Appendix J.3
Preliminary Design Report

ST03 - Ballydowd

Pedestrian and Cycle

Bridge

CBC006-ST03
Ballydowd Pedestrian and Cycle Bridge Preliminary Design Report

Lucan to City Centre Core Bus Corridor
BCIDA-ACM-STR_ZZ-0006_XX_00-RP-CB-0009

Client – National Transport Authority
Stage – Stage 2

Project Reference: BusConnects Package A
Project Number: 60599123
BCIDA–ACM-STR_ZZ–0006_XX_00–RP–CB–0009

Date (16th August 2021)

Preliminary Design Report – Consultation STA-1b

Categories 1, 2 & 3

Scheme

Name and Location BusConnects – CBC 06 Lucan to City Centre

Structures(s)

Name and nature of the Structure(s) CBC006-ST03 Ballydowd Pedestrian and Cycle Bridge

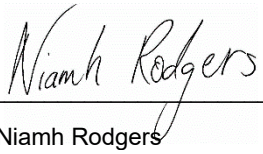
Preliminary Design Report

Reference BCIDA–ACM-STR_ZZ–0006_XX_00–RP–CB–0009

Revision L01

Date 16 / 08 / 2021

Submitted by

Signed 

Name Niamh Rodgers

Position Structures Design Lead (Team Leader)

Organisation AECOM

Date 16 / 08 / 2021

Structures Section confirmation of consultation:

Signed: - 

Name: - Fergal Cahill

Position: - Senior Engineer - TII Structures

Date: - 24-08-2021

Table of Contents

Figures

Tables

1. Introduction

1.1 Brief

The BusConnects Dublin – Core Bus Corridor (CBC) Infrastructure Works (herein after called the CBC Infrastructure Works) involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on sixteen radial core corridors in the Greater Dublin Area.

The National Transport Authority (NTA) have appointed AECOM in a joint venture with Mott MacDonald to undertake the design of the infrastructure works for Package A of the BusConnects Programme. Package A includes the following four CBC routes:

Clongriffin to City Centre CBC;

Lucan to City Centre CBC;

Clondalkin to Drimnagh CBC; and

Tallaght to City Centre CBC.

Each route contains several bridge structures with various structural forms. As part of the scope AECOM have agreed to take all structures which affect the Transport Infrastructure Ireland (TII) Road Network through the *Technical Acceptance of Road Structures on Motorways and Other National Roads* procedure as outlined in DN-STR-03001.

This Preliminary Design Report (PDR) will focus on CBC006-ST03, a new Pedestrian and Cycle Bridge over the N4 at Junction 3, replacing the existing Ballydowd Footbridge. The new bridge will be located within the TII road network and the Lucan to City Centre CBC. The PDR is a deliverable at Phase 4 of the Technical Acceptance process.

1.2 Background information

BusConnects plans to transform Dublin's bus and cycle network, with an aim of increasing the attractiveness of public transport and cycling encouraging a modal shift from private car. The scheme consists of 16 radial Core Bus Corridor's (CBC), which will be supplemented at a later stage with a network of orbital corridors. Overall, the scheme will provide 230kms of continuous bus priority lanes and 200kms of cycle tracks/lanes throughout Dublin.

The new bridge will be constructed as part of the Lucan to City Centre CBC which commences at Ballyowen Road Bridge, which carries the R136 Regional Road over the N4 at Junction 3. The CBC progresses east following the N4 to Junction 7 on the M50 where it continues via the R148 along the Palmerstown Bypass, Chapelizod Bypass, Con Colbart Road and St. John's Road West until tying in with existing infrastructure at the Frank Sherwin Bridge beside Heuston Station.

Ballyowen Road Bridge constructed circa 1988, originally opened with two traffic lanes and footpaths on either side. The bridge has since been widened and the footpaths removed in conjunction with the construction of the Ballydowd Footbridge (circa 2005). The road bridge currently carries three traffic lanes, a bus lane and cycle lanes in each direction. The combined lane arrangements and cross-sectional widths are currently not suitable to achieve the objectives of BusConnects. Namely, to prioritise bus traffic and to provide segregated cycle tracks while also maintaining two-way road and pedestrian traffic.

The proposed bridge will replace the existing Ballydowd Footbridge and will be constructed with sufficient cross-sectional width to carry a two-way cycle lane as well as pedestrian traffic.

1.3 Previous studies and their recommendations

The following table is a list of documents and previous studies for the development of the proposed bridge:

Table 1.1 Previous Studies

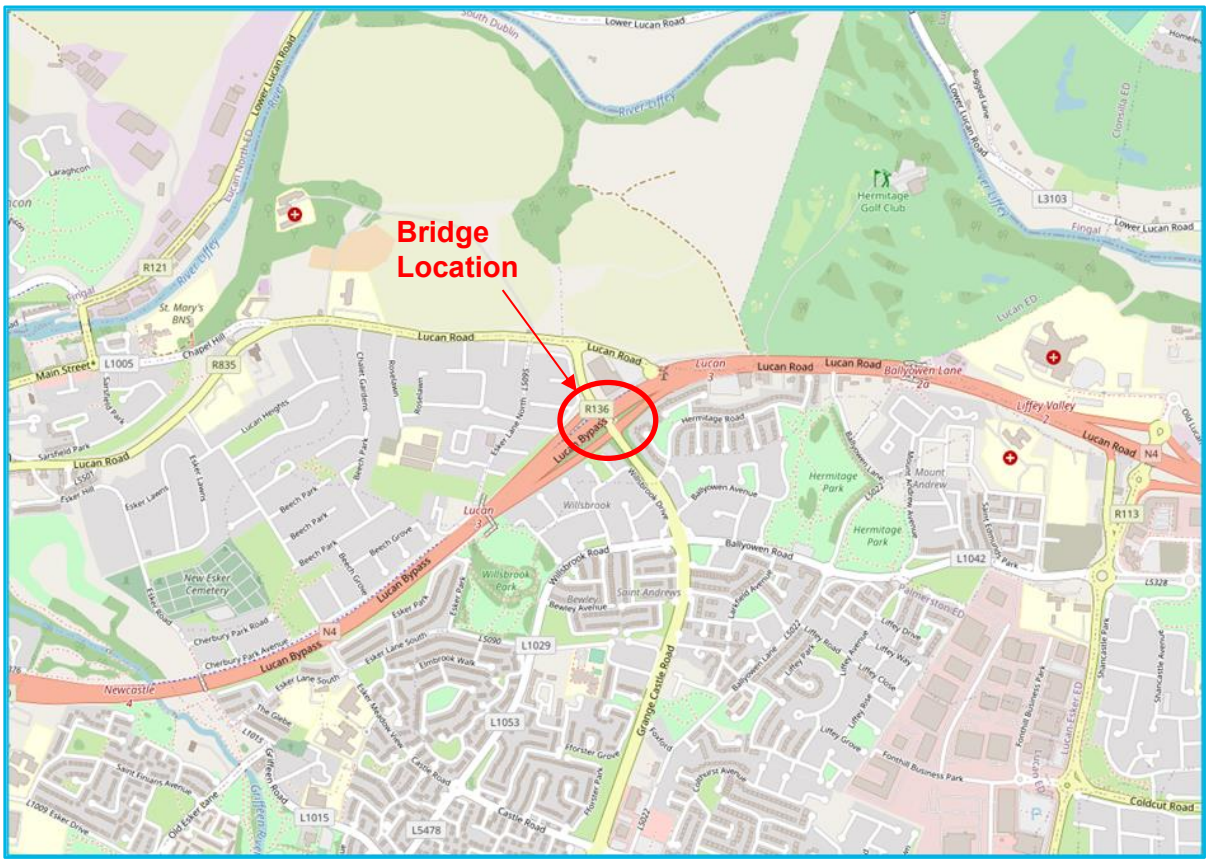
Date	Document Reference	Report Title	Author
May 2021	BCIDA-ACM-STR_ZZ-0006_XX_00-RP-CB-0008	CBC006-ST03 Ballydowd Pedestrian and Cycle Bridge Structures Options Report	AECOM
2020	RPT-16_080-004	Lucan to City Centre Core Bus Corridor Options Study – Feasibility Report	AECOM
2020	BCIDA-ACM-PMG_PD-0006_XX_00-RP-ZZ-0001	CBC06 Preferred Route Options Report	AECOM

The Structures Options Report (SOR) assessed three different bridge options for the Ballydowd Pedestrian and Cycle Bridge. The report assessed each option based on a Multi Criteria Assessment (MCA) and recommended that Option 3 (Removal of Ballydowd Footbridge and construction of a new pedestrian and cycle bridge to the east) should be taken forward to preliminary design as the emerging preferred bridge option. A signed STA-1a form has been received from TII confirming consultation for the SOR stage.

