

The background of the page is a vibrant red. It is decorated with several abstract, overlapping shapes in blue, green, and white. In the top right, there is a large white circle with a blue border, partially overlapping a dark blue rectangular shape. In the top left, there is a green curved shape. In the bottom left, there is a blue shape with a white circle inside, and a larger blue shape with a white circle inside. In the bottom right, there is a large green curved shape overlapping a red curved shape with a white border. The text is positioned in the upper left quadrant of the red background.

Appendix J2

Preliminary Design Report
- Structure K02 - Stone
Boat Boardwalk

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): Kimmage 02 Walkway

Preliminary Design Report

Reference BCIDD-ROT-STR-ZZ-0011-XX-00-RP-CB-0014

Revision L02

Date Jun-2022

Submitted by

Signed:



Name: Fernando Fernandez

Position: (Structures Team Leader)

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

Date: 27-06-2022

Structures Section confirmation of consultation:

Signed: _____

Name: _____

Position: _____

Date: _____

BUSCONNECTS INFRASTRUCTURE DELIVERY – PROJECT D

PRELIMINARY DESIGN REPORT – KIMMAGE 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 Kimmage 02 bridge as part of the Busconnects Infrastructure Delivery – Project D.

1.2 Background Information

The proposed scheme for Kimmage 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 Kimmage 02 walkway 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 bridges.

Photographs of the structure are included in Appendix 1.

1.3 Previous Studies

Reports prepared and published for this structure to date include:

- BCIDD-ROT-STR-ZZ_0011-XX_00-RP-CB-0012 – Structures Options Report: Kimmage 02
- BCID-ROT-ERW-GI_0011-RP-CR-0001 – Geotechnical Interpretive Report: Kimmage Corridors

2. SITE & FUNCTION

2.1 Site Location

The Kimmage 02 walkway is located over the western bank of river Poddle at Mount Argus Way. Construction of this bridge is proposed to carry the new cycle lane and the footpath along Mount Argus Way to connect this area with the car park and Sundrive Rd. The site location plan is included in Appendix 2.

2.2 Function of the Structure

The objective of the new walkway is to provide unimpeded passage of the cycle lane and footpaths along Mount Argus Way over the western bank of the River Poddle and provide access to the car park and Sundrive Rd.

2.3 Choice of Location

The location of the structure was chosen to facilitate the proposed Kimmage 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 footbridge is at 37m and at 36m at the east and west 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 structure follows Mount Argus Way alignment, with a bend at the eastern end.

Vertical Alignment

The proposed structure incorporates a constant gradient of 2.5%, from the existing ground level at parking area, to match the existing Mount Argus Way level at its eastern end.

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: Kimmage 02 Cross-Section

Parameter	Value
Railing	0.25 m
Footpath	2.00 m
Cycle track	2.00 m
Out-to-Out Width	4.25 m

2.7 Existing Underground and Overground Services

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

Low and Medium Voltage Electricity Lines

ESB low voltage underground lines are in the vicinity of the structure. It is not envisaged any diversion. These may need to be further discussed with ESB.

High Voltage Electricity Lines

No conflicts were found in the vicinity of the structure.

Telecommunications

Telecommunications are in the vicinity of the structure. It is not envisaged any diversion. These may need to be further discussed with EIR.

Water Supply

Desktop services tracking to date indicate water mains 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

No conflicts were found in the vicinity of the structure.

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. The bridge is over a watercourse, but the foundations are outside the wetted section of the river Poddle and the structure soffit is over the culvert adjacent to it. Therefore, there will be minimal hydrology effect in the area.

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 Kimmage 02 walkway shall be a steel structure supported by reinforced concrete pile foundations.

3.2 Aesthetic Considerations

The walkway structure form proposed pretends to be as slender as possible to minimise visual effect from opposite riverbank. The depth of the deck has been minimised as far as practicable to give a slender span-depth ratio.

The width of the walkway meets the intention to design the proposed footpath and cycle lane. The level of the walkway is lower than the street level at Mount Argus Way, only meeting the carriageway level at the east end at Mount Argus Way. Therefore, it will not be visible from this area.

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 bridge has 12No. spans with an average length of 4m. The overall length of the walkway is 50.44m.

3.3.3 Minimum Headroom Provided

The soffit of the proposed structure is over the existing Stone Boat and the culvert at the vicinity of the walkway.

3.3.4 Approaches (incl. Run-on Arrangements)

Not applicable.

3.3.5 Foundation Type

The substructure comprises of embedded foundations, formed by bored in-situ reinforced concrete single-pile column foundations.

3.3.6 Substructure

The superstructure will be supported directly on the foundations, which are reinforced concrete piles also acting as columns.

Geometry and dimensions of these columns are as described on the drawings included in Appendix 2.

3.3.7 Superstructure

The superstructure will be a steel frame walkway formed by longitudinal and transversal steel beams. The main transversal beams are supported on the foundations, cantilevering both sides. The deck incorporates perforated metal sheets with slip resistance.

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. Thermal actions acting on the frame will be resisted through soil-structure interaction and flexure of the frame.

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

A perforated metal deck is used for the deck of the walkway over the river Poddle, thus no drainage system is necessary for the structure.

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 BD57).
- Exposed concrete to be surface impregnated in accordance with the TII Specification for Road Works.
- Contract Documents should make allowance for impregnation and coating of steel beams to prevent corrosion.

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 a steel walkway with 14 spans supported on reinforced concrete piles which are considered a sustainable solution for the following reasons:

- Due to the lightness of steel structures, the loads transmitted to the foundations are relatively low, which means smaller columns-piles and consequently a lower environmental impact on the River Poddle's banks.
- 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.
- Local cement and aggregates are used in the production of concrete.
- It avoids the requirements for elastomeric bearings (replaceable element) due to its integral nature.

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.

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. Road traffic of Mount Argus Square should be partially and/or totally affected during construction process, no further affections are expected considering that Mount Argus Way, is a dead end road.

Furthermore, pedestrian diversion will be required during construction.

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 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 415,000€.

