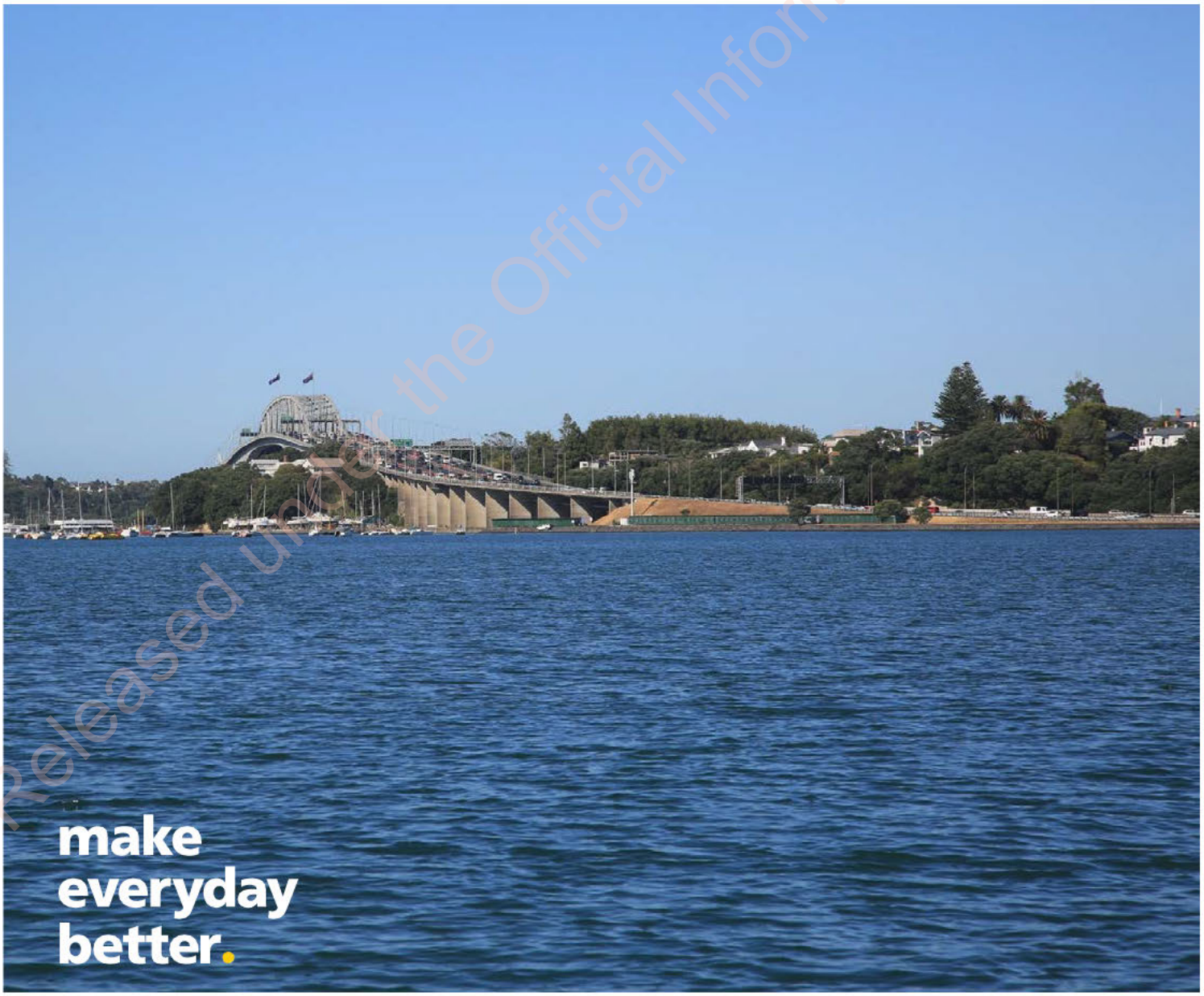
Northern Pathway Westhaven to Akoranga Option Development Summary

Prepared for Waka Kotahi, NZ Transport Agency

Prepared by Beca Limited

6 November 2020



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Contents

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Executive Summary

This report provides a summary of the timeline, investigations, option development and decision-making process for the design for the Auckland Harbour Bridge (AHB) section of the Northern Pathway Westhaven to Akoranga (NPW2A) Project.