2. Site & Function

2.1 Site location

The Ballydowd Pedestrian and Cycle Bridge will be constructed over the N4 to the east of the Ballyowen Road Bridge, SD-N04-010.00, in Lucan, Co. Dublin. The existing Ballydowd Footbridge will be demolished, and the new bridge will be constructed in the same location. The co-ordinates of the bridge will be 704870.000(E), 735329.000(N) (ITM).



© 2021 OpenStreetMap contributors

Figure 2-1 Location Plan

2.2 Function of the structure and obstacles crossed

The bridge will span six traffic lanes, a bus lane, cycle lane and hard shoulder of the N4 national primary road. The bridge will service the pedestrians and cyclists travelling North/South along the R136 Regional Road, replacing the existing Ballydowd Footbridge.

2.3 Choice of location

The location of the bridge has been determined based on the position of the existing Ballydowd Footbridge and the pedestrian/cycle desire lines along the eastern side of the R136.

2.4 Site description and topography

The surrounding area primarily consists of residential housing and a commercial property located immediately to the north-east of the bridge location. The bridge will span over the N4, which is a busy primary traffic route with high traffic volumes and poses a significant construction constraint. Slip roads on and off the N4 are located at either ends of the bridge and heavily vegetated areas are located at three out of the four corners of the site.

The topography of the site, and the abutment locations in particular, consist of 1:2 earthwork embankments and slip roads sloping down to the N4.

The vertical alignment of the N4 has a shallow gradient, falling to the west. The horizontal alignment of the N4 is a spiral curve at the bridge location, and the carriageways are superelevated as a result with a crossfall towards the existing bridge's south abutment.

Multiple services and utilities are located near the bridge and will be taken into consideration during all project phases.

2.5 Vertical and horizontal alignment

The vertical alignment of the bridge will be a parabolic arch detailed to ensure a minimum vertical clearance of 5.7m to the edge of the N4's vehicle restraint system (vrs) working width envelope.

The horizontal alignment of the bridge will be designed straight from the north abutment to south over the N4 at a skew of 0° to the perpendicular and will be parallel to the adjacent Ballyowen Road Bridge.

2.6 Cross sectional dimensions on the alignments

The proposed cross-section of the bridge is provided below:

Table 2.1 Ballydowd Pedestrian and Cycle Bridge Cross-Section

Section	Width (m)
Three-Dimensional Warren Truss	Varies 0.38 – 2.00
Pedestrian Walkway	2.00
Two-way cycle lane	3.90
Three-Dimensional Warren Truss	Varies 0.38 – 2.00
Total Width	**Varies 6.66 – 9.90**

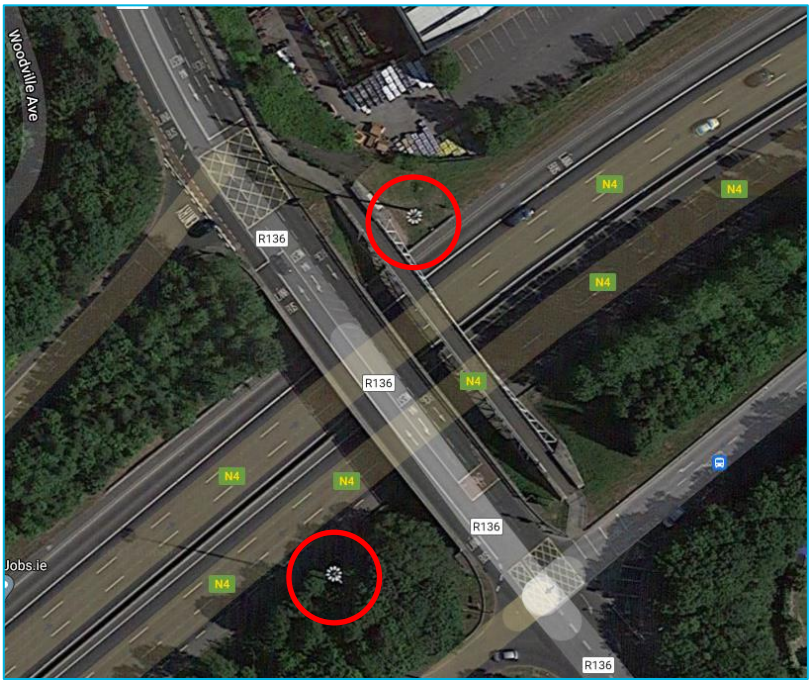
The N4 cross section at the bridge location is as follows:

Table 2.2 N4 Primary Road Cross-Section

Section	Width (m)
Eastbound Cycle Lane	2.00
Eastbound Bus Lane	3.30
Eastbound Carriageway	10.50
Central Median and hard shoulders	2.30
Westbound Carriageway	10.50
Westbound Hard Shoulder	2.60
Total	**31.20**

2.7 Existing underground and overground services

There are a number of existing services, utilities, lighting columns and signage gantries in the immediate vicinity. Lighting columns can be seen on both the westbound and eastbound verges of the N4 at regular intervals, including north-east and south-west of the bridge location.



©Google 2021

Figure 2-2 Lighting Columns at the Bridge Location

The lighting columns are connected to underground electrical cables with low and medium voltage underground electrical cables running under the N4's verges and embankments, as well as at the approaches to Ballyowen Road Bridge.

A water main also runs parallel to the N4 Carriageway beneath the southern verge. Stormwater drainage pipes run along the edges of the N4 with multiple catch basins and manholes in the vicinity. EIR Cables run through ducts in the raised verge on the Ballyowen Road Bridge and Virgin Media Fibre Optic Cables cross the N4 at Ballydowd Footbridge.

2.8 Geotechnical summary

A Preliminary Sources Study Report (PSSR) for the BusConnects Lucan to City Centre CBC was prepared in accordance with Managing Geotechnical Risk DN-ERW-03083 (October 2019), Section 6.1, specifically Appendix C. It addressed the geological, geotechnical, geomorphological, hydrogeological and geo-environmental aspects of the BusConnects CBC.

The Ballydowd Pedestrian and Cycle Bridge was not part of that initial desk study; however, it lies within the general route study.

No site-specific ground investigation has been carried out at this stage.

2.8.1 Relevant existing ground investigations

2.8.1.1. Historical Investigations

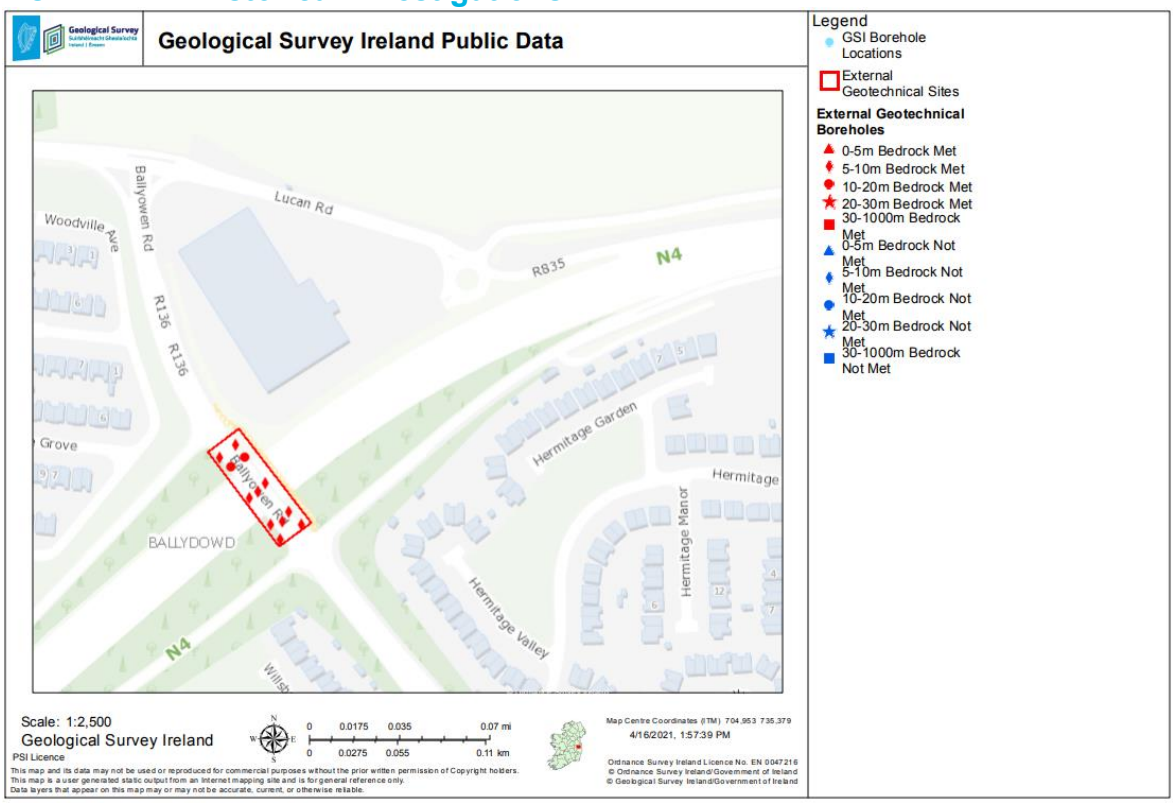


Figure 2-3 Historical Geotechnical Investigation

The above shows the location of the geotechnical investigation carried out for the original bridge, as available from the Geological Survey of Ireland Public viewer. The report was titled “Report on Site Investigation at Ballydowd, Lucan” dated June 1985. The GSI reference for the document is Report 121.

