Appendix A21.5
Broome Bridge - Architectural Heritage Impact Assessment

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DART+ West

Proposed works at Broome Bridge, Cabra, Co. Dublin

Architectural Heritage Impact Assessment

June 2022

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1.0 INTRODUCTION

This report has been prepared by Blackwood Associates Architects to accompany the Railway Order application for the DART+ West project. The report will assess the impact of the proposed works on the existing structure and setting at Broome Bridge. The proposed works referred to in this document have been designed by IDOM, the design team lead, for the client, Iarnród Éireann.

2.0 DESCRIPTION OF STRUCTURE

Note: Much of the information below is based on the report provided by Rob Goodbody in the appendices to Chapter 21 – Architectural Heritage (Appendix A21.4 in Volume 4 of this EIAR).

Broome Bridge is a masonry road bridge, dating originally from 1790 and spanning over the Royal Canal and rail line in Cabra, Co. Dublin.

The bridge is accessed from Broombridge Road from the north and south, with both sections of road having slightly different angles of approach. The change in angle is corrected on the section of the bridge spanning the railway line, whereas the canal section crosses perpendicular to the Royal Canal. To the east of the bridge are Broombridge Train Station and Luas Station.

Originally Broome Bridge spanned over only the canal, but it was then extended in c.1846 to provide passage over the railway line, which was introduced as part of the Great Western Railway. The railway line passes directly to the south of the canal. A small bank of vegetation remains between the canal and the railway line.

The bridge is built of a mixture of rubble and squared limestone of varying sizes brought to courses in parts and laid randomly in others. It comprises two arches, one spanning over the canal and one over the railway line. When the bridge was extended over the railway the second arch was constructed with two engaged piers, one of which now sits centrally in the middle of the bridge. A continuous string course and parapet run across the bridge's hump-back shape.

The older portion of the bridge spanning over the canal is characterised by a lower semi-circular arch with keystone. The later extension of the bridge over the railway line is characterised by a higher elliptical arch.

Figure 1 – East elevation of Broome Bridge showing both arches with the railway on the left hand side and canal on the right hand side.

The bridge terminates at land to the north with wing walls that curve away from the bridge and slope down towards ground level before terminating in piers. The wing walls are capped with rounded concrete flaunchings. At the south east end of the bridge, the wing wall is in the same format and appears heavily obscured by vegetation. This wing wall appears to have retained its original coping stones.

The canal arch is decorated with an arch ring of voussoirs and a raised keystone which also drops below the soffit. Voussoirs run only as far as the arch spring. From the centre point of the canal arch, the extension to the bridge is visible in the stonework style and the orientation of the parapet and string course which continue to rise towards the crown of the bridge, over the railway line.

The vault of the canal arch is constructed in slender squared limestone, evenly coursed. Five putlog holes are visible just below the spring of the arch. Below the spring, abutments are constructed in larger pieces of squared limestone, evenly coursed and turning the corner below voussoirs.

The spandrels of the canal are faced with squared limestone laid in courses. The west face of the canal bridge contains a plaque commemorating a significant mathematical equation carved into the bridge by astronomer Sir William Rowan Hamilton in 1843.

Figure 2 – Canal spandrel with squared limestone and commemorative plaque for Sir Hamilton.

Figure 3 – West spandrel of bridge and canal arch.

The railway arch is elliptical in shape, and the vault of the arch is impressively skewed due to the angle of construction necessitated by the differing angle of Broombridge road. The railway arch is decorated by an arch ring of voussoirs, without a keystone, and flanked either side by two engaged piers. Quoins below the arch spring extend to the piers on either side.

The spandrels of the railway arch and the piers, are in the same style being of squared rubble limestone, laid in courses.

Figure 4 – Railway arch showing voussoirs of arch ring, string course, engaged pier and a wing wall curving away to the east (left hand side).

The parapet of the bridge contains a myriad of construction phases and stonework and pointing styles which contribute to its overall mixed appearance. The parapet of the bridge is generally constructed of coursed squared rubble limestone with a mixture of concrete and dressed limestone copings.

The canal section of the bridge contains the oldest coping stones. The parapet has a modern breach on the east side between the arches, providing pedestrian access from the bridge to the train platform below.

Figure 5 – Breach in east parapet wall.

On the north end of the bridge, the parapets meet directly with a lower section of wall, which has been reconstructed in a mixture of stone and blockwork. The wall is topped with a combination of rounded concrete flaunchings and block coping stones laid on edge. It continues parallel with the road before stopping short of the embankment paths down to the canal on the west and east sides.

