The Network Rail (Leeds To Micklefield Improvements) Order

Alternative Options Evaluation Study: HUL4/14 Ridge Road Overbridge

Author	Network Rail
Date	June 2023
Revision Number	Rev 1

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1. INTRODUCTION

1.1 Purpose

1.1.1 This report considers the proposed development options for the HUL4/14 Roman Ridge Road Overbridge, relating to Transpennine Rail Upgrade electrification works, setting out options considered, the assessment methodology and resulting preferred option design.

1.1.2 This document will be submitted as part of the Listed Building Consent for the works, alongside the Heritage Statement.

1.1 Scope

1.1.3 This report contains the following sections:

- A summary of the technical justification for the bridge works and resulting benefits.
- An outline of the options that were considered and retained or rejected ahead of the assessment.
- A description of the assessment methodology
- The options assessment result
- A summary of findings and justifications for the preferred option

1.1.4 This report focuses on work associated with HUL4/14 Roman Ridge Road Overbridge (hereafter 'the bridge'). The bridge is a Grade II listed building and forms part of the original Selby to Leeds Railway, constructed in the 1830s. It is one of a number of similar bridges along the route, of which eight are listed and a further four are considered to be of historic interest. A concise Statement of Significance is presented in Section 4.

1.1.5 The bridge is in active use and carries the A656 Roman Ridge Road over the Leeds to York mainline railway (NGR SE 430 328). It is located between Garforth and Micklefield, West Yorkshire within an area of predominantly agricultural fields, but adjacent to a small light industrial estate (Peckfield Business Park). The railway is at this point within cutting, with the road carried over the railway at grade, following the natural rise in the landscape.

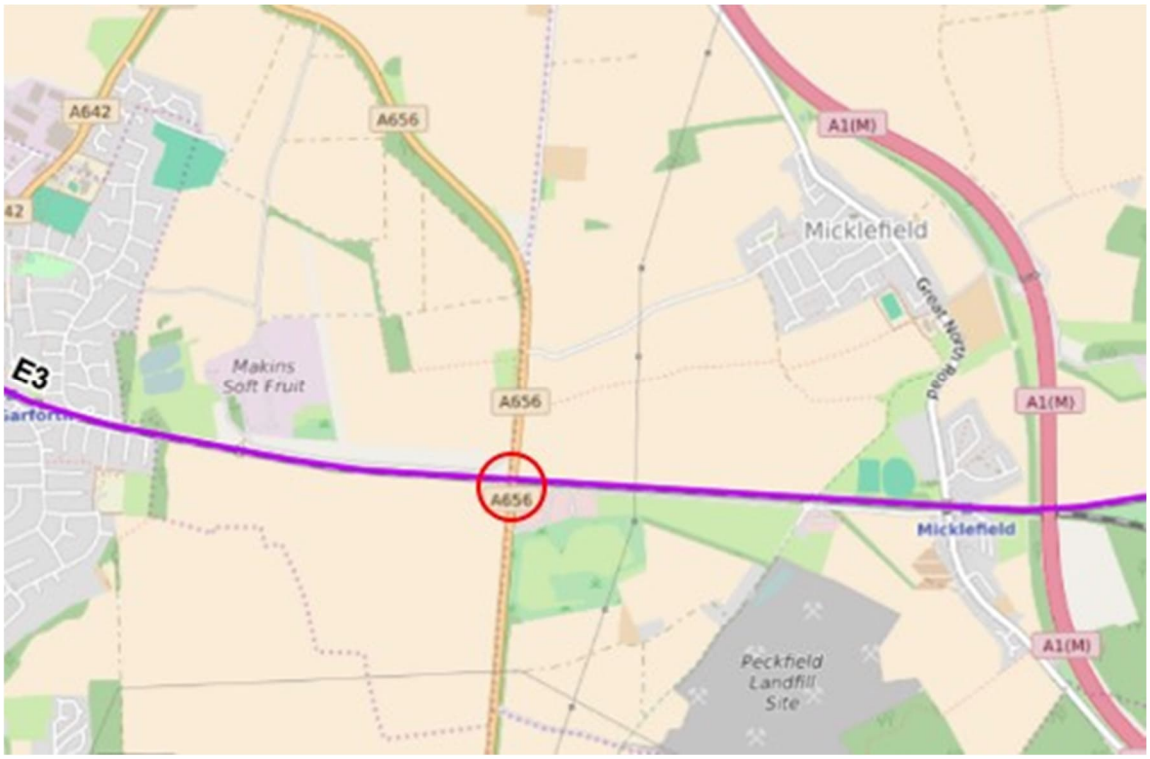

Figure 1 Location Plan

1.2 Definitions

Term to be defined	Concise definition of term
Listed Building	A structure identified on the National Historic List of England due to its special historic and architectural interest. Protected by law.
TMLA	Track Lift Maintenance Allowance – allowance give for future maintenance tamping for the track to maintain the geometry for the safe passage of trains
VCC	Voltage Controlled Clearances
WLC	Whole Life Costs

Table 1 Definitions

1.3 Abbreviations

Abbreviation	Full terminology
BMV	Best and Most Versatile (relating to agricultural land)
GRIP	Governance for Railway Investment Projects
NHLE	National Heritage List Entry
OLE	Overhead Line Electrification
PROW	Public Right of Way
TOC	Train Operating Company
TRU	Transpennine Route Upgrade

TWAO	Transport and Works Act Order
WRaCCA	Weather Resilience and Climate Change Adaptation

Table 2 – Abbreviations

2. NEEDS AND BENEFITS CASE

2.1.1 This section of the report summarises the strategic need for the TRU project which requires alterations to the Grade II listed Roman Ridge Road Overbridge (HUL4/14; NHLE 1419084) and the benefits that will be derived from the project.

2.1.2 TRU will help to promote sustainable transport in accordance with the National Planning Policy Framework (2021) (Chapter 9) and the government objectives set out in the National Policy Statement NPS for National Networks (2015). Section 2 of the NPS states:

The Government will deliver national networks that meet the country's long-term needs; supporting a prosperous and competitive economy and improving overall quality of life, as part of a wider transport system. This means:

- *Networks with the capacity and connectivity and resilience to support national and local economic activity and facilitate growth and create jobs.*
- *Networks which support and improve journey quality, reliability, and safety.*
- *Networks which support the delivery of environmental goals and the move to a low carbon economy.*
- *Networks which join up our communities and link effectively to each other.*

2.1.3 Further paragraph 2.2. of the NPS states that "'there is a critical need to improve the national networks to address road congestion and crowding on the railways to provide safe, expeditious and resilient networks that better support social and economic activity; and to provide a transport network that is capable of stimulating and supporting economic growth." Paragraph 2.10 confirms that at a strategic level that there is a compelling need for the development of national networks.

2.1.4 TRU is an important commitment made by the Secretary of State for Transport that aims to create a better performing railway that passengers can depend on; one that provides more trains, more seats and creates a better-connected North. This will include a large number of key interventions between Manchester, Leeds, and York. The government commitment to delivering TRU was confirmed in the Integrated Rail Plan for the North and Midlands

(November 2021), as the first phase of the wider Northern Powerhouse Rail project.

2.1.5 TRU will facilitate the provision of electrification of an operational railway. The project will, therefore, improve the provision of public transport (rail) through the local area and across the region in the long term, due to the intended provision of longer, faster and more reliable rolling stock on the route, alongside the reduction in freight across the road network. TRU will also support the UK response to the climate challenge through the electrification of the Transpennine route and subsequent de-carbonisation of rail transport.

2.1.6 In section 4.9 of the Leeds City Council Core Strategy (2019) notes that the electrification of the Transpennine route (the TRU) is an important part of its sustainable transport plan.

2.1.7 The City Council 'Connecting Leeds Transport Strategy states that "The Transpennine Route Upgrade will enhance connections to Huddersfield and Manchester, providing reliable connections and quicker services." The delivery of the TRU is a major element of the West Yorkshire Combined Authorities Transport Strategy 2040.

2.1.8 Works to HUL4/14 Ridge Road Overbridge are essential in achieving the proposed electrification of the route. Without works to the Listed Structure then the TRU Programme cannot be delivered at this location. Without works at this location the scheme as a whole cannot be achieved and the benefits of the TRU Programme will not be realised.

3. STATEMENT OF HERITAGE SIGNIFICANCE

3.1.1 Roman Ridge Road Overbridge is a Grade II listed building. It was designated in 2015 as part of a thematic review of the structures associated with the upgrade works to the Transpennine Railway from York/ Selby through to Manchester. The bridge is part of the original construction of the Leeds to Selby Railway in the 1830s following the designs of the noted engineer James Walker. Walker acted as consulting engineer, alongside his assistant Alfred Burges and was responsible for some of the detailed design. He was also responsible for instigating the four-track design which, although never implemented, resulted in a need to redesign the traditional railway structures to accommodate the wider line. The result was a single basket arch structure, enabling a wider span without the need for higher arch (Figure 2).

Figure 2 – view through Ridge Road looking towards York

3.1.2 Roman Ridge Road Overbridge follows Walker and Burges' basket arch design, despite the fact that the rock cutting in this area make it unlikely that it could have ever accommodated the promised four track (Figure 3). It should also be noted, that although originally designed for a four track arrangement in 1830, it would not accommodate a modern rolling stock four track arrangement.