The investigation comprised 12 testholes that were generally terminated in presumed bedrock, by cable percussion boring, or confirmed in bedrock through rotary drilling.

Details of the ground conditions encountered are detailed in Section 2.8.3.

2.8.2 Geology

2.8.2.1. Quaternary Sediments

A review of the site’s underlying geology was completed using available data derived from the GSI spatial data viewer; this indicates that the route is underlain by Glacial Till deposits, derived chiefly from Carboniferous limestone, known colloquially as Dublin Boulder Clay.

It is likely there are fill deposits all present associated with construction of the existing bridges.

2.8.2.2. Bedrock

The GSI Bedrock Geology map (scale 1:100,000) indicates that the site is underlain by the Waulsortian Limestones described as massive unbedded lime-mudstone.

The bridge is fairly close to the boundary between the Tober Colleen Formation described as calcareous shale, limestone conglomerate.

2.8.3 Ground Conditions

Based on a review of the historical report and published literature, typical idealised soil conditions to be anticipated at the site are as follows:

Table 2.3 Soil stratigraphy

Soil Unit	Depth below ground surface (m)	Thickness (m)	
		Range	Average
Topsoil	0 to 0	0.15 to 0.15	0.2
Upper firm sandy gravelly CLAY/SILT	0 to 0.8	0.4 to 2	1.1
Silty Sand (BH 13 only)	1.3 to 1.3	0.6 to 0.6	0.6
Dense sandy GRAVELS with cobbles	0.4 to 1.9	0.3 to 1.5	1.0
Very Stiff to Hard sandy gravelly silty CLAY	1.9 to 4	2 to 6.5	3.7
Bedrock	5.3 to 10.5	0.5 to 5 (penetrated)	1.5

2.8.3.1. Made Ground

Highway fill is associated with existing roads or areas of hard standing; it typically comprises general fill of reworked clay/silt/sands with selected fills formed by silty sandy gravels.

Although not encountered in the historical investigation, it is likely there is made ground or engineered fill associated with construction of the two bridges and development of the area.

The historical construction drawings for the footbridge shows the abutment founded on a strengthened earth embankment of class 6J fill. The existing topography was also regraded with 6N fill.

2.8.3.2. Glacial Till Deposits

The Glacial Till is typical of the drift cover in much of the Dublin area, comprising boulder clay, a lodgement till deposited during the last ice age, about 10,000 years ago. Farrell et al. (1995) made the distinction between the 'Brown Boulder Clay' and the 'Black Boulder Clay', stating that the Brown Boulder Clay was a weathering product of the Black Boulder Clay, and is broadly similar to it in terms of particle size distribution.

The brown Dublin boulder clay, found in the upper 1.5 m to 2.0 m, generally consists of:

- sandy gravelly silt/clay with low to medium cobble content; occasionally soft to firm to 0.5 m; typically, firm / firm to stiff to maximum of about 2 m
- Plasticity Indices ranging from non- plastic to about 15%.
- An undrained shear strength of approximately 50 kPa is typically achievable assuming it is not excessively weathered, corresponding to a CBR % of about 2.0.

The black Dublin Boulder clay is typically found underlying the brown Dublin Boulder Clay but at this location was found underlying granular deposits. It generally consists of:

- Generally stiff / very stiff / sandy gravelly silt/clay with high cobble content and occasional boulders are typical below 2.0m below ground level (bgl).
- SPT blow counts are generally greater than 30 increasing to refusal within 1-2 m from the top of the stratum.
- BS8002 (British Standards Institute, 1994) can be used to relate plasticity index to $\emptyset'_{crit}$, the critical state angle of shearing resistance. Adopting a plasticity index of 15% for soils at greater than 1 m depth, Table 2 of BS8002 provides a "conservative" value for $\emptyset'_{crit}$ of 30°. The relationship published by Knappet & Craig (Craig's Soil Mechanics, 8th Edition, 2012) provides a $\emptyset'_{crit}$ of approximately 32°.

  Published case studies of construction in Dublin Boulder Clay report peak values of the angle of shearing resistance of 30 - 38°. The gravel content of the soils would provide additional frictional resistance, due to interlock, and there is likely to be some long-term effective cohesion.

2.8.3.3. Granular deposits

In all boreholes, a dense sandy fine to coarse gravel, sometimes with cobbles and boulders layer, was encountered. This gravel layer varied in thickness from 0.3 m to 1.5 m. A thin layer of grey silty sand was found overlying the gravel in one borehole.

Suggested weight density published in Figure 1 and Figure 2 of BS 8004:2015 can be used as a guide as well as assessing the relative density based on the measured SPT results.

Using the guidance of BS8004 (British Standards Institution, 2015), a characteristic critical state angle of shearing resistance for the sand and gravel deposits can be derived from the combination of the following:

- 30° + “contribution from angularity of the particles (0-4°)” + “contribution the soil’s particle size distribution (0-4°)”

A characteristic peak angle of shearing resistance can be derived by including the contribution from the soil’s relative density (0-9°) to the above equation.

2.8.3.4. Bedrock

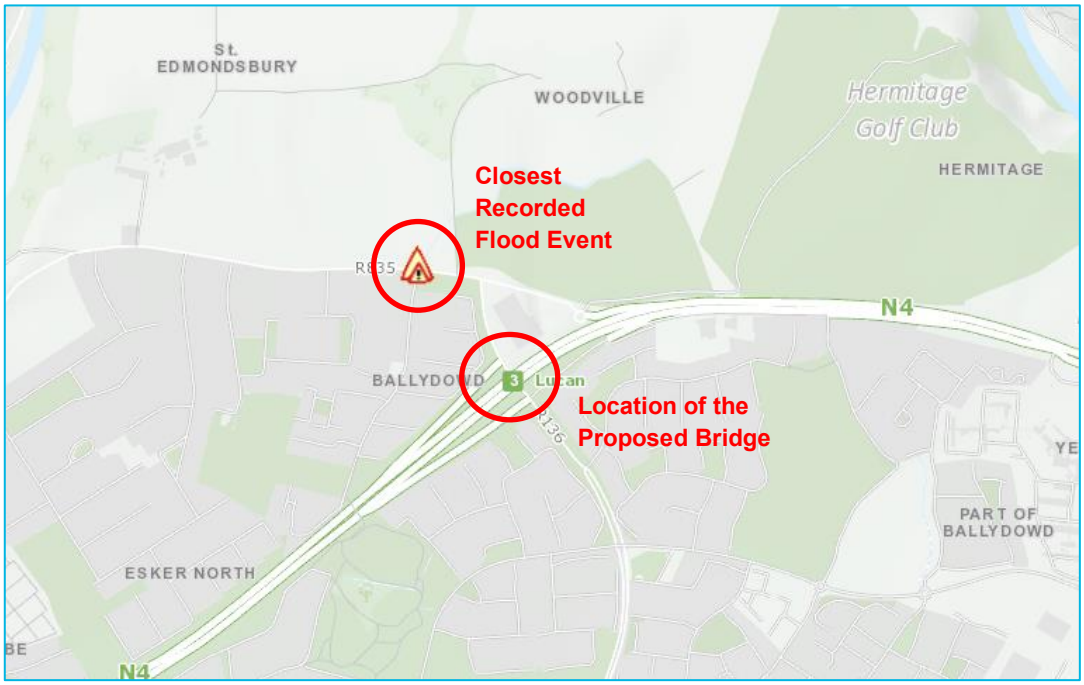
Rockhead level was relatively consistent across the site. It typically varied between 5.3 m and 6.1 m bgl. There was one rotary cored borehole in which rock was found at 10.5 m depth. The authors of the report indicated that it was possible that, due to the very hard nature of the black boulder clay, the driller may have missed the boundary between it and the rock or assumed that a dip occurs in the rock level at this point.

The cores show that the rock consists of alternate layers of limestone and mudstone and displays colour banding. In some places, it becomes very shaley and broken. It is generally strong, but some core recovered from one borehole in the area was weak to moderately weak and very shaley. There was little evidence of weathering except in the top 0.5m or so of the rock.

