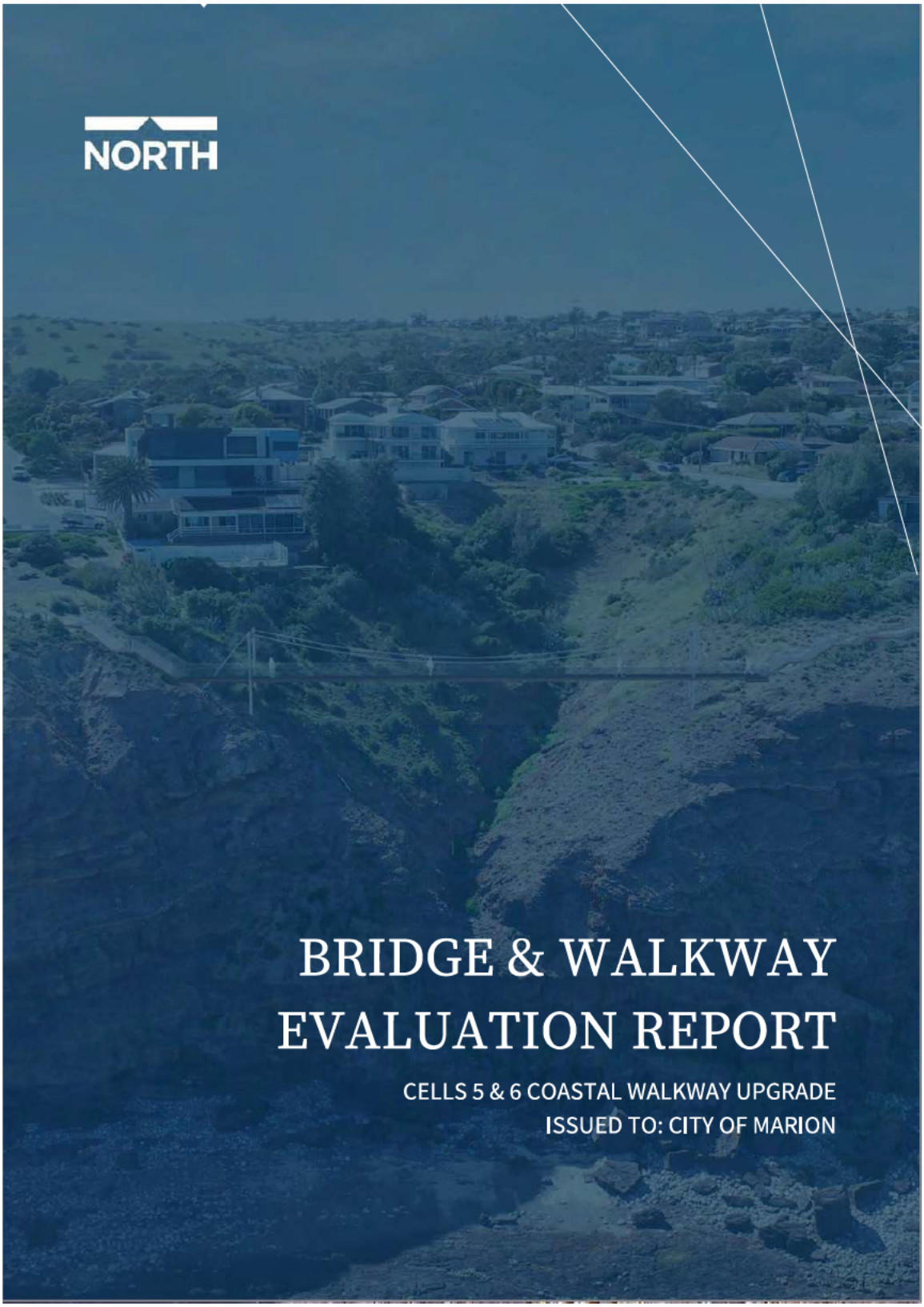

NORTH
BRIDGE & WALKWAY
EVALUATION REPORT
CELLS 5 & 6 COASTAL WALKWAY UPGRADE
ISSUED TO: CITY OF MARION

Table of Contents

1. Executive Summary

City of Marion and the State Government allocated $4.8M to redevelop Cells 5, 6 and 10 of the existing Coastal Boardwalk. The budget did not suffice as founded in early cost consultations and as a result, Council decided to proceed with developing Cell 10 (Heron Way and Field River connection) and then Cells 5 & 6 would be procured through Early Contractor Involvement to have industry specialists and contractors to provide advice to inform design changes that would assist and influence a more feasible and sensible design for construction.

The full extent of the ECI process can be sighted in Appendix A. This procurement method was elected due to the complexity of the project site and the original pricing revised in the early phases of project development. The benefits of the ECI include a more cost-effective final design and less variations during construction. During the ECI process it was tabled that the inclusion of a bridge could be beneficial to the project and elevate a lot of the main concerns and key risks.

In Council exploring the inclusion of bridges to each gully it was suggested that this would minimise the construction risk, project timeframe, environmental impact, project cost and accessibility constraints for the project. The industry specialists informed the evaluation of both structures and Council then investigated both the boardwalk and the bridge based on these key elements.

The bridge was the recommended option from a financial standpoint as it the direct and ongoing whole of life costs are considerably less than the boardwalk option. The bridge structure also has reduced construction risks resulting in less contingency required for the total project cost.