Figure 3 – rock cutting approaching Ridge Road from the west

3.1.3 The bridge is located between East Garforth Station 1.5km to the west and Micklefield Station 1.4km to the east. It is situated in a largely open rural landscape, although a small light industrial estate has been constructed to the east. Historically the bridge carried the main road north from Castleford, much of which runs along the course of the Roman road which led to the fort at Castleford. Historically, the area to the east and west of the bridge was in use for limestone quarrying, with a mine established to the south of the line by the mid-20th century.

3.1.4 It is constructed from sandstone and quarry faced limestone. The abutments are straight with a quarry faced impost band from which springs the semi-elliptical basket arch. The arch itself is formed by rusticated, v-jointed ashlar voussoirs above which rises the parapet, set upon a square moulded string course. The parapet itself is capped with a curved coping and oval piers and decorated with defined horizontal tooling.

3.1.5 The structure is Grade II listed in recognition of its historic and architectural interest. It has historic interest in its association with the Leeds to Selby Railway, one of the earliest railways in the country, representing one of the original structures along the line dating to 1830-32. It is also of architectural interest due to its unusual basket arch design, employed to span four tracks rather than the usual two, and demonstrating technical innovation. This is characteristic of the Leeds to Selby line, with 12 examples surviving (eight of which are designated). The bridge survives largely unaltered from its historic construction. The results of a recent (2020) survey concludes that the bridge survives in a fair condition with some evidence of spalling and fractures, alongside historic repairs.

4. REASONABLE ALTERNATIVES

4.1.1 The aim of TRU is to create a better performing railway that provides more trains, more seats and creates a better-connected North, in line with the commitments made by the Secretary of State. Non-electrification solutions were explored during the early phases of the project; however, these did not provide the outputs required by the project.

4.1.2 In order to achieve the benefits delivered by TRU, overhead line electrification (OLE) infrastructure is needed to power faster and more environmentally friendly electric trains. Due to the historic construction of the line, a number of historic structures cannot accommodate the proposed electrification in their current form. This includes Roman Ridge Road Overbridge which is not of sufficient height to accommodate the operational minimum requirements for clearance distances between the trains and the OLE.

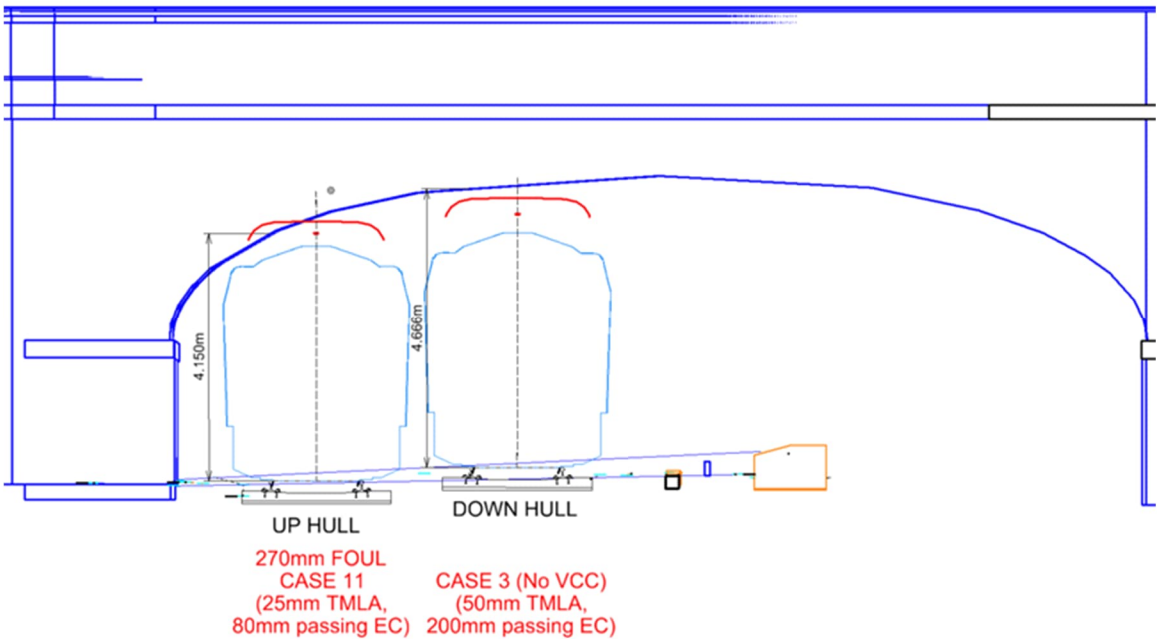

Figure 4 – Current clearance

4.1.3 An initial engineering review was undertaken to identify alternative options which would facilitate OLE construction through the bridge while maintaining an active highway above. This process looked at various high-level options to achieve electrical clearance for the installation of OLE through the bridge;

1. Structure intervention to increase soffit height
2. Track lowers/slews to increase soffit height

4.1.4 These options included reviewing potential reduced electrical clearances with additional control mitigations i.e., surge arrestors, voltage limiting devices, where this provided economic or heritage benefits.

4.1.5 The outcome of the initial engineering review was the identification of three potentially feasible options to enable the installation of new OLE.

- Option A (1 and 2) – Structure Intervention to raise soffit height
- Option B - Track Slue
- Option C - Track Lower

4.1.6 For option A, two sub options have been reviewed, Option A1 reconstruction of the bridge deck, and Option A2 jacking of the existing bridge arch. For options B and C three sub-options have been identified and assessed. These vary the magnitude of the track slue/lower to take into account the potential to agree a sub-functional clearance for the structure. This would involve deviation from normal Network Rail standards following bespoke assessment of the specific conditions at the bridge location in question.

4.2 Option A – Structure Intervention

4.2.1 Option A involves a structure intervention to raise the existing soffit height of the structure to accommodate OLE.

Option A1

4.2.2 Option A1 proposes the removal of the present basket arch and replacement with a flat deck to achieve the necessary clearance for electrification. Reconstruction in stone, following the existing arrangement was initially considered, but was rejected as the geometry of the arch means that it is not possible within current standards to span the full width of the railway. Significant stabilisation works would be required to the embankment in order to provide the necessary bracing to carry the arch. This is not possible given the local geology and potential mine workings. In addition, in order to achieve the required clearance, the highway above the bridge would need to be raised. This would considerably worsen the visibility for road users and pose a safety risk.

4.2.3 Two sub-options have therefore been considered for A1, reconstruction with a standard composite flat deck or reconstruction with a bespoke feature bridge. Both options are outlined here; however, for the purposes of this options evaluation, only the principle of reconstruction is assessed.

Composite Flat Deck

4.2.4 The arch will be removed to springer level, with the stone abutments retained. A new superstructure will be installed on the original abutments. The precast concrete units would be faced with sandstone to maintain visual similarity to the existing structure. Refer to Figure 5 below.

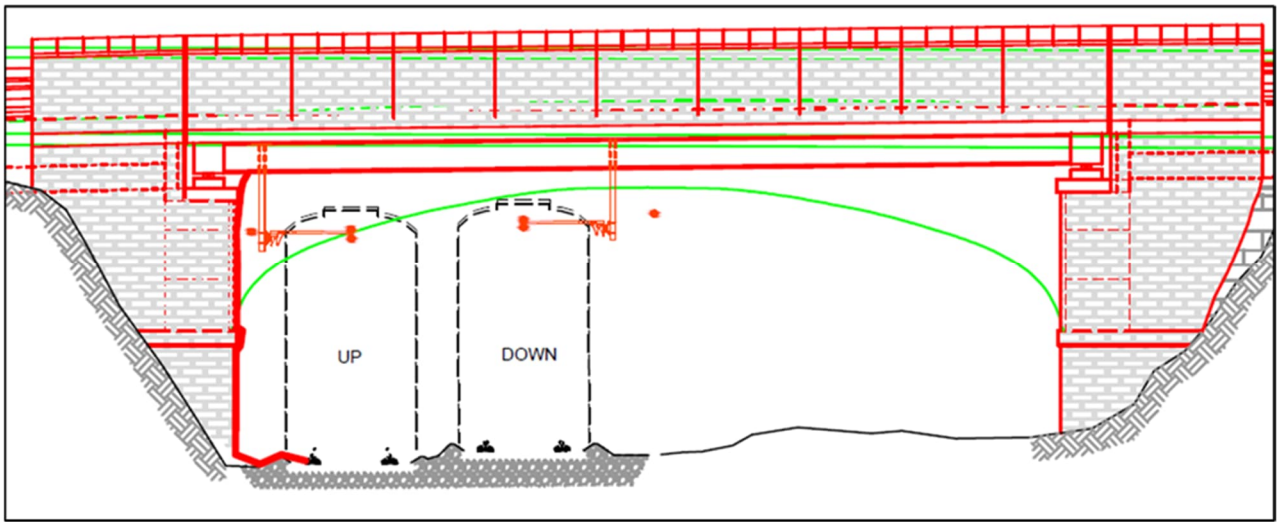

Figure 5 – Deck reconstruction with a composite flat deck

4.2.5 A concrete arch alternative was reviewed, but there are technical limitations to the maximum span (9.4m max) which can be achieved with precast concrete arches (9.4m max). The existing arch span is currently 16.3m and therefore this structural form is considered to be unsuitable for this site. In addition, the existing clearance issue would remain. In order to achieve sufficient clearance, the abutments would need to be built up from the springer level, while retaining the existing abutments. This would impact the existing Ridge Road highway alignment. There are junctions on either side of the structure which would likely require realignment due to the rise in highway level.