2.9 Hydrology and hydraulic summary

The River Liffey forms the main hydraulic feature in the surrounding area. The River Liffey is located approximately 830m to the north of the bridge location with no other major waterways or distributary streams in the immediate surrounding area.

A review of the OPW flood mapping (www.floodinfo.ie) in May 2021 shows that the closest historical flood event is a recurring event, located approximately at the junction of Lucan Road and Esker Lane (refer to Figure 8.1). It is expected that construction of a new bridge at the proposed location would have no impact on flood events in the area.



©Ordnance Survey Ireland

Figure 2-4 Historical Flood Locations

Review of the flood mapping in the area should be revisited at detailed design stage to identify any updates to the flood record.

2.10 Archaeological summary

No sites of major archaeological importance were identified at the proposed bridge location during the EIA stage of the project.

2.11 Environmental summary

The EIAR prepared as part of the preliminary design did not identify any particular major environmental impacts associated with the construction of the bridge. The main findings of the EIAR relating to the bridge are as follows:

- Construction of the new cycle and pedestrian overbridge would result in a temporary increase in construction activity. The presence of machinery and visual clutter will contribute to a negative, moderate and short-term impact on townscape/streetscape on this section of the scheme (N4 Junction 3 to M50 Junction 7) during the construction phase.
- There will be no appreciable alteration to the townscape and streetscape character in the operational phase due to new cycle and pedestrian overbridge.
- There is potential for construction activities to result in adverse noise impacts at properties in the surrounding area, however a noise impact assessment is still to be completed. Further detail will be provided on its completion.
- No protected structures are located in the area of the proposed bridge construction.

3. Structure & Aesthetics

3.1 General description of recommended structure or family of structures and design working life

The bridge will be a single-span fully integral structure formed of painted steel three-dimensional arched trusses (50m) spanning the N4 carriageways with cast in-situ reinforced concrete bank seat abutments with spread footing foundations. Expansion and contraction of the bridge will be accounted for by flexure of the arched steel trusses. The longitudinal top, middle and bottom chords, vertical and diagonal bracing will be formed from steel circular hollow sections.

The design working life of the bridge will be a minimum of 120 years as defined in the TII publication, DN-STR-03012 - Design for Durability. Maintainable elements and components listed below are subject to greater wear and will require replacement within the design life. Careful design and detailing combined with thorough routine inspections, quality control and supervision on site will help achieve the minimum expected design life listed in the below table:

Table 3.1 Minimum Design Life for Structural Elements

Component	Years
Parapets	50
Drainage Systems	50
Deck Waterproofing	50
Steelwork Paint Systems	20

3.2 Aesthetic considerations

The appearance of the bridge has been designed in the form and aesthetic of the existing Ballydowd Footbridge which contrasts with the adjacent Ballyowen Road Bridge. This approach is suitable for enhancement of major roadways, where something different will contrast well with the surrounding ‘low-key’ structures. To achieve a contrasting structure, the span arrangement, construction materials, surface finish and principle dimensions, will look distinct form the Ballyowen Road Bridge. This proposal ensures that the new bridge does not visually block the full opening size and shape of the existing bridge and maintains sight distances.

The bridge will be constructed from painted steel, with the choice of paint colour to be determined at detailed design. The choice of colour will be in accordance with DN-STR-03007 and BS4800.

The bridge aesthetics will be considered in depth during detailed design with the CIRIA C543 Bridge Detailing Guide used to determine a number of aesthetic requirements thus ensuring consistency across the bridge.

3.3 Proposals for the recommended structure or family of structures

3.3.1 Proposed Category

The bridge will be a Category 2 structure as the main span is greater than 10m and not greater than 50m in accordance with TII publication DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads.

3.3.2 Span Arrangements

The bridge will be a single span structure composed of an arched three-dimensional warren truss span of approximately 50m over the N4 carriageways with an internal clear width of 5.9m.

3.3.3 Minimum headroom provided

A minimum vertical clearance of 5.7m will be provided and shall include the area within the working width of the vehicle restraint system (vrs) located along the edge of the N4 in accordance with TII publication DN-GEO-03036, Cross-Sections and Headroom.

3.3.4 Approaches including run-on arrangements

The bridge will be required to tie-in to the existing and proposed infrastructure along the R136. The tie-in points will be at the proposed pedestrian and cyclist crossing of the N4 westbound diverge slip road and the proposed two-way cycle lane and pedestrian footpath running along the R136 on the North Approach. All approaches will be designed in accordance with DN-STR-03005 and DMURS and be provided with a maximum 1-in-20 gradient from finished deck level.

No run-on slabs will be included within the design.

3.3.5 Foundation type

The high-level bank seat abutment will have a pad foundation supported on structural fill. The dimensions of the pad foundation will be confirmed during the detailed design stage and are dependent on the soil bearing pressure at the north and south support locations.

3.3.6 Substructure

The substructure will be reinforced concrete bank seat abutments to the north and south of the N4 of a similar design to the existing bridge's design. The front wall of the abutments will be inclined, with the pleasing effect of adding visual 'tension' to the deck. Due to the curve of the bottom truss chord in both plan and elevation, the abutments are required to be relatively large. To minimise this effect, the existing bridge abutments' front faces form taper 'H' sections, with the inner section of the abutment hollow. The side slope in front of the abutment will continue into this hollow, effectively reducing the perceived scale of the concrete abutment.

3.3.7 Superstructure

The superstructure will consist of three-dimensional warren-trusses supporting a steel deck. The superstructure will be fully integral with the northern and southern abutments. Structural steel circular hollow sections will be used as the main top and bottom longitudinal chord members. Diagonal bracing between the top, middle and bottom chords will stiffen the superstructure against deflection and provide lateral stability.

3.3.8 Articulation arrangements, joints and bearings

The bridge will be designed to be fully integral at the superstructure and supports. The result is that no bearings or expansion joints will be required. Thermal expansion and contraction of the bridge will be accounted for by flexure of the arched steel trusses.

3.3.9 Vehicle Restraint System (VRS)

No vehicle restraint system is required on the bridge superstructure.

The existing steel vehicle restraint system at the south side of the N4 carriageway will be replaced with a W1 steel barrier during the construction of the bridge, extending a minimum of 30m on approach and departure from supports in accordance with TII publication DN-REQ-03034, The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges. A W1 rated barrier is required at this location to minimise vehicle intrusion and prevent accidental impact with the superstructure's bottom longitudinal chord. The required 5.7m minimum vertical clearance shall be achieved to the back of the W1 barrier working width.

The concrete barrier at the north side of the N4 carriageway will be retained. The barrier prevents errant vehicles from impacting the existing road bridge's northern concrete pier. This barrier is not required to prevent collision with the proposed pedestrian and cycle bridge as the supports and bridge superstructure do not encroach on the existing barrier's VRS clearance envelope.

3.3.10 Drainage

The bridge's arched shape shall ensure water runs off the deck longitudinal from the centre of the span towards the abutments. This avoids the need for longitudinal drainage systems along the bridge deck and limits the risk of standing water and ice on the bridge deck. Drainage systems will be provided at either end of the bridge to connect the bridge run-off to nearby drainage infrastructure.

3.3.11 Durability

The bridge will be designed in accordance with the TII publication DN-STR-03012 - Design for Durability with a minimum design life of 120 years. The design life for replaceable parts such as waterproofing systems and surfacing will be 50 years in accordance with DN-STR-03012. The design working life of the bridge will be working life category 5 while replaceable parts will be working life category 2 in accordance with GE-POL-01008.

All exposed structural steelwork will have a protective paint system applied such that no maintenance shall be required up to 12 years and no major maintenance before 20 years. The steelwork will be designed and detailed to discourage the accumulation of water, dirt and debris and minimise the risk of rusting or deterioration. Intermittent welds will be avoided, with simple connections utilised as the preferred.

All buried concrete surfaces will be treated with two coats of epoxy resin waterproofing in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

All exposed concrete surfaces will receive a hydrophobic pore lining impregnation in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

3.3.12 Sustainability

Structural steel members will be prefabricated in a factory with high precision and efficiency. This reduces the material waste and disposal requirements thus reducing the environmental impacts and harmful emissions created in production.

The use of cement replacement products, such as Ground Granulated Blast Slag (GGBS) will be maximised in the foundation design, reducing the environmental impacts of concrete production. The replacement levels will be in accordance with the levels specified within IS EN 206:2013.

3.3.13 Inspection and maintenance

Maintenance and inspection of the Ballydowd Pedestrian and Cycle Bridge will be required throughout its service life. The inspections will be carried out in line with the TII EIRSPAN Bridge Management System. The EIRSPAN system was introduced in 2001 to provide an integrated management system for the bridges in Ireland. The system coordinates activities such as inspection, repairs and maintenance work to ensure optimal management of the bridge stock. As a minimum the following inspection regime should be implemented:

- Routine Inspection – every year;
- Principal Inspection - every six years.

