m	11.5
		R16-CP04	15-20m	-	12.5m	12.5
Ringsend 03 D=0.5m	210 / 604	R16-CP03	15-20m	-	12.5m	15.5
		R16-CP04	15-20m	-	12.5m	16.5

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.

In Ringsend 01 and 03 0.5m diameter driven piles embedded in the Dublin boulder clay and Ringsend 02 0.2m piles, the estimated piles length that satisfies the ULS is as detailed in the table above.

APPENDIX 4
OTHER RELEVANT DOCUMENTATION/REPORTS

(Not used)