4.2.6 The new bridge would be constructed from concrete for the purposes of future maintenance; however, the new elements would be faced in reclaimed stone to reflect the original. The new parapets will also be higher (to a minimum of 1.8m) to deliver standard parapet protection over electrified lines. The current parapet height is less than 1m high.

Bespoke Structure

4.2.7 The design of Option A1 is subject to further refinement. Whilst the option detailed above looks to retain the sandstone effect of the structure whilst achieving the necessary slimmed down construction depth required for the replacement superstructure, an alternative that could be offered would be to replace the superstructure with a modern feature bridge. The design of the bridge would also be consistent with other replacement structures along the route to ensure a cohesion reflected in the historic route. For the reasons outlined above, the bridge would maintain a flat deck with an applied arch.

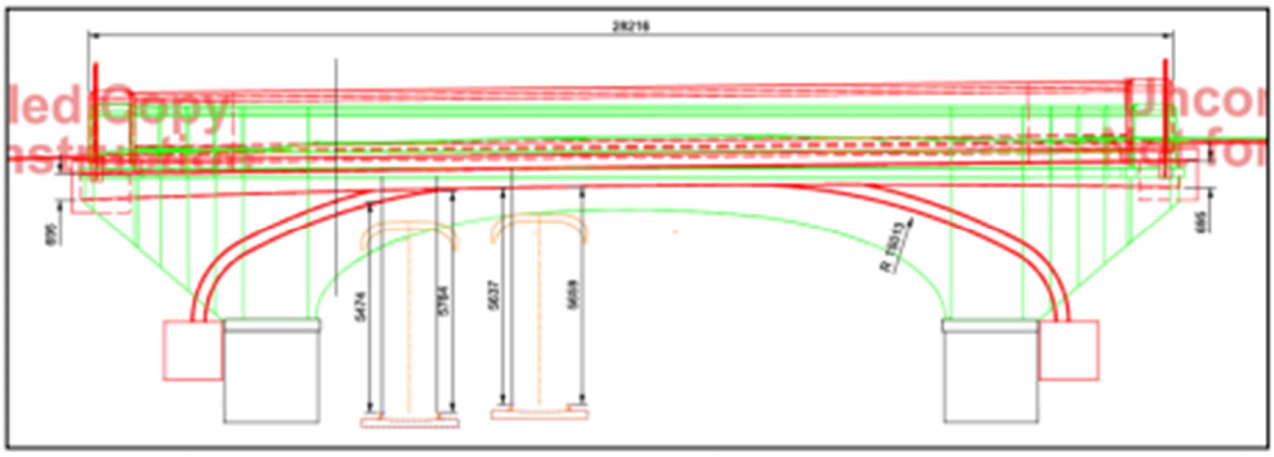

Figure 6 – Reconstruction with an applied arch structure

Option A2

4.2.8 Option A2 looked at jacking of the existing masonry arch structure using a system called “ElevArch®”.

4.2.9 ElevArch® is a patented technique which involves cutting the arch free from its abutments and wing walls so it can be jacked skywards to enlarge the space below it. A sequence of operations is key to maintaining the all-important thrust line - a horizontal saw cut is made through each abutment, just below the arch springing in conjunction with coring five holes horizontally into each abutment. Vertical lifting jacks are inserted into these holes, supporting the weight of the bridge (Figure 6).

Figure 7 – Trial brick arch jacking site Moco Farm

4.2.10 The system was developed by Freyssinet in response to a competition to reduce the cost, environmental impact and programme of bridge reconstructions and a trial was undertaken on a suitable brick arch structure of shorter span, which carried a live farm access over a non-operational railway that was to be recommissioned.

4.2.11 Bridge jacking would also require modification of the existing parapets in order to raise their height to a minimum of 1.5m with the addition of steeple coping (anti-climb measure) for the purpose of protection against electrocution from the proposed OLE system.

4.3 Option B - Track Slue

4.3.1 Track slue involves moving the tracks to install OLE and enable trains to pass under the bridge at its highest point. The bridge was originally constructed to

span four tracks, but only two tracks were installed. As a result, the current tracks pass under the bridge to one side, thus not making use of the full height of the arch. By moving the track so that the lines run under the centre of the arch, there would be no requirement to demolish the arch. To achieve this, the rail, sleepers, track drainage and track level services would need to be moved horizontally. Realigning the tracks locally at the structure will have an impact of the line speed, sighting and ride comfort of the train as the slues would need to extend far beyond the structure due to track geometry rules. In addition to this, extensive works would also be required to the approaches along the cutting. This would be achieved by stabilising the existing rock cutting slopes with retaining walls. The extent of the stabilisation would likely be in the region of approximately a few hundred metres to the approach/exit of the structure.

4.3.2 Modification works would also be required to the existing parapets in order to raise their height to a minimum of 1.5m with the addition of steeple coping (anti-climb measure) for the purpose of protection against electrocution from the proposed OLE system.

4.3.3 Three options have been reviewed for track slue:

- Option B1 Moving the track 1765mm to the left to achieve functional electrical clearance
- Option B2 Moving the track 1085mm to the left to achieve >150mm passing electrical clearance
- Option B3 Moving the track 605mm to the left to achieve sub functional electrical clearance

4.3.4 All of the track slue options will require excavation works to the embankment on the Down Hull line, including removal of vegetation. This would require rock breakout and restabilising works to the cutting slopes within an area of historic mine workings. . For Options B1 and B2 the length of track involved would be c.900m to each track. Option B3 would require less excavation of the slope, limited to reprofiling and stabilisation for c.830m for each track.

4.4 Option C - Track Lower

4.4.1 Track lower involves lowering the track, but retaining it on its current horizontal alignment in order to achieve the necessary clearance under the arch and avoid the need for reconstruction.

4.4.2 A Track lower involves locally lowering the level the rails, sleepers, track drainage, track level services, ballast and sub ballast layers to provide clearance. Rock is located between 0.45m & 0.75m below existing ground level, so excavation would involve rock break out within a known mine working

area below the existing track bed. Track lower also requires excavation over a significant length (approximately 500m) due to restrictions on the change of gradient on the approaching tracks.

4.4.3 Modification works would also be required to the existing parapets in order to raise their height to a minimum of 1.5m with the addition of steeple coping (anti-climb measure) for the purpose of protection against electrocution from the proposed OLE system.

4.4.4 Three options have been taken forward for track lower:

- Option C1 Lowering of the track by 650mm track lower to achieve functional electrical clearance
- Option C2 Lowering the track by 465mm to achieve >150mm passing electrical clearance
- Option C3 Lowering the track 275mm to achieve sub-functional electrical clearance

4.4.5 A combination of track slue and lower has also been considered to minimise the magnitude of each, but the same principles apply with respect to impact on the adjacent rock cuttings and mine workings, therefore they have not been separately assessed.

5. ALTERNATIVE OPTIONS ASSESSMENT METHODOLOGY

5.1.1 This section of the report describes the alterative options assessment methodology that was developed to assess the four options and sub-options and identify a preferred option.

5.1.2 An Options Assessment Matrix (OAM) was created to ensure all relevant matters (topics) were identified and considered by planning, engineering and environmental specialists as relevant.

5.1.3 The topics and assessment criteria were defined in order to allow an objective and consistent assessment of alternative options across all options. However, categorisation (Highly Unsupportive – Highly Supportive) did rely on an element of professional judgement and consistent application of professional judgement was ensured via a quality review.

5.1.4 The assessment topics and sub-topics are set out in the OAM at **Appendix A** of this report. A summary of the topics and sub-topics used is listed below.

- Environment and Consent Risk – addressing environmental concerns, planning risks and consents risk.
- Land & Property – addressing land access and availability concerns.
- Cost – addressing capital and maintenance cost constraints.

- Design / engineering feasibility – to address varying levels of design complexity.
- Construction – to address varying levels of construction complexity.
- Maintenance – to address varying levels of maintenance burdens.
- Deliverability – to address the impact on wider project programme timescales.

5.1.5 A RAG (Red Amber Green) type rating was assigned to each component of the assessment. The RAG rating includes five grades from Highly Unsupportive (red) through Unsupportive (amber) and Neutral (yellow) to Supportive (pale green) and Highly Supportive (green). The assembled factual evidence was assessed against the evaluation parameters by qualified professionals to award a grade (i.e., Highly Unsupportive – Highly Supportive), based on professional judgement and supported by a statement setting out the justification for each categorisation. Following all of the individual assessment, these were reviewed by a senior professional to moderate and ensure consistency.

6. ASSESSMENT OF ALTERNATIVE OPTIONS

6.1.1 This section of the report presents the findings of the options evaluation against the assessment topics.

6.1.2 The section below identifies overall considerations that are applicable to all options and sets the wider context for the options. These are summarised upfront to avoid repetition. Specific considerations relevant to each option are then identified under each option in the subsequent sections.

6.1.3 The below is a factual description of the relevant matters for each option to enable an understanding of the optioneering process. It is not intended to provide a justification for the options. This will be presented within the Heritage Statement which accompanies the Listed Building Consent.

6.2 Overall Considerations

6.2.1 Temporary acquisition of land would be required for all options during the construction phase. This acquisition may lead to a temporary adverse impact on a PROW as it is possible that it would need to be diverted while construction work was ongoing. However, this would not be a permanent diversion.

6.2.2 All options are to facilitate the provision of electrification of an operational railway; therefore, all options have the potential to replace diesel power on this route.

6.2.3 The existing bridge has high bat roost potential and its reconstruction could have potentially significant effects on the protected species. All options would disturb any protected species present.