Figure 6 – North east wall, showing reconstructed end and path to the canal on the left side.

Figure 7 – North west wall and path to the canal on the right side.

On the south end of the bridge its parapets continue parallel with the road to a point where random rubble limestone walls butt directly against the parapets and continue alongside the road at the same height. These are topped with vertically laid limestone slabs. On the east side of the road, the wall appears to be historic. On the west, the wall appears to have been reconstructed recently to match the style of the original.

Figure 8 – South west parapet end and recently reconstructed random rubble limestone wall.

Figure 9 – South east parapet end and historic random rubble limestone wall.

The east parapet wall contains various stonework styles and coping types. At the north end, it is constructed in coursed squared limestone, with courses of varying heights. The coursing angle follows the rise of the bridge. Apart from the concrete coping on the pier, this section is topped with large historic limestone copings. This continues up to the apex of the canal arch. From this point, the extension to the bridge for the railway line begins, and the rising angle of the parapet is carried through. Coping stones are then replaced with concrete slabs for a length where the breach in the parapet provides access to the pedestrian bridge. The parapet continues south with large historic limestone coping stones for the majority of the railway span before ending with a pier and a larger coping stone to cover.

Figure 10 – East parapet wall over canal with historic limestone copings.

Figure 11 –View looking south over the bridge, with historic coping stones on the parapet.

Figure 12 – East parapet and crown of bridge over railway line.

The west parapet wall also contains various stonework styles and coping types. At the north end it is constructed in randomly laid small sections of squared limestone. This section is topped with large limestone coping stones which are historic, up to the apex of the canal arch. From this point, the extension to the bridge for the railway line begins, and the rising angle of the parapet is carried through with the copings. The parapet stonework changes in style and continues south with large historic limestone copings completing the parapet, for rest of the railway span. The parapet ends with a pier and a larger coping stone to cover.

Figure 13 – Oblique view of west parapet looking south showing step where the parapet meets the adjoining wall and differing stonework styles and copings.

Figure 14 – West parapet showing section of parapet rebuilt.

3.0 STATUTORY CONTEXT

Broome Bridge is included in Dublin City Council's Register of Protected Structures (RPS) with reference number 909. The description of the bridge however, only makes reference to the section spanning the Royal Canal.

It is included in the National Inventory of Architectural Heritage (NIAH), with reference number 50060126 and has been assigned a National significance with the special interest categories architectural, historical, social and technical. However, we believe the bridge should be assigned with a Regional significance.

Broome Bridge is also documented in Dublin City Council's Industrial Heritage Record with the following description and appraisal:

''Single-arch masonry bridge, built c.1790, carrying Broombridge Road over the Royal Canal. Squared coursed limestone walls with ashlar stringcourse and dressed voussoirs to segmental-arch with central keystone. Deck is humped. Parts of parapet walls rebuilt with some replacement coping. Limestone walls flank the canal beneath the bridge. Limestone plaque to northwest of bridge''

Broome Bridge is one of a number of bridges constructed in association with the Royal Canal, whose building commenced in 1790. The bridge follows the style apparent throughout all Irish canal bridges with the simple humpbacked design enhanced by finely-executed stonework. The bridge also has a historical connotation through its being the location where Sir William Rowan Hamilton first wrote down the fundamental formula for quaternion on the 16th October 1843, making the site of historical importance with respect to mathematics.''

The description and appraisal of the extension to the bridge reads:

''Single-arch masonry bridge, built c.1847, to carry Broombridge Road over the Royal Canal. Coursed squared limestone walls with dressed stone string course. Tooled limestone voussoirs to elliptical arch. Terminating piers. Curved deck with ramped approach from south. Forms a single unit with canal bridge to north.

Built as part of the Midland and Great Western Railway project, which commenced construction in 1846, this bridge is a testament to the engineering and technological skills of the nineteenth-century builders of Ireland's railways. Its siting beside a canal bridge highlights the number of facets of Ireland's infrastructural expansion during this period, further enhancing the significance of the site within Dublin's industrial heritage.''

Broome Bridge is not in an Architectural Conservation Area (ACA).

4.0 HISTORY & DEVELOPMENT

Below is an extract taken from the conservation report provided by Rob Goodbody in the Appendix A21.4 to Chapter 21 – Architectural Heritage.