Both structures are comparable in respects to time as expected completion date is similar between the two. Time advantages for the bridge had been nullified by the endorsement process and additional design work required to implement the structure. Provided construction works commence by April 2022 it is anticipated that works will be complete early 2023.

Through this process, the project team identified several accessibility constraints and the implications of these. It was also evident the boardwalk structure would result in a larger environmental impact, as well as a greater amount of safety concerns associated with the construction of the structures. Limited by the inability to get machinery access to the base of the gullies, the majority of the boardwalk would need to be delivered and installed by hand resulting a lengthier project program.

Council was advised on the risks associated with each structure which are summarised in Appendix B and Appendix C. The risk assessments outlined that there was a significantly higher degree of risks associated with the construction of the boardwalk than for the bridge which has the potential to substantially impact time and cost of the project.

Community consultation identified public concerns around the visual and noise impact of the bridge. It was found that all nominated locations of the bridge portals (pillars) are beneath the line of sight for neighbouring residents and that the structures noise and vibration impact would be negligible and considering this the adverse impacts of the bridge are reduced.

With an emphasis on the key project deliverables being noted as a positive in the adoption of the bridge, such as safety in construction, time for completion, accessibility, and budget as well as the additional environmental benefits it was evident through this exercise that the bridge was the favourable structure to achieve a best for Council outcome. This in conjunction with the compared key factor assessments as noted in Section 3 reiterates the superiority of the bridge in lieu of the boardwalk.

2. Introduction

Note all information provided within this report is confidential in nature and is for internal use only.

City of Marion and the State Government have allocated $4.8M to redevelop Cells 5, 6 and 10 of the existing Coastal Boardwalk. The existing walkway is approximately 20 years old and coming to the end of its design life. The intent for the funding and redevelopment was to remove and replicate that of the existing boardwalks, climbing the natural gullies terrain.

Through early cost consultation and concept designs, it was discovered that the allocated $4.8M would not suffice to deliver all the required works as per Council's scope and as detailed within the Concept Designs due to the site complexities with access.

As a result, it was decided that Council would proceed with developing Cell 10 (Heron Way and Field River connection) and issue as a separate tender for commencement in early 2021. Cells 5 & 6 then would then be procured through Early Contractor Involvement to engage industry specialists and contractors to provide expert advice to inform design changes that would assist and influence design detailing and drive a more feasible and sensible design for construction.

Throughout this process, Design Consultants, Cost Consultants and the Council have been informed and educated on the key complexities determining and identifying the constraining elements. The alterations from the original design to the current design, with the adoption of bridges to provide access across both the Gullies can be understood within the assessments as detailed in the below report.

3. Bridge & Boardwalk Evaluation

3.1 Financial Assessment

With costs being the rationale behind undertaking an alternative procurement method, an ECI, it was a key consideration at the basis of each decision and when progressing through each phase. With the project team knowing the current allocated budget did not suffice to construct the original concept design, the intent of design critique in Workshop 1 was to determine areas of opportunity that would decrease final project costs.

In completing cost comparative estimates based off the pricing provided by the contractors within Workshop 1 for the bridge construction, the opportunity was identified to implement a bridge as a more feasible alternative.

The below tables outline the cost per cell for each design concept:

TABLE 1: ORIGINAL CONCEPT BOARDWALK ESTIMATE (LM BREAKDOWN)

	QUANTITY (LM)	RATE (EX GST.)	TOTAL	SUM TOTAL
Cell 5 Grey Road Gully	341	[redacted]	[redacted]	[redacted]
Cell 6 Kurnabinna Gully	351	[redacted]	[redacted]	

TABLE 2: REVISED CONCEPT BRIDGE ESTIMATE (LM BREAKDOWN)

	QUANTITY (LM)	RATE (EX GST.)	TOTAL	SUM TOTAL
Cell 5 Grey Road Gully	330	[redacted]	[redacted]	[redacted]
Cell 6 Kurnabinna Gully	299	[redacted]	[redacted]	

The above figures are reflective of early figures provided by industry specialists for cost per bridge. It does not include future design development of the bridges. The tables above outline the cost per linear meters for each concept design - Table 1 reflecting the total linear meters covered with the installation of a boardwalk and Table 2, the bridge. It highlights the cost benefit in implementing the bridge within Cell 6 showing a reduction in excess of [redacted]per meter.

An addition to the project cost, there is a considerable difference in the costs for risks allowances associated with the construction methodology of each structure. Due to the complexity of the terrain and poor ground conditions, there would be larger sum for contingency required in the construction of the boardwalks due to the reliance of foundations down the steep embankment, potential increases in temporary works to provide access and project duration risks increasing preliminary costs. This is not factored into the above comparative costs and would further increase the price variance between both structures.

Further to the above, in evaluation of each structure, the maintenance, detailed in Section 3.6, and the consideration of the whole of life costs needs to be considers. It was identified that the boardwalk was a more costly option due to its larger footprint, maintenance schedule and accessibility constraints noting that the design life of each structure is equivalent.

Based on the information provided, the bridge is the recommended option from a financial standpoint as it the direct costs are considerably less than the boardwalk option. The bridge structure has reduced construction risks resulting in less contingency required and smaller costs associated with maintenance of the structure throughout it's design life. The below table outlines the overall costs per structure.