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/m³
- Structural steelwork 77 kN/m³
- Pavement 23 kN/m³
- Backfill to structures 20 kN/m³

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 actions will be considered in accordance with I.S. EN 1991-1-7.

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;
- Waterways Ireland.

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".

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-0011-RP-CR-0001. An extract of the Geotechnical Interpretation Report is included in Appendix 3.

There is not current site investigation information for Kimmage 02. It has been assumed that piled foundations are required due to the nature of the structure proposed, the reduce available space within the area and the requirement to minimise affection to the Stone Boat. Further site investigation shall be undertaken during subsequent design stages to develop the detailed design of the structure.

8. DRAWINGS & DOCUMENTS

8.1 List of All Documents Accompanying the Submission

Appendix 1 – Photographs:

(2No. of photos)

Appendix 2 – Site Location and Drawings

- BCIDD-ROT-STR_KP-0011_XX_00-DR-SS-0001 – Kimmage to City Centre Core Bus Scheme – Bridges and Retaining Structures – Key Plan
- BCIDD-ROT-STR_ZZ-0011_XX_00-DR-SS-0005 – Kimmage 02. General Arrangement.
- BCIDD-ROT-STR_ZZ-0011_XX_00-DR-SS-0006 – Kimmage 02 Sections

Appendix 3 – Relevant Extracts from Ground Investigation Report

(6No. of pages)

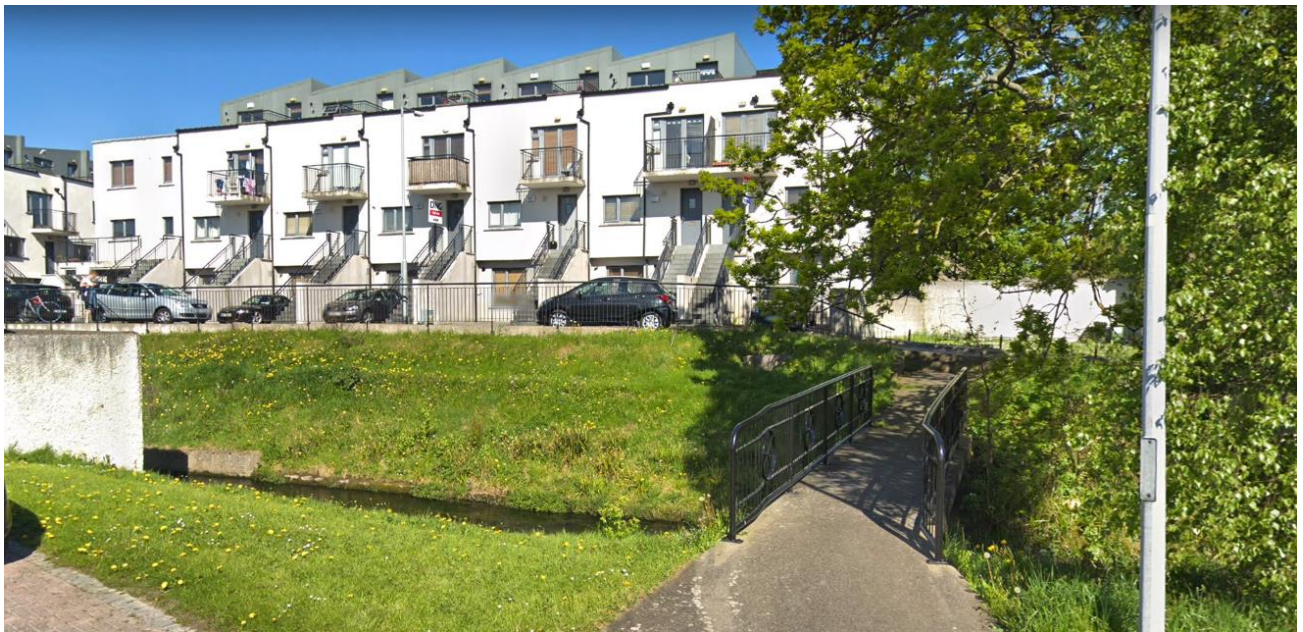
Appendix 4 – Other Relevant Documentation/Reports

(Not Used)