''Prior to the construction of the Royal Canal there was a road that ran from near the Cabra Gate of Phoenix Park along what is now Nephin Road and Broombridge Road, and the northward along Farnham Drive to Finglas. This was not a major road and there were alternative, more direct, routes to Finglas through Glasnevin and along a more westerly route that has since more or less disappeared. By the 1790s the route along what is now Broombridge Road had deteriorated and appears not to have run northward to Finglas. Nonetheless it was a local road, and it was necessary to provide a bridge over the canal so as to keep the right of way open.

The road that is now called Broombridge Road runs at an angle to the canal, though the bridge was built at right angles, necessitating the introduction of slight bends in the road at either side of the bridge. The bridge was named Broome Bridge in honour of one of the directors of the Royal Canal Company, William Broome, who served on the board from 1792 to 1801.

The most significant historical event associated with the bridge is an act of justifiable vandalism carried out in 1843 by William Rowan Hamilton. Hamilton had been appointed Andrews Professor of Astronomy and Royal Astronomer of Ireland in 1827 at the age of 21. His scientific achievements at that time were in the realm of optics, but he also had a strong interest in algebra. One problem that he wrestled with for ten or fifteen years was the possibility of using algebra in three or four dimensions and on 16th October 1843, while walking from his home at Dunsink Observatory to the Royal Irish Academy along the towpath of the Royal Canal he had a flash of inspiration, resulting in him devising the equation that he had long sought, relating to a concept he called quaternions. Conscious that he may not remember it, he used his penknife to carve the equation into one of the stones of Broome Bridge. The long-term significance of this discovery has led, among other things, to three-dimensional physics and computer technology, ranging from 3D modelling to video games.

Even as Hamilton was carving the formula on the bridge abutment the directors of the Midland Great Western Railway Company was negotiating with the directors of the Royal Canal Company for the acquisition of the canal with a view to constructing a railway along its route toward Mullingar and beyond. Work commenced on the construction of the railway in January 1846 and the line opened between Broadstone and Enfield in June 1847. In the interval between these two dates the canal bridge known as Broome Bridge was extended to include a second arch spanning the new railway line. The extension of the bridge directly southward from the canal bridge at right angles to the railway would have exacerbated the bend in the road at the southern end of the bridge and to avoid this the railway arch was built at as a skew bridge at an angle to the alignment of the canal bridge. ''

Map Comparison
Broome Bridge as portrayed in available historic maps generally aligns with its construction date of 1790 and its latter extension in c.1846 over the railway line.

In the OS Map below, the railway line has not yet been constructed. A clearing north of the bridge is seen, possibly indicating access to the towpath at canal level. The construction of the bridge perpendicular to the canal is clearly shown. A small structure sits to the south of the bridge. The approach roads north and south are lined with trees on one side. The map also records the level of the canal and the keystone of the bridge.