TABLE 3: OVERALL COST COMPARISON

	BOARDWALK	BRIDGE
PRELIMINARIES	[redacted]	[redacted]
CELL 5	[redacted]	[redacted]
CELL 6	[redacted]	[redacted]
PROVISIONAL SUM	[redacted]	[redacted]
WOL COST (50 YEARS)	[redacted]	[redacted]
TOTAL	[redacted]	[redacted]

The above table does not encapsulate contingency allowances required within the project budget to accommodate for potential variations that may arise as discussed in Section 3.5 below. It does outline the comparative total costs for construction and whole of life for each structure, solidifying that the bridge is a more feasible alternative.

3.2 Time Assessment

During the Expressions of interest, the contractors provided an indicative timeline for the completion of works to Cell 5 and Cell 6 based off the boardwalk design, this indicated a 12-month period was required to complete both Cells. Upon exploring the bridge option further, the contractors engaged provided a revised program for the construction of each Cell with a bridge which demonstrated a decreased time frame for the total construction period, however a lengthier timeframe was required to allow for bridge design.

Further to the construction timeframe, it is important to note due to the current volatile market constraints associated with procurement of materials with long lead times. Procurement of long lead time items have been allowed for and captured within each program. These would be relevant for both structures. The below table outlines items of concern for each.

TABLE 4: LONG LEAD PROCUREMENT ITEMS

ITEM	LEAD TIME (APPROXIMATE)	STRUCTURE
TIMBER	Up to 3 months	Both
STEEL	3-6 months	Both
FRP	3 months	Both
CABLES	6 months	Bridge

Additionally, within the current project timeframe constraints with a desired completion before the end of 2022 it is unconfirmed if such a large quantity of timber can be acquired in line with the project program. Expected completion date is comparable between the two as any time advantages for the bridge have now been nullified by the endorsement process and additional design work required. Provided construction works commence by April 2022 it is anticipated that works will be complete early 2023.

3.3 Environmental Impact Assessment

[redacted] completed an Environmental report which states recommendation for construction environmental management plans incorporating recommendations for weed and vegetation management and advice from Birdlife Australia to minimise the impact to local bird species. At the time of assessment, in August, it was noted there was only one native species identified and it was not detected as a location for migratory shorebirds, although it is important to note the report also states it was not optimal season to do so.

The notable impact in which the project area might have significant impact to the Lomandra Grassland, approximately 2500 square meters, two species of rare flora, Ptilotus Angustifolius and Myoporum Parvifolium and one fauna, Two Sooty Oystercatchers. The rare flora and fauna were only sighted at Cell 5, although further to this it was noted that there where few bird species inhabiting the mature trees in the general project area. Within Cells 5 and 6 five native vegetation associations where mapped, there are pictured within the gullies and climbing the cliffs edge adjacent to the at grade paths.

Due to the significant impact on the environment due to the complex terrain and susceptibility to inclement weather, it was a key discussion point when detailing the design and methodology for construction. To ensure safety in construction and endeavour to minimise the impact, it was noted that in designing the footings without large machinery for installation would minimise the need for temporary access tracks and significant temporary works.

Further to this, minimising the number of footings and associated disruptions to the ground would more greatly decrease the Council's risk to discovering latent conditions as well as the disturbance to local flora and fauna. The Bridge in comparison to the boardwalk has significantly less impact on the environment with only eight footings and a pile cap instead of the hundreds of footings required to install the boardwalk as well as substantial reductions in the temporary access tracks down the embankments.

Additionally, in the design development as a value management option, it was raised that removing the beach access at Kurnabinna Gully would result in significant cost savings and would minimise risk to the environment and public safety. By preventing the beach access, it removes the risk of entrapment from potential rock fall and associated hazards with tidal sea levels at the bottom of the gully, whilst additionally decreasing the project footprint. This assessment allowed council to land on the preferred position of removal of the beach access, noting that alternative accesses are available 1km to the south and to the west of Kurnabinna gully.

In decreasing the overall footprint within the gullies, it significantly minimises the potential impact to the environment and eases the environmental management obligations of Council and the contractor.

3.4 Accessibility Assessment

The current boardwalk is only accessible to the physically able and is classed as Grade 3 walking trail, alluding to the difficulty of its terrain, and whilst it promotes fitness aspects, it may deter the general public. The inclusion of a bridge in lieu of the boardwalk to the gullies reduces the difficulty of the entire boardwalk stretch by eliminating the need to traverse the gullies and creates a more appealing and inclusive asset for Council to attract the broader community. It would provide further access to portions of the coastal walkway for people of all abilities to enjoy the coastline views safely. Accessibility both during and post construction was a key project objective during the design development phase.

General public safety with the installation of the bridge was a noted risk when exploring the Bridge alternative, specifically the potential of falling / jumping risk due to height of the bridge. Additionally, there were concerns around people's apprehension to use the bridge because of it heights.

Further to the final product being more accessible post construction, the construction of a bridge provides the opportunity for the contractors to expedite the program and minimise the risk with the bridge alignment being positioned at accessible points of the gully. This would mitigate the safety risk in construction with the requirement to traverse the gullies. It was noted in early investigations that it was near impossible to have machinery access within the gullies and that an alternative construction method would be required to install the boardwalk, which would be costly in both time and money. The installation of the bridge eliminated the need to navigate the gullies and also allowed the use of the existing structures to complete demolition in lieu of additional temporary works such as harnesses and scaffolding, which would create further impact on the environment and be timely.

The decision to cut off access to the beach at Cell 6 inhibits local residents ease of access to their local beach and was not positively received by all members of the community in consultation. Although it prohibits this usage the removal of the access allows a safer construction methodology, with notable financial benefits and minimised public safety risks as detailed in section 3.3.

