Cork City Council

Harley Street Pedestrian/Cycle Bridge

Pre Planning Application Coordination Package

Preliminary Design Report

Job Number: 253690-00

ARUP

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Harley Street Bridge Pedestrian/Cycle Bridge

Preliminary Design Report

253690_RPT_002

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Contents

1 Introduction

1.1 Design Brief

In September 2016, Cork City Council released tender documentation calling for a new bridge that would traverse the North Channel of the River Lee between the existing Brian Boru Bridge and St. Patrick's Bridge in Cork City Centre, The location of the bridge was to be as shown in Figure 1 below.

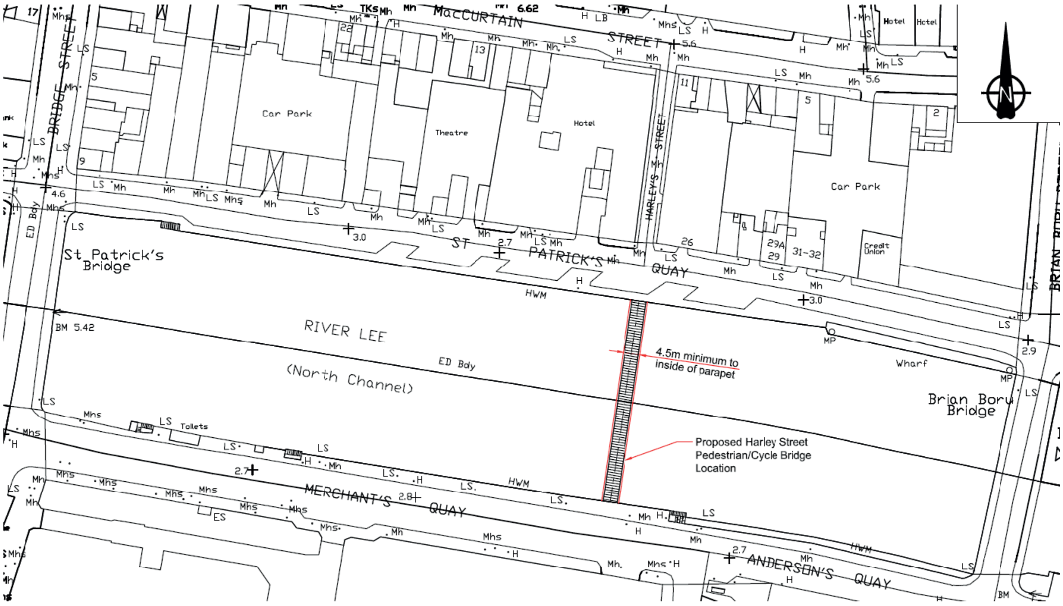

Figure 1: Initial proposed location of bridge

The brief stated that the purpose of the proposed structure is to improve pedestrian and cycle connectivity between St. Patrick's Quay and Merchant's Quay, thereby improving the links between the City Centre, MacCurtain Street, Kent Railway Station and the surrounding areas. The design for the bridge was also to include crossing facilities to the north and south of the proposed bridge and related public realm treatments.

The proposed bridge was required to be a low level structure with a single span of approximately 66 metres. The general parameters and requirements for the bridge were as follows:

• Safe and attractive pedestrian and cycle passage across the North Channel of the River Lee through a common pedestrian/cyclist area

• Minimum clear parapet-to-parapet width of 4.5 metres

• An elegant and attractive solution that is appropriate for and sympathetic to its environment and topographical setting

• Cost-effective design

• Allowance for floodwater levels in accordance with the Lower Lee (Cork City) Flood Relief Scheme, with a minimum quay wall opening level of +3.5m AOD or alternatively a suitable flood defence proposal must be provided.

• Protection bollards or similar to restrict access to pedestrian and cyclists only.

• Wind protection

• Aesthetically-pleasing night-time illumination

• High quality detailing and execution

• Design and construction methods that minimise social and environmental impacts

• Minimised impacts on the river view

• Maintain the current navigation passage along the river

• Embrace current developments and practice in sustainable development

• Provide for a sustainable and cost effective solution that minimises future maintenance

1.2 Proposed Scheme

Our design team's response to the brief was a simple, yet elegant, shallow arched bridge. The low key proposal resided in its setting with a muted calm, allowing users to enjoy a moment of solace on their journey and inviting them to rest a while and take in the stunning views of St Patrick's Bridge, the distant Northern Suburbs and the Church of the Ascension, while Shandon Bells casts its eye over the flow of the City.

The design refrains from having dramatic above deck structure so as to fit in with the surrounding area. The central spine beam structure that transitions from below deck to above deck allowing the slender arch form to be achieved minimising the perceived depth while maximising the access of the user to the water. The uninterrupted single span from between the quaysides results in a clear body of water over which the bridge appears to hover, see Figure 2.

Located on axis with Harley Street, the design of the proposed bridge offers clear sight lines up Harley Street to enhance the connectivity between the central island and MacCurtain Street. Orientated at right angles to the existing quay walls and parallel to the existing bridges, the position and orientation of the bridge complements its existing surroundings. To enhance the connectivity with MacCurtain Street it is proposed to continue the surface treatment of the bridge up Harley Street and coordinate the Public Realm treatment of both Harley Street and St Patrick's Quay in front of the new proposed Metropole Hotel.

When seen from above, the width of the walkways either side of the central spine beam can be seen to increase in width from 2 x 2.70m clear at the abutments before increasing to 2 x 3.60m clear at mid-span. The increased width at mid-span accommodates a timber bench on each side of the central beam where bridge users are encouraged to sit and enjoy the splendid views of the surrounding area, see Figure 3.

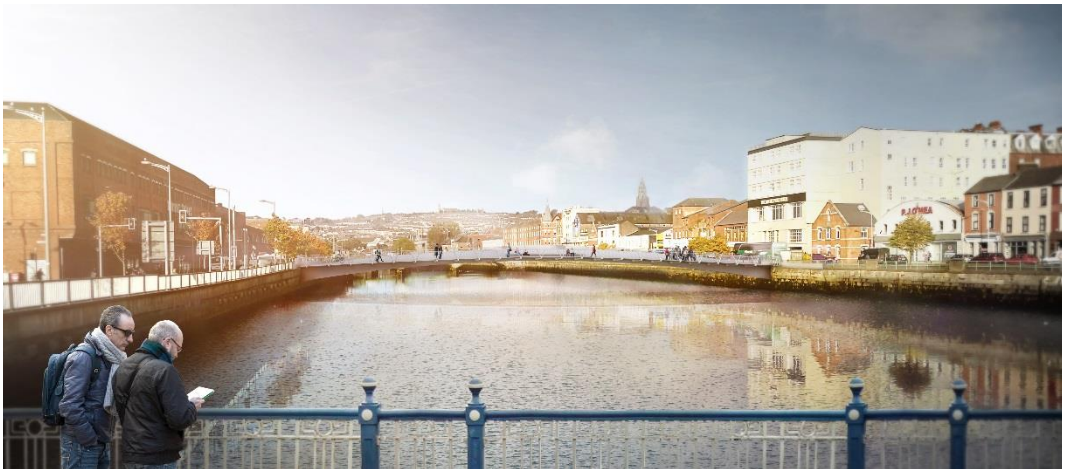

Figure 2: View from Brian Boru Bridge

Figure 3: Deck view

This report includes the considerations and assumptions made during the preparation of the preliminary design for the new pedestrian/cycle bridge and is in accordance with the guidelines detailed within TII DN-STR-03001 (formally NRA BD02). The purpose of the report is to provide assistance in the approval of the structure as part of the planning approval process and will be submitted to Cork City Council as part of the planning application.

1.3 Extent of Bridge Works as Part of the Planning Application

The pedestrian/cycle bridge will link two areas zoned in the Cork City Development Plan (CCDP) as 01- City Centre Retail Area. This planning application includes the pedestrian/cycle bridge linking St.Patrick's Quay and Merchants Quay and associated treatment to the quay walls and abutment areas.