6.2.4 The bridge carries an active highway (the A565 Roman Ridge Road) over the railway. Any changes to the highway need to take into account visibility for road users, taking into consideration the proximity of road junctions and access for adjacent landowners. Given these constraints, it is not possible to heighten the highway at this location.

6.3 Option A1 - Bridge Deck Reconstruction

Environment and Consent Risk

6.3.1 Option A1 requires the demolition of the existing Grade II listed bridge and the construction of a replacement flat soffit bridge deck. Listed structures are protected by the Planning (Listed Buildings and Conservation Areas) Act 1990[1] and consent will be required for this option. In planning policy terms, clear and convincing justification is required for the harm caused to the structure (National Planning Policy Framework (NPPF)[2], paragraph 200). Leeds City Council Local Plan policies[3] P11 (conserve and enhance the historic environment, including the 19th century transport network), and P12 (conserve and enhance the character and quality of Leeds' townscapes and landscapes, including historical and cultural significance) are also relevant. The option is considered to constitute total loss of the significance of the asset resulting in substantial harm. Although Network Rail considers it can be demonstrated that the alterations to the heritage asset are necessary to achieve substantial public benefits that outweigh that harm, this option has been graded Unsupportive on cultural heritage grounds to reflect the great weight to be applied to conservation of nationally designated heritage assets in national planning policy. However this option does offer the opportunity for a bespoke design, that looks to build in features that retain the ethos behind the original basket arch design, which new arch profiles replicating the shallow arch feature and reuse of sandstone materials on the bridge parapets to retain the existing appearance at road level.

6.3.2 Option A1 will require temporary closure of public rail transport as works to reconstruct the bridge can be done within standard possession access opportunities, although a road closure and temporary diversion of public

[1] The Stationary Office, 1990, Planning (Listed Buildings and Conservation Areas) Act

[2] Ministry of Housing, Communities & Local Government, 2021, National Planning Policy Framework

[3] Leeds City Council, 2019, Leeds Local Plan: Core Strategy

footpath will be required. All options will be accessed from nearby secure compounds which are to be created temporarily, and access to the site will be via the rail line (or adjoining roads) during closure. Option A1 would require both full road closure of the A656 and rail-line blockage during works to avoid risk to the public. However, given the number of crossings available, there would be an alternative route in the area. The option is therefore Supportive.

Land and property

6.3.3 Option A1 is Highly Supportive in terms of land availability. No permanent land take is required as all work would be within Network Rail Land. Temporary acquisition of land would be required during the construction phase.

6.3.4 There is a PROW which follows the A656 to the north or the railway line. A PROW also meets the A656 approximately 175m to the south of the bridge coming from the east. There is the potential that the PROWs would be temporarily diverted during construction; however, this would not be a permanent diversion and the option is considered to be Supportive.

Cost

6.3.5 If a standard concrete flat deck option is installed, the cost of Option A1 is considered Supportive as it provides the most cost effective and risk free option to retain a structure at this location whilst achieving the necessary clearance for electrification. Whole Life Cycle (WLC) costs for a bridge reconstruction (circa £1.4m) are half those for the track slue options and between two and four time less than the track lower options.

Design/ Engineering Feasibility

6.3.6 As discussed in Section 5.2 above, options for the replacement of the superstructure are available that achieve the slim deck construction required to facilitate electrical clearance for OLE below whilst reducing impact on the highway levels above which are constrained by adjacent properties and junctions. Both options are straight forward from a design and engineering point of view and as such have been scored as Neutral. This option also allows additional capacity should a four-track railway be proposed in the future.

Construction

6.3.7 The site has good accessibility, and although it will require temporary land access and partial/full road closures, it is expected that these would be of a manageable duration and pedestrian diversion can be provided via the temporary services scaffold bridge.

6.3.8 The existing gas main, BT services and water main situated beneath the footpaths will also need to be temporarily diverted onto a temporary scaffold bridge.

6.3.9 Given the above and the relatively minor nature of any temporary works to achieve the superstructure replacement, this option has been scored as Supportive.

Maintenance

6.3.10 The proposed new structure will require minimal ongoing maintenance for the next 50 years. This option is scored as Highly Supportive as it will replace a structure that currently needs regular maintenance checks and significant life extension works in due course.

Deliverability (timescales)

6.3.11 Option A1 will require several extended weekend possessions of the railway, but can be designed and delivered in line with the proposed TRU build programme, therefore it has been scored, Highly Supportive. Partial and full road closures will be required to support the works, but it is expected that these will be of manageable durations.

Feasibility

6.3.12 Option A1 remains feasible within the constraints of the project. There are constraints on what could be achieved as part of the reconstruction of the structure due to its relationship with the highway; however, a number of options remain which overcome these constraints.

6.4 Option A2 - Bridge Jacking

Environment, Sustainability and Consent Risk

6.4.1 Option A2 would involve significant interventions into the historic fabric of the Grade II listed structure and result in aesthetic changes due to increasing its vertical dimensions. Listed structures are protected by the Planning (Listed Buildings and Conservation Areas) Act 1990 and consent will be required for this option. In planning policy terms, clear and convincing justification is required for the harm caused to the structure (NPPF, 200). Leeds City Council Local Plan[4] policies P11 (conserve and enhance the historic environment, including the 19th century transport network), and P12 (conserve and enhance the character and quality of townscapes and landscapes, including

[4] Leeds City Council, 2019, Leeds Local Plan: Core Strategy

historical and cultural significance) are also relevant. This option would retain the key feature of the bridge, being its basket arch. It is considered that this would constitute less than substantial harm to the significance of the asset in terms of the NPPF and local planning policy.

6.4.2 Jacking of the arch deck would result in a visual difference due to the increased height of the road, parapets and the infill material on the abutments/wingwalls. The exact lift required would be in the order of 650mm similar to the track lower in order to achieve functional clearance.

6.4.3 This option will require significant closure of public rail transport through the area during works. Initial advice from specialist sub-contractor Freyssinet is that four weeks would be required to jack a structure of this size. Closure of this section of route for four weeks affects commuter services not only between Leeds and York but also affects all the Leeds to Selby and Hull services. Option A2 would require both full road closure of the A656 and rail-line blockage during works to avoid risk to the public. However, given the number of crossings available, there would be an alternative route in the area. The option is therefore Supportive.

Land and property

6.4.4 Option A2 is Unsupportive in terms of land availability. Temporary acquisition of land would be required during the construction phase. The option has the potential to affect access to Ridgebridge Cottage through permanently raising the road level with junction works requiring permanent land take.

6.4.5 There is a PROW which follows the A656 to the north or the railway line. A PROW also meets the A656 approximately 175m to the south of the bridge coming from the east. There is the potential that the PROWs would be temporarily diverted during construction; however, this would not be a permanent.

Cost

6.4.6 Due to Option A2 being a relatively untested technique and given that the feasibility from a track access and construction risk is Highly Unsupported, Whole Life Cycle (WLC) costs have not been ascertained. But given the works involve a 4 week rail closure (and the significant track access costs associated with that) and significant highway realignment works the initial capital costs would be expected to be greater that Option A1 and with the unknown ongoing maintenance costs it is expected to have one of the highest Whole Life Cycle (WLC) costs of all the Options.

Design/ Engineering Feasibility

6.4.7 Option A2 is technically novel and has never previously been done on a structure of this span carrying an A road over a main commuter railway - previous trial site was a farm access track over a non-operational railway. Following discussions with specialist consultants at Freyssinet (who carried out the trial site operation), their feedback was that it may be possible but would require a minimum of four weeks of railway closure to complete the jacking procedure due to the amount of stitch drilling required.

6.4.8 The lifting of the structure will result in a significant lift of the highway worsening the visibility for road users. Currently the highway visibility criteria for white lining is compromised such that solid white lining is in place. Any changes/white line surveys will need to be agreed with the local authority through the use of F006 (Highway Authority Agreement for Bridgeworks). The realignment of the new highway will also require design consideration for accommodating the adjacent landowners for their access/use. The resulting impact on the highway levels would require the road re-alignment over circa 300m including two junction accesses and approach earthworks, strengthening/heightening of approach retaining wall on the south east corner of the bridge and drainage works on the south side. For these reasons this option is graded Highly Unsupportive.

Construction

6.4.9 Option A2 has be graded as Highly Unsupportive as the construction risks are high and disruptive in event of a failure of the operation. Bridge jacking a masonry arch of this span carrying an A Class road over an operational railway has not been completed before and presents a very high risk option with potentially critical failures including collapse of the structure leading to loss of historic fabric and prolonged closure of the railway.

6.4.10 Jacking up the structure will have an associated impact on the highway alignment. Some reduction of the 650mm may be possible by reducing the fill on top of the structure, or by agreement of sub functional electrical clearances. There are adjacent junctions on either side of the structure which would require realignment due to the rise in carriageway level and adjacent retaining wall on the south east corner that would require strengthening/extending. The highway closure required for these works would have a significant impact on the local community.

6.4.11 The existing gas main, BT services and water main situated beneath the footpaths will also need to be temporarily diverted prior to the bridge jacking operation. The services could be diverted to a temporary pedestrian and services bridge during the jacking works.

6.4.12 There is currently very limited data to support the long term performance of the method with historic structures and therefore this option has an associated level of risk attached to it.

Maintenance

6.4.13 There is currently very limited data to support the long term performance of the method with historic structures and therefore this option has an associated level of risk attached to it. For this reason, it has been graded Highly Unsupportive.