APPENDIX 1 PHOTOGRAPHS

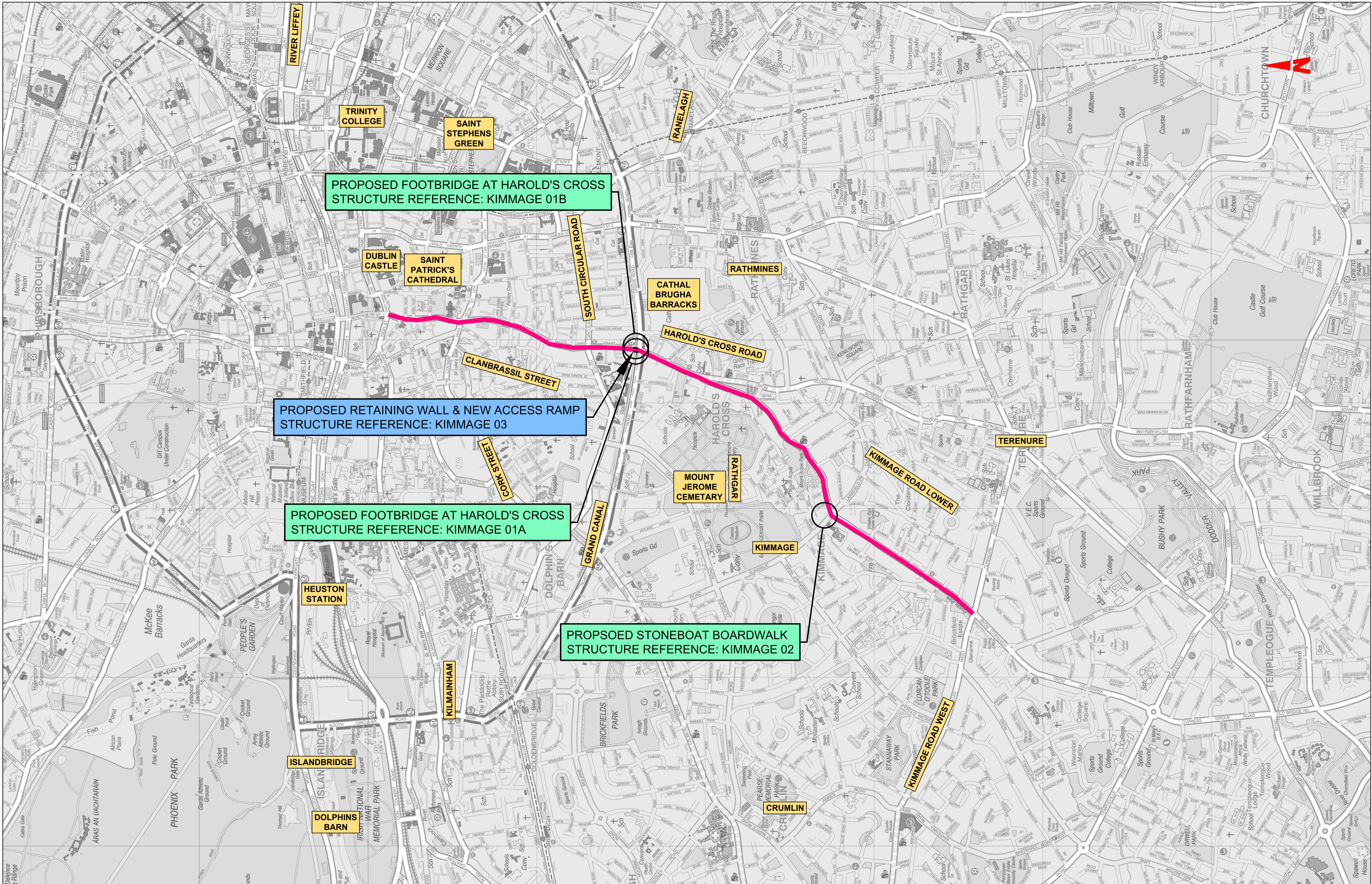


Existing culvert at location of proposed Kimmage 02 walkway



The banks of the River Poddle at the location of proposed Kimmage 02

APPENDIX 2 DRAWINGS



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Project Ireland 2040
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Rev	Date	Dn	Chk'd	App'd	Description
L01	02/07/2021	JGE	EFD	SMG	ISSUE FOR APPROVAL
L02	26/11/2021	JVG	EFD	SMG	ISSUE FOR PHASE 3: PRELIMINARY DESIGN

Client		Engineering Designer		Programme Title	
NTA Údarás Náisiúnta Iompair National Transport Authority		IJD IJD & DOROVAN TVPSA		BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS	
Date	Scale	Drawn	Checked	Approved	Drawing Title
26/11/2021	1:10000 @ A1 1:20000 @ A3	JVG	EFD	SMG	CBC 11 KIMMAGE TO CITY CENTRE CORE BUS CORRIDOR SCHEME BRIDGES & RETAINING STRUCTURES KEY PLAN
Project Code	Originator Code	QMS Code		Drawing File Name	Sheet Number
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					Status
					A
					Rev
					L02

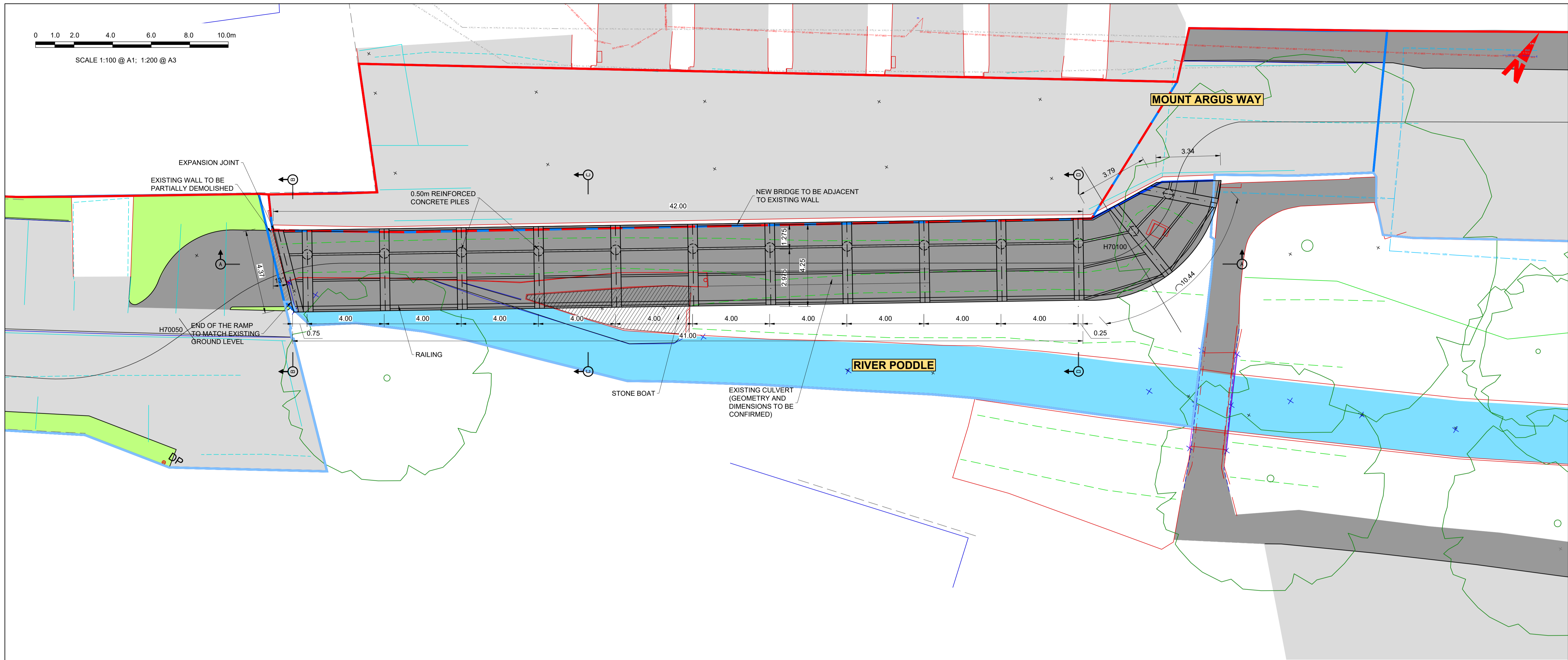
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NTA Údarás Náisiúnta Iompair National Transport Authority		IJD IJD & DOROVAN TVPSA		BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS	
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26/11/2021	1:10000 @ A1 1:20000 @ A3	JVG	EFD	SMG	CBC 11 KIMMAGE TO CITY CENTRE CORE BUS CORRIDOR SCHEME BRIDGES & RETAINING STRUCTURES KEY PLAN
Project Code	Originator Code	QMS Code		Drawing File Name	Sheet Number
BCIDD	NTA			BCIDD-ROT-STR_KP-0011_XX_00-DR-SS-0001	01 of 01
					Status
					A
					Rev
					L02