Notwithstanding this, treatment to the public realm on Harley Street and tie-in with proposed cycle routes along St. Patrick's Quay under the tCork City Movement Strategy (CCMS) has also been considered in design development.

2 Site

2.1 Site Location

Harley Street Bridge is located in the city centre spanning the River Lee between two quays with a high volume of daily traffic, see Figure 4.

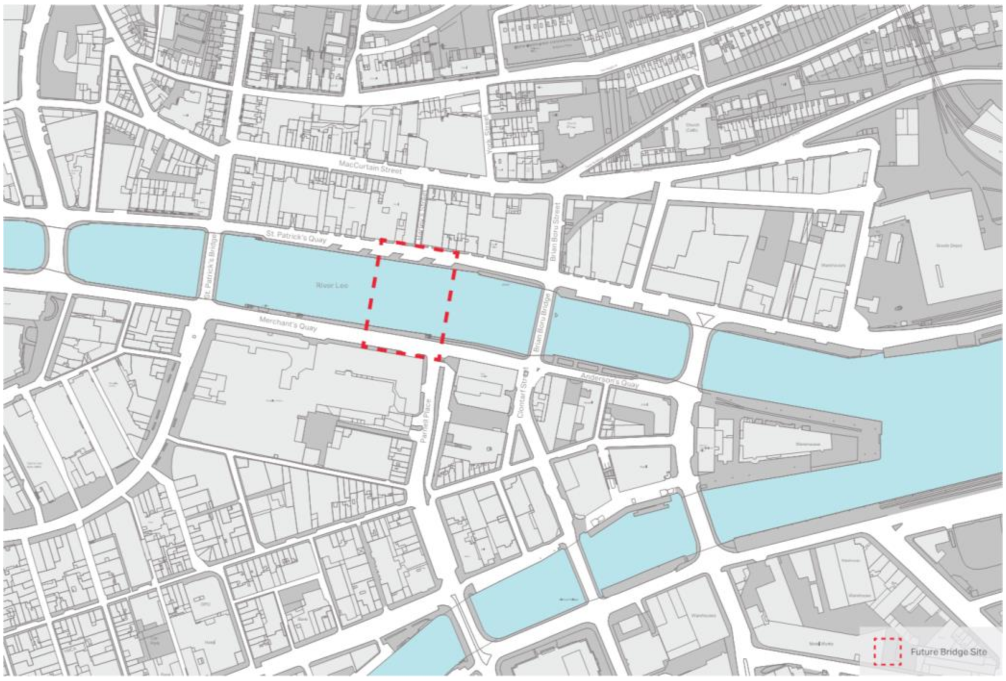

Figure 4: Site Location

2.2 River Lee

The River Lee (Figure 5) flows from the lake of Gougane Barra on the western border of County Cork and flows eastwards through Cork, where it splits in two for a short distance, creating an island on which Cork's city centre is built. It empties into the sea at Cork Harbour on the south coast of Ireland, one of the largest natural harbours in the world.

Given the long history of flooding in Cork City, the Office of Public Works, (OPW), has carried out a Catchment Flood Risk Assessment and Management (CFRAM) Study for the Lee Catchment. This study recognises the high levels of existing flood risk in and around Cork City and is in the process of implementing a flood defence scheme for the city.

The Harley Street Bridge project is cognisant of the OPW's flood defence proposals and is being designed in accordance with the future scheme in mind.

Figure 5: River Lee flowing through Cork City

2.3 Nearby Structures

There are a number of important structures and destinations in the vicinity of the new bridge and it is important that these are recognised during the design process. The following section analyses these and considers the impact that each has on the design of the bridge.

2.3.1 St Patrick's Bridge

Located approximately 190m to the west of the new Harley Street Bridge site, St.Patrick's Bridge was first completed in 1789, see Figure 6. The original structure was destroyed by floods in 1853 and a temporary timber bridge was erected in its place. In 1861, a three span, stone arch bridge was opened and remains on the site to this day. The bridge is a three lane road bridge, with the easternmost southbound lane being dedicated to bus traffic. The roadway is flanked by pedestrian walkways on both sides of the bridge.

Figure 6: St. Patrick’s Bridge

2.3.2 Brian Boru Bridge

Built in 1911, the Brian Boru Bridge is a four span crossing sited approximately 130m to the east of the Harley Street Bridge site, see Figure 7. The original bridge included a 19m long Scherzer rolling bascule span, to allow river traffic to pass through, however, this was decommissioned in 1987. The bridge is a three lane road bridge and is flanked by pedestrian walkways on both sides of the bridge.

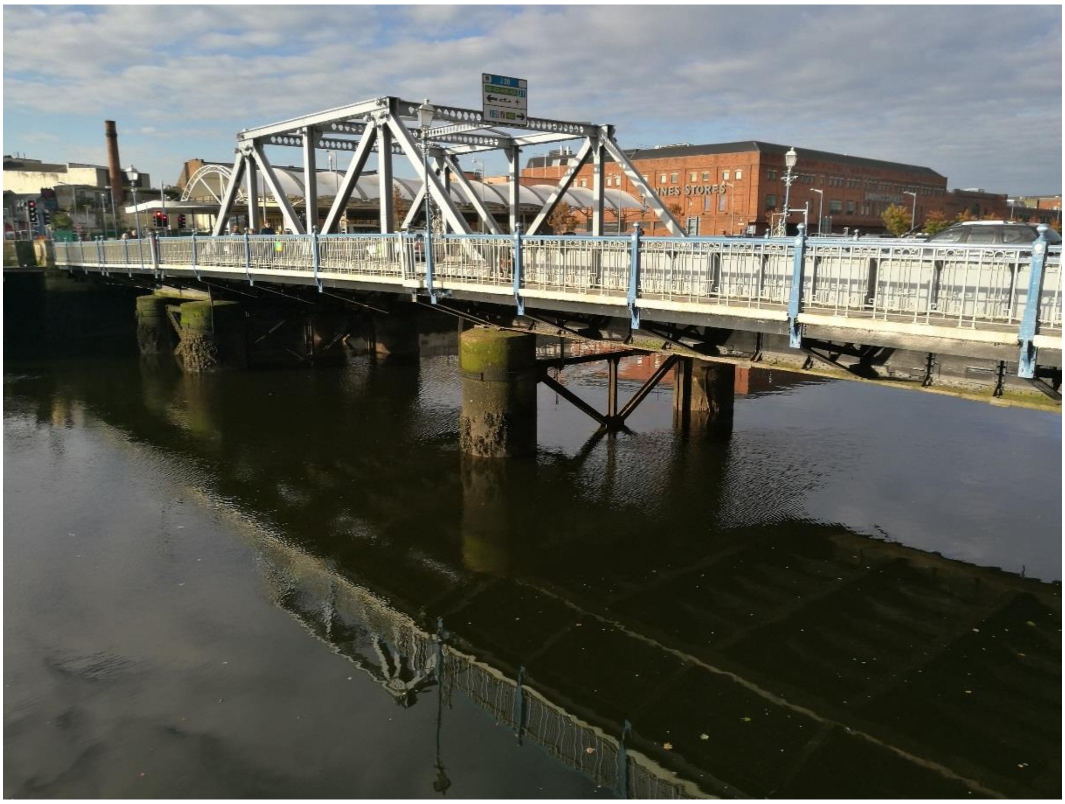

Figure 7: Brian Boru Bridge

2.3.3 Metropole Hotel

The Metropole Hotel is seen as an iconic hotel in Cork City with River frontage on St Patrick's Quay to the rear and access to MacCurtian Street to the front. It is believed that redevelopment of the hotel and the adjacent P.J.O'Hea building is in planning stage. Given the location of the hotel directly at the north abutment of Harley Street Bridge there is an opportunity to tie the public realm treatment of the hotel into the proposed Harley Street Bridge. It is proposed that public realm considerations will be carefully coordinated with all stakeholders.

