[redacted]

COASTAL WALKWAY CONSTRUCTION - GULLIES
BRIDGE VS BOARDWALK CLARIFICATION

To further clarify City of Marion's (CoM's) queries regarding the final design solutions adopted for the Hallett Cove Coastal Walkway project, BluBuilt provides responses to the following CoM questions:

1. What environmental benefit does the bridge solution have over the replacement of the boardwalk and step?
2. Provide an overview of construction processes, complete with environmental considerations for both the boardwalk and bridge options?
3. Impact of the bridge foundations / anchors on overall stability of the existing cliffs?

OVERVIEW

In providing context as to why a bridge option was originally tabled during the ECI phase, several significant risks and environmental aspects were identified as key factors influencing investigation of bridge option, summarised below.

Risk/ Aspect	Description	Benefit of a Bridge Solution
Existing topography, site access and logistical constraints	Inability to get larger plant to the top of embankment of each gully and on/ down the existing embankments due to the steepness	Localised anchor works limited to upper embankment areas only. Some accessible by larger equipment.
Structure collapse due to batter erosion / collapse –	Extensive erosion is evident and has impacted the structural integrity of existing boardwalk. Likely to be recuring with no means to control overland/ embankment water flow	Limiting the extent, founding deeper and relocating further away from the ocean facing cliffs reduces erosion risk in comparison to the multiple, shallower boardwalk anchors
Personnel safety during construction	Extensive manual handling and construction works at height, requiring implementation of appropriate fall prevention systems.	Extensive works on the embankment face, at multiple locations is eliminated. Fall prevention system installation simplified.
Extensive environmental footprint associated with Concept Design (boardwalk/ stairs)	Construction of new boardwalk requires boardwalk anchor, fall prevention anchors and general personnel access across the entire footprint of the proposed boardwalk.	Works limited to one area on each gully embankment. Boardwalk option potentially increases the risk of embankment erosion.

We provide the following commentary on your queries below.

1. **WHAT ENVIRONMENTAL BENEFIT DOES THE BRIDGE SOLUTION HAVE OVER THE REPLACEMENT OF THE BOARDWALK AND STAIRS?**

Whilst BluBuilt does not profess to be expert in environmental engineering or environmental science, it is experienced in the construction of elements within sensitive environmental areas and has carried these learnings through into the ECI process with CoM and its wider delivery team.

As summarised in the aforementioned overview, the bridge solution was investigated on the basis of the following key environmental principals:

- Reduction of the overall construction footprint across the gully footprints – positive environmental outcome.
- Relocation of works away from the ocean facing cliffs – reducing erosion impacts clearly evident within this zone of the embankment
- Reduction in the number of foundations within the gully embankments, reducing the extent of erosion as a result of overland/ embankment water flow becoming turbulent at the many boardwalk column / embankment interface locations.

Initially, and for the purpose of understanding the commercial viability of an alternate bridge option, a simple negative camber 'swing' bridge option was tabled at a nominal 50m length, with preliminary foundation allowances provided by [redacted]. Ignoring the constructability benefits, this initial bridge solution supported the environmental assumptions noting:

- Cable stay anchors comprised 4 x 10m deep anchor with a small pile cap, all accessible from the upper embankment
- Portal foundations were shallow with a small pile cap only and located within proximity of the cable stay pile caps
- Erection of the bridge structure provides for 'stringing' of the cables and delivery of portal frames using a helicopter, eliminating any construction footprint within the gully

As the design was progressed, it became evident that the following issues impacted the final design solution:

Design Change	Environmental Impact
A positive camber suspension bridge was specified, with spans reduced to 39m and 41m between portals for Grey Rd Gully and Kurnabinna Gully respectively. We understand this was reduced by the Design Team to mitigate visual impact to residents and improved visual amenity.	The portal frame and cable stay foundations are now located further down the gully embankment, marginally increasing the construction footprint within the gully embankment
Suspension bridge introduced an additional set of foundations to support the approach platforms	Additional anchor and pile cap works increase the construction footprint within the gully embankment.
Final bridge loading and geotechnical investigation and design resulted in significant increases to foundation requirements, both in terms of extent of rock anchors and size of pile caps.	Significant increase in earthworks within the existing gully embankments during construction. Visually, this may appear to be a negative environmental outcome, however final solution will be negligible.

2. PROVIDE AN OVERVIEW OF CONSTRUCTION PROCESSES, COMPLETE WITH ENVIRONMENTAL CONSIDERATIONS FOR BOTH THE BOARDWALK AND BRIDGE OPTIONS?

The bridge solution was primarily tabled on the basis of improved constructability and safety-in-design outcomes over the boardwalk and stair solution, noting secondary benefits related to improved environmental outcomes as detailed in commentary no. 1 above.

When assessing the construction processes in a comparative sense, it is important to understand the evolution of the design and the associated impacts on both constructability and environmental outcomes.