In August 2018, the Government announced that an Auckland cross-harbour walking and cycling facility will be fully funded by the Government if a detailed business case confirmed the economics of the project. With Waka Kotahi, NZ Transport Agency (Waka Kotahi) being requested to be the lead agency in the further development and delivery of a cross-harbour walking and cycling link, a single stage business case (SSBC) was developed which sets out the case for investment and a recommended option.

A cross-harbour walking and cycling link aligns with the Government and Auckland Counci s strategic direction for transport. It has been clearly expressed through both the Auckland Transport Alignment Project and the Auckland Plan, and the project is included in both the Auckland Regional Land Transport Plan and the National Land Transport Programme.

Twelve options were considered, including the consented SkyPath option developed by the SkyPath Trust. Through a multi-criteria assessment process and subsequent option refinement, the recommended option was a new 5m wide shared path built alongside the AHB. (NZ Transpo t Agency, 2020). The recommended option included a constraint, based on resource consent and programme risk, whereby no new structures were to be placed in the seabed.

Further work was undertaken to develop the recommended option to a Specimen Design. During the development of the Specimen Design, several risks (both threats and opportunities) were identified for further investigation. The most significant threats were associated with wind vibrational response, seismic performance and geotechnical conditions.

The wind and seismic assessments were able to continue during the COVID-19 lockdown. However, geotechnical investigations and analysis had to be postponed until the Auckland Level 3 lockdown was reduced to Level 2. The resultant analyses indicated lower than expected rock strengths. This, coupled with wind loads on the AHB structure, le to the requirement for additional tie-downs to be placed within the seabed. This is contrary to the constraint placed on the recommended option from the SSBC.

The resource consent process was initiated at the start of the Specimen Design development. One requirement for any new structure in the Coastal Marine Area (CMA) is the need to demonstrate that there is no practicable alternative or that efforts have been made to minimise incursion into the CMA.

The work carried out for the development of the specimen design supports the resource consent process and the need to demonstrate that alternatives (to structures in the seabed) have been considered in detail and discounted only if they are not practicable.

An alternative concept for independent piers was evaluated at an initial concept level for comparison pu poses only during the Specimen Design development. The Northern Pathway Alliance has subsequently investigated this further and is proposing to take this option forward to detail design, consenting and construction. A high-level review of the options promoted by the Northern Pathway Alliance for an independent structure indicates that the Alliance proposals are feasible.

This report compares and contrasts, the Specimen Design and the Alliance proposed design options, thereby providing Waka Kotahi with confidence to take a preferred option through the COVID-19 Recovery (Fast-Track Consenting) Act 2020 process and construction.

The finding of this comparison is that an independent structure will provide less construction risk and more technical certainty than a structure supported by the existing AHB.

1 Introduction

1.1 Purpose

This report is intended to provide a summary of the timeline, investigations, option development and decision-making process for the specimen design for the Auckland Harbour Bridge (AHB) section of the Northern Pathway Westhaven to Akoranga (NPW2A) Project. The report also provides a high-level review carried out by Beca, as Owner Verifier, of the design options proposed by the Northern Pathway Alliance (the Alliance) for the AHB section of NPW2A project.

The purpose of this summary is to compare and contrast, in terms of threats and opportunities, he Specimen Design and the Alliance proposed design options, thereby providing Waka Kotahi, NZ Transport Agency (Waka Kotahi) with confidence to take a preferred option through the Fast Track (COVID) resource consenting process and construction.

1.2 Background

In August 2018, the Government announced that an Auckland cross-harbou walking and cycling facility will be fully funded by the Government if a detailed business case confirmed the economics of the project. With Waka Kotahi, NZ Transport Agency (Waka Kotahi) being requested to be the lead agency in the further development and delivery of a cross-harbour walking and cycling link, a single stage business case (SSBC) was developed which sets out the case for investment along with the economic assessment of a recommended option.

A cross-harbour walking and cycling link aligns with the Government and Auckland Council's strategic direction for transport. It has been clearly expressed through both the Auckland Transport Alignment Project and the Auckland Plan, and the project is included in both the Auckland Regional Land Transport Plan and the National Land Transport Programme.

Twelve options were considered to address the problems and investment objectives, including the consented SkyPath option developed by the SkyPath Trust. Through a multi-criteria assessment process and subsequent option refinement, the recommended option was a new 5m wide shared path built alongside the AHB. (NZ Transport Agency, 2020). The recommended option included a constraint, based on resource consent and programme risk whereby no new structures were to be placed in the seabed.