The structural form enables inspection and minor maintenance of the top of deck, top chord, middle chord, vertical and horizontal bracing and mesh to be carried out from the deck level. Inspection and maintenance of the bridge soffit will require access from the N4 carriageway and temporary lane closures. The soffit of the bridge can be designed to incorporate details allowing rope inspections which eliminates the need for MEWP access to the N4. Lane closures should be programmed to coincide with inspection of the existing Ballyowen Road Bridge to minimise disruption to traffic.

4. Safety

4.1 Traffic management during construction including land for temporary diversions

The bridge is to be constructed over the N4 carriageway at Junction 3. The N4 is a highly trafficked national primary road. The construction sequence will avoid construction within/over the carriageway where possible and reduce the need for traffic management measures on the N4. The bridge has been detailed with a main clear span over the N4 to avoid works within the central reserve and associated traffic management.

Options to fabricate and transport the fully assembled superstructure directly from the fabricators to the bridge location in one piece shall be considered. However, if this is not possible the superstructure will be transported in sections and assembled within the temporary land take boundary within the Liffey Valley Shopping Centre (2km east of the bridge location). Once fabricated, the superstructure will be transported in one piece to site along the N4 carriageway, while appropriate road closures and traffic management are in place. Erection of the superstructure will be carried out by a crane positioned on the N4 carriageway and hard shoulders. During the bridge erection all carriageways of the N4 will be closed in the eastbound and westbound directions with traffic management required to divert traffic. It is expected that during the closures traffic will be diverted via the on and off-slip roads at Junction 3, the R136 regional Road and the Lucan Road slip road to the N4. It is expected that closure of the N4 carriageways will be limited to a single closure during night-time or weekend works, limiting the effects on traffic flow.

During construction stage, a vertical clearance of 5.7m to the N4 carriageways will be maintained at all times.

The location of the new bridge is approximately 5m east of the existing Ballyowen Road Bridge, which carries R136 road traffic over the N4 at Junction 3. One lane of this bridge should be made available for pedestrians and cyclists to cross over the N4 following the closure of the existing Ballydowd Footbridge until construction is complete. Site compounds and site access routes should account for pedestrian and cyclist movement over the N4 via the Ballyowen Road Bridge.

4.2 Safety during construction

As part of the design development, a Designer's Risk Assessment (DRA) has been prepared in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013 and the amendments of 2019 and 2020. The DRA shall be viewed as a working document to be developed further as the design develops. The DRA includes all risks identified and the resulting mitigation measures or alterations incorporated within the design, where no mitigation is possible the DRA will be used to communicate the risks to the Contractor and site personnel.

Where possible, the hierarchy of risk control will be implemented within the design and construction, with the Designer and Contractor aiming to control all risks through elimination. Where this is not possible, reduction, isolation or mitigation controls will be incorporated to ensure safety during construction.

The bridge will be detailed with a single span over the N4 eliminating construction requirements within the central median of live carriageways and minimising disruption to traffic. A site compound will be established at the Liffey Valley Shopping Centre and away from the N4 carriageway allowing for storage and assembly of the prefabricated structural steel units and minimising construction requirements adjacent to the live carriageways. Hoarding, fencing and secure compound entrance locations will need to be established to prevent access from the public potentially leading to injury and mitigate the risk of vandalism and theft of construction equipment at the bridge location.

4.3 Safety in use

Safety of the end user will be considered as part of the Designer's Risk Assessment. A routine inspection will be carried out at least once a year or after any significant event in line with the recommendations contained within the EIRSPAN Bridge Management System, as defined by TII. The routine inspection will take account of any defects and establish whether the bridge requires a Principal Inspection to be carried out or if routine maintenance consisting of simple remedial works is sufficient to maintain the safety of the day to day pedestrian traffic on the bridge. A Principal Inspection can only be carried out by an approved Principal Inspection Team Leader according to the TII Bridge Management Section. The Principal Inspection shall record all findings from the bridge on the EIRSPAN database for future reference.

Pedestrian bridges in the past have been susceptible to dynamic excitation, due to the frequency of pedestrian movements and wind loading. Depending on the conditions, if the frequency of the loading approaches the natural frequency of the bridge it can result in excessive vibrations causing discomfort to the user. A dynamic analysis will be carried out as part of detailed design to determine the natural frequency and response of the bridge to movement. This analysis will allow the designers to make adjustments to the bridge design such as increasing the dead load moving the natural frequency of the bridge away from the expected range of frequencies from the live loading and improving the comfort of the user.

The bridge incorporates a longitudinal fall across the deck to mitigate the slip hazard due to standing water and ice on the deck surface. The approaches will have a maximum constant gradient of 1-in-20 in line with DMURS recommendations. The main bridge span will be greater than 2m from the adjacent Ballyowen Road Bridge to deter attempts from people to cross between the bridges (in accordance with Section 3.2 of DN-STR-03005).

Vehicle restraint systems will be provided as defined by TII Publication DN-GEO-03036. The vehicle restraint systems will provide sufficient approach and departure lengths for the proposed footbridge and existing road bridge. They will protect against collision from an errant or oversized vehicle and account for the working width of the restraint system and vehicle intrusion width.

4.4 Lighting

No public lighting is to be installed on the bridge structure. Instead the existing public lighting levels in the area will be maintained providing suitable lighting levels across the bridge deck.

5. Cost

5.1 Budget Estimate in current year

The construction costs provided below have been based on quantities calculated from the preliminary bridge design. Elements associated with bridge and ramps such as earthworks, piling, concrete, reinforcement, structural steelwork and waterproofing have been included. Rates have been based on AECOM's internal cost database or based on Spon's Civil Engineering and Highway Works Price Book 2021 as required. It should be noted that costs are indicative only and may vary depending on the detailed design and the Contractor's methodology.

During the preliminary design stage, Thompsons of Carlow Ltd. have been engaged to provide current Structural Steelwork rates (2021). The steel tonnage quantities were based off the preliminary design drawings provided in Appendix B. The rates provided include supply, fabrication, painting, installation, and all associated quality assurance for all structural steel elements including bridge parapets.

Allowances have been made for preliminaries, consultancy fees and contingency. A budget of 20% of the construction cost has been provided for preliminaries to cover traffic management, PSCS, temporary accommodation etc. The contingency is 20% of the construction cost and will cover minor elements such as drainage, fencing, landscaping works and any unforeseen unknowns. Finally, an allowance of 10% of the construction cost has been provided for professional fees to deliver the bridge from detailed design to handover. These fees will include detailed design, CAT II checks, construction supervision and handover.

The rates used to calculate the amounts presented in the below table are all exclusive of VAT. No allowance has been made for land acquisition within the costs provided below. The cost of land acquisition will be covered under the construction costs for the entire BusConnects CBC06 Lucan to City Centre route.

Table 5.1 Budget Estimate in the current year

Series	Amount (€)
CC-SPW-00400 – Road Restraints Systems (parapet)	150,000.00
CC-SPW-00600 – Earthworks	219,672.00
CC-SPW-01700 – Structural Concrete	418,560.00
CC-SPW-01800 – Structural Steelwork	506,906.00
CC-SPW-02000 – Waterproofing of Structures	31,500.00
Construction Cost	1,326,638.00
Demolition Cost	200,000.00
Preliminaries (20% of Construction Cost)	265,328.00
Contingency (20% of Construction Cost)	265,328.00
Professional Fee (10% of Construction Cost)	132,664.00
Total Cost	2,189,957.00

6. Design Assessment Criteria

6.1 Actions

6.1.1 Permanent Actions

Permanent actions and material densities will be applied in accordance with IS EN 1991-1-1 and the Irish National Annex. Material/partial factors will be as detailed in IS EN 1990 and the Irish National Annex. The accepted densities for principal construction materials are as follows:

Table 6.1 Material Densities for Design

Material	Density
Reinforced Concrete	25 kN/m^3
Structural Steelwork	78.5 kN/m^3
6N/6P backfill to structures	21 kN/m^3

6.1.2 Snow, Wind and Thermal Actions

Snow loads are not deemed a critical load case and will not be considered in accordance with the National Annex to IS EN 1991-1-3.

Wind loading will be considered in accordance with IS EN 1991-1-4 and the Irish National Annex. Wind loads will be taken to act simultaneously with other loads in accordance with the NA to IS EN 1990. Wind loads will not be considered in combination with thermal loading in accordance with clause A2.2.2 (6) of the NA to IS EN 1990.

Thermal loading will be considered in accordance with IS EN 1991-1-5 and the Irish National Annex. The combination of thermal and wind loading will not be considered for the bridge in accordance with the National Annex to IS EN 1990.

6.1.3 Actions relating to normal traffic

Not applicable.