Task	Original - 50m bridge	Final Design - 39m & 41m Bridge	Concept Design - Boardwalk and Stairs
Personnel access / Fall Prevention	Installation and testing of temporary rock anchors at the top of the embankment, directly inline with the bridge centreline, allowing personnel to abseil to portal and cable stay location. Minimal abseiling works due to higher portal locations	Identical method to the original bridge proposal, noting majority of works at the portals and cable anchors are required under abseiling conditions.	Installation and testing of multiple temporary rock anchors, both horizontally and vertically with double lanyard fall prevention approach allowing safe connection between anchor points.
Rock anchor drilling	Rock drilling with Marini hydraulic tripod drill supported via cable and winch anchored at the top of the embankment	Identical process, however nearly double the length of anchors required to be installed across an increased vertical and horizontal footprint.	Same rock drilling rig to be utilised. Extensive number of anchor points to be installed at each boardwalk column location, resulting in an extensive number of temporary anchor points required (directly above proposed rock drilling location) to support the rig.
Anchor installation and grouting	Stock length rods manually inserted into the holes and coupled together to achieve design embedment. Grout placed using a grout pump sited on the upper embankment.	Due to the increased number of anchors and difficulty of access, an alternative proposal to utilise strand anchors for the deep embedment anchors and onsite 'Double Corrosion Protection' was proposed and adopted. Nil negative environmental impact but an increase in material and labour efficiencies in the difficult access locations.	Installation of prefabricated rod/ boardwalk connection brackets are installed and grouted in a similar manner to the original bridge solution, noting the anchor depths are minimal.
Cable stay pile caps and portal frame pile caps	Excavation of small pile caps using both mechanical (excavator) and manual (jackhammer) methods. Minimal waste fill that is simply incorporated into the final works. Conventional form, reinforce and concrete placement adopted, with concrete placed via excavator or winched trolley, subject to location.	Excavation of significantly larger pile caps (>10 times larger by volume), requiring mechanical excavation on the embankment. Temporary construction platform to be installed with small excavator lifted into position with a helicopter. More robust winched trolley system to be designed for transportation of waste fill to the top of the embankment.	Not required.

Task	Original - 50m bridge	Final Design - 39m & 41m Bridge	Concept Design - Boardwalk and Stairs
	Minimal environmental footprint.	Environmental footprint increased by Approximately 200% over the original bridge design.	
Bridge construction	Portal frames mobilised and lifted into final position using a helicopter Temporary work platform established at each portal approach, founded on shallow rock anchors Cables 'strung' over the portals and connected to the cable stay anchor blocks Bridge deck support frames landed on the temporary work platforms (helicopter), allowing the frames to be systematically fixed to the cables, working from the portal out Deck and balustrade units landed on temporary work platforms (helicopter), allowing them to be systematically fixed to the cables, working from the portal out	Identical process adopted, noting: • larger portal frames • larger deck support frames • larger cable	Not required
Boardwalk construction			Mobilisation of heavy, long boardwalk components presents a logistical challenge, particularly noting the alignment traverses a varied vertical and horizontal alignment. Manual handling methods would be primarily required (significant WHS risk), with various access 'corridors' required vertically on each gully embankment allowing materials to be winched down to the site. From an environmental perspective, it is likely a large footprint would be occupied to facilitate construction.

3. **IMPACT OF THE BRIDGE FOUNDATIONS / ANCHORS ON OVERALL STABILITY OF THE EXISTING CLIFFS?**

An extensive amount of geotechnical design work has been undertaken by [redacted], with slope/ cliff stability assessment an integral part of the final foundation design solution. [redacted] would be best positioned to provide these assurances accordingly.

Notwithstanding, it is BluBuilt's opinion that the final rock anchor configuration and depths (comprising raked anchors across a larger footprint) would improve the structural integrity of the existing embankments and cliffs particularly noting that rock / soil nailing is the leading engineering solution for cliff and embankment stabilisation works. It is BluBuilt's understanding that the composite design of the rock anchors and concrete footings has a secondary benefit of not only supporting the bridge loads directly from the higher capacity rock substrate but are also designed to reinforce the poor overlying soil layers and reduce the potential for landslip. This is a design element that was not incorporated in the original boardwalk design.

With the question of cliff stability, it is pertinent to understand that the option to construct a new boardwalk requires its alignment to traverse a similar vertical and horizontal alignment to existing. It is clearly evident that significant portions of the new boardwalk will be required to be founded in sections of the embankment / cliff that are located in close proximity to the ocean facing cliffs, and, in sections of the embankment that are clearly disposed to erosion.

The location of the multiple boardwalk columns is thought to produce obstructions across embankment potentially impacting overland/ sheet water flow and increasing erosion impact on the embankment together with increased risk of undermining the foundations, potentially requiring substantial ongoing future maintenance/ repair.

King regards,

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