Deliverability (timescales)

6.4.14 Option A2 has been graded as Highly Unsupportive as it would require a four week consecutive closure of the railway. This would cause significant disruptive access to the Leeds-York and Hull commuter corridor, impacting all services between Leeds and York and Leeds and Selby/Hull with no readily available diversionary route for the stopping services to Crossgates. This significant access that would be required to undertake these works is not currently available within the existing programme or likely to be able to be negotiated with the train operating companies.

6.4.15 The jacking option would also require the existing highway to be closed for an extended duration with diversion routes in place to enable the bridge jacking operation and associated highway realignment works to be carried out.

Feasibility

6.4.16 This option is not feasible due to the length of track closure required which would not be possible with the train operating companies. This closure is required for the physical works to the bridge and does not take account of the high risk of further closure due to a failure of the structure.

6.5 Option B Track Slue

Environment and Consent Risk

6.5.1 Option B (including all sub-options) will retain the Grade II listed bridge and the significance of the listed structure would be sustained and the context, while undergoing minor visual changes, would not be altered from its present context or setting. The bridge parapets will still need raising, resulting in physical changes to the listed fabric.

6.5.2 All track slue options will require significant disruptive track access resulting in temporary closure of public rail transport through the area during works. All options will be accessed from nearby secure compounds which are to be

created temporarily, and access to the site will be via the rail line (or adjoining roads) during closure. Option B would require closure of the road crossing for a longer period than option A. In addition, the track slue cannot be undertaken in stages and will, therefore, require track closure for a prolonged period.

6.5.3 Options B1-B2 will require excavation and will, therefore, generate large volumes of material. Option B1 would generate c. 9000t of spoil for the track works plus c. 3600t of rock break out on the slope cutting. For Options B2-B3 the amounts are slightly lower with c. 7800t of spoil for the track works plus c. 1000t of rock break out on the slope cutting. There is the potential that this material may be utilised in other areas of the Project and thereby reduce the use of primary aggregates, however, due to volumes (and potential unsuitability) this cannot be guaranteed. Option B3 is more favourable, taking place within existing cess and is not expected to require excavation. The extent of rock breakout and restabilising works has the potential to generate instability of embankments due to the removal of base material and increase in relative slope angle. In addition, works are in an area of known mine workings, which would need to be considered in the formation design.

6.5.4 Options B1-B2 involve excavation within the existing cutting, which, due to the requirements for shallow gradients, may involve excavation within areas at High (>3.3% annual) risk of surface water flooding west of the bridge, into which surface water flooding is likely to flow and which may increase the likelihood of flooding in a given year due to the lowering of ground level. While it is expected that suitable drainage will be installed for these options, this will increase the risk of damage to the railway from surface water flooding and increase the risk to operational users. The option is therefore Unsupportive.

<u>Land and Property</u>

6.5.5 Options B3 is graded Neutral in terms of land availability. Temporary acquisition of land would be required during the construction phase, but no permanent land take would be required as all work would extend within Network Rail Land. The option would have no effect on private property including access to private properties and tenants and there would be no loss of community assets. There would be temporary effects on agricultural land including Grade 2 BMV (Best and Most Versatile) land. Standard best practice guidelines would be followed to reinstate agricultural land following construction to the original BMV grade.

6.5.6 Options B1-B2 will require rock breakout and restabilising works which would necessitate the relocation of an access road at the top of the cutting slope. This requires some permanent land take making the option Unsupportive.

6.5.7 There is a PROW which follows along the A656 to the north or the railway line, before turning westwards and running parallel to the railway line approximately 20m to the north of the railway line. A PROW also meets the A656 approximately 175m to the south of the bridge coming from the east. There is the potential that the PROWs would be temporarily diverted during construction. This would be of a longer duration than Option A; however, it would be temporary for the duration of the construction works.

Cost

6.5.8 The WLC's for Options B1-B3 varied between £14.1m and £14.9m, double that of the preferred option A1 and with higher ongoing maintenance costs to maintain sub optimal alignments and clearances. For these reasons this option was graded Highly Unsupportive on cost.

Design/ Engineering Feasibility

6.5.9 Option B1 and B2 are graded Highly Unsupportive due to the extent of slue required (c. 900m) towards an existing steep rock cutting slope on the north west approach to the bridge which would require rock breakout and restabilising works. Option B3 would still require rock cutting of slope to reprofile and stabilise (c. 830m). The works are also in an area of known mine workings which would require significant stabilisation to support the railway. The implementation of the proposed track slues would also impact on the proposed design solution for the OLE through this area, potentially incorporating the OLE mast positions within the rock cutting slope.

6.5.10 The slue solution would require the introduction of two sets of new reverse curves due to the long straight at this location. A slight track lower would also be required on the Down Hull to rectify an existing non-compliance and parapet works would still be required to the structure to upgrade for an electrified railway.

6.5.11 In addition, this option has the potential of preclude future upgrading of the railway to four tracks as additional tracks would fall under the lower geometry of the arch, thus limiting clearance. As a result, Options B1-2 are graded Highly Unsupportive, while B3 is Unsupportive.

Construction

6.5.12 The track slues would extend circa 500m each side of the structure in order to attain the slew at the structure and tie the track geometry back into the existing alignment. As the slue would be towards the north side, the rock cutting would require breaking out and restabilising and the existing track drain on the south side would need to be move along with the track alignment.

The works would also introduce multiple staging of signalling/telecoms to relocate lineside infrastructure and ensure sighting for the two signals within the track slue area is not compromised. The slues would also inflict further constraints to positioning of OLE gantries for electrification. Construction would also take place over a prolonged period, causing closure over long periods. The closure would continue for the duration of construction. For the above reasons Options B1-2 are graded Highly Unsupportive, while B3 is Unsupportive.

Maintenance

6.5.13 Option B (including all sub-options) would result in the management of sub functional/minimal clearances and introduction of two reverse curves on an existing straight alignment. The reduction of clearances will cause additional strain on the OLE resulting in greater wear. Likewise the track curves generate additional forces which create wear on the rail and require continued maintenance of the track geometry. As such,, from a maintenance perspective, these options are graded as Unsupportive.

Deliverability (timescales)

6.5.14 Option B (including all sub-options) would require significant disruptive access for a period that is not currently available within the existing programme. It is also unlikely that it will be negotiable with Train Operating Companies (TOCs) due to the significant effect on train services between Leeds and York and Leeds and Hull/Selby. To undertake the works over a number of shorter disruptive possessions would require excessive multi-disciplinary staging and temporary alignments that would also be unviable economically and from a programme perspective. This option is, therefore, graded Highly Unsupportive on deliverability.

Feasibility

6.5.15 Due to the length of track works required to enable the slue, and the rock break out required this option is not feasible within the constraints of the project. The works would require track closure over a prolonged period which falls outside that possible with the train operating companies. There is also the potential for further delays in the event that historic mine workings are discovered during construction.

6.6 Option C Track Lower

Environment and Consent Risk

6.6.1 Option C (including all sub-options) will retain the Grade II listed bridge. This is deemed to be in accordance with legislative and planning policy considerations. The significance of the listed structure through its retention, would be sustained and the context, while undergoing minor visual changes, would not be altered from its present setting. The parapets will still need raising, resulting in physical changes to the listed fabric.

6.6.2 All track lower options will require significant disruptive track access resulting in temporary closure of public rail transport through the area during works. All options shall be accessed from nearby secure compounds which are to be created temporarily, and access to the site will be via the rail line (or adjoining roads) during closure. Option C would require closure of the road crossing for a longer period than Option B to facilitate abutment pinning. In addition, the track lower cannot be undertaken in stages and will, therefore, require track closure for a prolonged period.

6.6.3 Options C1-C3 will require excavation and will, therefore, generate large volumes of material. For Options C1-C2 this is anticipated to be c. 7000t spoil out, 3800t new material (ballast/sand) in. For Option C3 this is reduced to c. 5700t spoil out, 3800t new material (ballast/sand) in. There is the potential that this material may be utilised in other areas of the Project and thereby reduce the use of primary aggregates, however, due to volumes (and potential unsuitability) this cannot be guaranteed.

6.6.4 Option C involves excavation within the existing cutting, which, due to the requirements for shallow gradients, may involve excavation within areas at High (>3.3% annual) Risk of surface water flooding west of the overbridge, into which surface water flooding is likely to flow and which may increase the likelihood of flooding in a given year due to the lowering of ground level.

6.6.5 Option C will involve excavation as part of the track lower. This will require significant rock breakout and restabilising works due to the underlying geology in this area. Additional stabilisation may also be required due to the presence of historic mine workings. Track lowering is likely to have significant implications for earthwork stability and track drainage. The option is therefore Unsupportive.

Land and Property

6.6.6 Temporary acquisition of land would be required for Option C during the construction phase, but no permanent land take would be required as all work

would extend within Network Rail Land. The option would have no effect on private property including access to private properties and tenants and there would be no loss of community assets. There would be temporary effects on agricultural land including Grade 2 BMV (Best and Most Versatile) land. Standard best practice guidelines would be followed to reinstate agricultural land following construction to the original BMV grade.

6.6.7 There is a PROW which follows along the A656 to the north or the railway line, before turning westwards and running parallel to the railway line approximately 20m to the north of the railway line. A PROW also meets the A656 approximately 175m to the south of the bridge coming from the east. There is the potential that the PROWs would be temporarily diverted during construction. This would be of a longer duration than Option A; however, it would be temporary for the duration of the construction works.