A summary of the Single Stage Business Case (SSBC) and Specimen Design development is included, outlining key design constraints and criteria for assessment at each of these prior milestone delivery points.

A key objective of the Specimen Design was to develop a concept to support the Northern Pathway from the existing AHB without additional foundations in the seabed. There is a range of complexities associated with new structures in the coastal marine area, particularly from a resource consent perspective. The AHB-supported bridge was the selected option from the multi-criteria analysis (MCA) carried out for the SSBC.

However, it was found from new geotechnical information obtained from recent site investigations that founding rock capacity is significantly lower than had been assumed at the concept stage, and additional means of reducing demands on the foundations were required. These additional means included permanent structures in the seabed and several options were considered.

An alternative concept for independent piers was evaluated at an initial concept level for comparison purposes only during the Specimen Design development. The Alliance has subsequently investigated this option further and is now proposing to take this option forward to detail design, consenting and construction.

The Alliance's proposal was presented to the Project Alliance Board (PAB) for endorsement on 19 October 2020.

2 The Concept – Outcomes

The project objectives that were used for assessment purposes during the Specimen Design are those used in the Project Establishment Report (PER). The PER is the basis for the approval of the current funding allocation ($360M). The PER objectives are provided in Section 2.1. below.

Additional objectives have been established for the project to comply with consent requirements as well as to inform the procurement process for the Auckland Harbour Bridge Alliance. These additional objectives were considered as constraints (refer section 2.2 below).

2.1 Project (Establishment Report) Objectives

The objectives of this project, as defined in the NZ Upgrade Programme Establishment Report are to:

- Increase the number of those walking and cycling to work across the Auckland Harbour Bridge from 0% - 3% of daily trips by 2028
- Increase the number of daily walking and cycling recreation and tourism trips across the Auckland Harbour Bridge from 0 to 2,500
- Increase the total number of walking and cycling trips between Esmonde Road and the Auckland Harbour Bridge to 1,500 by 2046
- Improve transport system capacity
- Improve access to community assets and the natural and built environment
- Increase the number of households with access to the natural environment and community assets between Esmonde Road and the Auckland Harbour Bridg by walking and cycling.

2.2 Constraints

2.2.1 Consenting Objectives

- To construct, operate and maintain a direct, and continuous shared walking and cycling path, separated from the roadway, that:
- Enables active transport choices and modes between the Westhaven Drive/Curran Street intersection and Akoranga, using the existing Auckland Harbour Bridge to cross the Waitematā Harbour.
- Enables a safe, accessible and efficient user experience for a wide range of users.
- Connects with existing and planned local and strategic transport networks.

2.2.2 Procurement Objectives

- Provide a new, world-class, walking and cycling facility across the Waitemata Harbour to complete a critical missing link to the wider Auckland walking and cycling network
- Connect seamlessly to the proposed Northern Pathway Westhaven to Akoranga (land component) section
- Working with our project partners, key stakeholders and neighbours to design and construct an innovative new facility that recognises the social, cultural and environmental values in which it is located
- Leverage this contract to achieve broader outcomes i.e. social, economic and environmental benefits (Broader Outcomes) that go beyond the immediate aim of purchasing goods, services and capital works

3 Timeline

The AHB portion of the project forms part of a wider continuous shared path project linking Westhaven to Akoranga Road and Esmonde Road, Takapuna. In August 2018, the Government announced that cross-harbour walking and cycling will be fully funded by the Government if a detailed business case confirmed the economics of the project. The funding is part of a $390 million package of investment in walking and cycling projects around the country over the three years 2018-2021.

There have been investigations into how to provide shared pathway access over the Auckland Harbour Bridge in 2001, 2006, 2007 and ongoing since 2011, when the SkyPath Trust was formed to advocate and lead the development of a walking and cycling facility. This led to resource consents being granted for SkyPath in 2016.

In parallel, the NZ Transport Agency and partners have been developing the case for investment in the SeaPath, a proposed four-kilometre shared walking and cycling path along the Northern Motorway corridor from the Auckland Harbour Bridge to Esmonde Road, Takapuna.

Auckland is one of the most car-dominated cities in the world – in 2013 around 70 percent of all journeys to work were made by car compared to only 4% by walking and a little under 1% by cycling.