Client		Engineering Designer		Programme Title	
NTA Údarás Náisiúnta Iompair National Transport Authority		IJD IJD & DOROVAN TVPSA		BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS	
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Project Code	Originator Code	QMS Code		Drawing File Name	Sheet Number
BCIDD	NTA			BCIDD-ROT-STR_KP-0011_XX_00-DR-SS-0001	01 of 01
					Status
					A
					Rev
					L02

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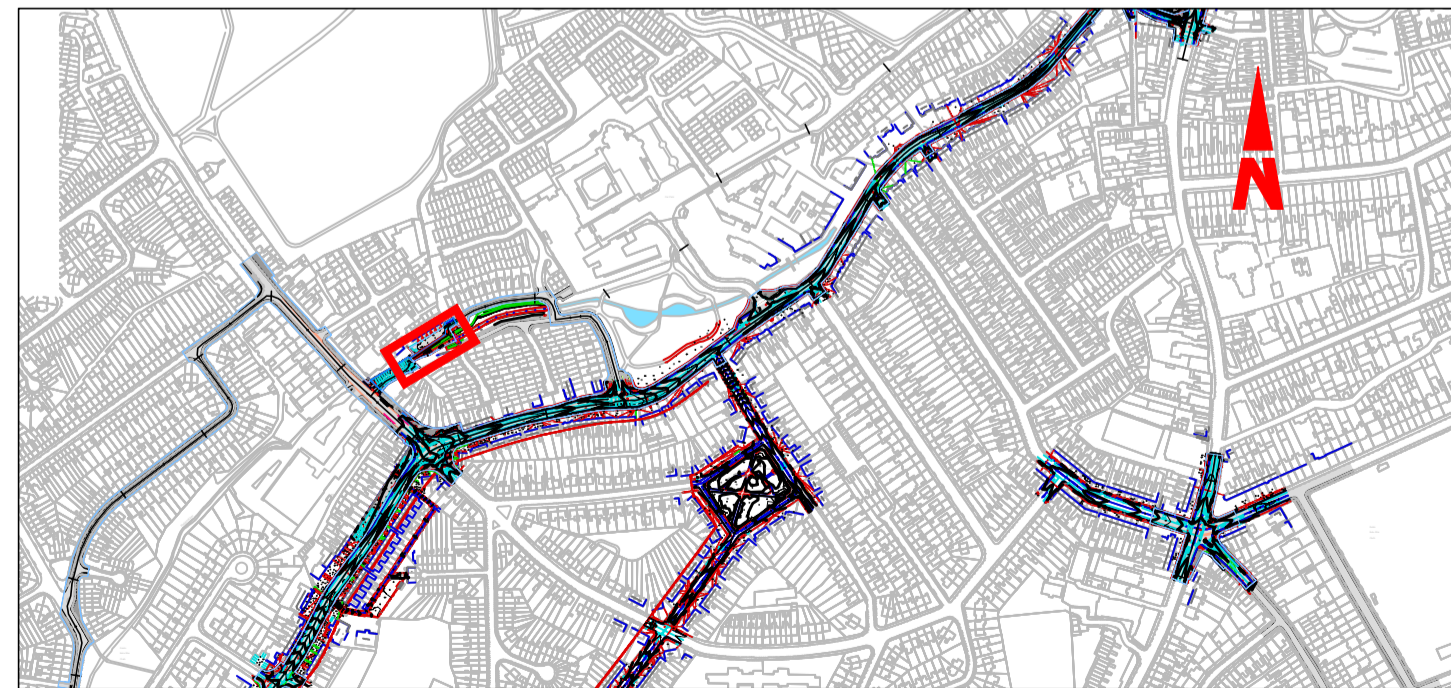
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GENERAL PLAN
SCALE 1:100

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. THE GENERAL ARRANGEMENT IS INDICATIVELY ONLY.
3. 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 COMMUNICATED IMMEDIATELY TO THE PROJECT DIRECTOR PRIOR COMMENCING CONSTRUCTION WORKS.
4. ALL BURIED SURFACES TO BE WATERPROOFED IN ACCORDANCE WITH THE T11 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. 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
L01	16/04/2021	JGE	EFD	SMG	PEER REVIEW STAGE B
L02	02/07/2021	JGE	EFD	SMG	ISSUE FOR APPROVAL
L03	26/11/2021	JVG	EFD	SMG	ISSUE FOR PHASE 3: PRELIMINARY DESIGN

Client		Engineering Designer	
 Údarás Náisiúnta Iompair National Transport Authority		 TYPSA	
Date	Scale	Drawn	Checked
26/11/2021	1:100 @ A1 1:200 @ A3	JVG	EFD
Approved	SMG	QMS Code	
Project Code	Originator Code	QMS Code	
BCIDD	ROT		