2.4 Existing Quay Walls

The majority of the quay walls as they are known today were built during the 19th century by the Cork Harbour Commissioners and are described in papers by F.O'C Saunders entitled *"The Development of the River Port of Cork City"* dated 1956 and by Langford & Mulherin entitled *"Cork City Quay Walls"* dated 1982.

The quay walls located at Merchants Quay and St Patrick's Quay at the location of the Harley Street Bridge abutments were constructed of bonded rubble masonry faced with 0.6m average thickness cut limestone blocks. The walls are typically 5m high and 1.5m thick and are founded on timber toe piling at approximately low water spring tides.

Figure 8 and Figure 9 below show the plan layout and details of trial pits taken on Merchants Quay close to the location of the abutment. Additional trial pits and cores will be procured as part of the SI works to confirm the composition of the walls and foundations.

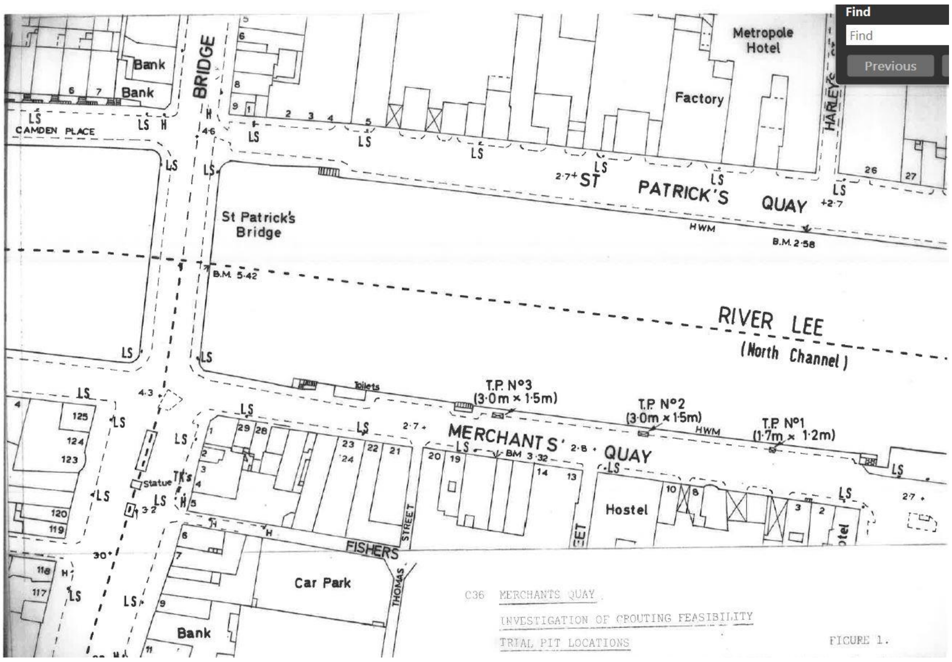

Figure 8: Trial Pit Plan Layout on Merchants Quay

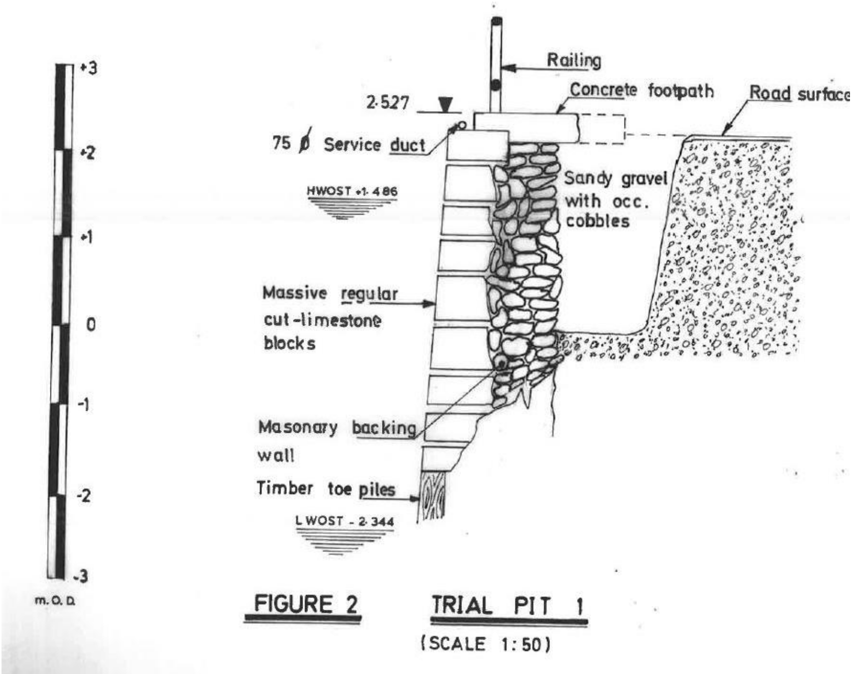

Figure 9: Trial Pit close to Harley Street Bridge Abutment

2.5 Alignment

2.5.1 On-Axis with Harley Street

The alignment proposal is for the bridge to be on-axis with Harley Street. This places the centre line of the bridge on a centrally aligned axis with Harley Street, see Figure 10. This would appear to be the most natural alignment in terms of both sight lines and desire lines from the bridge leading up towards MacCurtain Street, especially given the proposed pedestrianisation of Harley Street.

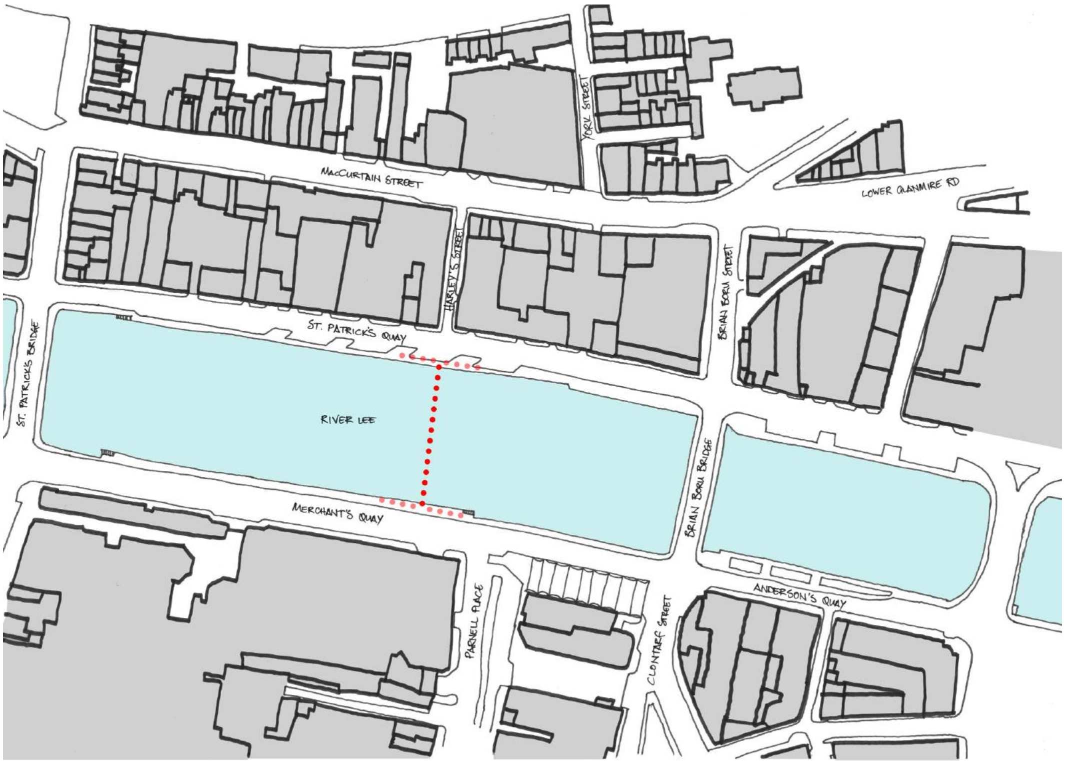

Figure 10: Alignment on-axis with Harley Street

2.6 Underground and Overground Services

2.6.1 Existing Services

The services mentioned in the tables below are existing services in the vicinity of the proposed structure.