Both Auckland Council and the Government recognise there are many opportunities for walking and cycling to play a more substantial role in improving access and contributing to an effective transport system for Auckland, and in recent years have increased investment into cycling in Auckland from under $20 million a year in 2013 to around $40 million in both 2016 and 2017.

The Auckland Transport Alignment Project 2018 (ATAP) strengthened this commitment by placing greater weight on public transport, walking and cycling to support the realisation of the city's environmental, health and growth outcomes. The resulting ATAP walking and cycling investment package, together with the Auckland Cycle Programme Business case has shaped the next ten years of investment priorities for cycling and walking across the city.

Auckland Regional Land Transport Plan 2018-2028 (RLTP) includes a ten year $685m walking and cycling programme aimed at increasing walking and cycling mode share and reducing deaths and serious injuries among pedestrians and cyclists. The programme includes $60 million per annum (or $600 million over the ten-year programme period) for network development funded by Auckland Transport and the NZ Transport Agency, together with $3.5 million per annum (or $35 million over ten years) on complementary initiatives.

A Single Stage Business Case was prepared August 2019 to January 2020 setting out the investment case, along with the economic assessment of a recommended option and an implementation strategy for the next steps.

In developing the Business Case for the Auckland Harbour Bridge Shared Path, the Transport Agency has used existing relevant analysis prepared for the complementary detailed business case for SeaPath.

While initially intended to be procured as two separate contracts the AHB portion and the SeaPath portions of the Northern Pathway, Westhaven to Akoranga were combined into one procurement process (an Alliance) in June 2020. An interim Project Alliance Agreement was signed with the non-owner participants in September 2020.

On 18 September 2020, severe wind gusts resulted in a truck impacting one of the AHB structural steel members. The resultant repairs and impact on the Auckland transport network highlighted the critical importance of the AHB for the efficient movement of goods and people.

4 Background Information and Data

During the development of the concept design of the AHB-supported structure, some gaps were identified in design information needed to confirm the feasibility of the proposed option. Lateral load effects from wind and seismic loading were found to pose critical design challenges for the structure and its foundations.

Wind loading for the Northern Pathway structure is affected by the adjacent AHB bridges. Wind tunnel testing was carried out to provide data for design.

A Site-Specific Seismic Hazard Assessment (SSSHA) was completed to provide appropriate design loading spectra for the AHB in the Waitemata Harbour location.

The wind and seismic load effects were found to be critical for the existing bridge piers and foundations. Reliable geotechnical data was needed to assess the effects of design loading on the substrata. Geotechnical site investigations were completed to fill gaps in available information on ground conditions and rock strength beneath caisson foundations of the AHB. This required mobilisation of barge-mounted drilling rigs in the harbour to core samples of rock close to the base of the piers in early 2020.

For the AHB-supported structure, a key design constraint is the support of pedestrian loads in combination with existing bridge dead and live loads without overstressing the existing substructures. Dead and live loading on the AHB was derived from previous assessments completed by Beca.

The effects of pedestrian-induced vibrations on long spans were also assessed to address user comfort.

The main outcomes of these investigations and the implications for the Specimen Design of the structures are summarised below. A full description of the derivation of the loads used for the assessment is described in a separate report prepared for the Specimen Design (G.1.2 Structural Design Standards).

4.1 Wind tunnel testing

Wind engineering specialists, MEL consultants carried out testing of scaled sectional models of the bridge decks in Spans 2 and 4 in a wind tunnel in Melbourne in early 2020. Data from the testing was used to derive the wind loading to be applied to the Northern Pathway bridge. Previous wind load assessments by Beca were used to derive the design wind loading applied to the AHB truss and extension bridge structures.

4.1.1 Wind vibrational response

During wind tunnel testing a vibrational response issue was identified for the Northern Pathway bridge which showed significant vertical excitation under a range of wind speeds. Testing showed large amplitude oscillations of the deck particularly in the longest span, Span 2, that was assessed to be unacceptable. Options for controlling vibrations aerodynamically were tested and it was concluded that additional damping was required.

An assessment of the feasibility of viscous dampers provided to limit excessive vibrations was carried out by Beca. This showed that viscous damping could be applied to effectively control the vibrational response of the Specimen Design.

4.2 Seismic assessment

The AHB is a critical piece of Auckland's transport infrastructure and a detailed assessment of its resilience to earthquakes is necessary. The addition of the Northern Pathway to the structure led to a detailed analysis of the seismic performance of the bridge.