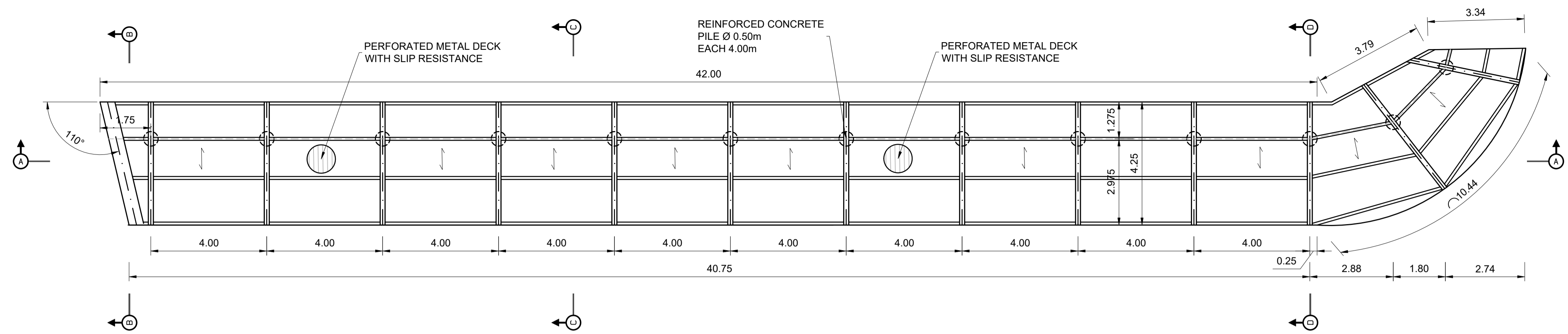
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Drawing Title			
CBC11 KIMMAGE TO CITY CENTRE CORE BUS CORRIDOR SCHEME STRUCTURES KIMMAGE 02. GENERAL ARRANGEMENT			
Drawing File Name	Sheet Number	Status	Rev
BCIDD-ROT-STR_ZZ-0011_XX_00-DR-SS-0005	01 of 02	A	L03