Table 1: Existing Services along Merchant's Quay

Services	Overground	Underground	Notes
Watermain		Yes	750-1000mm cover
Gas		Yes	75mbar pipe on shopping centre footpath Abandoned distribution pipe under the road
Telecoms		Yes	4x100mm Eircom 300mm cover
Lighting	Yes	Yes	

Stormwater		Yes	
Foulwater		Yes	
ESB		Yes	MV/LV under footpath beside shopping centre on Merchants Quay and across road near toilets
Traffic Light	Yes	Yes	Traffic poles on both footpaths with underground electricity cables between poles
CCTV	Yes	Yes	
Other		Yes	Spare ducts

Table 2: Existing Services along St. Patrick's Quay

Services	**Overground**	**Underground**	**Notes**
Watermain		Yes	
Gas		Yes	4 bar distribution pipe under road beside riverside footpath. Cover 0.75-1.72m 75 mbar inserted pipe under road beside north side footpath. Cover 0.49-1.4m Abandoned gas pipe under north side footpath
Telecoms		Yes	Aurora Telecom Duct with UPC Fibre Optic Cable
Lighting	Yes	Yes	Public lighting on footpaths
ESB		Yes	MV/LV Cables under footpath on north side of road 0.5-0.8m deep
Other			

Existing services on both Merchants Quay and St Patrick Quay have been identified using available information on GIS, see Figure 11 and Figure 12. These will be verified with utilities companies and confirmed with the trial pit/slit trenches proposed as part of the SI works during detailed design.

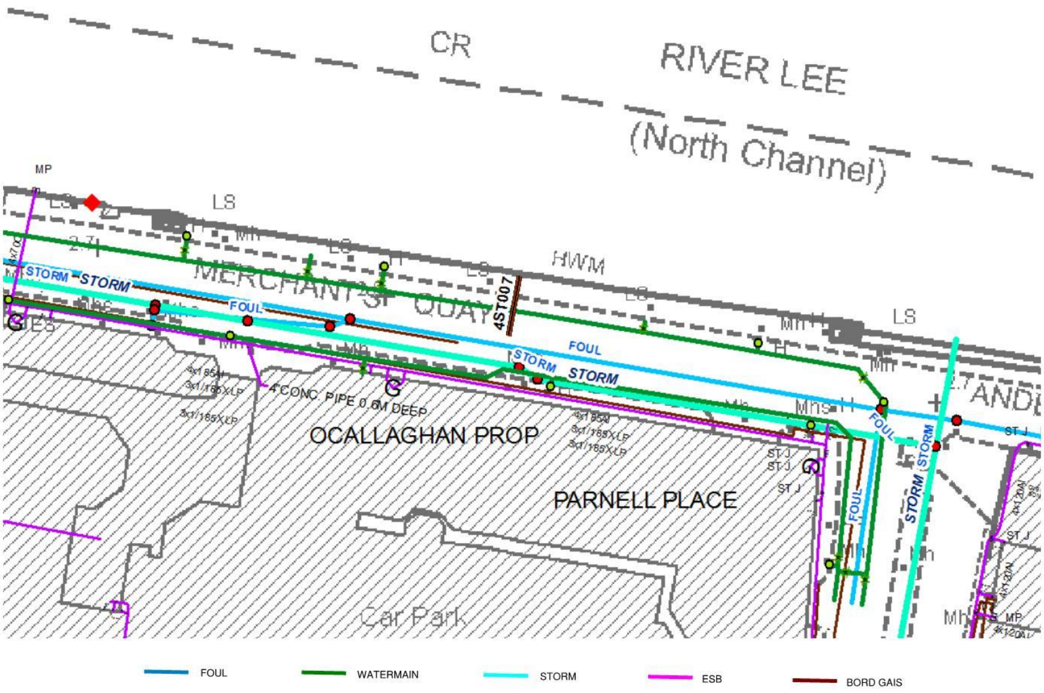

Figure 11: Existing services on Merchant's Quay

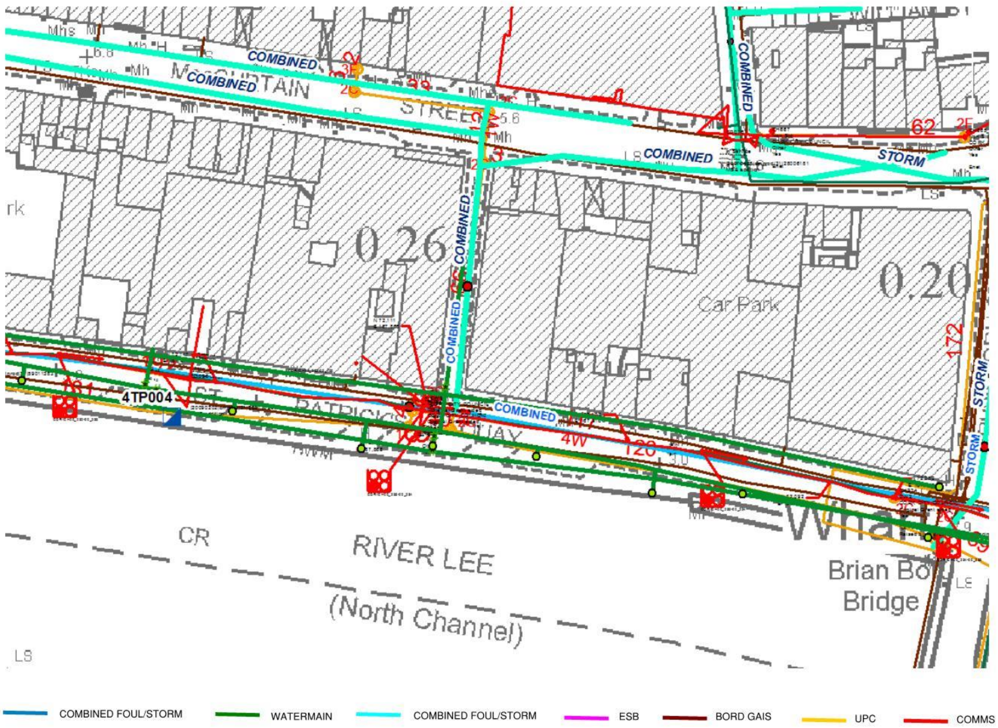

Figure 12: Existing services on Patrick's Quay

At this stage it is evident that the only services to conflict with the proposed abutments are communications conduits and watermain running east west on both quays. Proposals for relocation of these and all other services will be developed as part of the detailed design.

2.6.2 Proposed Services

Electrical cabling will be required along the length of the bridge to supply power to the functional and feature lights on the bridge. These will be connected to a control box (location TBC). The opportunity to combine the Harley Street Bridge control box with a proposed control box for St. Patricks Bridge will be investigated further during detailed design.

2.7 Geotechnical Summary

Based on available GI retrieved from past projects in the area, the ground is expected to comprise of made ground, alluvial deposits, fluvial gravels, glacial gravels and boulder clay. The bedrock is expected to be below 40mbgl. Currently available borehole information is limited to a depth of 25m so it is recommended that additional boreholes be carried out in the vicinity of the proposed abutments.

2.8 Hydrology Summary

Flood risk is relatively high in the region and Cork city has a long history of fluvial and pluvial flooding. Flooding in the city has generally been less severe since the construction of the dams in the 1950s, however there has been relatively frequent flooding of land, roads and properties. There is a range of existing flood defence assets and infrastructure in Cork city which are currently being upgraded as part of the Lower Lee FRS.