A new SSSHA was prepared in 2020 to generate the design loading spectra for assessment of the AHB piers.

The overall outcome of the seismic analysis was that the critical piers were found to comply with assessment standards, and it was concluded that ULS wind load effects were more onerous than the seismic case.

4.3 Geotechnical investigations

Original borehole data from the construction of the AHB in the 1950s did not provide sufficient information regarding rock strength at the piers for the detailed analysis of substructure foundations under wind and seismic loading. Therefore, site investigations were carried out in early 2020 to retrieve rock samples from boreholes adjacent to each pier for laboratory testing. The laboratory testing was completed in May after the nationwide COVID-19 Level 4 and 3 lockdown periods. This provided the data necessary for a detailed computer analysis of the rock stresses when wind and earthquake loading is applied to the bridge

The outcome of the geotechnical investigations was that rock strength was found to be lower than anticipated at the concept design stage, for some piers. Differing ground conditions were d scovered across the critical foundation at Pier 2 and a potential fault was identified on the western side of the AHB.

4.4 Pedestrian and live load design

While wind and seismic loading are critical for the AHB substructures, the combination of dead and live loads was found to be critical for the Northern Pathway superstructure and the connection of the pier brackets to the AHB piers.

Live loads include traffic loading on the AHB and pedestrian loading on the Northern Pathway. Traffic loading was taken from previous assessments and design of strengthening for the AHB truss and box girder structures. This includes bridge-specific assessment live loads derived from data measured from vehicles crossing the bridge to represent AHB traffic lane loading The load combinations for dead and live loads effectively applied the maximum possible traffic loading the AHB superstructures can carry.

Pedestrian loading is derived from design standards for the box girder structure. Standard pedestrian loading intensity depends on the length of the span being designed. The loading applied effectively represents a limit on the number of users of the bridge at any one time. From a safety perspective, it was assessed at a high level that the maximum user numbers calculated from design pedestrian loading could evacuate the bridge safely in an emergency. The number of users will need to be monitored during operation of the bridge.

An assessment of vertical and horizontal vibrations from groups of pedestrians walking in step showed that the Specimen Design complied with the appropriate standards.

5 Option Development

5.1 Design Development Process

This section describes the design development during and up to the Specimen Design.

In the Business Case stage, several options for walking and cycling facilities across the Waitemata Harbour were compared. AHB-supported options and an independent structure option were included in that analysis

5.2 Single Stage Business Case assessment of options

Multi-criteria analysis (MCA) for a walking and cycling facility on the AHB was carried out in 2019 in close collaboration between designers, planners, Waka Kotahi and the business case team. The MCA process assessed several options for supporting the shared path on the AHB together with assessment of a completely independent structure. The assessment criteria were:

i. Alignment with project objectives;
ii. Constructability – covering ease of construction, risks to road users and potential damage to existing infrastructure, potential unforeseen circumstances, design complexity and programme;
iii. The potential requirement for additional AHB strengthening – superstructure and/or piers needing to be strengthened to carry the shared path;
iv. Consentability – likelihood of achieving consents taking into consideration whether SkyPath consent could be used, and the possible significance of adverse effects;
v. Operational impacts – restrictions on the level of service of SH1; and
vi. Impact on harbour use – restrictions on navigation under the bridge.

5.2.2 Shared path supported on AHB, MCA summary

The AHB-supported option was assessed to have negative constructability impacts due to the design and construction complexity associated with the strengthening of the concrete piers and construction of the elevated superstructure from the harbour. It was also assessed that resource consent would be required, but that the existing SkyPath consents could likely be used or altered.

5.2.3 Independent structure on new foundations, MCA summary

Amongst the options considered through the MCA process, an independent structure with additional piers in the harbour was assessed A key negative impact assessed was that new piers in the Waitemata Harbour would require coastal resource consents which would likely be very hard to secure and would not be able to make use of the existing SkyPath consents. The programme risk associated with gaining new consents for work in the Coastal Marine Area (CMA) was deemed to be significant. This option was also assessed to have minor impacts on harbour use due to the piers adjacent to the navigation channel.

5.2 4 Recommended Option

Both options were assessed to be difficult to construct because of the major challenge with constructing the high-level superstructure close to the existing AHB from the harbour. The optioneering and MCA process was reported in the Single Stage Business Case report in November 2019.