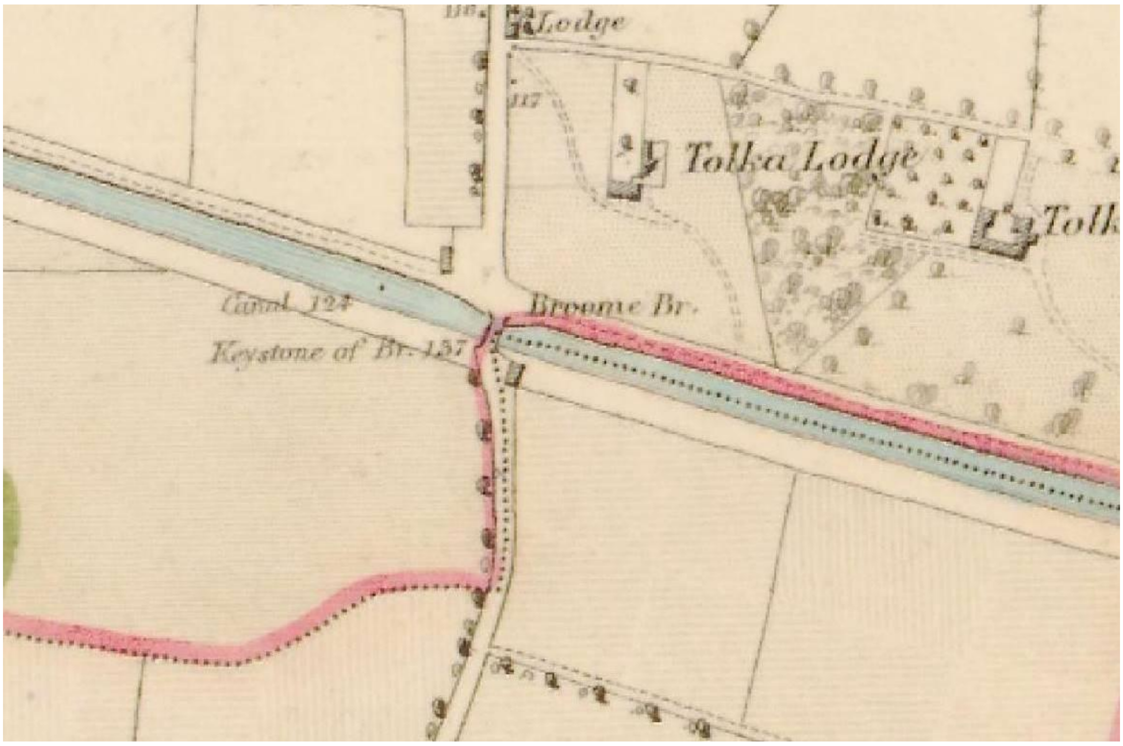

Figure 15 – 6inch OSI Map 1829 - 1841 showing Broome Bridge crossing the Royal Canal.

The 25inch OS Map (Figure 16) records the arrival of the railway line in Cabra and also documents Broome Bridge in context in greater detail. Ramped paths to the towpath at canal level are now clearly visible to the north of the bridge. The bridge is also now extended over the railway line. However, the angle of the bridge and its extension are not recorded. The paths to the north of the bridge indicate a route from the road down to the level of the canal. The towpath along the south of the canal is also visible along with train lines terminating to the south.

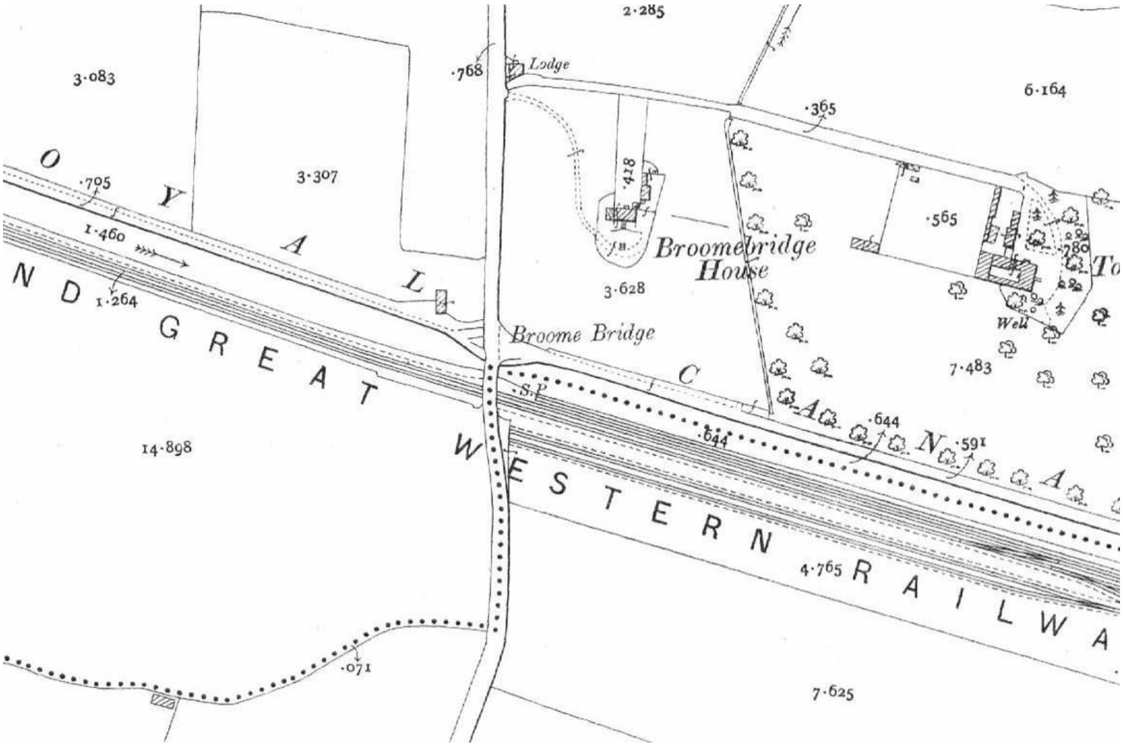

Figure 16 – 25inch OSI Map 1888-1913 showing the addition of the rail line and the extension to Broome Bridge.