6.1.4 Actions relating to abnormal traffic

Not applicable.

6.1.5 Footway or footbridge live loading

Actions on the bridge will be considered in accordance with IS EN 1991-2 and the Irish National Annex. The bridge will be designed for a uniformly distributed load pedestrian loading of 5kN/m^2. In addition, the bridge will also be designed for a concentrated load of 20kN acting on a square surface area 0.2m by 0.2m. If required, the bridge will be designed as a large footbridge (greater than 6m) and complementary load models, with associated combination rules, would have to be defined for the project in accordance with IS EN 1991-2 5.1(2) Note 2.

No service vehicle loading will be considered as part of the design as service vehicles will be excluded from crossing the bridge through the introduction of suitable bollards on approach to the bridge.

6.1.6 Provision for exceptional abnormal loads

Not applicable

6.1.7 Accidental actions

Not applicable. The bridge will be designed to provide a minimum of 5.7m clearance above the N4 carriageways avoiding the risk of accidental impact with the superstructure. The bridge substructures will be set-back sufficiently outside of the clear zone of the carriageways.

6.1.8 Actions during construction

Actions arising during construction will be considered in accordance with IS EN 1991-1-6 and the Irish National Annex.

6.1.9 Any special loading not covered above

Not applicable.

6.2 Authorities consulted and any special conditions required

The following authorities have been consulted as part of the development of the scheme:

- South Dublin County Council
- Transport Infrastructure Ireland
- National Transport Authority

6.3 Proposed departures from standards

No departures from standards are envisaged for the design and construction of the bridge.

6.4 Proposed methods of dealing with aspects not covered by Standards

Not applicable.

7. Ground Conditions

7.1 Geotechnical Classification

Applying the guidance in IS EN 1997-1, it is considered that Geotechnical Category 2 is currently the most appropriate for the proposed bridge.

7.2 Description of the ground conditions and compatibility with proposed foundation design

A review of the historical tender drawings for the Ballydowd Footbridge constructed circa 1986 indicate the foundations for the northern and southern abutment, and northern, central and southern piers consisted of shallow footings founded at elevation 48m.

A review of the historical construction drawings for the footbridge constructed circa 2005 indicate the foundations for the northern and southern abutment consist of shallow footings at an elevation of 50.721m founded on a strengthened earth embankment.

The strengthened earth embankment comprises Class 6J fill and is reinforced with geogrid and has side slopes of 1H:1V. The thickness of the earth embankment is about 2.2 m. The embankment is founded at elevation 48.5m.

A review of the geotechnical report carried out in 1985 indicated the thin gravel layer was present between 49m and 50 m OD. As the formation level is 48 and 48.5 m respectively, it is likely that the existing bridges have been founded on the very hard brown/black boulder clay underlying the gravel layer. The existing report quoted allowable bearing capacities in the order of 375 kN/m².

It is recommended the new pedestrian and cycle bridge is founded on spread footings at a similar elevation to the existing bridges on the likely hard black/brown boulder clay. Should the abutment level be kept at similar level to the existing footbridge, a strengthened earth embankment or similar founded on the hard black/brown boulder clay could be considered to meet design elevations.

Care should be taken to avoid disturbing the existing bridge during deconstruction and excavating to a suitable formation depth.

Groundwater was encountered in the gravel layer in the historical report. Any dewatering during construction should be carefully designed to avoid inducing additional settlements into the existing bridge.

8. Drawings and Documents

8.1 List of all documents accompanying the submission

The following table lists the drawings accompanying this submission. The drawings are contained within Appendix B:

Table 8.1 Ballydowd Pedestrian and Cycle Bridge Drawing List

Drawing Number	Revision	Drawing Title
BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0101	L02	ST03 – Ballydowd Pedestrian & Cycle Bridge Plan
BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0102	L02	ST03 – Ballydowd Pedestrian & Cycle Bridge Details Sheet 1
BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0103	L01	ST03 – Ballydowd Pedestrian & Cycle Bridge Details Sheet 2

Appendix A – Photographs

Figure A1 East Elevation of the Existing Ballydowd Footbridge

Figure A2 The soffit of the bridge structure and the South Revetment

Figure A3 The south abutment of the Existing Ballydowd Footbridge

©Google 2021

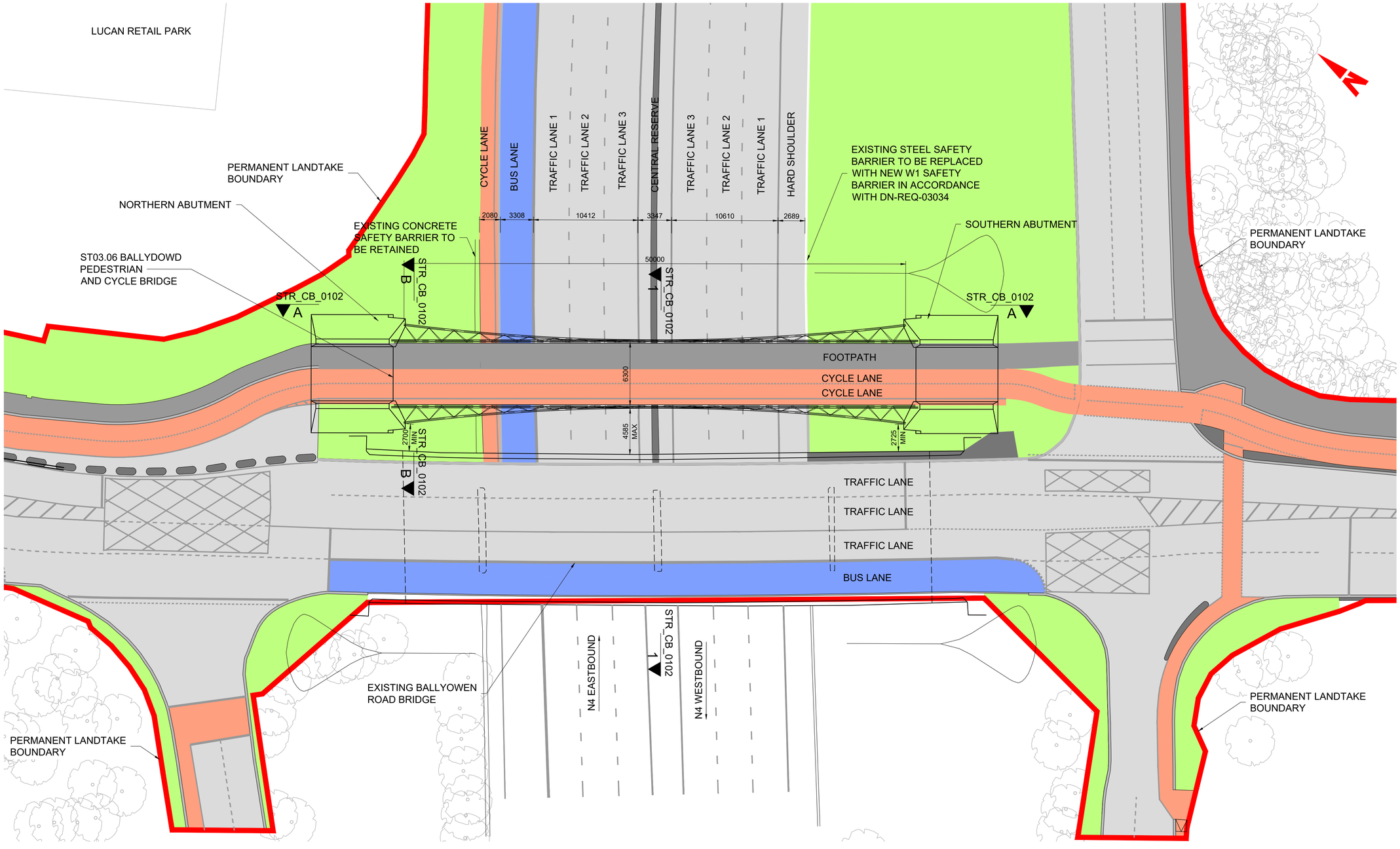
Figure A4 East Elevation of Ballydowd Footbridge

Figure A5 Proposed South Abutment Location

Figure A6 Existing Junction at the South Approach to the Bridge

Figure A7 North Approach to the Exsting Ballyowen Road Bridge and Ballydowd Footbridge

Appendix B - Drawings



PLAN
1:200 @ A1
1:400 @ A3

C:\users\stephen.french\appdata\local\projectwise\workdir\mott-gb-pw-03\d0242614\BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0101.dwg

Project Ireland 2040
Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L02.1	13/07/21	---	---	---	
L01	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL

Client: NTA Údarás Náisiúnta Iompair / National Transport Authority
Engineering Designer: AECOM / MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
13/07/21	AS SHOWN @ A1 AS SHOWN @ A3	---	---	---