In addition to satisfying the constraints provided by the Lower Lee FRS, consent under OPW Section 50 will be required to gain approval for construction over an existing watercourse. A more detailed description of the proposals to mitigate flood risk, gain Section 50 approval and tie-in with the proposed Lower Lee FRS is given in Section 5.

2.9 Archaeological Summary

For further details on the Archaeological constraints in the vicinity of Harley Street Bridge refer to the Environmental Impact Assessment Report contained in the planning application.

2.10 Environmental Summary

2.10.1 General

For further details on the Environmental constraints in the vicinity of Harley Street Bridge refer to the Environmental Impact Assessment Report contained in the planning application.

2.10.2 Lighting

The proposed bridge will have both functional and feature lighting. Careful and sensitive design will be required to ensure that the proposed development does not create excessive glare or light spillage, while also meeting minimum requirements for public safety and security.

Objective 12.19 of the Cork City Development Plan – External Lighting requires that '*the design of external lighting minimises the incidence of light spillage or pollution on the surrounding environment and results in no adverse impact on residential amenities or distraction to road users. Development proposals that require lighting of outdoor areas shall be required to include details of external lighting scheme and proposed mitigation measures'*.

2.11 Sustainability

The steelwork will be painted with a system complying with the Highways England (formerly UK Highways Agency) Specification to improve its durability and reduce maintenance. Consideration has been given to remove all flat surfaces on exposed steelwork in order to prevent ponding of saline water and reduce risk of corrosion.

The concrete proposed for the bridge abutments is a highly durable material and are expected to require minimal maintenance during its 120 year design life. Recycled GGBS will be used in the design and construction of some of the

3 Structure & Aesthetics

3.1 Aesthetic Considerations

There are a number of aesthetic features that were considered during the design of Harley Street Bridge along with the structure's appearance.

The design of the proposed bridge is an arched steel box girder; the soffit of which is shaped with a gentle cylindrical form across the water. The uninterrupted single span from between the quaysides results in a clear body of water over which the bridge appears to hover. The transitioning of the central spine beam from below to above deck and the minimal structural thickness at the edge serves minimised the perceived depth and give a slender, light weight structure.

3.1.1 Aesthetically-pleasing Illumination

Well considered lighting is one of the key components of successful bridge projects. It is vital that all fixtures and fittings are fully integrated and do not appear as a bolt-on after thoughts. They must be seen to fulfil their functional and feature lighting requirements effortlessly and all cabling, drivers and power supplies should be considered at an early stage. Lighting concept comprises both functional and feature lighting which is described in more detail in Section 7.

3.1.2 Bridge Surfacing

The aggregates to be used on the bridge surface can be sourced in a variety of sizes and colours to suit the environment in which they are applied, see Figure 13. The Design Team recommends an aggregate size of 0.9-1.4mm and is currently investigating whether an aggregate with a red/pink hue can be sourced, so as to complement the red sandstone that is seen throughout the city.

Figure 13: Bridge Surfacing

3.1.3 Floor Grille

In addition to the standard steel deck plate, the current proposal also includes a varying width zone of aluminium decking grille that runs down the middle of the bridge deck, on either side of the central spine beam. One function of this grille is to provide a visual contrast to the constant 2m wide pedestrian and cycle way, and indicate a zone for slower movement, whilst diverting those travelling at higher speeds around the benches located on either side of the central beam at mid-span.

The secondary function of the grille is to allow an indirect light source to shine up through the bridge deck during the hours of darkness and wash a soft light across the face of the central primary structure. The images in Figure 14 show the proposed decking material, as well as the attractive affect that is achieved at night as light shines up from below.

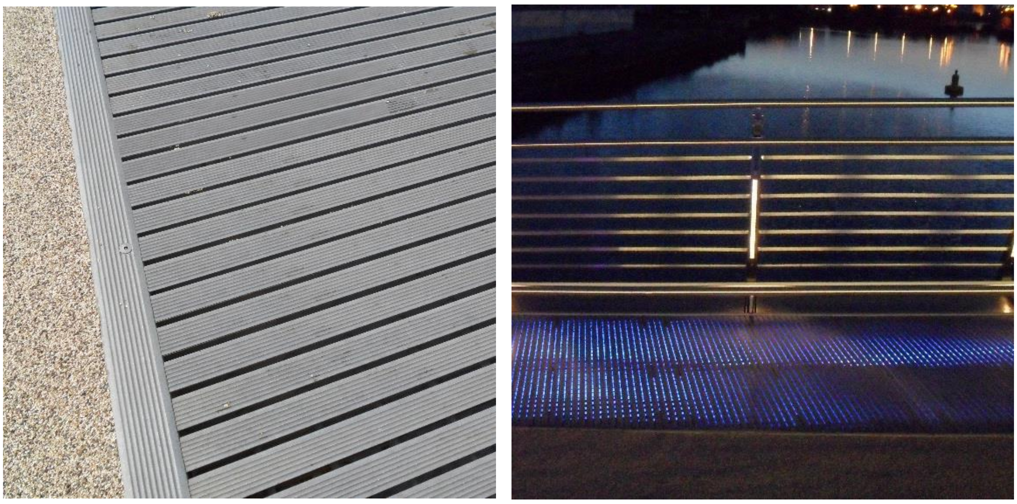

Figure 14: Left:Floor Grille; Right Floor Grille at night lit up

3.2 Structural Options Considered

3.2.1 Skewed between Harley Street and Parnell Place

This alignment considers placing the bridge on a diagonal skew across the River Lee. Whilst this may provide the most direct route for users travelling north-south from Harley Street on towards Parnell Place, and vice versa, it does not address the desire for the bridge to provide axial views along Harley Street.

Another negative to this proposal is that it would increase the span of the bridge from 67m to approximately 90m in length. Furthermore, the alignment would not sit comfortably with its neighbouring St. Patrick's Bridge and Brian Boru Bridge, both of which are arranged perpendicularly to the water.

3.2.2 'S-shaped' Alignment

An 'S-shaped' alignment has also been considered with a geometry that is tangential to both Harley Street and Parnell Place, however, this would increase the complexity of the design and would require a support in the centre of the river. This would significantly increase costs and is not in keeping with the single span arrangement required in the original project brief.

3.2.3 Abutment Level

The existing level of the quays (assuming an alignment on axis with Harley Street), is approximately +2.75m. With the proposed flood defence level set at +3.60m in accordance with the Lower Lee FRS, the bridge will either need to pass above the flood defence level, or penetrate through the flood defence wall and include some form of flood barrier.

The advantages and disadvantages of each solution are considered here.

Abutment level at +2.75m.

With the abutment located at +2.75m, the proposed flood defence system would be breached, therefore some form of flood barrier with a height of 850mm would be required at the end of the bridge.

No ramps or steps would be required thereby making the bridge fully accessible without any obstacle on the quayside.

Abutment level at +3.60m with compliant ramps

Locating the abutment at a level of +3.60m would enable the bridge to land above the level of the proposed flood defence system, therefore, no additional flood barrier would be required.

However, in order to provide fully compliant access to the bridge, ramps with a gradient of 1:20 would be required and this would result in the ramps being approximately 17m long. This is not currently feasible at the Merchant's Quay end of the bridge as the quayside cuts in and the ramp would clash with the quay wall.

Abutment level at +3.60m with non-compliant ramps

One way to deal with the problem would be to apply for a dispensation from the regulations and request a non-compliant ramp with a gradient of 1:15 at the southeast end.

Another option would be to replace the non-compliant ramp with steps, however, this is undesirable as it would limit cycle access to one side of the bridge.

This is not a preferred solution as it does not provide a fully accessible design.

Abutment level at +3.17m

A solution to the level difference at both quays may be to land the bridge at a level of +3.17m. This would ensure that the bridge lands at the design flood level with a 380mm high flood defence barrier required only for freeboard allowance. The lower level of the bridge means that the extent of 1:20 ramps is limited to 8.4m.

3.3 Proposed Category

The Pedestrian Bridge is a Category 2 structure.