The conclusion from the SSBC report stated “a new completely separate structure within the harbour was deemed to have a significant consenting risk when there is a feasible option (Option 10) which could achieve the same objectives with lesser impact” and the option was not preferred. The shared path supported on the AHB piers was taken forward for the business case which was approved by Waka Kotahi in December 2019.

5.3 Structures Option Report and Minimum Standards and Requirements

The development of the Specimen Design of the bridge component of the Northern Pathway following the conclusion of the SSBC is reported in document G.1.1 Structures Options Report. The design basis is reported in G.1.2 Structures Design Standards. The Structures Options Report summarised key design considerations and assessment of options for superstructure and substructure of the AHB section of the project.

The preferred option taken forward from SSBC was the AHB-supported structure. An assessment of the existing piers was carried out to confirm feasibility. Although the feasibility study found that the proposed addition was technically feasible it may expose the existing bridge to the risk of damage by either construction activity or by the addition of significant new loads to the existing substructure while the bridge is open to traffic.

Consequently, the option of an independent bridge supported on new piers in the harbour was also considered. However, this option would not be compliant with the existing resource consent and would require new resource consents for permanent structures in the CMA, which would delay the project and would likely have significant opposition. At that stage, the cost of separate piers was estimated to be slightly higher and it was decided to proceed with the design of the AHB-supported option and to mitigate the risk of damage to the existing piers from new loads through a rigorous design and peer review processes.

5.4 The Alliance Proposed Design

The Alliance carried out further analysis of the Specimen Design along with investigating a series of new options as part of a scope and cost optimisation exercise. The outcomes of these investigations were presented to the interim Project Alliance Board (iPAB) on 19 October 2020 including:

Two options for a structure supported by the AHB

i. Specimen Design
ii. Widening Suspended Truss (not priced - engineering unfeasible); and

Three options for an independent bridge st ucture supported by new piers.

i. Independent Truss
ii. Independent Arch
iii. Independent Box Girder

The Alliance recommended to the iPAB that an independent bridge structure option is taken forward to design, consenting and construction.

The design information presented to the iPAB was at a concept level. We have not had an opportunity to discuss the proposed designs with the Alliance. However, we have carried out a high-level review of the three options, based on the material contained in the iPAB presentation and confirm the concepts are feasible pending detail design and cost estimation.

While the independent structure options present some additional consenting risk, our initial assessment is that an independent structure provides a reduced risk profile during construction and more certainty of engineering design when compared to an AHB supported structure.

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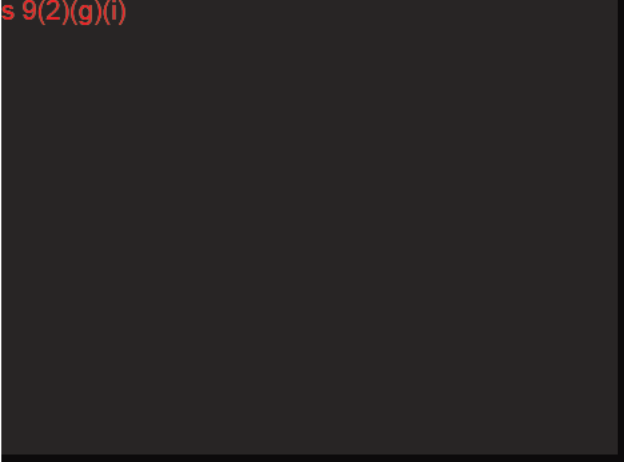

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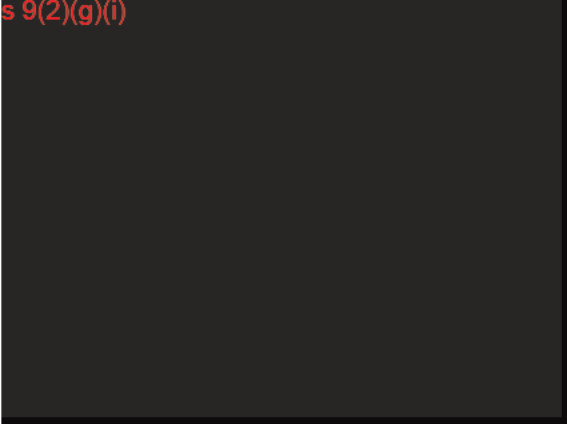

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