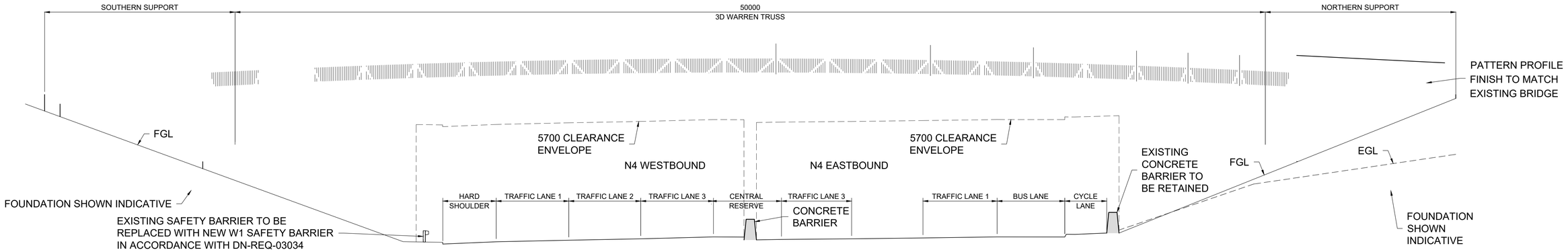
Project Code	Originator Code	QMS Code
BCIDA	ACM	

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

Drawing Title: LUCAN TO CITY CENTRE SCHEME
ST03.06 BALLYDOWD PEDESTRIAN & CYCLE BRIDGE
PLAN

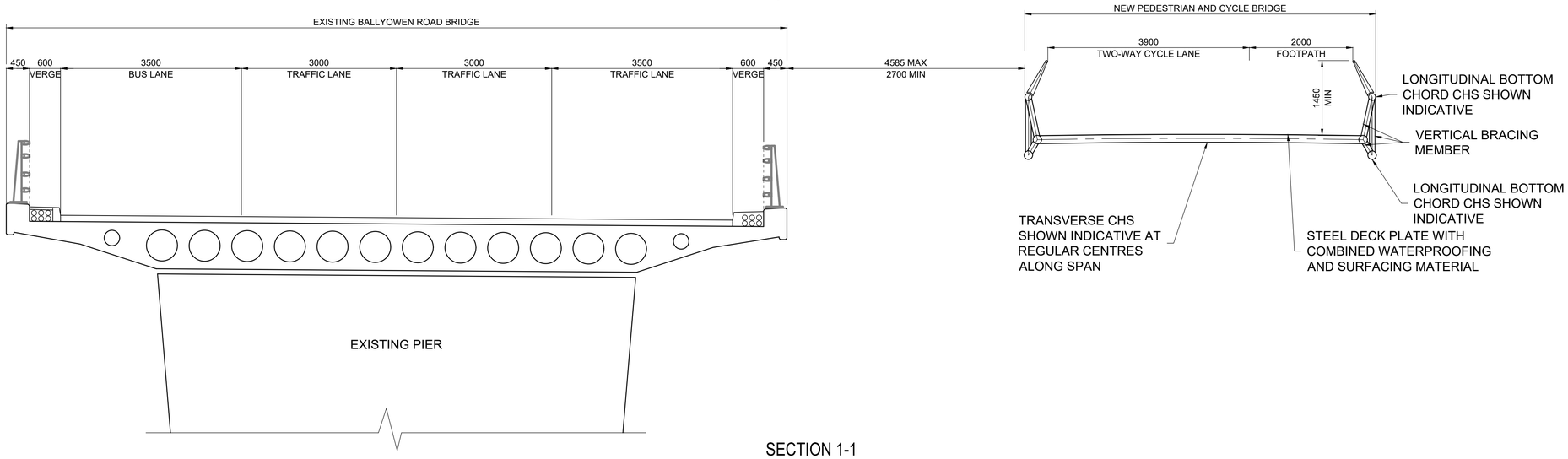
Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0101	1 of 1		L02.1

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



ELEVATION A-A

1:100 @ A1
1:200 @ A3

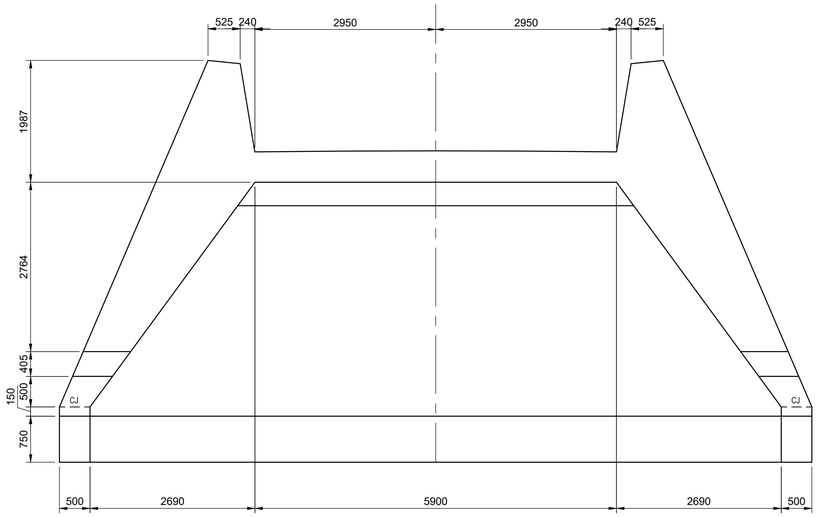


SECTION 1-1

1:50 @ A1
1:100 @ A3

TYPICAL SECTION THROUGH ABUTMENT

1:50 @ A1
1:100 @ A3



ELEVATION B-B

1:50 @ A1
1:100 @ A3

L02.1	13/07/21	---	---	---	
L01	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL

Project Ireland 2040
Building Ireland's Future

NTA
Údarás Náisiúnta Iompair
National Transport Authority

AECOM

MOTT MACDONALD

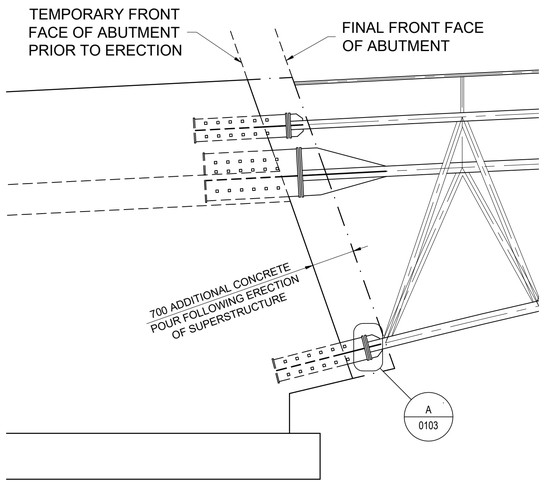
BUSCONNECTS DUBLIN
CORE BUS CORRIDORS INFRASTRUCTURE WORKS

LUCAN TO CITY CENTRE SCHEME
ST03.06 BALLYDOWD PEDESTRIAN & CYCLE BRIDGE
DETAILS SHEET 1

13/07/21
AS SHOWN
AS SHOWN
--- --- ---

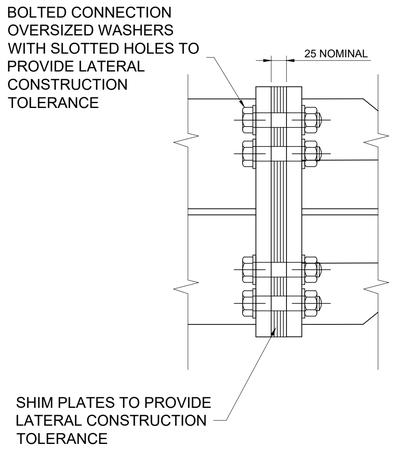
BCIDA ACM BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0102 1 1 L02.1

C:\users\stephen.french\appdata\local\projectwise\workdir\mott-gb-pw-03\d0242814\BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0102.dwg