3.4 Foundation Type

The proposed foundation is to comprise of a concrete pile cap to connect the central spine beam and transfer the loads via a strut and tie system to a series of tension piles at the road side and compression piles at the quay wall side. It is currently proposed that the piles will comprise of 900mm diameter Continuous Flight Auger Piles (CFA) which are suitable to the gravels located behind the quay walls and have been used in this type of construction in the Cork Area previously. Figure 15 and Figure 16 give elevation and plans of the proposed foundations which will be developed further during detailed design.

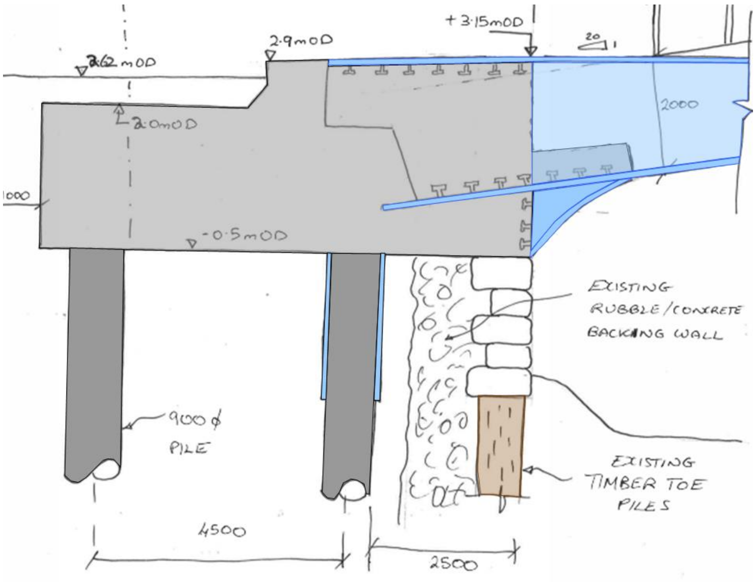

Figure 15: Preliminary Foundation Elevation

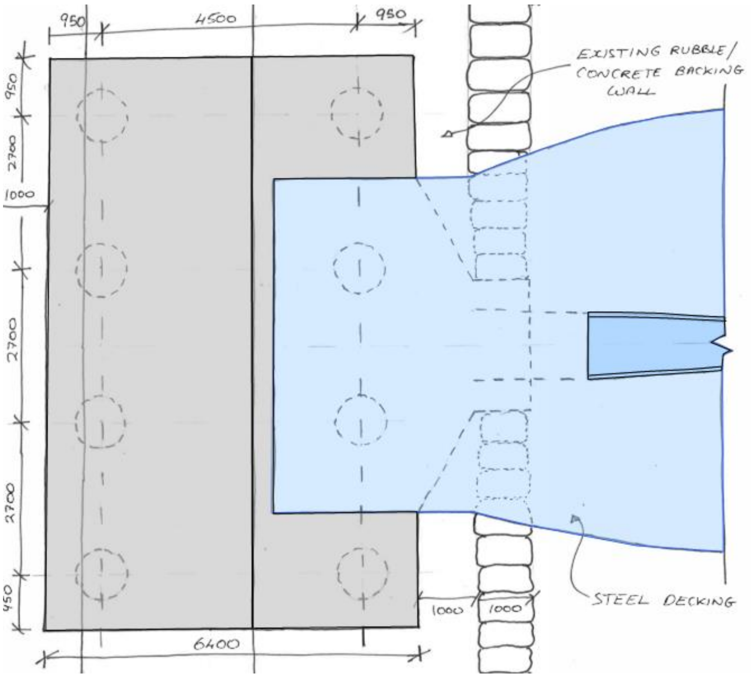

Figure 16: Preliminary Foundation Plan

3.5 Superstructure

The design of the proposed bridge is an arched steel box girder; of semi cylindrical shape in both plan and elevation. Both the depth and widths of the top and bottom flanges vary from abutment to midspan. The girder will be of rolled steel plate between 20mm and 40mm in thickness and with welded stiffeners where needed. Cantilever "V" shaped beams will be placed at 3m centres to support the deck plate. The "V" shaped cantilevers will have a 100mm min bottom flange at the connection with the spine beam which will taper to a point at the tip of the cantilever to form the connection with the "V" shaped parapet posts. The parapet posts will be formed of welded steel plate and will support both the cycle and pedestrian handrails at 1.1m and 1.4m respectively. Longitudinal stiffener ribs will run longitudinally to stiffen the deck plate and prevent excessive deflection and vibration.

3.6 Articulation Arrangements, Joints and Bearings

The bridge articulation is for a fixed-fixed single span beam with stiffness of the abutments and the tension/compression arrangement of the piles resisting the hogging moment at the supports. As a result there is not requirement for joints or bearings in the structure which will minimise maintenance requirements. The main spine beam will have to be designed for thermal effects as the bridge is fully fixed at both ends.

3.7 Parapet

There are a wide variety of possibilities for the parapet design of the Harley Street Bridge, however, it is vital that the materials must be durable, of high quality and above all provide a safe working solution that meets all current regulations.

The proposed design currently presents an array of painted carbon steel flats in a V-shaped arrangement, see Figure 17. The posts are inclined inwards to reduce climbability and rise up to support a handrail at 1.1m and a cycle rail at 1.4m above the deck. Both rails shall be fabricated from stainless steel and are designed to deter birds from perching.

Having considered a good variety of appropriate materials for the design of the parapet infill, the Design Team believes that the most suitable solution is the framed, stainless steel tension mesh system, see Figure 18.

Figure 17: Parapet Design

Figure 18: Example of Tension Mesh parapet infill

This highly transparent material provides excellent visual connectivity both on and off the bridge, thereby ensuring a good user experience. It requires little to no maintenance and offers a highly durable solution with competitive lifetime costs.

The use of tension mesh as the parapet infill presents a contemporary, durable and versatile solution. It is possible to install the mesh as a continuous run from abutment to abutment, however, the Design Team's recommendation is for a panelised system between consecutive parapet posts, thereby permitting easy replacement in the event of damage, without the need to replace the entire bridge parapet.

Different sized mesh apertures are available and the Design Team's recommendation would be sized to prevent foot-holds, thereby further reducing climbability, whilst still maintaining a high degree of transparency.

3.8 Weather Protection

The Harley Street Bridge is a crossing from one outdoor environment to another and full enclosure is therefore not a requirement of the brief. However, people will be encouraged to use the bridge as a vantage point from which they can enjoy views of the River Lee and the surrounding area. As such, user comfort is an important consideration in the design of the bridge.

Overhead shelter is deemed unnecessary, however the introduction of a vertical glazed screen, mounted on top of the longitudinal arch, is considered a viable solution that will offer a sufficient degree of protection from inclement weather conditions.

It is proposed to install localised weather protection within the realm of the timber bench that will be provided at mid-span on the bridge, see Figure 19 and Figure 20. It is anticipated that those wishing to stop on the bridge and enjoy the views will do so whilst sitting at this location. Therefore, a screen to a height of approximately 1.6m above the level of the deck would provide sufficient shelter for those sitting down.