Cost

6.6.8 The WLC's for Options C1-C3 varied between £11.19m and £28m for Option C1 due to the impact on the rock cutting and potential mine remediation works, between 2-4 times that of the preferred option A1 and with higher ongoing maintenance costs to maintain sub optimal alignments and clearances. For these reasons this option was graded Highly Unsupportive from a cost point

Design/ Engineering Feasibility

6.6.9 Option C (including all sub-options) is Highly Unsupportive as the track lower will necessitate significant rock breakout and restabilising works due to the underlying geology in this area, with rock levels found to be at between 450mm and 750mm. The works are also in an area of known mine workings which would require significant stabilisation to support the railway. Track lowering will also have destabilising effect on the abutment foundations and the existing steep rock cutting slopes on the approaches (noting that the Up side cutting slopes west of HUL4/14 already have an Earthworks Hazard Category of D i.e., High Risk). A track lower of this magnitude would likely undermine the Upside abutment foundations due to its close proximity to the Up line (1.7m lateral distance). Therefore, it would be necessary to underpin the abutment foundation by installation of pali radice piles (Refer Figure 3 below) or a similar alternative method. The Downside abutment would be assumed to be unaffected by the proposed track lower as it is some distance away (>9m) from the Down line.

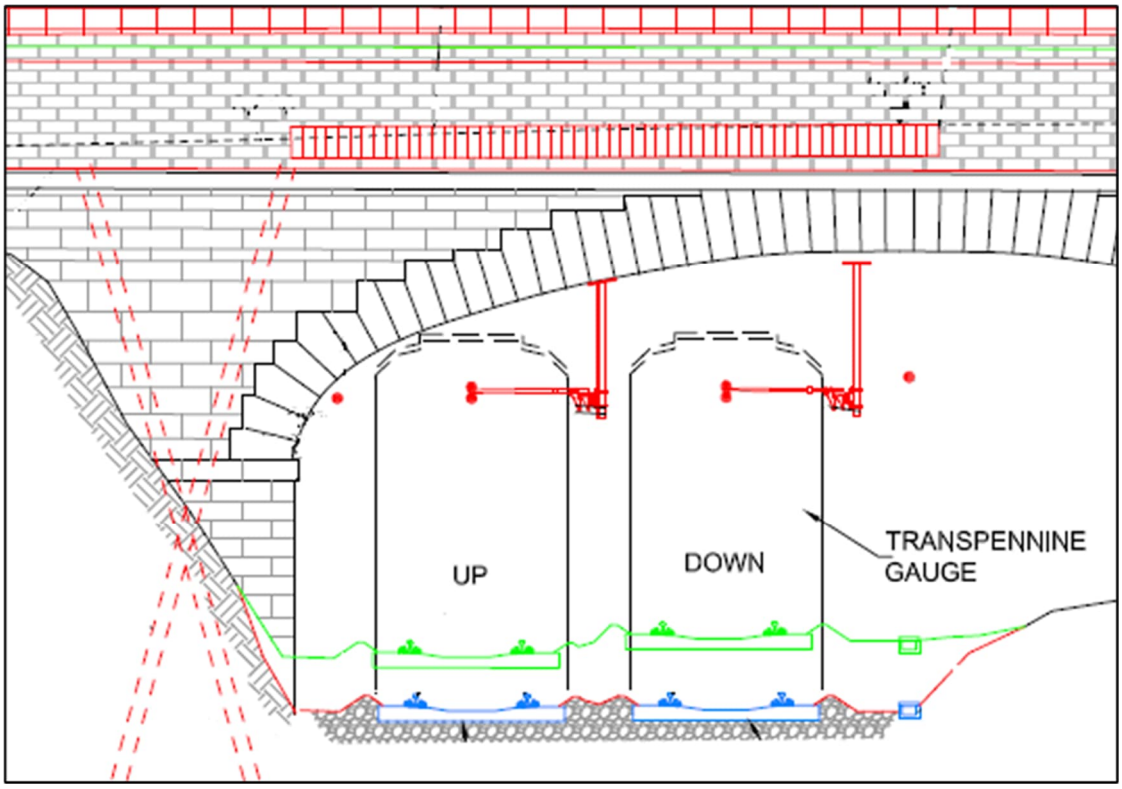

Figure 8 - track lower section – (pali radice piles shown in dashed red line)

6.6.10 In addition to this, extensive works would also be required to the approaches along the cutting. This would be achieved by stabilising the existing cutting slopes with rock bolting, netting or additional retention as appropriate. The extent of the stabilisation would be likely to be in the region of approximately a few hundred metres to the approach/exit of the structure.

6.6.11 Modification works would be required to the existing masonry parapets in order to raise their height to a minimum of 1.8m with the addition of steeple coping (anti-climb measure) for the purpose of protection against electrocution from the proposed OLE system. Since the height of the existing parapets are approximately 1m, the considerable increase in height will require rebuilding them rather than just extending vertically.

Construction

6.6.12 The rock breakout works required within an area of existing mine workings. This carries the risk of instability of the railway should mine working be encountered. It also has the possibility of undermining the structural integrity of the existing bridge. This makes the option Highly Unsupportive. The works required to achieve compliant ballast depth would mean access requirements and risk beyond viability.

Maintenance

6.6.13 Option C (including all sub-options) would result in the management of sub functional/minimal clearances. The reduction of clearances will cause additional strain on the OLE resulting in greater wear. T track lowering would result in a sump within the vertical track alignment requiring additional drainage solution. The option is therefore graded as Unsupportive.

Deliverability (timescales)

6.6.14 Option C (including all sub-options) would require significant disruptive access for a period that is not currently available within the existing programme. The requirements are even greater than those required for Option B and would not be acceptable to the Train Operating Companies (TOCs) due to the significant effect on commuter traffic between Leeds and York, Selby, Hull and misalignment with the "passenger first" directive. To undertake the works over a number of shorter disruptive possessions would require excessive multi-disciplinary staging and temporary alignments that would also be unviable economically and from a programme perspective. This option is, therefore, Highly Unsupportive on deliverability.

Feasibility

6.6.15 Due to the required high risk stabilisation works, this option is not feasible within the constraints of the project. The works would require track closure over a prolonged period which falls outside that possible with the train operating companies. The requirement for rock break-out to achieve the track lower and re-stabilisation of the adjacent cutting slope is a high risk construction activity and considered unviable as an option. There is also the potential for further delays in the event that historic mine workings are discovered during construction.

7. DEVELOPMENT OF PREFERRED OPTION

7.1.1 Taking the above assessment into consideration, the preferred option for the bridge is Option A1 structure intervention. Two main options were considered:

- Deck reconstruction with a flat composite steel/concrete deck
- Full replacement with an arched feature composite deck

7.1.2 The flat deck reconstruction option would involve removal of the existing arch superstructure and replacement with a new flat deck type structure. This would retain the sandstone effect of the original bridge through applied facing; however, it would remove the basket arch feature.

Figure 9 – Standard bridge reconstruction with stone cladding to parapets

7.1.3 Whilst this option would retain the sandstone effect of the structure whilst achieving the necessary reduced construction depth required for the replacement superstructure, an alternative considered is to replace the superstructure with a modern feature bridge. This recognises the historic importance of the Transpennine route and the architectural importance of the individual structures, particularly those designed by Walker and Burges.

7.1.4 A process of design iteration has been undertaken to refine the replacement structure, focussing on the provision of an arch to emulate the historic character of the railway. Two options were considered; one that retained the flat deck, but incorporated an arch above the deck, and a second which recreated the basket arch, but utilised an applied weathered steel structure.

Figure 10 – Bespoke feature arch

Figure 11 – weathered steel arch

7.1.5 It is proposed to take forward the second option incorporating a flat concrete deck arrangement with composite main girders and a slender steel arch

anchored into the rock at both ends. New foundations and new abutments would be constructed to support the new superstructure.

8. CONCLUSIONS

8.1.1 Roman Ridge Road Overbridge (HUL4/14) is a grade II listed structure which forms part of the original Selby to Leeds Railway. It was constructed in the 1830s to the designs of Walker and Burges and incorporates an unusual basket arch form which was designed to accommodate a four track railway. The bridge is one of 12 of its type which survive along the original route, eight of which are listed.

8.1.2 The structure does not meet the clearance requirements for the OLE as part of the proposed electrification of the Transpennine Railway. In order to achieve the benefits of the Transpennine upgrade, the height of the structure needs to be increased. Three options have been considered to achieve the necessary clearance while meeting Network Rail's minimum functional/ operation requirement. These were assessed against the Assessment Matrix. This concluded that the track lower and track slue options are not feasible due to impact on the associated highway, construction risk, programme impact and cost; therefore, bridge intervention is necessary.

8.1.3 Two options were considered, both resulting in changes to the physical fabric. Option A2 bridge jacking was ruled out due to the uncertainties in the process and the risk to both the live railway and highway above. Option A1 is therefore considered to be the only feasible option to deliver the benefits of the project. The option is considered Highly Unsupportive in heritage terms, involving the total loss of the listed structure. Work has been undertaken to compensate in part for this loss through the provision of bespoke structure which integrates features from the historic structure and compliments the group value of the Walker and Burges' bridges.