Google satellite imagery from 2022 shows Broome Bridge as it is today with the train station to the east. The pedestrian access to the canal from the north is clearly visible.

Figure 17 – Screengrab taken from Google Maps, 2022.

5.0 ASSESMENT OF SIGNIFICANCE

Statement of Significance

The categories of special interest which define a Protected Structure as per the Planning and Development Act 2000 (as amended) are Architectural, Historical, Archaeological, Artistic, Cultural, Scientific, Social or Technical. These categories are not mutually exclusive, and a structure may be attributed with several of the categories. The categories identified as particular to Broome Bridge by the NIAH are Architectural, Historical, Social and Technical. The bridge has been recorded as having of National significance, but we believe it should be Regional. As noted previously, Broome Bridge is also a protected structure. The Royal Canal is also included in the Fingal County Council register of Protected Structures from locks 10 – 12 (RPS no. 944a, b, c and d), further west of Broome Bridge.

It is important to note that while the canal and railway bridges are individually a typology of their own, in this instance their compositions and significance must be read together due to their co-dependency and the fact that both are experienced as essentially one symbiotic bridge. This is due to the fact that the canal bridges in many cases were extended to span over the railway line which was constructed adjacent to the canal.

Architectural
Though Broome Bridge has undergone many alterations over time, the architectural merit of the bridge remains evident. The fine masonry craftsmanship of the bridge can be clearly seen in the decorative details, overall worksmanship and its elegant integration into the canal infrastructure. Like other canal bridges of this typology, the simple decorative features of the bridge in carved and dressed limestone contribute to the overall architectural expression of the bridge and testify to the skilled masonry craftsmanship employed in its construction. Relatively few of the railway bridges remain unchanged today, further highlighting the bridge's importance as part of Ireland's industrial architectural heritage.

Historical
Historically Broome Bridge carries significance for several reasons. The bridge represents two significant periods in Ireland's transport and industrial heritage in the form of two distinct developments with the construction of The Royal Canal and The Great Western Railway. The fact that the railway was added after the canal is also important as a layer of history of the overall composition of the bridge.
In this the twin form of Broome Bridge can be read as the embodiment of the period in the history of transport in Ireland, when the canals were superseded by the railways, but continued to function in parallel.

The bridge is also associated with astronomer and mathematician Sir William Rowan Hamilton who inscribed the important quaternion formula on the bridge in 1843. This equation carries great significance even today in three-dimensional physics and is credited with leading to developments in modern day technology such as computer modelling software among others.

Social
The bridges along the Royal Canal, including Broome Bridge, carry significance as pieces of social infrastructure for a number of reasons. Bridges act as a connection point between areas previously separated by the canal and railway and often provide a sense of identity and place for the people and communities around them. Both the canal and the railway line formed a manmade boundary, where the bridges then provided essential connection points. This is especially true for pedestrian bridges as they are more directly experienced by people. Additionally, bridges often survive development around them over a long period of time, as standalone independent structures further reinforcing the sense of identity provided. Today the bridges are important architecturally as standalone features, acting as nodes of identity along the canal which extends through many towns and communities into the midlands.

The canals and some railway lines around Ireland are now important places used for walking and cycling, especially in urban settings where outdoor recreational infrastructure is limited. The Royal Canal Way is one example on the Royal Canal. The canals are also popularised with barge boating culture and disused railway infrastructure has also been converted into greenways around Ireland.

Technical

Technically, the manner in which the bridge was extended over the railway in 1846 is significant. The vault of the arch spanning over the railway was constructed with a skew. This critically allowed the arch to be constructed at an angle over the railway line which was essential due to the angle of the approaching road to the south. The skewed arch is a technically impressive feat which required skilled engineering and craftsmanship to ensure the thrust of the arch was successfully transferred either side. The execution of it in slender stone sections tying in with quoins and voussoirs either side also demonstrates exceptional craftsmanship and skill.

6.0 OUTLINE CONDITION ASSESSMENT

Broome Bridge is generally in fair condition considering its proximity to the canal and road, but there are areas where repair works are required.