Accessibility factors attributed notably more benefits to implementing the bridge in lieu of the boardwalk. A Bridge is a more accessible both during construction and post construction and will appeal to a broader portion of the public.

3.5 Risk Assessment

In evaluating both the bridge and boardwalk concepts the risks associated where considered from both a cost, time and safety perspective. In completing early cost estimates, the Council where informed on the various risks that attribute to total project cost for each structure. Items such as higher contingencies due to increased risk for latent conditions associated with the boardwalk and additional design costs in order to inform the bridge design.

Due to the location, the construction period will be subjected to severe weather which leaves it susceptible to program delays. In order to mitigate this risk, the industry specialists provided recommendations around the formation of structures and constraints in constructability. In these discussions it was noted that due to the requirement for the boardwalk to climb the steep gully terrains it was more susceptible to longer construction timeframes and unknown issues resulting in latent conditions. It was this rationale that led to the suggestion of removing the beach access at Kurnabinna gully. In preventing the beach access, it mitigated potential rock fall risk to the public and minimised the construction risk by removing further need to traverse the gully with heavy materials and machinery.

Noting the susceptibility of inclement weather, all construction of the boardwalk would be completed off harnesses, leaving the project exposed to the chance of both safety concerns and program delays, resulting in higher contingency allowances and overall project cost. A detailed risk assessment is provided in Appendix C & B summarising the key risks associated with each structure. The risk assessments demonstrate the level of risk associated with each structure and clearly demonstrate that there are far greater risks in proceeding with the Boardwalk Concept Design.

3.6 Maintenance Assessment

Council Report issued in October 2021 noted that the bridge aligned to Coastal Walkway Asset Management Plan 2020 - 2030 which commits to the reduction of asset life cycle costs and improved functionality. The Council Report reflected on a whole of life assessment for both the Boardwalk and the Bridge structures, identifying the total assets cost to Council. This report founded that the bridge has a lifespan of 50-60 years with significantly less maintenance costs resulting in a whole of life cost [redacted]ess than that of the boardwalk.

The following table outlines the high-level maintenance requirements for each structure:

TABLE 5: STRUCTURE MAINTENANCE REQUIREMENTS

MAINTENANCE REQUIREMENT	CABLE BRIDGE	BOARDWALK
GENERAL	Easy access for visual inspection of all components	Hard access to visually assess the condition of the structure
LEVEL 1	Biannual inspections of condition of all components required by Council staff	Biannual inspections of condition of all components required by Council staff
LEVEL 2	5 yearly inspection on main support cables to test requirement for tightening and monitor structural elements by experience consultant	3 yearly inspections on structural elements by experienced consultant

Furthermore, the majority of the boardwalk structure would be constructed with timber decking that within the current market it is difficult to procure. Untreated timber requires more ongoing maintenance and upkeep to ensure its structural integrity remains in tack and splitting is avoided.

It was evident through the whole of life assessment that the longevity of the bridge was more suitable to the harsh conditions of the coastal environment than the boardwalk and aligned with Councils strategic goals more so than the boardwalk.

4. Industry Engagement (ECI Process)

4.1 Overview

North had been initially engaged to assist City of Marion to understand the project costs associated with the construction of Cells 5, 6 and 10. Through this engagement North discovered that the $4.8M budget allocated by Council and the State Government for the project works was an insufficient amount to complete the delivery as per concept drawings and its associated requirements.

North suggested that the City of Marion undertake an Early Contractor Involvement process to work through the project complexities and land at a design that was aesthetically pleasing, more budget friendly and buildable through the employment of selected contractors and expert personnel. The timeline of this process is summarised in Appendix A.

4.2 Benefits

The Early Contractor Involvement (ECI) process is typically utilised on projects that are complex in nature and require specialist input from experienced personnel in order to guide the design to assist in improving the constructability of the project. Due to the specialist nature of the process, an expression of interest was issued to five (5) contractors believed capable of both informing and delivering a complex project based on their previous experience and allocated personnel.

The benefits of an ECI can be summarised below:

- Δ More cost-effective final design
- Δ Less variations during construction
- Δ Great value than alternative procurement models
- Δ Increase in transparency
- Δ Shared project risk

4.3 ECI Process

The ECI Process founded the basis of information required to inform Council's design for Cell 5 and Cell 6 Structures. Due to the complexity of the sites, it was crucial to have consultation from industry specialist via the form of contractors to specify the constructability constraints, such as machinery access, design details to ease constructability and potential alternative methodologies to form the parameters of the design.

BluBuilt and [redacted] were the contractors engaged by City of Marion to partake in the ECI process alongside North Projects, [redacted] and [redacted] All parties during the ECI attended Workshops structured to inform the design development at each stage highlighting the crucial elements driving the project price, program and construction risks. It was within Workshops 1 & 2 the contactors highlighted the extreme difficulty in access within the gullies and inability to get any machinery to the base in order to complete construction of the boardwalks inclusive of foundations and material delivery. The inability to traverse the gullies to construct and install the boardwalk started the discussion around the design teams limitations in detailing the footing structures and that in calculating these they must consider the tools required for installation and the weight of materials proposed. In this workshop it was suggested by the contractors that Council consider the installation of a bridge across the top of the gullies in lieu of the climbing boardwalk to mitigate these risks, provide a more feasible design solution and decrease the construction duration.

After deliberation with the design and cost consultants it was identified that the bridge was a viable option and was proposed within the Council October 2021 report for endorsement. Concurrently [redacted] and Council coordinated drone photos of the gullies in order to complete a render to understand the visual impact of the bridges at each gully. This meant that after endorsement within the October Report Council had images to release for Community consultation.