ELEVATION ON ABUTMENT

1:50 @ A1
1:100 @ A3

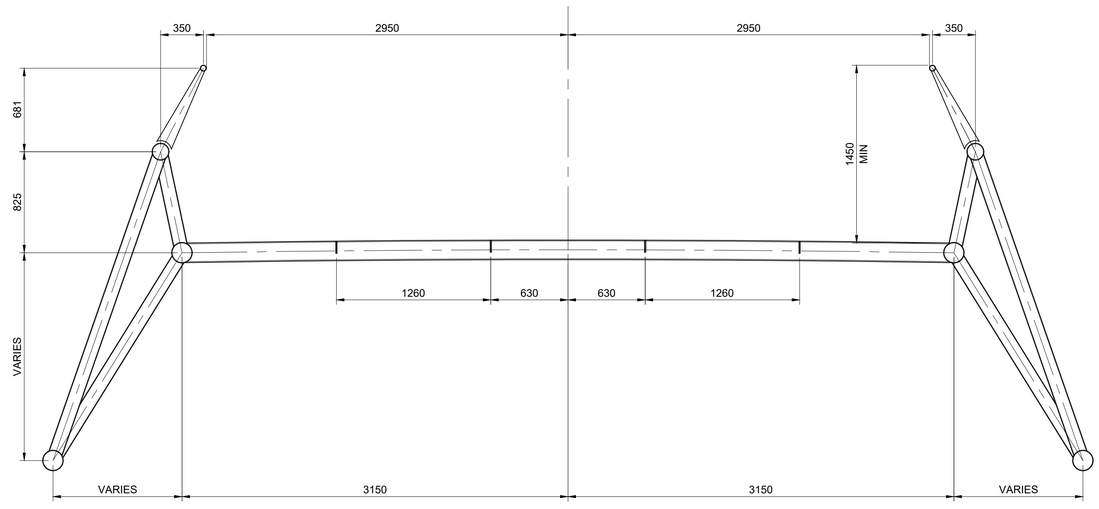


DETAIL A

1:5 @ A1
1:10 @ A3

TYPICAL PLAN VIEW OF DECK PLATE

1:50 @ A1
1:100 @ A3



TYPICAL SECTION THROUGH DECK PLATE

1:25 @ A1
1:50 @ A3

Project Ireland 2040
Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L01.1	13/07/21				

Client: NTA — Údarás Náisiúnta Iompair, National Transport Authority

Engineering Designer: AECOM / MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
13/07/21	AS SHOWN @ A1, AS SHOWN @ A3			

Project Code	Originator Code	QMS Code
BCIDA	ACM	

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

Drawing Title:
LUCAN TO CITY CENTRE SCHEME
ST03.06 BALLYDOWD PEDESTRIAN & CYCLE BRIDGE
DETAILS SHEET 2

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_BR_01-DR-CB-0103	1 of 1		L01.1

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

Appendix C - Designers Risk Assessment

BusConnects Package A – CBC006 Lucan to City Centre
CBC006-ST03 Ballydowd Pedestrian and Cycle Bridge
Designers Risk Assessment

Project Number:	60599126	**Revision**						
Client:	National Transport Authority	**Rev**	01	02	03	04	05	06	07
Designer:	AECOM	**Date**	17/08/21						
Contractor:	Not applicable	**Client**	✓						
Prepared by:	Stephen French	**Designer**	✓						
Checked by:	Arthur Costello	**Main Contractor**	-						
Approved by:	Niamh Rodgers	**Sub-Contractors**	-						
		Other	-						

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
1	Live National Primary Road	Site is on the N4. The road will be live during majority of construction.	High	Bridge has been designed with a main span over all lanes of the N4 avoiding works within the central reserves. All traffic lanes to be closed during lifting of bridge superstructures Traffic management to be implemented to ensure that safe working zones are provided to any works near live carriageways.	Live traffic with traffic management zones	Medium	Traffic Management will be required for bridge lifts and any construction works on or near live carriageways. All traffic management plans to be developed in accordance with Chapter 8 of the Traffic Signs Manual. Contractor is to ensure that all staff are aware of the risks of working near a live road.
2	Access and egress to the site and compound	Access and egress to site and compound from busy urban area.	High	Design of the overall CBC06 Lucan to City Centre has ensured that sufficient lands are made available within the temporary CPO area. All lands are to be accessed from the N4 westbound off-slip road and the R136 Regional Road to avoid requirements for site entrances/exits on the main N4 carriageway.	N/A	Low	Contractor to be made aware of temporary CPO area and to ensure that construction works are carried out within this area. Contractor to ensure that access and egress to the site is from the N4 westbound off-slip road and the R136 Regional Road.
3	Site security	Unauthorised access by members of the public to the works areas	High	Sufficient space has been provided within the Temporary CPO area to allow suitable hoarding/fencing to be erected to prevent unauthorised access to the works areas	N/A	Low	Contractor to ensure that fencing is erected and maintained throughout the construction works.

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
4	Plant movements	Insufficient ground bearing pressure for site works.	Medium	Preliminary Ground investigations have been carried out to determine if there are potential risks of low ground bearing pressures.	N/A	Low	Further Ground Investigations to be carried out as part of Detailed Design to determine any further areas of low ground bearing pressures. Appropriate hoarding to be provided at construction stage to separate works from areas of adverse ground conditions.
5	Multiple Nearby Construction Activities	Numerous concurrent construction activities are expected to take place at different locations along the N4 as part of the construction of CBC006	Medium	Phasing of the construction works has been considered to avoid works being carried out in parallel on CBC006	N/A	Low	Contractor to discuss sequencing and construction programme with the client. On-site personnel to be aware of ongoing site activities and follow any appropriate safety requirements. Barriers and hoarding to be put in place as appropriate to protect on-site personnel and segregate different site activities.
6	Underground services	Potential for unknown and/or undocumented services in the vicinity of the proposed structure.	Medium	Desk top study of available utility information carried out and all known services in the vicinity of the proposed structure have been shown on preliminary design drawings.	In correct utility locations provided in information received from utility providers. Changes to utilities in the period before construction.	Low	Further desk top study to be carried out at Detailed Design stage to identify any additional services which have been constructed in the interim. At construction stage full CAT scan site survey to be carried out prior to commencement. Any services identified should be located by hand excavation, marked and protected or re-routed before commencement of works.
7	Excavation adjacent to an existing Structure and live carriageway	Excavations required to construct the bridge run the risk of undermining the live carriageways and adjacent Ballyowen Road Bridge.	High	The bridge location and geometry has been determined to avoid excavation works that would undermine Ballyowen Road Bridge. The bridge supports have been set back from the edge of carriageways to ensure safe working zones can be achieved with minimal traffic management required.	N/A	Low	The contractor is to be aware of the risk of undermining existing N4. As part of the detailed design the construction methodology should consider if sheet piling is required to avoid undermining. The contractor is to ensure that vibration levels from excavation are limited and that safe working limits are developed prior to works.

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
8	Structural Instability	Instability of structural elements during construction	High	The preliminary design has been developed for a three-dimensional warren truss construction with a braced pair of trusses chords to ensure stability during construction.	N/A	Medium	Where required the Contractor shall ensure that temporary works are provided on site to ensure structural stability during construction. All temporary works required are to be designed by a temporary works designer.
9	Bridge Superstructure Construction	Risks to operatives during cutting & welding of steel members	High	The preliminary design has ensured that the bridge superstructure can be fabricated off site in a controlled environment and assembled on site limiting the amount of on-site works required.	Works to assemble the superstructure within the site compound	Low	Contractor is to ensure that assembly of the bridge superstructure is carried out by suitably qualified steel workers
10	Bridge Superstructure Construction	Transportation and delivery of bridge superstructure	High	The preliminary design has ensured that the bridge superstructure can be fabricated off site and assembled within the site compound. The bridge will be delivered to site in sections to avoid major logistical issues with delivery of the a fully assembled superstructure	N/A	Low	Contractor and detailed designer to liaise with the steel work fabricator to ensure that transportation and delivery of the bridge can be successfully achieved.
11	Working at Height	Risk of fall of plant, materials, and people.	High	The bridge design has been developed to ensure the main bridge span can be lifted into position fully assembled avoiding the need for works from height over live carriageways of the N4. Simple connection details such as bolting have been considered as part of the preliminary design to avoid the need for welding from height. Back span/ramps and stairs have also been designed to be lifted into position fully assembled where practical.	N/A	Medium	Detailed Design and Contractor to consider construction methodology of back span, ramps and stairs to ensure minimal lifts are required. Where these elements are lifted in sections the Contractor shall ensure appropriate guard rails and netting provided to the structure to prevent falling objects. Contractor to ensure suitable fall restraint systems/harnesses to be used when working at height.

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
12	Night-time Working	Reduced visibility and fatigue caused by night-time working poses the risk of slips, trips, falls and unsafe working practices being incorporated.	High	The preliminary design has assumed that main span of the bridge will be lifted during night-time works and closure of the N4. The design has been developed to ensure the lifting can be carried in a single night limiting the requirements for night-time working.		Low	The Detailed Designer and Contractor will need to consider the construction methodology and sequencing to limit night-time working. Where night works are required the Contractor must ensure that all staff are briefed on the dangers of night-time work and that site personnel are not overworked and remain vigilant.
13	End-users pedestrian crossings	The bridge is located at a busy junction on the highly trafficked N4 national primary road and there is a potential for a pedestrian to be struck by an errant vehicle.	Medium	A number of locations were considered for the new bridge. The designers have selected the option that requires the minimum number of pedestrian crossings at Junction 3.		Low	Not Required.