The stonework of the arches, buttresses and spandrels do not appear to have major structural issues. It was not possible to get access to many areas but no structural cracks were identified. The stonework on the face and the rising wall under the arches generally appears to be in good condition apart from a number of areas on the canal side where extensive weathering is visible. This is particularly evident on the north east face near the base of the arch. There are small pockets where the stone face has broken away, especially on the canal side, but this is not widespread. The smaller stonework forming the arches appears to be more weathered and there is some evidence of moisture penetration from the road deck above. The railway side could not be properly inspected due to access constraints but it is clear that all the stone has been painted at low level, presumably to cover earlier graffiti. There appears to be a number of phases of pointing on the bridge, some of which is likely to be an inappropriate cement mortar. This pointing has been washed out or has fallen away in many areas, predominantly beneath the arches and on the spandrels of the canal span. The joints on the railway side are tighter but there is evidence of localised pointing loss there as well.

Figure 18 – Weathered facing stone visible, especially below the spring of the arch.

Figure 19 – Condition of canal arch stonework.

Figure 20 – Graffiti under railway arch.

There are three wing walls on the bridge and their condition varies. The wall to the north west is in fair condition with slightly increased weathering present on stone at low level. The original copings have been lost and replaced with concrete and a section of the wall is covered in graffiti. The stonework on the north east wall has weathered considerably in the area that adjoins the bridge face. Like the north west side, the original copings have been lost and replaced with concrete. It was not possible to inspect the south east wing wall due to the limited access and extent of growth over the wall during the inspection. It looks like the original copings are still in place and the stonework appears to be in fair condition from a distance. The painting of stonework below the arch extends onto this wing. The walls have been repointed a number of times, some more successfully than others. This pointing is failing in localised areas.

Figure 21 – North east wing wall.

Figure 22 – Original copings visible to south east wing wall.

The parapet stonework appears to be sound but there are a number of phases of rebuilding visible. It is difficult to get close to the external face of the parapets but from a distance they appear to be in fair condition with the exception of localised areas of vegetation. The ramp to the platform connects to the bridge through the parapet and these junctions are poorly executed. Original stone on the parapet was broken away to create the junction. There are a variety of coping stones on the bridge including the original canal bridge copings, original railway arch copings and several versions of replacement concrete copings. The concrete copings have hairline cracks in places and localised repairs have been carried out. There are a variety of pointing styles on the bridge including recessed pointing on the newly built stone and the pointing is buttered over the stone on the older sections. Both of these styles are inappropriate for this historic bridge and all cement mortars are detrimental to the historic stonework.

Figure 23 – Poor condition of pointing & concrete copings.

Figure 24 – Pier stone damaged.

7.0 PROPOSED WORKS

As identified in the accompanying documentation, it is proposed to demolish the section of existing historic bridge over the railway line to allow for the electrification of the rail system. The existing bridge does not provide the clearance required to allow the Overhead Line Equipment (OHLE) to run under the bridge.

A number of approaches to provide the additional clearance required were considered. These included re-directing the tracks around the bridge, lowering the tracks and demolishing the railway side of the bridge to build a new bridge at a higher level. The evaluation process is detailed in EIAR Volume 4 Appendix A3.3 Option Selection for OHLE Intervention. On completion of this assessment the design team lead and client concluded that the demolition of the existing bridge and re-building at a higher level was the most suitable approach for the overall scheme.

The removal of this section of bridge over the tracks is an irreversible loss of important historic fabric and permanently alters the historic structure and surrounding setting. This section of the bridge has significant historic value, particularly as it is a carefully designed and built extension to the 1790's bridge over the canal. As such, it is very much an important layer of history. To mitigate the loss of the historic fabric as far as possible, the construction of the new bridge arch is being carefully considered. It is essential that the replacement section of bridge is well designed, detailed and executed. The most important consideration in the process is to ensure that the new build element sits comfortably alongside the remaining canal bridge. The stonework from the dismantled railway arch will also be salvaged and used for repairs where required.

Due to the significant raising of the bridge to accommodate the OHLE and the requirement to install a precast concrete arch, it is not possible or desirable to reconstruct the span to match the existing. Instead, a contemporary solution using modern materials is being designed to complement the proportions and style of the remaining canal bridge. The extent of demolition will be confined to the section of bridge between the stone piers to ensure that the reconstructed section will be read as an insertion rather than an entirely new bridge.

A number of finishes and construction methods were assessed during the design process. Initially the preferred option was to re-use the original facing stone but it became clear that this would not be successful due to the technical constraints of the new construction. The string course is an essential element of the existing composition but the increased height of the arch would distort its connection to the string over the canal. The precast arch construction would reduce the existing voussoirs to cladding stones and the facing stone of the spandrels would also become cladding stones tied back to the concrete structure behind. The combination of all these factors makes it very difficult to design or build stonework that would sit well alongside the original fabric and there were concerns that it would very much read as modern stone cladding.