Based on the feedback provided within the consultation period on concerns around the potential noise, vibration and visual impact of the bridge, further investigations were undertaken to understand implications of the bridge inclusive of a cost estimate. It was founded that the reduced level of the bridge was beneath the line of sight for neighbouring residents and that the structures noise and vibration impact would be negligible and therefore the bridge is a more practical and feasible option.

It was determined through specialist advice that irrespective of cost a bridge was a safer and more beneficial asset to council as demonstrated in the assessments detailed within Section 3 of this report. Therefore, demonstrating a comparable cost and being more favourable in terms of access, environmental and constructability considerations the bridge alternative was incorporated within the design documentation for costing for the contractor's submission of their Gross Maximum Price's.

Further detail for the ECI process and its timeline can be founded in Appendix A.

4.4 Bridge Pros & Cons

As a part of the ECI Process and various workshops when providing a design critique and solution for Council's consideration the contractors identified the key pro's and con's, the table below summarises all pro's and con's for the bridge:

TABLE 6: PRO'S AND CON'S FOR BRIDGE INCLUSION

PROS	CONS
Δ Significantly reduced the amount of foundation works required generally and to the steep embankments when compared to a conventional boardwalk (improved WHS outcomes and minimised risk for Council to incur variations for unknown ground conditions)	Δ General public safety – falling / jumping risk due to heigh of bridge
Δ Reduced construction cost	Δ Larger foundations required to support portals at each entrance
Δ Easier access for maintenance and visual inspection of all components over the life of the structure	Δ Removal of beach access at Cell 6
Δ Utilises more durable materials (i.e.: Stainless Steel throughout with FRP deck) provide improved better outcomes for Councils ongoing maintenance	Δ Community dissatisfaction with bridge alignment and obstruction with property views (note, this has been assessed and aligned below the line of sight)
Δ Fewer materials to procure which would result in cost effective replacement if required and minimise councils risk to delays in procurement and/or rise and fall in current volatile market	Δ Removal of multiple stairs that are currently utilised for fitness training
Δ Improved program timeframes over the conventional boardwalk system and minimised construction risk.	Δ People apprehension to use (afraid of heights, etc)
Δ Potential to be an accessible and iconic landmark tourist attraction	

Δ Removes the risk of flooding and damage to a boardwalk founded at lower levels	
Δ Removes risk of rock slips and falls onto lower-level landings or pedestrians	
Δ Improved pedestrian and emergency services access removing multiple flights of stairs	
Δ Structure for founding footings is reduced (i.e., Deep 10m rock anchors at two locations in lieu of 100 small anchors founded into varying/unknown rock/geotechnical conditions at multiple locations)	
Δ Prevents damage to flora & fauna – potential to revegetate gullies	
Δ The cost of overheads, labour, and temporary structure savings are reduced when compared to boardwalk construction	
Δ Minimises the extent of investigative works required inclusive of time and cost associated with this due reduced footprint	

With an emphasis on the key project deliverables being noted as a positive in the adoption of the bridge, such as safety in construction, time for completion, accessibility, and budget as well as the additional environmental benefits it was evident through this exercise that the bridge was the favourable structure to achieve a best for Council outcome. This in conjunction with the compared key factor assessments as noted in Section 3 reiterates the superiority of the bridge in lieu of the boardwalk.