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APPENDICES

Appendix A Assessment Matrix

Assessment Topic	Assessment sub-topic	Evaluation Criteria	Evaluation Parameters				
			Highly Unsupportive	Unsupportive	Neutral	Supportive	Highly Supportive
Environment, Sustainability and and Consent Risk	Planning Policy/ Consideration	NPPF policy Adopted development plan policies Adopted development plan allocation Emerging development plan policies Emerging development allocation Extant planning applications Policy land allocation (e.g. Green belt) Other relevant local transport or environment policy.	Contrary to NPPF golden thread Inappropriate development in the Green Belt Clearly contrary to adopted development plan policy and allocations Clear land use conflict with extant planning application Clearly contrary to adopted transport or environmental policy	Some elements inconsistent with NPPF policies Partially contrary to adopted and emerging development plan policy and allocations Partial conflict with extant planning application Partially contrary to adopted or emerging transport or environmental policy	Consistent with NPPF policy No relevant adopted or emerging Local Plan policies No extant planning application	Consistent with NPPF policy In accordance with adopted and emerging local plan policies and allocations. Consistent with extant planning application In accordance with to adopted transport or environmental policy	Supported by NPPF policy Proposed development meets and exceeds adopted and emerging local plan policies Proposed development meets and exceeds land allocation requirements Would enhance extant planning application Supports delivery of adopted transport or environmental policy
	Consent Risk	Number & type of primary consents; need for listed building consent; need for appropriate assessment; need for EIA; need for special parliamentary procedures.	Appropriate Assessment required. High risk of primary development consent being refused (e.g. due to multiple likely statutory consultee / local authority / local community objections)	Appropriate Assessment required and outcome expected to be positive. Special parliamentary procedures are triggered (allotments, Common Land, National Trust land), which would significantly extend the programme. However outcome expected to be positive. Medium right risk of primary development consent being refused (e.g. due to likely statutory consultee / local authority / local community objections) Listed building consent unlikely to be supported by Historic England	EIA required. Habitat Regulations Screening Assessment Required. Multiple primary consents required: planning permission, Transport and Works Act Orders (to enable compulsory purchase of land, planning permission and operational authorisation). Listed building consents required. Public Inquiries in some cases anticipated.	EIA Screening required. Habitat Regulations Screening Assessment Required. Majority of works are permitted development; single primary consent required. Planning permissions and listed building consents required. However it is assumed that these would be granted subject to conditions.	EIA not required. Appropriate assessment under the Habitat Regulations not required. Primary development consents granted (i.e. all works are permitted development).
	Landscape/ Townscape and Visual	Visual impact on key receptors. Landscape character effects including on nationally (National Park / AONB) or locally valued landscapes and/or townscapes. TPOs Design quality	Permanent adverse visual effect on long views or multiple receptors (individuals / locations) or protected view Permanent adverse effects on landscape character as a result of the introduction of unsympathetic feature within area of national designation/ high landscape value that cannot be mitigated against. Removal of tree subject to TPO	Permanent adverse visual effect on limited number of near viewpoints Permanent adverse effects on landscape character as a result of the introduction of unsympathetic feature within area of local landscape designation/value and/ or townscape designation/ value. Inappropriate development within local context/ unsympathetic to existing character	Replacement of existing with feature of similar scale and design Minor and negligible changes to existing structure Location within a landscape / townscape able to absorb change Temporary adverse impact from construction works resulting in temporary adverse effects on landscape character and visual amenity	Design sensitive to setting/ context and character No obstacles key view	Introduction of new public space/ access and improvements to existing landscape High quality/ innovative design making positive contribution to context
	Biodiversity	Ecological designations (SSSI, Nature Reserves, Special Area of Conservation, Special Protection Area, Local Wildlife Site, Ramsar) Protected species and/or their habitat Other recognised ecological, biodiversity, nature conservation important receptors (red databook or other notable species)	Works within, or outside, an internationally or nationally designated ecological site resulting in permanent damage to these sites despite mitigation. Irremediable loss of protected and/or irreplaceable habitat. Development likely to have significant adverse effect on protected species.	Works within, or outside, an internationally or nationally designated ecological site requiring significant mitigation to avoid permanent damage. Development within, or outside a locally designated wildlife site likely to cause some harm. Net loss of biodiversity at a scale difficult to offset. Adverse effect on protected and irreplaceable habitat. Adverse effect on protected species.	No net loss of biodiversity. It is anticipated that this would involve mitigation and compensatory measures.	Overall biodiversity gain. Mitigation measures above what is required to mitigate any harm.	Enhancement of designated area of nature conservation and habitat of protected species.
	Cultural Heritage	Internationally designated heritage assets (World Heritage Sites) Nationally designated assets (Areas of Archaeological Importance; Scheduled Monuments; Listed Buildings; Conservation Areas; Registered Parks and Gardens) Non-designated historic structures (archaeological sites, locally listed structures) Opportunities for enhancement of heritage assets	Substantial harm to, or loss of designated heritage assets : Scheduled Monuments, battlefields,listed buildings, registered parks and gardens and World Heritage Sites.	Less than substantial harm to designated heritage assets	Conserves heritage assets in a manner appropriate to their significance. Sustains the significance of heritage assets.	Better reveals the significance of heritage assets. Puts heritage assets to viable uses consistent with their conservation. Secures the future conservation of a heritage asset.	Better reveals the significance of heritage assets. Puts heritage assets to viable uses consistent with their conservation. Secures the future conservation of a heritage asset. Puts heritage assets to viable uses consistent with their conservation. Enhances the significance of heritage assets. Makes a positive contribution to local
	Air Quality	Air Quality Management	Significant anticipated temporary air quality issues associated with construction which cannot be managed using industry standard best practice measures. Permanent anticipated adverse operational air quality effects. Site lies within an AQMA and is in contradiction with relevant local air quality action plan.	Anticipated temporary air quality issues associated with construction which cannot be managed using industry standard best practice measures. Some anticipated adverse operational air quality effects. Site lies within an AQMA and is in temporary contradiction with relevant local air quality action plan measures due to construction.	Anticipated temporary air quality issues associated with construction can be managed using industry standard best practice measures. No additional operational adverse air quality effects. Site lies outside AQMA	Anticipated temporary air quality issues associated with construction can be managed using industry standard best practice measures. Reduced adverse operational air quality effects. Site lies outside AQMA and is aligned with relevant local air quality action plan measures.	Local air quality substantially improved as a result of the development. Site lies outside AQMA and actively supports relevant local air quality action plan measures.
	Noise and Vibration	Noise sensitive receptors (residential properties, community facilities and PRoW) Noise Important Area Tranquil area	Likely to affect a large number of noise sensitive receptors Operational noise increase above Significant Observed Adverse Effect Level (SOAEL). Increase to noise within a designated noise important area. Construction or operational vibration levels likely to result in structural damage to buildings and adverse effect on health and wellbeing of communities. Operational vibration not tolerable for humans.	Likely to affect a moderate number of noise sensitive receptors Operational noise increase above Lowest Observed Adverse Effect Level (LOAEL) but below the SOAEL. Construction vibration levels evaluated to have potential to result in cosmetic damage to buildings or reach intolerable levels for human receptors. Operational vibration is likely to be perceptible by human receptors.	Likely to affect few noise sensitive receptors. Operational noise increase at or approximating to Lowest Observed Adverse Effect Level (LOAEL). Construction sound, noise and vibration effects can be partially mitigated to acceptable levels New operational vibration levels likely to be perceptible to human receptors.	Operational noise increase between Lowest Observed Adverse Effect Level and No Observed Effect Level. Slight reduction in operational noise and vibration levels at noise sensitive receptors compared with that currently experienced.	Construction sound, noise and vibration effects can be effectively mitigated to acceptable levels. Operational noise increase at or below No Observed Effect Level. Moderate or large reduction in operational noise and vibration levels compared with that currently experienced.
	Soils and Geology	Presence of contaminated land Designated area of geological conservation Safeguarded mineral resource	Permanent adverse effects to designated area of international geological conservation Permanent adverse effects to Soils, including loss of mineral resources, directly supporting an EU designated site. Creates contaminated land which cannot be mitigated. Contributes to land instability which cannot be mitigated.	Adverse effects to designated area of national geological conservation. Adverse effects to soils, including loss of mineral resources, directly supporting a nationally designated site. Contributes to land instability which can be mitigated.	Effective use of land, including reusing previously developed land. Minimised harm to geological conservation interests. Where appropriate incorporates extraction of safeguarded mineral deposits prior to development taking place. Makes no contribution to land instability or contributes to land instability which can be mitigated.	Best and most versatile agricultural land, restored to a higher agricultural grade following construction. Protects geological conservation interests. Remediates and mitigates despoiled, degraded, derelict contaminated and unstable land. Avoids safeguarded mineral deposits. Makes no contribution to land instability.	Removal of existing contamination. Reveals and expands knowledge of geological conservation interests. Makes no contribution to land instability.