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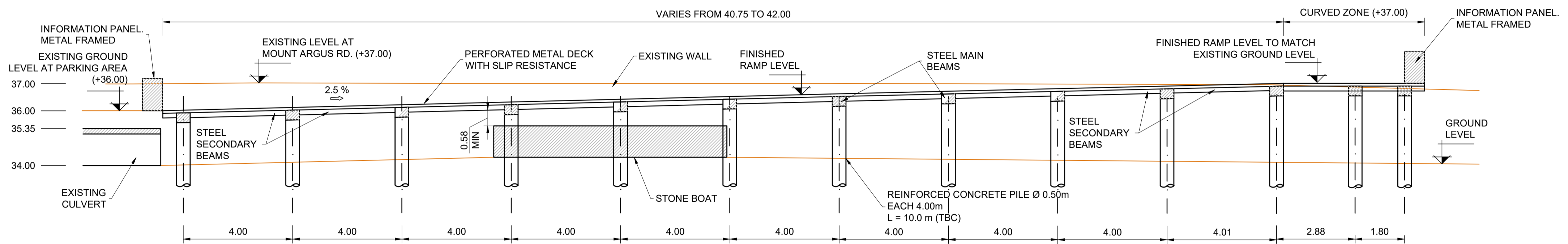
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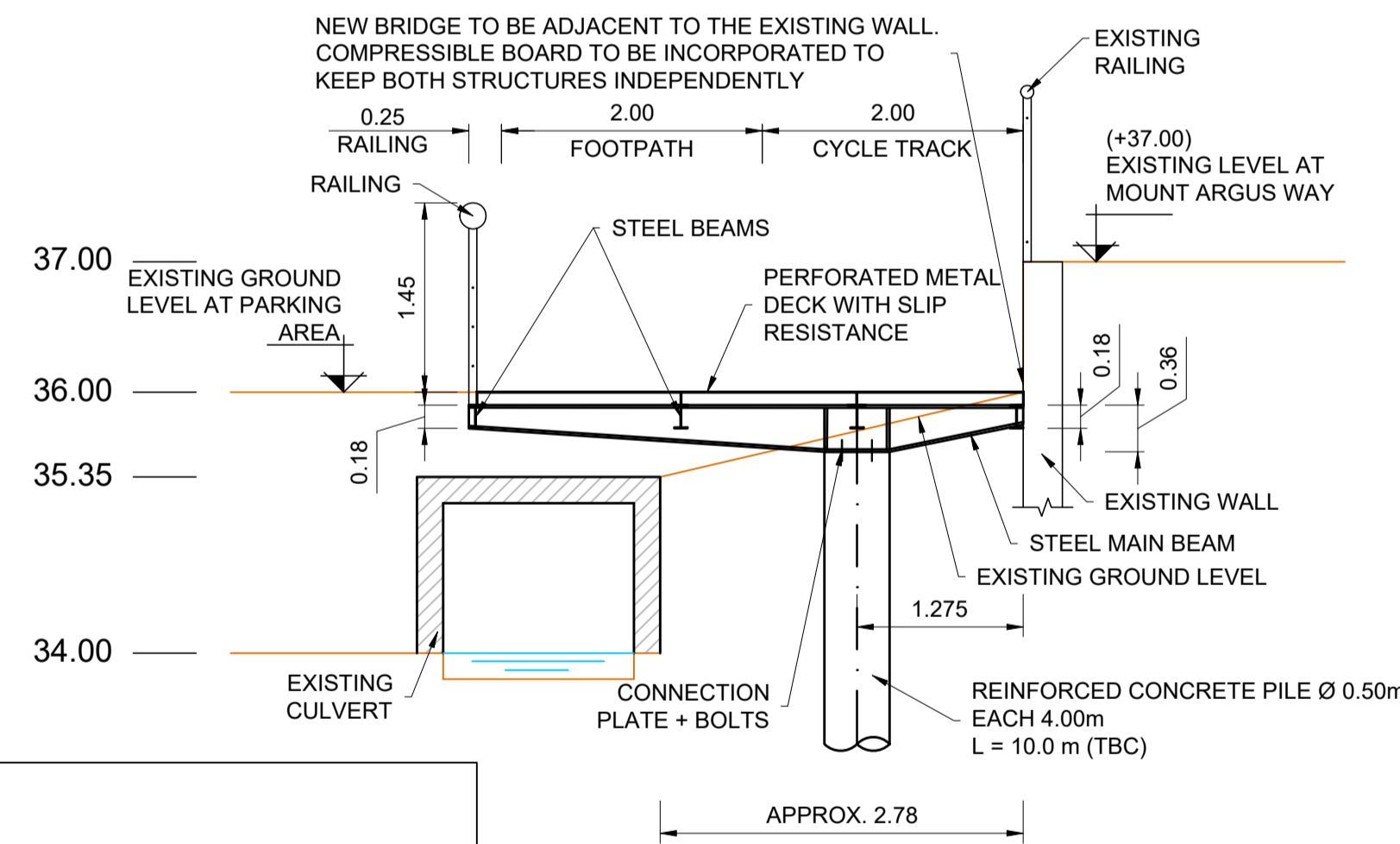
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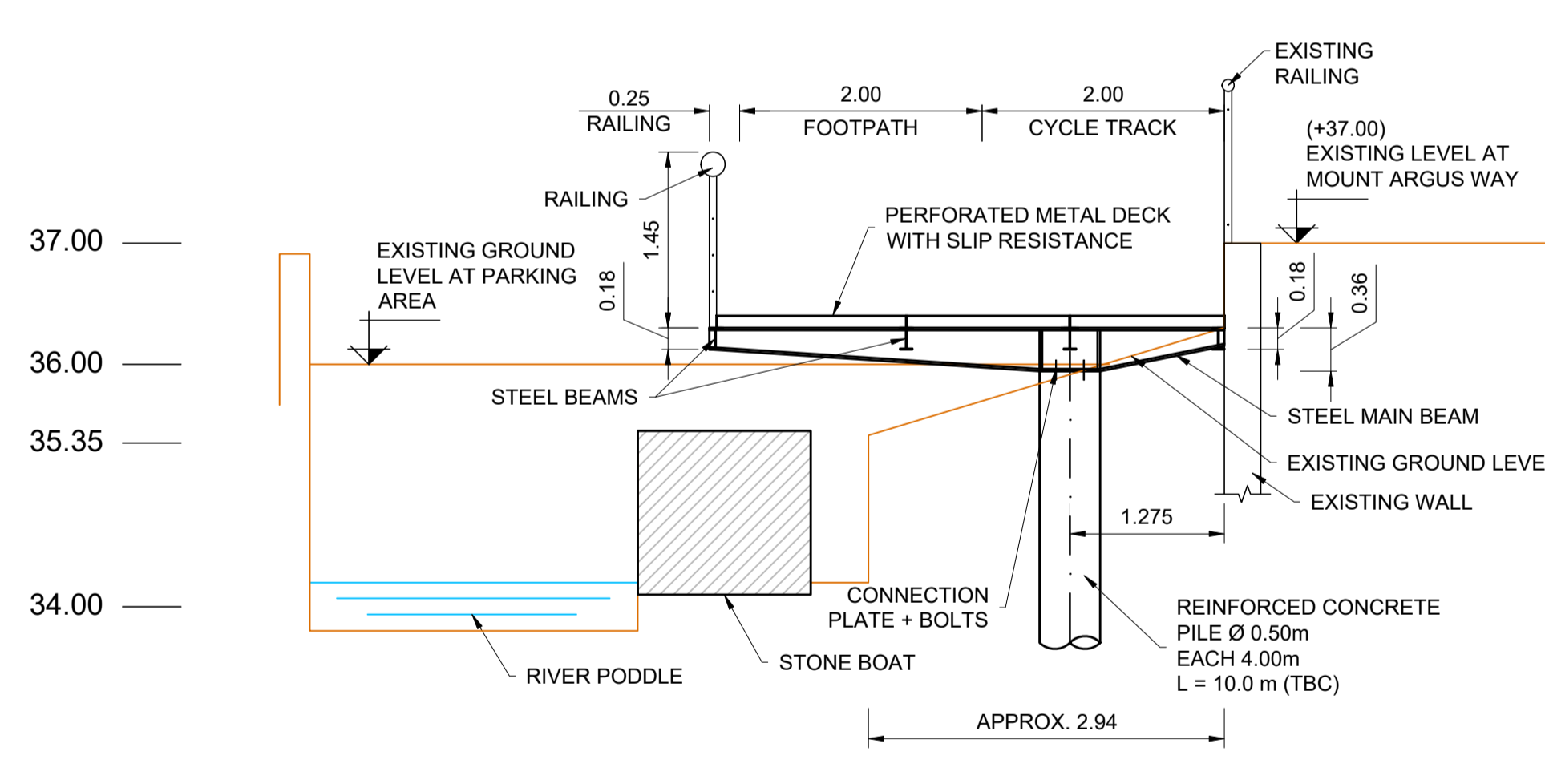
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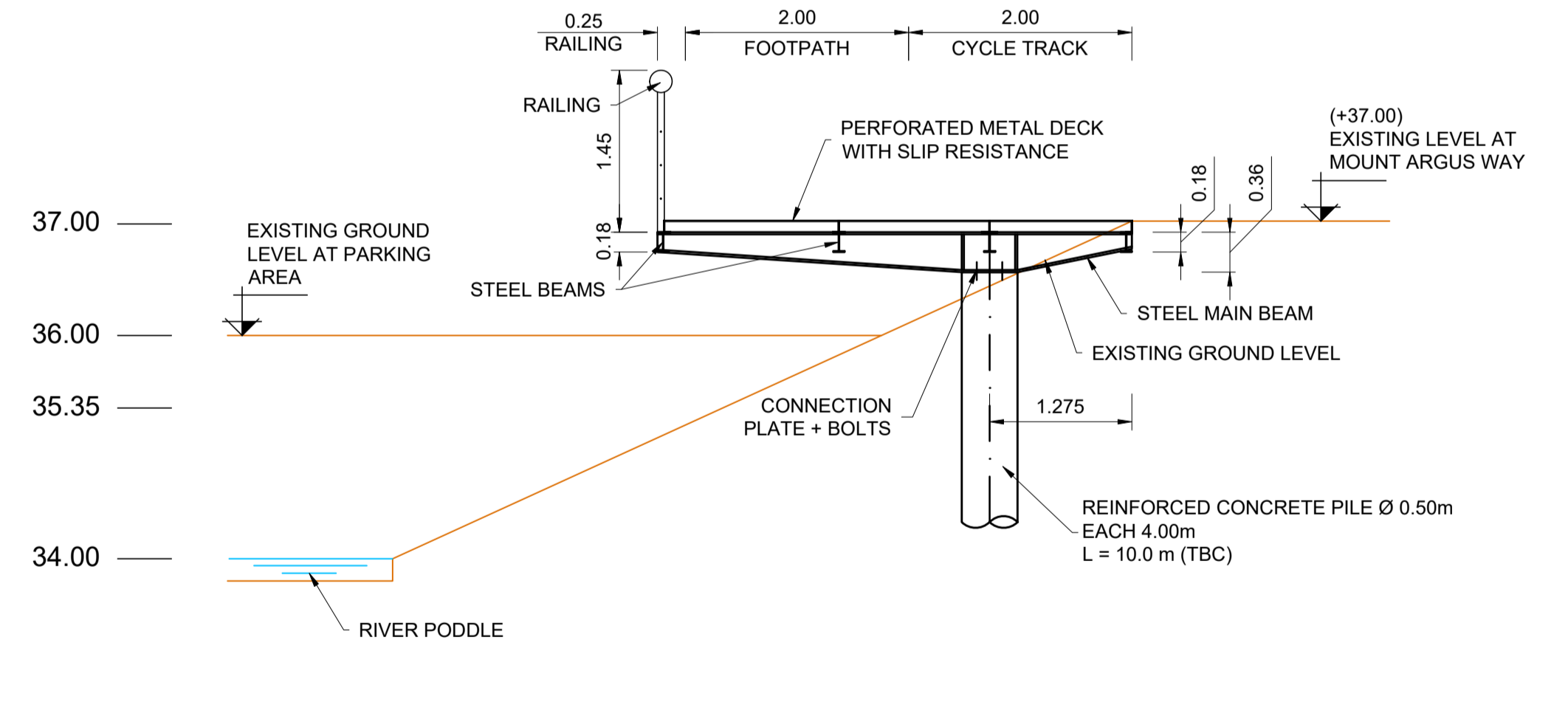
LONGITUDINAL SECTION A-A
SCALE 1:100