5. Conclusion

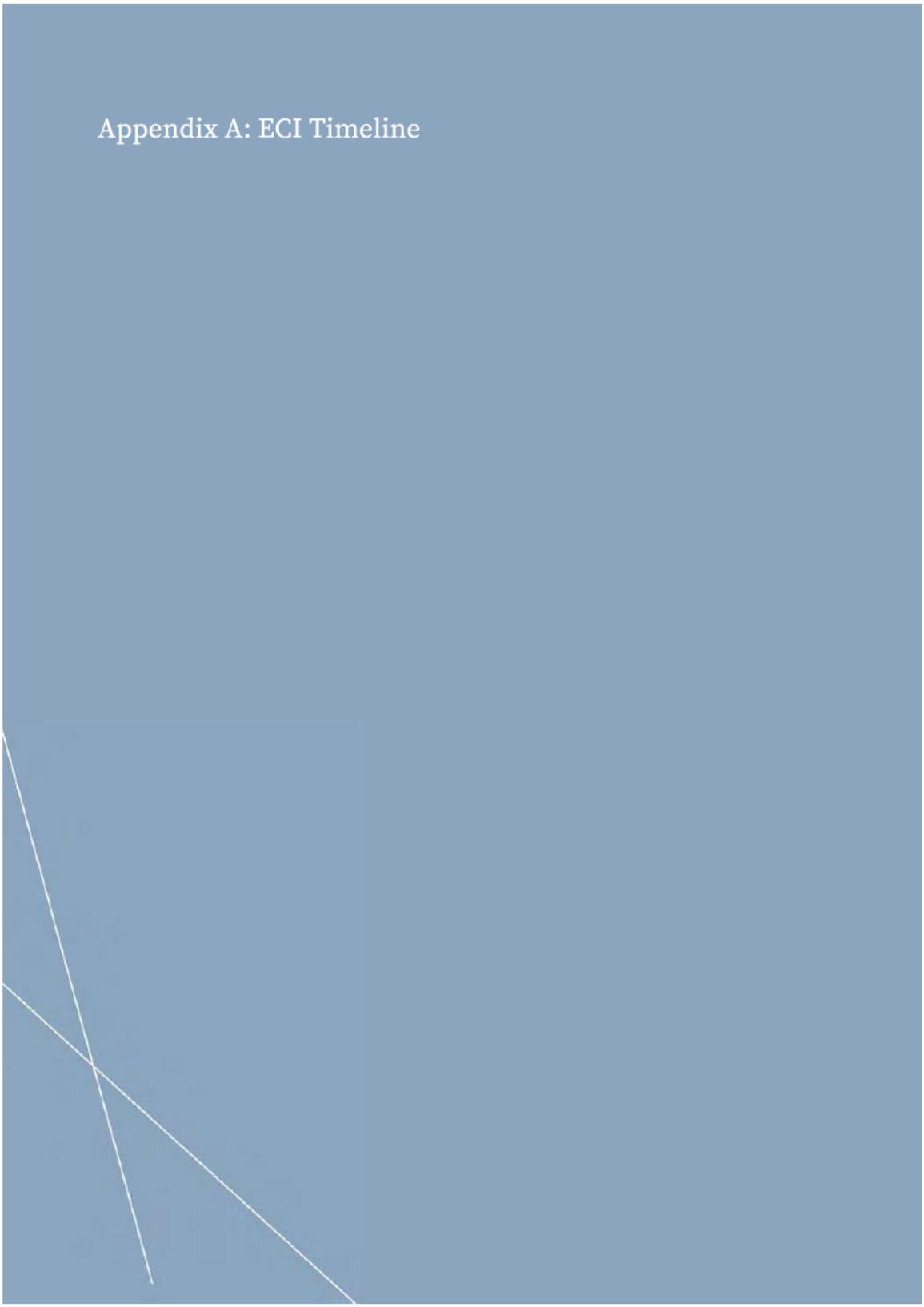
It was evident through the process that the implementation of bridges to each Gully would be a more favourable option for council due to the various factors such as accessibility, minimised environmental impact, reduced construction risks, shorter project program timeframes and minimised whole of life costs as outlined within this report. There is another body of work required within Phase 3 to further minimise the project costs and risk for Council through value management and design adjustments to accommodate access requirements. To assist in motivating the preferred contractor to do this in concluding Phase 2, a letter of intent will be issued to the preferred proponent in lieu of a contract in order to ensure that prior to contract award Council can confirm project funding commitment and enter in a contractual agreement that is more reflective of the final contract price.

6. Document Title

PROJECT REFERENCE

ISSUE	DESCRIPTION OF AMMENDMENT	AUTHOR	CHECKED	APPROVED	DATE
A	Creation	AF	CB	AC	09/02/2022

Previous issues of this document shall be destroyed or marked SUPERSEDED.


Appendix A: ECI Timeline


JULY 2021
1
1. EXPRESSION OF INTEREST - 13/07/2021
City of Marion to assess and select the two best contractors for the project based on their experience, recommendations, and personnel.
2
2. WORKSHOP 1 & 2 - 31/08/2021
Session for both proponents to attend a site walk. Workshop demonstrated the project parameters, design intent, site complexities, and aimed build a collaborative working relationship between the project team.
3
3. WORKSHOP 3 – 07/09/2021
Opportunity for proponents to explain their critiques, and for the design team to provide feedback and suggestions in their inclusions. Discussions from this workshop informed the 70% design.
4
4. NEXT STEPS MEETING – 17/09/2021
CoM directive to North to undertake new cost comparison boardwalk vs Bridge based on figures provided by proponents and concept design at this stage.
5
5. PROJECT TEAM CHECK IN TO DISCUSS PROGRESS – 24/09/2021
Δ Aspect a render for the bridge concept for Council Report and Community Consultation
Δ RFI's 5 & 6 issued for proponents' response
Δ North's comparison costing on revised Schematic Design
6
6. REVISED DRWG PRESENTATION & CONCEPT DISCUSSION – 07/10/2021
Meeting to run through new concept design inclusive of bridges with proponents.
7
7. COUNCIL RECEIVED FORMAL ENDORSEMENT OF BRIDGE DESIGN – 26/10/2021
Council received formal endorsement of new proposed bridge design.
8
8. WORKSHOP 4 – 04/11/2021
Expectations of RFT submissions and the revised 70% design from the architects. Proponents were granted additional time to complete the RFT to enable more accurate pricing. During post meeting discussions, it was evident that the design team had not placed the appropriate level of consideration into the 70% design
9
9. REQUEST FOR TENDER – 15/11/2021
Procurement Documentation completed and submission of Tender documentation from Aspect. Pricing exceeds previous estimates by more than [redacted] Program delays as a result of additional design work required.
10
10. SECOND COUNCIL REPORT – 14/12/2021
Report informing Council on pricing received for GMP's for additional funding consideration.
11
11. NOTIFY PREFERRED PROPONENT – 18/01/2022
BluBuilt were identified as the preferred contractor winning marginally by 0.4. Notification is pending and will be completed by CoM procurement team on the above date.
12
12. NEXT STEPS
Δ 90% Design Development - 19/01/2022
Δ Engagement of Bridge Designer - 01/02/2022
Δ 100% Design Development - 21/02/2022
Δ Final Price - 01/03/2022
Δ Issuing of Council Report - 22/03/2022
Δ Contract Award - 09/03/2022
Δ Construction Commencement -
FEB 2022