	Water Environment	Environment Agency Flood zone Surface water groundwater	Development in Flood Zone 3 that occupies flood storage capacity or impacts flow of surface or groundwater - difficult to mitigate. Could enable pollution pathways that enable migration of contamination from a site. Groundwater source protection zone 1 Large adverse effect on a sensitive water body that cannot be mitigated. Sustainable water management measures cannot readily be incorporated into the design.	Development in Flood Zone 2/3 that occupies flood storage capacity or affects flow of surface or groundwater acceptable mitigation solution proposed. Groundwater source protection zone 2 or 3 Limited sustainable water management measures can be incorporated into the design.	Site within flood zone 1 Temporary disruption to water body quality (including practicable and proportionate mitigation). Sustainable water management measures can readily be incorporated into the design.	Design reduces flood risk. Enhances local surface water and groundwater quality. Sustainable water management measures can readily be incorporated into the design.	Design significantly reduces flood risk. Removes interruption to surface and groundwater. Creation of flood storage. Sustainable water management measures can readily be incorporated into the design and will improve existing situation.
	Transport	Transport impacts on the local community through the transport of materials, waste and employees. Impacts on connectivity and accessibility for local community, including severance and impacts on walkers, cyclists & horse riders.	Safe and suitable access to construction sites is unavailable and cannot be created. Removed accessibility of public transport. Permanent adverse impact on strategic and sustainable transport networks including impact on non-motorised users.	Safe and suitable access to construction sites is unavailable and cannot be created without adverse impacts. Reduced accessibility of public transport. Impact on strategic and sustainable transport networks including impact on non-motorised users.	Safe and suitable access to construction sites is available or can be created temporarily. Temporary impact on accessibility of public transport. Temporary impact on local transport networks including non-motorised paths.	Safe and suitable access to construction sites is available. Maintains existing accessibility of public transport. Maintains existing local transport networks including non-motorised paths.	Utilises opportunities to transfer significant construction related traffic onto sustainable transport modes. Improves accessibility of public transport. Utilises opportunities to promote walking cycling and public transport.
	Resource Management	Waste generation Use of primary materials	Scheme is likely to result in a very large effect in relation to the generation of waste which cannot be reused or recycled; or the substantial use of primary aggregates and materials.	Scheme is likely to result in a large effect in relation to the generation of waste which cannot be reused or recycled; or the use of primary aggregates and materials.	Scheme is likely to result in a near neutral effect in relation to the generation of waste which cannot be reused or recycled; or the use of primary aggregates and materials.	Scheme is likely to result in a positive effect in relation to the minimal generation of waste which cannot be reused or recycled; or the minimal use of primary aggregates and materials. It supports the reuse of renewable resources; uses recycled materials; incorporates recovery, recycling and reuse of materials generated during construction; and energy recovery.	Scheme is likely to result in a positive effect in relation to the minimal generation of waste which cannot be reused or recycled; and maximises use of secondary and recycled materials. Utilises and/contributes to renewable energy systems (district heating systems etc).
	Weather Resilience & Climate Change	Route Weather Resilience & Climate Change Adaptation (WRCCA) Plan high and medium priority impact areas.	The medium and high impacts are not avoided or expected to be mitigated.	High impacts are not avoided or expected to be mitigated.	All medium and high impacts can be either avoided or addressed through mitigation.	All of the avoidable high impact are avoided.	All of the avoidable medium and high impacts are avoided.
	Carbon	Qualitative assessment	Scheme is likely to result in a very large impact in terms of embodied and lifetime carbon emissions.	Scheme is likely to result in a large impact in terms of embodied and lifetime carbon emissions.	Scheme is likely to result in a moderate impact in terms of embodied and lifetime carbon emissions.	Scheme is likely to result in a small impact in terms of embodied and lifetime carbon emissions.	Scheme is likely to result in a neutral or negative impact in terms of embodied and lifetime carbon emissions.
Land & Property	Land availability Third party assets	Land Acquisition requirements Effect on utilities and statutory undertakers	Permanent acquisition of third party land required - sensitive occupiers: residential property; community assets; businesses; land subject to special parliamentary measures (common land, allotments, National Trust) etc.	Permanent acquisition of third party land required - no sensitive occupiers. Temporary acquisition of land / rights - known obstructive landowners. Adverse effect on utilities and statutory undertakers (assets)	No permanent acquisition of third party land required. Requires permanent acquisition of third party air rights. No adverse effect on utilities and statutory undertakers (assets)	No permanent acquisition of third party land required. No third party air rights required.	No permanent or temporary third party land requirements.
	Land use and accessibility, including: - private property & access - community land & assets - agricultural land	Effects on private property & tenants Effects on community land assets including local green infrastructure and open space Effects on development land and business Effects on agricultural land holdings	Permanent significant adverse effect on private property or tenants and/ or access to private property Permanent loss of access to community land assets including local green infrastructure and open space and/ or access to them. Likely significant adverse effect on businesses Permanent loss of agricultural land holdings including permanent loss of best and most versatile agricultural land (Grade 1,2,3a) and/ or access to it.	Permanent adverse effects on private property or tenants and/or access to private property Adverse effects on community land assets including green infrastructure and open space and/ or access to them. Moderate impact/ adverse effect on businesses Adverse effects on and/ or access to agricultural land holdings including best and most versatile agricultural land (Grade 1,2,3a).	Temporary loss of access to private property or tenants Temporary loss of community assets including green infrastructure and open space and/ or access to them. No impact on businesses Temporary loss of best and most versatile agricultural land (Grade 1,2,3a) and/or Agricultural Land Classification Grade 4 or 5 - fully restored.	Minimal effect on private property and/ or access to private property or tenants Enhancement of existing community assets including green infrastructure and open space and access to them. Beneficial effect on businesses No permanent loss of best and most versatile agricultural land (Grade 1,2,3a). Minor effects on Agricultural Land Classification Grade 4 or 5.	No effect on private property/ access to private property or tenants. Creation of new community assets including green infrastructure and open space and access to them. Significant beneficial effect on businesses No permanent loss of best and most versatile agricultural land (Grade 1,2,3a). Minor temporary effects on Agricultural Land Classification Grade 4 or 5 due to construction.
	Public Rights of Way (PRoW)	Diversionary Routes - Convenience & suitability (incl. length, maintenance & accessibility) and enjoyment of diversionary route (for existing users)	Diversionary route substantially longer than existing route Long term and costly maintenance of diversionary route required No accessible alternative access proposed Amenity of diversionary route (including views, noise, landscape) significantly reduced compared to existing route Likely significant adverse effect on businesses or other defined user groups of the existing crossing (e.g. horse riders, cyclists)	Diversionary route slightly longer than existing route Long term low cost maintenance of diversionary route required Accessibility of diversionary route is worse than existing route (including level change, quality and evenness of footpath, access for disabled or older people or people with young children) Amenity of diversionary route (including views, noise, landscape) of lower quality than existing route Moderate impact/ adverse effect on businesses or other defined user groups of the existing crossing (e.g. horse riders, cyclists)	Diversionary route of similar length to existing route Short term low cost maintenance of diversionary route required Diversionary route reprovides like for like accessibility (including level change, quality and evenness of footpath, access for disabled or older people or people with young children) Temporary impact on amenity and views of diversionary route No impact on businesses or other defined user groups of the existing crossing (e.g. horse riders, cyclists)	Diversionary route shorter than existing route Diversionary route poses no safety risks and provides enhancement in some areas Diversionary route causes no maintenance issues Diversionary route improves accessibility for some users (including level change, quality and evenness of footpath, access for disabled or older people or people with young children) Some improvement on amenity of diversionary route (including views, noise, landscape) Beneficial effect on businesses or other defined user groups of the existing crossing (e.g. horse riders, cyclists)	Diversionary route significantly shorter than existing route Diversionary route safer than existing route Diversionary route is maintenance free / improves maintenance issues Diversionary route provides improved accessibility for all users / the public (including level change, quality and evenness of footpath, access for disabled or older people or people with young children) Amenity of diversionary route (including views, noise, landscape) is of significantly higher quality than existing route Significant beneficial effect on businesses or other defined user groups of the existing crossing (e.g. horse riders, cyclists)
	Safety	Safety for all users	Introduces significantly less safe route across railway line than existing route. Increases need for pedestrians and other non-motorised users to use road network	Diversionary route poses greater safety risk than existing route. Increases need for pedestrians and other non-motorised users to use road network, but appropriate pavement/ cycleway is provided	Diversionary route causes temporary safety risk Leads to temporary increases need for pedestrians and other non-motorised users to use road network, but appropriate pavement/ cycleway is provided	Diversionary route poses no safety risks and provides enhancement in some areas Reduces need for pedestrians and other non-motorised users to use road network compared to existing route	Diversionary route safer than existing route Provides enhanced route four pedestrian and other non-motorised users
Cost**	Whole Life Cycle Costs	Capital construction costs Maintenance costs	High Capital and high maintenance Cost	High Capital and neutral maintenance cost	Medium Capital and neutral maintenance cost	Low Capital and neutral maintenance cost	Low capital and low maintenance cost
Design / engineering feasibility**	Key design constraints, e.g. maintenance and public safety; wire height affecting height of any bridge solution.	Extent of temp works needed Procurement lead times Fabrication complexity	High design Complexity	Medium design Complexity	Standard design Complexity	Low design Complexity	Retain /Modify Asset
Construction**	Buildability, including site access.	Extent of site constraints to be managed Extent of temp works needed Procurement lead times Fabrication complexity	High build complexity/Challenging site constraints	Medium build complexity/Challenging site constraints	Standard build complexity/Manageable site constraints	Low build complexity/Manageable site constraints	Low build complexity/No site constraints
Maintenance**	Maintenance Regime	Meets Transversal Requirements Impact on Maintenance budget Maintenance staff exposure to lineside risks	High Ongoing Maintenance Burden	Medium Ongoing Maintenance Burden	Standard Ongoing Maintenance Burden	Standard Ongoing Maintenance Burden	Low Ongoing Maintenance Burden
Deliverability (timescale)	Meets Programme Requirements	Access Availability Alignment with multi-disciplinary programmes Programme Deconfliction	Impacts proposed commissioning dates	Causes delay to programme timescales	Meets programme timescales	Improves programme timescales for asset delivery	Enables Early commissioning/Benefits