SECTION B-B
SCALE 1:50



SECTION C-C
SCALE 1:50



SECTION D-D
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 COMMUNICATED IMMEDIATELY TO THE PROJECT DIRECTOR PRIOR COMMENCING CONSTRUCTION WORKS.
4. ALL BURIED SURFACES TO BE WATERPROOFED IN ACCORDANCE WITH THE T11 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. SERVICES SHOWN INDICATIVELY ONLY. THE CONTRACTOR SHALL IDENTIFY THE SERVICES ON SITE PRIOR COMMENCING CONSTRUCTION WORKS.

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Rev	Date	Drn	Chk'd	App'd	Description
L01	16/04/2021	JGE	EFD	SMG	PEER REVIEW STAGE B
L02	02/07/2021	JGE	EFD	SMG	ISSUE FOR APPROVAL
L03	26/11/2021	JVG	EFD	SMG	ISSUE FOR PHASE 3: PRELIMINARY DESIGN

Client NTA Údarás Náisiúnta Iompair National Transport Authority		Engineering Designer PROD TYPSA		
Date 26/11/2021	Scale 1:100 @ A1 1:200 @ A3	Drawn JVJ	Checked EFD	Approved SMG
Project Code BCIDD	Originator Code ROT	QMS Code		

Programme Title BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS		Drawing Title CBC11 KIMMAGE TO CITY CENTRE CORE BUS CORRIDOR SCHEME STRUCTURES KIMMAGE 02. PLAN VIEW & SECTIONS	
Drawing File Name BCIDD-ROT-STR_ZZ-0011_XX_00-DR-SS-0006	Sheet Number 02 of 02	Status A	Rev L03

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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.

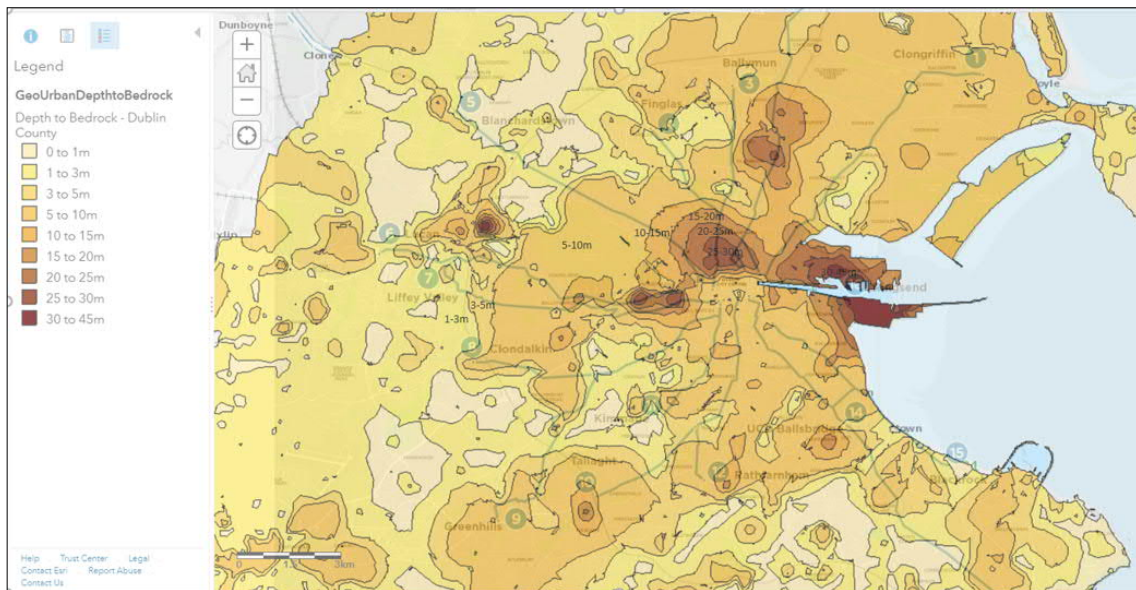
The Lower Brown Dublin Boulder Clay (LBrBC) exists as a 5 m to 9 m thick hard, brown, silty clay, with gravel, cobbles and boulders. It has previously been called the “sandy boulder clay” as it is similar to but siltier than the UBkBC above.