Appendix B: Risk Register - Boardwalk

RISK REGISTER

Project: Coastal Walkway Cell 5 & 6 - Boardwalk
Version: V1

ITEM	IDENTIFIED RISK	RISK DESCRIPTION	CURRENT RISK			MITIGATION METHOD & CONTROLS	RESIDUAL RISK		
			LIKELIHOOD	CONSEQUENCE	RATING		LIKELIHOOD	CONSEQUENCE	EXPOSURE
1	Risk of personnel falling during maintenance and inspection post construction	Unsafe access for maintenance personnel to undertake inspections and ongoing maintenance for boardwalk in gullies	4	5	20	Consideration of materials to be adopted - prioritise selection of highly durable, low maintenance materials. Installation of safe access system / static line down gully batters (adjacent structure).	3	5	15
2	Geotechnical Investigation	Geotechnical investigation requires pegs to be placed at multiple points within steep gullies. Significant Cost to project to project for investigations required to inform the 100% design.	5	3	15	Adoption of a bridge structure in lieu of boardwalk, would reduced the need for geotechnical investigations within these steep gullies.	3	2	6
3	Rock Anchor Foundations	Over 100 rock anchors are required to be founded in unstable surfaces within steep gullies for the boardwalk construction. This presents a safety hazard for personnel falling and a significantly high cost.	4	5	20	• Extensive and costly site investigations required to understand complexities of terrain. • Adopting bridge in lieu of boardwalk, would require signicantly less Rock Anchor foundations	2	3	6
4	Boardwalk vertical and horizontal alignment flexibility	Boardwalk requires flexibility in structural design to allow for slight variances in installation location due to the difficulty in founding structures in steep unstable terrain. This is a risk to staging and can result in program delays.	3	4	12	Prioritise horizontal / vertical alignment design at front end of project. Submit proposed alignment as a 'stand alone' design element for approval and sign off from Council to ensure design works / design program can be progressed without delay.	2	3	6
5	Construction access constraints—effect on design outcomes	Safe access within the steep gullies for conventional construction plant and equipment is not possible. This gives rise to the risk of Personnel falling and plant rollover.	3	5	15	• Constructability assessment will be a key factor in defining the final alignment, structural form and materials selection with construction access a key consideration when defining boardwalk type, configuration etc. • A bridge construction within these steep gullies would not require workers to utilise heavy machinery and plant while traversing. • Detailed geotechnical investigation to identify viability of rock anchors using hand-held installation equipment	3	3	9
6	Structure collapse due to gully batter erosion/collapse	The existing gullies have been subject to erosion/slips and will remain so post-construction. Significant erosion could undermine foundations / impact boardwalk structure.	3	5	15	Investigate viability of 50m span bridge spanning both gullies, limiting the extent of boardwalk rock footings to be constructed within the gulley batters.	3	3	9
7	Working at height within Gullies	Personnel falling from heights during construction of boardwalks	3	5	15	Establish fall prevention system, likley involving a static-line system, fixed via rock anchors, and extending down the gully faces. All personnel to wear harness and connect to static line. Option to leave static line in place for maintenance/ inspection personnel 'post-construction'.	2	4	8
8	Plant Rollover	Materials, Plant and Equipment falling/rollover during construction of at-grade paths, steps and boardwalks.	3	5	15	Utilisation of primarily 'tracked' plant, with experienced operators. Construction access to established at commencement of site works - with access widths to reflect planned plant / equipment requirements. Batter/ bench slopes to minimise extent of crossfall and subsequent risk of rollover.	2	5	10
9	Manual Handling with limited opportunity for mechnical assistance	Personnel injuries associated with carrying heavy equipment and materials down steep batters (falling, tripping, back injuries, muscle injuries).	3	5	15	• Identify opportunities to prefabricate boardwalk elements and lift into position using helicopter • Stage boardwalk construction to allow materials to be transported on completed sections (ie:commencing, and completing in sections, boardwalk superstructure construction from the top, working to the bottom) • Adopting bridge in lieu of boardwalk in steep gullies to reduce the need for carrying heavy machinery down the batter	2	4	8
10	Impact on flora and fauna	Damage to existing flora and fauna in steep gullies during construction of boardwalk	4	3	12	• Establish flora protection zones as required to mitigate risk. • Bridge Construction in steep gulies would prevent damage to flora & fauna - potential to revegetate gullies	2	3	6
11	Durability of boardwalk structure	The harsh coastal environment, together with difficult post-construction access makes maintenance and inspection challenging within steep gullies for Council in the future.	4	3	12	Design Basis Report to developed at the 'front-end' of design defining design life, preferred materials and maintenancy strategy	4	2	8
12	Accessibility for emergency services and general public	The multiple steps within the steep gullies make access to the lower levels of the boardwalk difficult, presenting an accessibility and safety issue for emergency services attempting to reach an injured member of public.	3	5	15	Ensure 'barriers for entry' are checked daily along with all pedestrian management controls. Educate the public on what to do in the event of emergency.	2	5	10
13	Safety in Construction (Inclement Weather & Personnel Safety)	Due to the location of the boardwalk and susceptibility of incurring inclement weather, there is a risk to personnel working without harnesses. Strong winds are very likely to impact the works and staff not properly secured have the potential to fall from heights. This will also impact program and cost.	3	5	15	Personnel working at heights to be harnessed at all times regardless of wind level	2	5	10