Figure 25 - Image of existing spans with string course highlighted.

The use of a weathered steel facade was also explored as this material would tie together the rebuilt bridge and new pedestrian bridges on each side. After careful assessment it was decided to proceed with a concrete structure as this has the potential to sit most comfortably with the remaining original stonework. It is proposed to use a board marked concrete finish on all faces and to select a concrete colour that best complements the original stonework.

Figure 26 – Example of a new board marked concrete insertion in an existing stone structure.

The colour and texture of the concrete finish, along with the quality of the detailing and workmanship is critical to its success. There are many examples of fine concrete work next to historic stonework across

Europe, as identified in the image above. The design team is aware that Irish conditions are generally a lot damper than elsewhere, therefore the texture and finish of the concrete will be designed to minimise algae and vegetation growth. The texture created by the board will be controlled to ensure there are no large shelves for vegetation to take root and the surface finish will be carefully specified to limit the number of bugholes present on the finished concrete. It is proposed to use hand sawn boards to provide a finish that is not too uniform. Research into materials and sample panels will be essential prior to construction to ensure the new concrete finish complements the remaining historic stonework.

The form of the new arch and its relationship to the remaining canal arch is of critical importance. The design team have decided not to replicate the original arch exactly as the geometry of that shape would require the bridge to be raised even more than the current proposal. A slightly flatter arch provides the clearance required for both lines with less elevation.

The junctions between old and new will need to be carefully considered during detail design. The presence of the piers on either side of the arch allows the new build to be contained neatly at a natural break. These junctions will still need to be skilfully detailed and executed to ensure the concrete and stonework sit comfortably together. There will be a considerable amount of stone repair and repointing on the piers following the removal of concrete shuttering. These repairs will need to be carried out with great care by a skilled stonemason.

Figure 27 – Existing bridge with engaged piers highlighted.

The new concrete parapets will extend up to the height of the original with the additional height provided by the contemporary design discussed below. The original parapet thickness will be carefully designed to ensure the new parapet sits in as neatly as possible with the original. The piers extend up through the parapet externally providing a natural break but there is no detail on the internal face. This creates a challenge that will need to be overcome with careful detailing and skilled craftspeople.

Figure 28 – Image of parapet internally with line highlighting where the junction with the new concrete parapet will be.

It is a safety requirement that the parapets are a minimum of 1800mm high, with the bottom 1200mm solid in the area of the OHLE. This presents a significant challenge for Broome Bridge and all of the historic bridges along the line, as the existing original parapet heights are lower than 1200mm. A rigorous design process has taken place to identify a solution that will complement the historic setting and maintain a visual connection to the rail lines and surrounding landscape, when on the bridge. It is also essential that the parapet is not the dominant feature while viewing the bridge from the canal. The proposed design is a contemporary, adaptable solution that can be implemented throughout, bringing a degree of uniformity to all interventions along the railway. An alternative option with the extended parapet structure fixed on top of the coping, was also assessed. Due to wind loads and the uncertain structural integrity of the parapets, a considerable amount of damage to the original fabric would be required to anchor the new structure through the existing parapet to new concrete pads below.

For Broome Bridge it is proposed to provide a solid metal panel from the top of the parapet up to 1200mm with an expanded metal mesh to continue up to 1800mm. The vertical supports and mesh will be carefully designed to ensure the internal face of the parapet is not obscured and that the mesh allows a good visual connection to the surroundings.

Figure 29 – Render of design proposal to increase the parapet height to 1800mm with mesh about 1200mm.

Repair works will be required to the existing parapet before the proposed heightening works can take place. All joints will need to be examined and raked out where the existing mortar is lost or failing. Joints will need to be repointed in a suitable lime mortar and protected until satisfactorily carbonated. These works must be carried out by a skilled mason with extensive experience with historic stonework. The existing connection for the ramp access to the platform is to remain in position and no alterations are proposed.

Figure 30 – Existing parapet requires repair and conservation works.

Figure 31 – Render of proposal on completion – West Side.

Figure 32 – Render of proposal on completion – East Side.