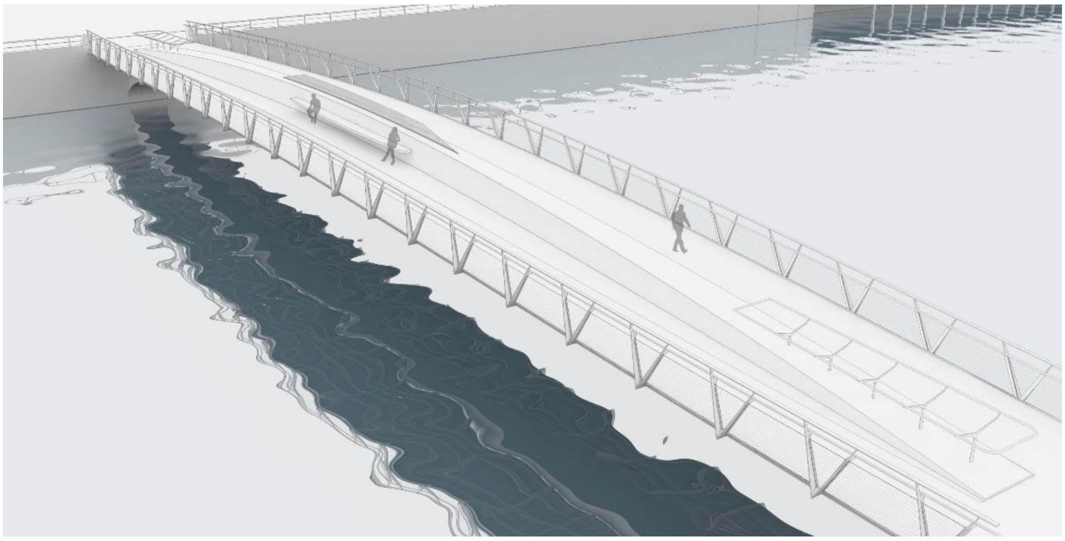

Figure 19: View of weather protection

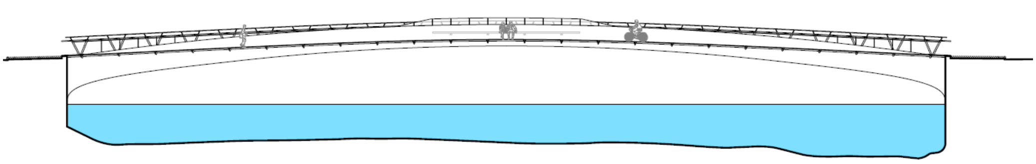

Figure 20: Elevation showing weather protection

3.9 Durability

The main spine beam structure is to comprise a fully enclosed painted carbon box to prevent water egress and increased corrosion. The proposed design of the cantilever beams is in a V shaped, fully enclosed section with limited flat sections to prevent water ponding of saline water. Likewise the parapet posts are to comprise painted carbon steel flats with no flat surfaces. Both handrails shall be fabricated from stainless steel for increased durability.

As previously discussed the parapet infill is to be a tension mesh in a panelised system between consecutive parapet posts, thereby permitting easy replacement in the event of damage, without the need to replace the entire bridge parapet.

The steelwork will be painted with a system complying with the Highways England (formerly UK Highways Agency) Specification to improve its durability and reduce maintenance. Consideration has been given to remove all flat surfaces on exposed steelwork in order to prevent ponding of saline water and reduce risk of corrosion.

The proposed surfacing for the new Harley Street Bridge is a resin bonded aggregate system. This is a highly durable system that can be applied by specialist suppliers to steel plate bridge decks, asphalt, timber or concrete.

The concrete proposed for the bridge abutments is a highly durable material and are expected to require minimal maintenance during its 120 year design life.

3.10 Inspection and Maintenance

It is possible to install the parapet infill tension mesh as a continuous run from abutment to abutment, however, the Design Team’s recommendation is for a panelised system between consecutive parapet posts, thereby permitting easy replacement in the event of damage, without the need to replace the entire bridge parapet.

It is proposed to install localised weather protection within the realm of the timber bench that will be provided at mid-span on the bridge. Therefore, a localised screen to a height of approximately 1.6m above the level of the deck would provide sufficient shelter for those sitting down while reducing any additional maintenance in comparison to a full length screen.

As there are no joints or bearings proposed for the bridge maintenance of any mechanical parts is limited. Maintenance will be required for the flood protection gate however this is minimal and can be done in a safe and control environment with minimal disruption to the operation of the bridge.

4 Construction and Buildability

A key consideration of the form of the bridge is the constructability. These considerations include safety during construction and minimisation of disruption to the traffic flow on the quays. The span of the bridge is proposed to be constructed of steel in order to allow the central spine beam to be constructed off site in three components for ease of transportation and erection on site.

It is proposed the spine beam sections, with a maximum length of 34m, could be transported to Anderson or Penrose Quay by a water borne vessel and lifted onto a set of self-propelled modular transporters (SPMT) for transportation the short distance to the site. Once delivered to the abutment, the segments of the spine beam can be lifted by mobile crane onto a low level barge for delivery to the optimum lifting position. It is proposed that the abutment sections of the spine beam be lifted onto an abutment seating plate by mobile crane located on the quay side with the central span lifted from barge from a hoist located at the tips of the abutment sections.

The above operations can be carried out during night time works with part road closure. This will be captured as part of the traffic management plan developed during detailed design.

The cantilever walkways, bridge decking and parapets can be constructed from platforms supported from the central spine beam once this has been erected.

The abutments themselves will need to be constructed behind the existing quay walls and will impact the traffic/pedestrian flow for the duration of the works. Careful traffic planning will be carried out to ensure minimum disruption, however it is envisaged that the bus lanes on Merchants Quay will need to be removed to facilitate the existing traffic flow (2 lanes westbound and 1 lane eastbound) for the duration of the abutment construction works. On St. Patricks Street it is envisaged that the existing traffic lanes can be retained by removing the existing parking bays for the duration of the works.

5 Flood Protection

The Office of Public Works (OPW) are advancing the Lower Lee Flood Relief Scheme as part the National Flood Risk Management programme. The scheme is being designed to provide protection to properties within the study area of the Catchment Flood Risk Assessment and Management (CFRAM) Study for the Lee Catchment and encompasses the section of Quays at the location of Harley Street Bridge. The Lower Lee FRS is to provide protection from the 1 in 100 year fluvial/1 in 200 year tidal flood events.

The flood defence level and flood protection options as presented in the Lower Lee FRS public exhibition documentation form constraints to the Harley Street Bridge tie in with the existing quay walls. The design flood level is taken as 3.17mOD with the flood defence level taken as 3.6mOD to allow for freeboard. The level of the bridge at the tie in with the existing quay walls must be such that it meets the flood defence level requirements through passive or active means.

Options to satisfy the flood protection requirements as presented in the following sections include the following:

- Deck level at the abutment of 3.6mOD
- Deck level at the abutment of 3.17mOD to satisfy the design flood level and providing demountable barriers or permanent edge plates to satisfy the error allowance or freeboard requirements

The proposed flood protection at Merchants Quay and St Patrick’s Quay and a photomontage of the proposed works as presentment in the Lower Lee FRS public exhibition documentation are shown in Figure 21 to Figure 23.

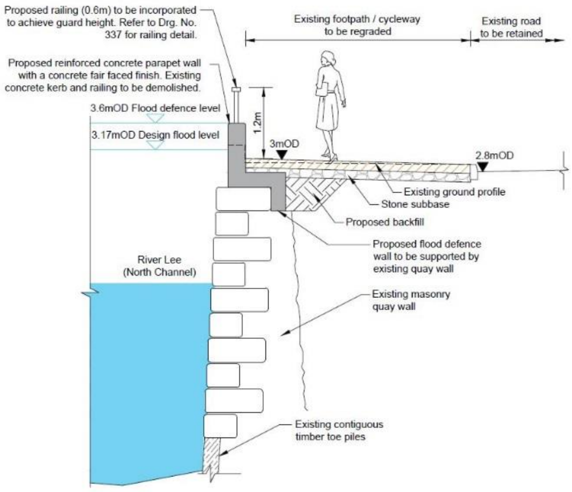

Figure 21: Merchants Quay Proposed Flood Relief Works

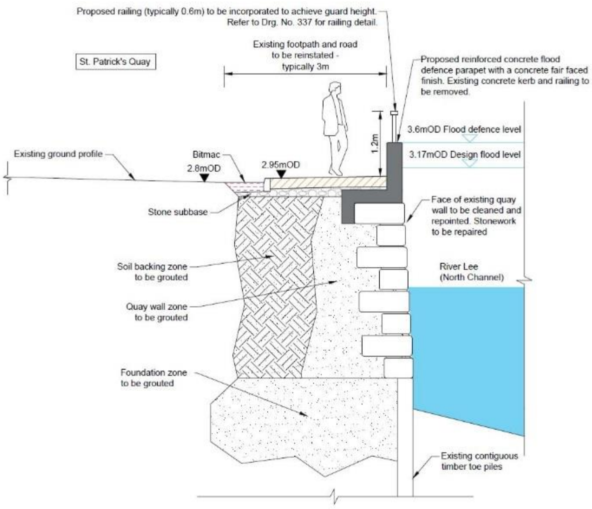

Figure 22: St Patrick’s Quay Proposed Flood Relief Works

Figure 23: Proposed Flood Relief Works at Merchants Quay

In addition to satisfying the constraints provided by the Lower Lee FRS consent under OPW Section 50 will be required, to gain approval for construction over an existing watercourse. The key aspect of this application will be justifying that Harley Street Bridge will not result in significant change to the hydraulic characteristics of the watercourse.