Appendix C: Risk Register - Bridge

RISK REGISTER

Project: Coastal Walkway Cell 5 & 6 - Bridge
Version: V1

ITEM	IDENTIFIED RISK	RISK DESCRIPTION	CURRENT RISK			MITIGATION METHOD & CONTROLS	RESIDUAL RISK		
			LIKELIHOOD	CONSEQUENCE	RATING		LIKELIHOOD	CONSEQUENCE	EXPOSURE
1	Risk of personnel falling during maintenance and inspection post construction	Maintenance personnel falling from heights during inspections and ongoing maintenance for boardwalk and bridge	2	5	10	The bridges across both gullies create more opportunities for easy to access harness points and minimise the frequency for maintenance staff to traverse steep terrain.	1	5	5
2	Geotechnical Investigation	Geotechnical investigations will need to occur at several points within the gullies resulting in a cost impact to the project.	3	4	12	The adoption of the bridge structure in lieu of boardwalk reduces the number of survey points required within the steep gullies.	2	2	4
3	Rock Anchor Foundations	Rock anchors are required to be founded in unstable surfaces within the gullies for the boardwalk and bridge construction. This presents a safety hazard for personnel falling could result in a higher cost.	2	5	10	• Extensive site investigations required to understand complexities of terrain. • Signicantly less Rock Anchor foundations to the steep embankments are required through adopting bridge in lieu of boardwalk.	2	3	6
4	Working at height	Personnel falling from heights during construction of boardwalks and bridges.	2	5	10	Establish fall prevention system, likley involving a static-line system, fixed via rock anchors, and extending down the gully faces. All personnel to wear harness and connect to static line. Option to leave static line in place for maintenance/ inspection personnel 'post-construction'.	1	4	4
5	Potential for Bridge to bounce under loads	Potential for bridge to 'bounce' under pedestrian traffic loads (including runners)	2	3	6	Engagement of specialist bridge consultant to assist in assessing and minimising bridge load impacts.	2	2	4
6	Potential for Bridge to sway	Potential for bridge to sway / vibrate under wind loads. Risk of people falling off or apprehension to use.	2	3	6	Engagement of bridge engineer to assess vibration and wind load capacity of bridge design to minimise impacts	2	2	4
7	Structure collapse due to gully batter erosion/collapse	The existing gullies have been subject to erosion/slips and will remain so post-construction. Significant erosion could undermine foundations and impact boardwalk and bridge structure.	2	4	8	• Due to the addition of the 50m bridge spanning both gullies, there are limited rock footings in the steep gullies, minimising the impact of gully batter erosion/collapse. • Preliminary load testing completed to inform alignment and ensure that the structure is founded on safe durable ground	2	3	6
8	Manual Handling with limited opportunity for mechnical assistance	Personnel injuries associated with carrying heavy equipment and materials down steep batters (falling, tripping, back injuries, muscle injuries).	2	5	10	• Identify opportunities to prefabricate boardwalk elements and lift into position using helicopter • Stage boardwalk construction to allow materials to be transported on completed sections (recommencing, and completing in sections, boardwalk superstructure construction from the top, working to the bottom) • Adopting bridge in lieu of boardwalk minimises the need for handheld heavy machinery within steep gullies.	2	3	6
9	Impact on flora and fauna	Damage to existing flora and fauna in steep gullies during construction of boardwalk and bridge	2	4	8	• Establish flora protection zones as required to mitigate risk. • Bridge Construction in steep gulies prevents damage to flora & fauna • The footprint compared to the exisitng boardwalk has been reduced providing the opportunity to revegetate gullies	2	3	6
10	Materials, Plant and Equipment falling/rollover	Materials, Plant and Equipment falling/rollover during construction of at-grade paths, steps and boardwalks.	2	4	8	Utilisation of primarily 'tracked' plant, with experienced operators. Construction access to established at commencement of site works - with access widths to reflect planned plant / equipment requirements. Batter/ bench slopes to minimise extent of crossfall and subsequent risk of rollover.	2	3	6
11	Accessibility for emergency services and general public	The multiple steps within the gullies makes access to sections of boardwalk difficult, presenting an accessibility and safety issue for emergency services attempting to reach an injured member of public.	2	5	10	Ensure 'barriers for entry' are checked daily along with all pedestrian management controls. Educate the public on what to do in the event of emergency.	2	4	8
12	Construction access constraints—Personnel Falling and Plant Rollover	Safe access within the steep gullies for conventional construction plant and equipment is not possible. This gives rise to the risk of Personnel falling and plant rollover.	3	5	15	• Constructability assessment will be a key factor in defining the final alignment, structural form and materials selection with construction access a key consideration when defining boardwalk type, configuration etc. • Detailed geotechnical investigation to identify viability of rock anchors using hand-held installation equipment • The bridge works do not require workers to utilise heavy machinery and plant while traversing • The alignment will be adjusted to facilitate where possible.	3	3	9

NORTH PROJECTS PTY LTD

MELBOURNE

LEVEL 3, 160 QUEEN STREET
MELBOURNE VIC 3000
T +61 3 9670 7211

SYDNEY

LEVEL 13, 83 MOUNT STREET
NORTH SYDNEY NSW 2060
T +61 2 8221 6444

PERTH

LEVEL 1, 100 HAVELOCK STREET
PERTH WA 6005
T +61 8 6160 5933

ADELAIDE

LEVEL 6 WEST, 50 GRENFELL STREET
ADELAIDE SA 5000
T +61 8 7078 3788

DARWIN

SUITE 407, LEVEL 4
66 SMITH
DARWIN 0800
T +61 8 7903 0303

NORTH

NORTHPROJECTS.COM.AU