8.0 ARCHITECTURAL HERITAGE IMPACT ASSESSMENT

Proposed Alteration	Negative Impact	Neutral Impact	Positive Impact	Mitigating Measures
Demolition of the section of original bridge over the railway line.	Loss of important historic fabric. Partial loss of one of the few remaining original canal and railway bridges in the area. Alters the historic setting.		Allows for the train system to be electrified.	The demolition will be contained between the stone piers on each side to minimise the loss of historic fabric. A carefully designed replacement section of bridge will be constructed to sit in harmony with the original fabric on each side. The stonework will be carefully dismantled and used for repairs on the historic bridges where necessary.
Removal of original parapets from the section of bridge being removed.	Loss of important historic fabric. Removes the only visible connection to the historic bridge when crossing over.		Allows for the train system to be electrified.	The replacement parapets will be reinstated to the original level. The additional required height will be provided with a modern parapet detail. The parapets will be carefully designed to ensure they connect neatly to the remaining historic parapets on each side.
Construction of the new bridge section over the railway line.	The use of precast concrete will create a construction joint under the bridge between the arch and board marked concrete face. The concrete arch will read differently to the shuttered concrete on completion.		Concrete colour and texture will be designed to be compatible with the surrounding historic stonework. The junctions between the concrete and original stone will be carefully detailed to ensure the two phases of construction sit comfortably together.	The cast in-situ concrete will be carefully designed to ensure the precast arch is not visible while viewing the original structure in elevation. The surface finish of the concrete will be carefully considered to limit the vegetation growth as much as possible.

Proposed Alteration	Negative Impact	Neutral Impact	Positive Impact	Mitigating Measures
Increase of parapet height.	Obscures the original design intent of the existing parapets to some degree on the internal faces. Visual connection to the top of the coping stones will be lost on internal faces. The connection to the surrounding setting is compromised by increasing the parapet height to 1800mm.		Allows for the train system to be electrified. This approach allows the original parapets to be retained on each side of the rebuilt section.	The new parapet will be carefully designed to minimise the impact on the remaining historic parapets. Fixings into the historic parapets will be minimised and will be installed in the joints where required. The majority of the structural load will be transferred to the deck, decreasing the impact on the parapets. The metal mesh will be carefully selected to ensure the visual connection to the surrounding landscape is maintained as much as possible. The parapet supports will be designed to be as slender and elegant as possible to reduce the visual impact on the parapets.
Existing ramp to platform.		This ramp is not appropriate to the historic setting but it is in place and no alterations are planned.		

9.0 CONCLUSION

The demolition and replacement of the span of Broome Bridge over the railway line is a very significant loss of important historic fabric. This will have a considerable and irreversible impact on the character of the setting, the surrounding environment and the remaining canal bridge, dating from the 1790's. From a conservation perspective it would be preferable to incorporate the welcomed new infrastructure into the existing setting, while retaining this important historic structure. As identified in Appendix A3.3 Option Selection for OHLE Intervention in Volume 4 of the EIAR, the bridge can be retained, but due to significant financial, programme and technical reasons, removal and replacement has been chosen as the preferred option.

By raising the railway arch, the connection between this and the canal arch is fundamentally altered, so constructing a stone facade on the new bridge section is not considered appropriate. After carefully assessing the alternatives, it was concluded that a contemporary concrete structure would sit most comfortably with the remaining historic stonework. Considerable effort will be required during detail design and construction, to ensure the colour and texture of the concrete complement the existing stonework. Careful detailing and execution at the junctions will also be fundamental but these are all achievable and should lead to a successful outcome. Containing the re-build between the piers on each side is positive and will allow the new section of bridge to be read as an insertion into the original rather than a new bridge.

The proposed parapet heightening design provides a flexible solution that can be adapted to each historic bridge along the length of the Dart+ West project. Raising the parapet is a fundamental safety requirement when installing OHLE, so the proposal needs to incorporate these essential requirements. The use of an expanded metal mesh above 1200mm ensures that a visual connection to the surroundings is maintained while on the bridge. The positioning of the new parapet on the internal face also ensures that it reads as a secondary element when viewing the external faces of the bridge. Unfortunately, the raised parapet will obscure the top of the existing coping stones internally, but it is an essential safety requirement to remove ledges that could be used to climb up on the parapet.

It is clear from a conservation perspective that the demolition of the section of bridge over the railway is a major loss to the overall structure and surrounding setting. However, the proposal to reconstruct the arch with a carefully designed and detailed concrete finish should sit comfortably with the remaining canal bridge and reflect a high quality contemporary design. The required conservation and repair works to the existing fabric should also be incorporated into any future works on the bridge.