The structural form of the bridge has taken this requirement into consideration by using a mixture of setting the bridge deck level at or above the maximum flood level over the full length of the bridge and transitioning the structure from below the deck to above deck over the length of the span to minimise the length of the structure below the maximum flood level.

A hydraulic model has been carried out utilising the findings of the Lower Lee FRS to derive design hydrological flows, design tidal heights and joint probability analysis. The model assumes that the Lower Lee FRS is in place in the analysis and both (a) fluvial dominated scenario, and (b) tidal dominated scenarios have been considered.

Options to satisfy the flood protection requirements include the following:

- Deck level at the abutment of 3.6mOD
- Deck level at the abutment of 3.17mOD to satisfy the maximum flood level and providing flood protection barriers or permanent edge plates to satisfy the error allowance or freeboard requirements

In order to provide a deck level that can be practically accessed without excessive ramps along the length of the quays and by maintaining the maximum ramp gradient of 5% the deck level has been set at +3.17mAOD at the abutments. This is between 0.37-0.47m above the existing footpath level and will be accessed by ramps from the existing footpath level. As a result a limited proportion of the bridge structure will be below the maximum flood level as the main spine beam transitions from below deck to above deck with a corresponding deck gradient of 5% to achieve a maximum deck level at mid span.

6 Safety

6.1 Traffic Management During Construction

Detailed traffic management proposals will be developed at detail design stage by the appointed Contractor in consultation with their Designers and the consent for the diversions and/or road closures will be sought from the appropriate local authority.

6.2 Safety During Construction

The Designer will take account of the General Principles of Prevention, as specified in the Schedule 3 of the Safety, Health and Welfare at Work Act 2005, liaise with the Project Supervisor appointed by the Client for the Design Process and the Project Supervisor appointed for the Construction Stage and carry out all other duties as required by Clause 15 of the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013).

The Project Supervisor for the Design Process will comply with all the requirements outlined in Clauses 11, 12, 13 & 14 of the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013).

6.3 Safety in Use

Pedestrian protection will be provided in accordance with DN-STR-03011 (NRA BD 52).

A non-slip surface will be applied to the steel deck.

7 Lighting

7.1 Lighting Concept

The proposed bridge will have both functional and feature lighting. Careful and sensitive design will be required to ensure that the proposed development does not create excessive glare or light spillage, while also meeting minimum requirements for public safety and security.

The new Harley Street Bridge lighting concept is to comprise of the following: project.

Functional Lighting

The functional lighting for the Harley Street Bridge will be provided by discrete point source LED fittings recessed into the handrails at the edge of the bridge deck. They will throw light across the deck and provide a safe environment for bridge users to be in during hours of darkness.

All functional light fittings shall be specified suitable for outdoor environments and shall be rated IP66 or above.

Feature Lighting

The architectural concept for the feature lighting of the bridge will be used to highlight the primary structural spine beam that runs centrally down the length of the bridge deck.

The light source will be mounted just below deck level and will wash a soft glow of light up the surface of the beam. It is possible for the light fittings to be RGB LED fittings which would allow the light to be programmable such that the beam could be bathed in a different coloured light depending on the occasion, for example public holidays, national festivals or religious holidays.

Just as with the functional lighting, all feature light fittings shall be specified suitable for outdoor environments and shall be rated IP66 or above.

7.2 Inspection & Maintenance

Inspections should be carried out regularly to ensure that lights are working correctly and bulbs haven't blown.

Bulbs will need replacing at regular intervals however if LEDs are used the replacement interval will be longer.

8 Design Assessment Criteria

8.1 Normal Traffic Loading

The structure will be designed for Load Models LM4 in accordance with IS EN 1991-2:2003 and the associated National Annex.

8.2 Abnormal Traffic Loading

Not applicable.

8.3 Footway Live Loading

Footway loading shall be in accordance with Clause 5.3.2.1 of IS EN 1991-2:2003. A nominal qfk = 5kN/m^2 will be adopted.

8.4 Accidental Loads

The superstructure and the intermediate supports will be designed for accidental collision loads in accordance with DN-STR-03013 (BD 60/10) and IS EN 1991-1-7:2006 and the associated National Annex.

8.5 Wind Load

Wind load will be assessed in accordance with IS EN 1991-1-4:2005 and the associated National Annex.

A computational fluid dynamics (CFD) model will be undertaken for this bridge incorporating the effects of the architectural façade. This model will be undertaken by a third party and does not form part of the analysis performed by Arup as part of this design.

8.6 Provision for Exceptional Abnormal Loads

No exceptional abnormal loads are proposed.

8.7 Any Special Loading not Covered Above

Not applicable.

8.8 Heavy or High Load Route Requirements Being Made to Preserve Route

Not applicable.

8.9 Authorities Consulted and any Special Conditions Required

Consultation with relevant authorities is on-going. The following groups have been consulted as part of the stakeholder engagement process

- Cork City Council (CCC)
- Office of Public Works (OPW)
- Irish Water
- ESB
- Gas Networks Ireland
- MacCurtain Street Business Group

8.10 Dynamic Response

The natural frequency of the bridge will be calculated using an appropriate structural model and compared to effects that generate periodic forces on the bridge, such as wind loads and pedestrian use.

9 Drawings and Documents

9.1 List of all Documents Accompanying the Submission

Relevant documents are included as appendices to this report.

Drawing Package

The following drawings are included as part of this submission.

Table 3: Drawing List

Harley Street Bridge Pedestrian/Cycle Bridge Planning Application Schedule of Drawings			
Drawing Number	**Drawing Title**	**Scale**	**Sheet**
Visualisations			
253690-B-200-060	Visualisation 1: View from Brian Boru Bridge	NTS	
253690-B-200-061	Visualisation 2: View on Bridge Looking North	NTS	
253690-B-200-062	Visualisation 3: View on Bridge at Night	NTS	
253690-B-200-063	Visualisation 4: Aerial View of Bridge	NTS	
General Drawings			
253690-B-10-001	Site Location Map	1:2000	A1
253690-B-10-002	Location Plan	1:500	A1
Architectiural Drawings			
253690-B-200-001	Existing Plan and Elevation	1:100	A1
253690-B-200-010	Proposed Bridge Plan & Elevation	1:100	A1
253690-B-200-030	Proposed Cross Sections	1:25	A1
253690-B-200-040	North Abutment	1:50	A1
253690-B-200-041	South Abutment	1:50	A1
253690-B-200-050	Exploded View	NTS	A1
253690-B-200-051	Detailed Bench Plan & Elevation	1:25	A1
253690-B-200-052	Precedent Materials	NTS	A1
Engineering Drawings			
253690-B-10-010	Structural Plan & Elevation	1:150	A1
253690-B-10-021	Structural Foundation Details	1:75	A1
253690-B-10-022	Structural Sections & Details	1:25	A1
253690-B-10-030	Construction Sequence	1:150	A1

Environmental Screening

The following reports are included as part of this submission.

- Appropriate Assessment Screening Report
- Environmental Impact Assessment
- Environmental Report