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, cu (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 Kimmage to City Centre 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
R11-CP01	5-10m	10	2
R11-CP02	5-10m	15	2
R11-CP03	5-10m	15	2
R11-CP04	5-10m	15	2
R11-WS01	5-10m	10	
R11-WS02	5-10m	10	

3. SUMMARY OF FACTUAL GEOTECHNICAL REPORT

The following factual reports have been received as part of the Lot 1 GI:

Detailed Stage 1 Lot 1 Route 11. 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
Kimmage 01	R11-CP01	5-10m	8.7	6.5 to 12.5	
	R11-CP02	5-10m	3.9	-	Changed to WS02
	R11-CP03	5-10m	6.3	-	
	R11-CP04	5-10m	2.9	-	Changed to WS03 (Drive-in Windowless Sampler)
Kimmage 01	R11-WS01	5-10m	3.6	-	
	R11-WS02	5-10m		-	Cancelled

The GI works undertaken comprise 2 No. Cable Percussion Boreholes to a maximum depth of 8.7m BGL, 3 No. Window Samples and 2 No. Rotary Core Boreholes to a maximum depth of 12.5m BGL; 14 SPT tests at 1 metre intervals alternating with disturbed samples and 9 GWL recordings.

10 disturbed samples were taken at each change of soil consistency or between SPT tests. Geotechnical testing consisting of 10 moisture content, 5 Atterberg limits, 1 Bulk Density and 7 Particle Size Distribution. Rock strength testing included 2 Unconfined Compressive Strength (UCS) testing.

Environmental & Chemical testing consisted of 9 Suite E samples and 2 PH and Organic matter content tests.

4. OVERVIEW OF SOIL CLASSIFICATION, AS APPLICABLE

4.1 Made Ground:

Made Ground deposits were encountered beneath the Topsoil/Surfacing and were present to depths of between 1.50m and 3.70m BGL.

These deposits were described generally as brown, dark brown, grey, dark grey or greyish brown sandy gravelly Clay with occasional cobbles or grey sandy subangular to subrounded fine to coarse Gravel with occasional cobbles and contained occasional fragments of ceramic, concrete, glass, metal, mortar, plastic, red brick and wood.

Soil classifies as CLAY of lower to intermediate plasticity, with a plasticity index ranging between 16% and 18%.

The Particle Size Distribution tests confirm percentages of sands and gravels of about 24% and 31% respectively.

PH and total organic carbon (TOC) were determined at R11-CP03 and C11-WS01 both at 1m depth. Organic matter content (OMC) was estimated from TOC. A PH average value of 8.1 was obtained.

TOC and OMC values at R11-WS01 were 1.8% w/w C and 3.1% w/w respectively. At R11-CP03, total organic carbon test showed high values (>6% w/w C).

Asbestos was detected at 1m depth at boreholes R11-CP03 and R11-CP04.

4.2 Cohesive deposits:

Cohesive deposits were encountered beneath the Made Ground or interbedded with Granular Deposits and were described typically as brown, grey, brownish grey or greyish brown sandy gravelly CLAY or as greyish brown or grey slightly sandy gravelly SILT. These deposits had rare, occasional, some or frequent cobble and boulder content.

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

The geotechnical testing carried out on recovered soil samples generally classify the deposits as CLAY of low plasticity, with a plasticity index ranging between 12% and 16%.

The Particle Size Distribution tests confirm generally well-graded deposits with percentages of sands and gravels ranging between 25% and 28% and 27% and 34%, respectively.

4.3 Bedrock:

The rotary core boreholes recovered medium strong to 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 varies from 4.40m BGL to 8.90m BGL. The total core recovery is good, typically 100%. The SCR and RQD both are relatively poor but both show an increase with depth in each of the boreholes.

5. SUMMARY OF GROUND INVESTIGATION INTERPRETATIVE REPORT

For Kimmage to City Centre 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	-	-
Made Ground: Brown Clay (possibly UBrBC) / Grey Clay	0.5 to 3.5	6	40
Stiff Brown Boulder Clay (UBrBC)	3.5 to 4	50	325
Stiff Grey Boulder Clay / Very stiff dark Grey Boulder Clay (UBkBC)	4 to 9	30-50	250
Limestone	Top level between 5 and 10m	-	-

No soil strength tests have been performed on Route 11.

2 uniaxial compression tests (rock strength) undertaken within the Limestone have shown base resistant values between 31.3 and 49.5 MPa. This range of values have been sustained by 7 UCS tests, 13 point load tests and 3 Brazil tests done in Glasnevin project and 5 UCS tests done in Metrolink project, in which base resistant values range between 17 and 101 MPa, with an average value around 46 MPa.

6. HYDROGEOLOGY, AS APPLICABLE

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
R11-CP01	1.44	1.94
R11-WS02	0.47	0.40
R11-CP03	2.74	2.67
R11-CP04	-	1.35
R11-WS01	0.68	0.61

7. GEOTECHNICAL INPUTS 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 at Routes 3, 11 and 16.

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)
Kimmage D=0.5m	TBC	R11-CP01	5-10m	9m	8m	-
		R11-WS02	5-10m	-	4m	-
		R11-CP03	5-10m	4.5m	3m	-
		R11-WS03	5-10m	-	2.5m	-
		R11-WS01	5-10m	-	3.5m	-

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 the estimated piles length that satisfies the ULS is as detailed in the table above.

**APPENDIX 4
OTHER RELEVANT DOCUMENTATION/REPORTS**

(Not used)